

**KANSAS GEOLOGICAL SURVEY
OPEN-FILE REPORT 64-4**

Stratigraphy of Labette County, Kansas

by

William L. Jungmann

Disclaimer

The Kansas Geological Survey does not guarantee this document to be free from errors or inaccuracies and disclaims any responsibility or liability for interpretations based on data used in the production of this document or decisions based thereon. This report is intended to make results of research available at the earliest possible date, but is not intended to constitute final or formal publications.

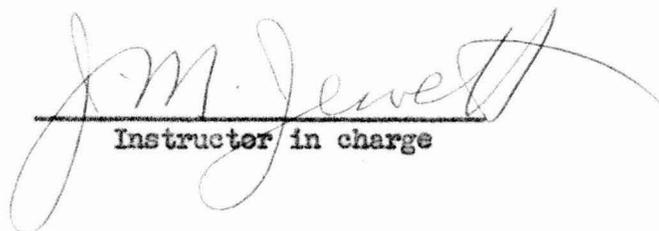
Kansas Geological Survey
1930 Constant Avenue
University of Kansas
Lawrence, KS 66047-3726

STRATIGRAPHY OF LABETTE COUNTY, KANSAS

by

William L. Jungmann
B.S., University of Kansas, 1960

Submitted to the Department of
Geology and the Faculty of the
Graduate School of the University
of Kansas in partial fulfillment
of the requirements for the degree
of Master of Science.


Instructor in charge

May, 1964

For the department

TABLE OF CONTENTS

	Page
ABSTRACT.	1
INTRODUCTION.	2
Purpose and scope of investigation	2
Location and extent of area.	2
Methods of investigation	2
Field studies	2
Laboratory studies.	3
Test-hole numbering system	3
Previous investigations.	4
Acknowledgments.	6
STRATIGRAPHY.	7
Pennsylvanian System-Middle Pennsylvanian Series	7
Desmoinesian Stage.	7
Cherokee Group	7
Cabaniss Formation.	9
Chelsea Sandstone Member	9
Mineral coal bed	9
Verdigris Limestone Member	10
Breezy Hill Limestone Member	16
Excello Shale bed.	16

Marmaton Group.	16
Fort Scott Limestone	16
Blackjack Creek Limestone Member	16
Little Osage Shale Member.	17
Higginsville Limestone Member.	18
Labette Shale	18
Pawnee Limestone.	20
Anna Shale Member.	20
Myrick Station Limestone Member.	21
Mine Creek Shale Member.	23
Laberdie Limestone Member.	23
Bandera Shale	25
Altamont Limestone.	29
Amoret Limestone Member.	29
Lake Neosho Shale Member	30
Worland Limestone Member	33
Nowata Shale.	33
Lenepah Limestone	34
Norfleet Limestone Member.	34
Perry Farm Shale Member.	36
Idenbro Limestone Member	37
Holdenville Shale	39
Pennsylvanian System-Upper Pennsylvanian Series.	40
Missourian Stage.	40
Pleasanton Group	40

	Page
Seminole Formation.	40
Hepler Sandstone Member.	40
South Mound Shale Member	42
Checkerboard Limestone.	44
Lower limestone member	44
Middle shale member.	45
Upper limestone member	45
Tacket Formation.	47
Lower shale member	47
Middle limestone member.	48
Upper shale member	48
Kansas City Group-Bronson Subgroup	48
Hertha Limestone.	48
Critzler Limestone Member	49
Ladore Shale.	49
Swope Limestone	51
Bethany Falls Limestone Member	51
Galesburg Shale	52
Dodds Creek Sandstone Member	54
Dennis Limestone.	55
Canville Limestone Member.	55
Stark Shale Member	55
Winterset Limestone Member	56
Kansas City Group-Linn Subgroup.	56
Cherryvale Shale.	56

	Page
Drum Limestone.	57
Cement City Limestone Member	57
Chamute Shale	58
Neogene System-Pleistocene Series.	60
Lower Pleistocene Subseries	60
Kansan(?) Stage.	60
Upper Pleistocene Subseries	61
Illinoisan Stage	61
Wisconsinan and Recent Stages.	63
STRUCTURAL GEOLOGY.	70
Regional structure	70
Local structure.	70
REFERENCES.	71
APPENDIX I: DESCRIPTIONS OF MEASURED SECTIONS	75
APPENDIX II: LOGS OF TEST HOLES.	109

LIST OF ILLUSTRATIONS

Figure	Page
1. Generalized map of Labette County illustrating test-hole numbering system used in this report	5
2. Index map of Labette County showing locations of correlation charts A-A', B-B', C-C', D-D', and E-E'. . .	8
3. Peel print of thin limestone lying above Mineral coal in SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 33, T. 34 S., R. 21 E..	11
4. Correlation chart of Fort Scott Limestone and adjacent beds.	12
5. Verdigris Limestone at Locality 41 in SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 35, T. 33 S., R. 21 E..	14
6. Peel print of limestone from base of Verdigris Limestone at Locality 41	14
7. Peel print of limestone from base of Verdigris Limestone at Locality 45 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 31, T. 34 S., R. 21 E..	15
8. Correlation chart of Pawnee Limestone and adjacent beds.	19
9. Peel print of limestone at base of Anna Shale at Locality 36, SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 29, T. 33 S., R. 20 E. . . .	22
10. Peel print of limestone at the base of the Myrick Station Limestone at Locality 34 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 3, T. 33 S., R. 20 E.	24

Figure	Page
11. Correlation chart of the Altamont Limestone and adjacent beds.	26
12. Lenticular sandstone near top of Bandera in $SW\frac{1}{4}SW\frac{1}{4}SE\frac{1}{4}$ sec. 36, T. 34 S., R. 18 E..	27
13. Peel print of limestone from middle of Amoret at Locality 43 in $SW\frac{1}{4}SW\frac{1}{4}SE\frac{1}{4}$ sec. 36, T. 34 S., R. 18 E.	31
14. Quarry face of Altamont Limestone at Locality 43 in $SW\frac{1}{4}SW\frac{1}{4}SE\frac{1}{4}$ sec. 36, T. 34 S., R. 18 E..	32
15. Correlation chart of Lenepah Limestone and adjacent beds	35
16. Peel print of limestone from nodular facies of Idenbro Limestone at Locality 9 in $SW\frac{1}{4}SW\frac{1}{4}NW\frac{1}{4}$ sec. 26, T. 31 S., R. 19 E..	38
17. Correlation chart of Hertha Limestone and adjacent beds.	41
18. Peel print of sample from calcareous facies of Hepler Sandstone at Locality 30 in $NW\frac{1}{4}NW\frac{1}{4}SW\frac{1}{4}$ sec. 27, T. 33 S., R. 18 E.	43
19. Peel print of limestone from base of the lower member of the Checkerboard Limestone at Locality 30 in $NW\frac{1}{4}NW\frac{1}{4}SW\frac{1}{4}$ sec. 27, T. 33 S., R. 18 E..	46
20. Peel print of limestone from base of Hertha Limestone at Locality 28, center north line sec. 19, T. 33 S., R. 18 E.	50

Figure	Page
21. Peel print of limestone from base of Bethany Falls Limestone at Locality 4 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 29, T. 31 S., R. 18 E.	53
22. Typical exposure of Drum Limestone at Locality 2 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 18, T. 31 S., R. 18 E..	59
23. Peel print of limestone from middle of Cement City Limestone Member of Drum Limestone at Locality 2 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 18, T. 31 S., R. 18 E..	59
24. Index map with locations of geologic cross-sections showing Pleistocene deposits given in Figures 25, 26, 27, 28, and 29	62
25. Geologic cross section V-V' showing Pleistocene deposits along Neosho River in northeastern Labette County.	64
26. Geologic cross section W-W' showing Pleistocene deposits along Neosho River east of Montana, Labette County	65
27. Geologic cross section X-X' showing Pleistocene deposits along Neosho River east of Oswego, Labette County.	66
28. Geologic cross section Y-Y' showing Pleistocene deposits along Labette Creek north of Chetopa, Labette County	67
29. Geologic cross section Z-Z' showing Pleistocene deposits along Neosho River east of Chetopa, Labette County	68

Plate

1. Areal geology of Labette County, Kansas. (in pocket)

ABSTRACT

Consolidated rocks of Pennsylvanian age exposed in Labette County have an aggregate thickness of about 750 feet and all are sedimentary. The section extends from the Chelsea Sandstone of the Cabaniss Formation at the base to the Chanute Shale at the top.

In general, the sandstones and shales thicken whereas the limestones, especially those of the Kansas City Group, thin from north to south. Southwest of sec. 19, T. 33 S., R. 18 E., the Hertha Limestone is not identifiable in the field. The coral Chaetetes is common in limestones of the Marmaton Group; Chaetetes bioherms comprise much of the Altamont Limestone.

Silt and gravel deposits of Wisconsinan and Recent ages with an average thickness of about 25 feet underlie the flood plain of Neosho River and other stream valleys. Terrace deposits of Illinoisan age occur locally in the valleys of Neosho River, Labette Creek, and Big Hill Creek. Thin deposits of gravel and clay tentatively designated as Kansan in age are found locally on the upland.

The Prairie Plains Monocline imparts a northwest dip of about 25 feet per mile to the Pennsylvanian rocks. Minor departures from the regional dip are seen in the southwest part of the county.

INTRODUCTION

PURPOSE AND SCOPE OF INVESTIGATION

A study of the geology and ground-water resources of Labette County, Kansas, was begun by the author in June, 1962, for the State Geological Survey of Kansas and the United States Geological Survey. This report includes the results of the investigation of the distribution, thickness, and lithology of the outcropping rocks in the county. These data will be published in a slightly modified form, with a discussion of the ground-water resources of Labette County, when hydrologic investigations in the area have been completed.

LOCATION AND EXTENT OF AREA

Labette County is in southeastern Kansas and is bounded on the north by Neosho County, on the east by Cherokee and Crawford counties, on the west by Montgomery County, and on the south by Craig and Nowata counties, Oklahoma. The county contains all or parts of 25 townships and has an area of about 650 square miles.

METHODS OF INVESTIGATION

Field Studies

The geology was mapped in the field during the summer of 1962 and October, 1963, on aerial photographs with a scale of approximately 1:20,000 furnished by the United States Department of Agriculture.

Mapped geologic contacts were transferred to a base map with a scale of 1:62,500 prepared by the Kansas Highway Department. The transferral was made by using a grid system on the photographs and base map. Several dozen stratigraphic sections were measured, and most of these have been included in this report.

Test holes in consolidated sediments in Neosho River valley and other stream valleys were drilled with a truck-mounted power auger owned by the United States Geological Survey. Sample logs were made for each test hole at the drilling site.

After geologic mapping was completed, lithologic samples were taken from selected outcrops.

Laboratory Studies

Samples obtained from the augered test holes were examined in the laboratory with a hand lens to determine if microfossils were present. None were found.

Acetate peels of vertical sections cut through limestone and calcareous sandstone samples were prepared for study and some were reproduced photographically for illustration purposes. All photographic prints of acetate peels used as illustrations in this report are oriented so that the upper surface of the sample shown is toward the top of the page.

TEST-HOLE NUMBERING SYSTEM

The test-hole numbers used in this report give the location of the holes according to the General Land Office surveys. The test-hole number is composed of township, range, and section numbers, followed

by lowercase letters that indicate the subdivision of the section in which the hole is located. The first letter indicates the quarter section, and the second letter denotes the quarter-quarter section, or 40-acre tract. The 160-acre and 40-acre tracts are designated a, b, c, or d in a counterclockwise direction, beginning in the northeast quarter. An example of the numbering system is given in Figure 1.

PREVIOUS INVESTIGATIONS

The stratigraphy of the Pennsylvanian rocks in Labette County and adjacent counties in southeastern Kansas has been studied by many geologists. Haworth (1898) discussed the coal measures of Kansas. Sayre (1930) described the fauna of the Drum Limestone in the state. Moore (1936) presented a classification of the Pennsylvanian rocks in Kansas. Pierce and Courtier (1937) described the coal resources of Crawford, Cherokee, and Labette counties. Jewett (1941) classified the Marmaton Group in southeast Kansas and in 1945 published a description of the stratigraphy of the Marmaton Group. Howe (1956) described the stratigraphy of the Cherokee Group in southeast Kansas. Emery and others (in review) discussed the stratigraphy of the Pleasanton Group in Kansas. O'Connor (in preparation), Jungmann (in review), and Seevers (in preparation) have studied the geology and ground-water resources of Montgomery, Neosho, and Cherokee counties, respectively. Seevers and Jungmann (1963) described Pleistocene deposits in Neosho River valley.

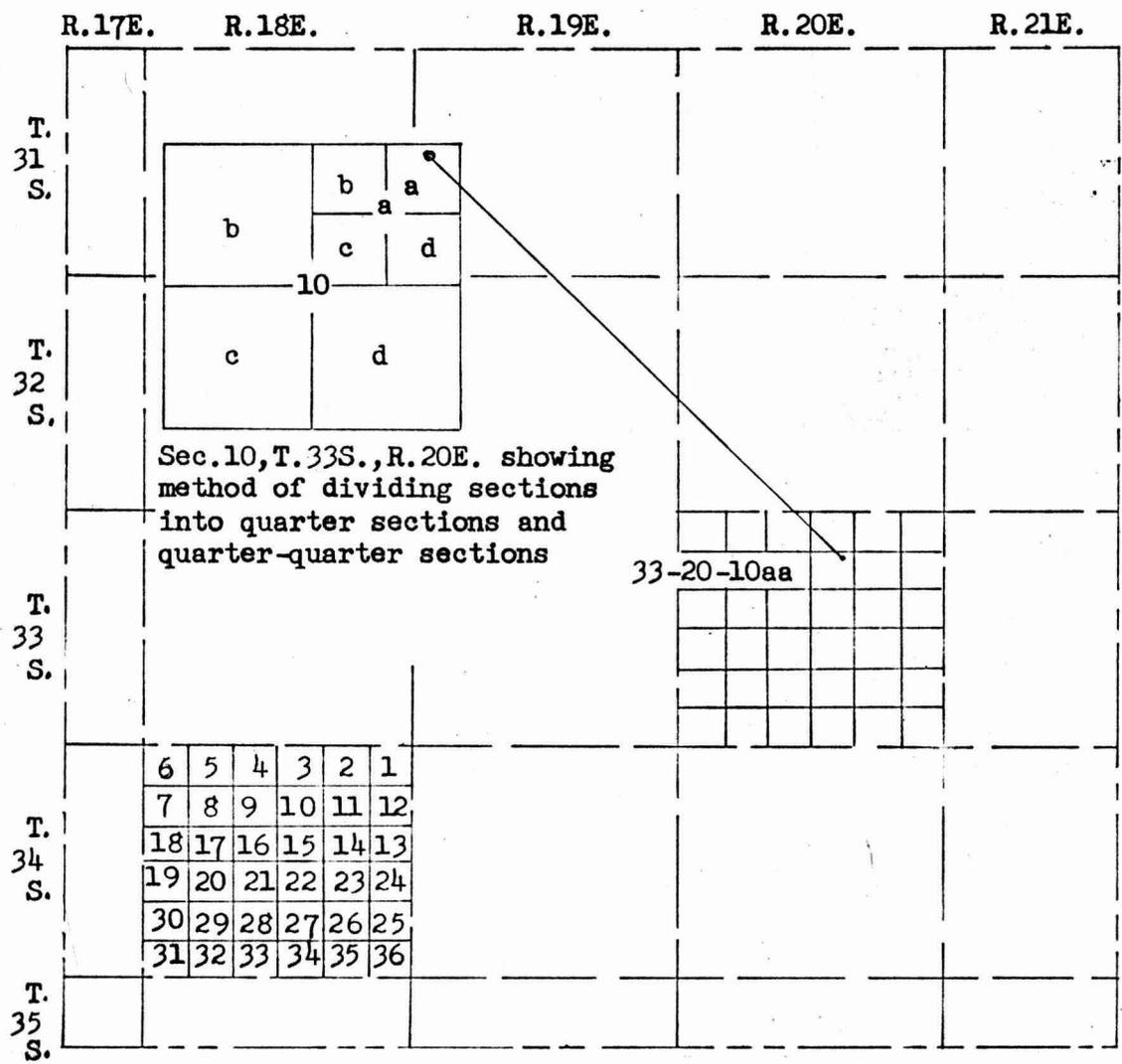


Fig. 1.--Generalized map of Labette County illustrating test-hole numbering system used in this report.

ACKNOWLEDGMENTS

Much thanks is given to Dr. J. M. Jewett for his many suggestions during the field work for and the preparation of this report. Thanks are also extended to Dr. Wakefield Dort, Jr., and Dr. C. W. Pitrat for their helpful suggestions and for critically reviewing this work. Appreciation is extended to members of the Ground-Water Divisions of the Kansas and United States Geological Surveys for their help and support during the writing of this report.

STRATIGRAPHY

The terminology used to describe the bedding of the geologic units in the discussion of the stratigraphy of outcropping rocks is that proposed by McKee and Weir (1953, p. 383) and modified by Ingram (1954). Grain sizes used in the descriptions of sandstones, siltstones, and alluvial deposits are according to the Wentworth Grade Scale as modified by Dunbar and Rodgers (1957, p. 161). The texture of limestones has been described according to an adaptation of the Wentworth Grade Scale proposed by Payne (1942, p. 1706).

Several correlation charts showing bedrock units are given as figures in the text. Figure 2 is an index to the location of measured sections shown in these correlation charts. Correlation lines shown on the charts relate rocks which are considered lateral equivalents of each other. Exact time equivalence of the rocks shown is not necessarily implied.

PENNSYLVANIAN SYSTEM-MIDDLE PENNSYLVANIAN SERIES

Desmoinesian Stage

Cherokee Group

Reconnaissance exploration during field work for this report indicated that a detailed treatment of the complex stratigraphy of the Cherokee Group (Moore, 1949, p. 37, 39) would require more time than

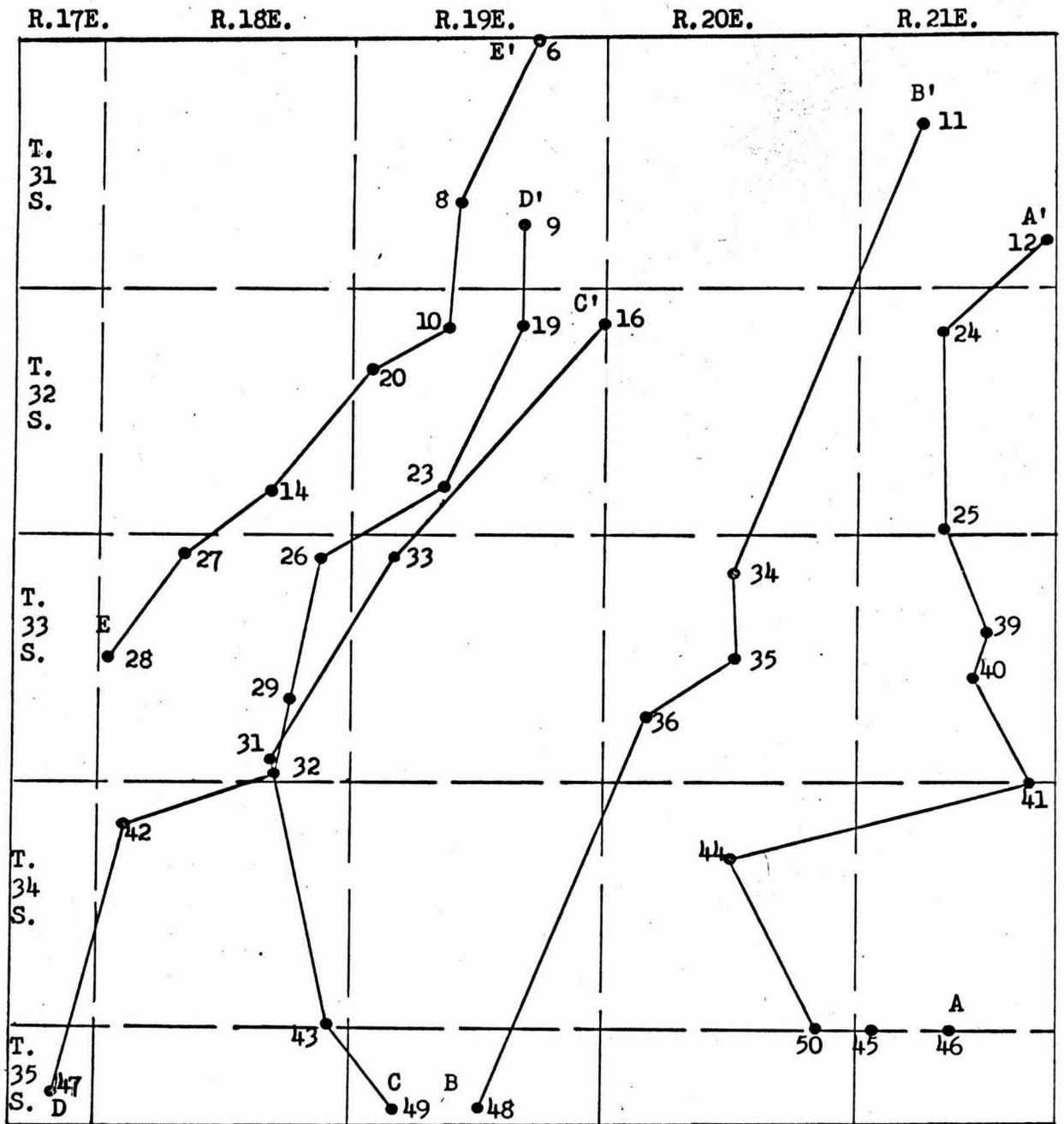


Fig. 2.--Index map of Labette County showing locations of correlation charts A-A' (Fig. 4), B-B' (Fig. 8), C-C' (Fig. 11), D-D' (Fig. 15), and E-E' (Fig. 17). Numbers refer to locations of measured sections.

was allotted for field work for the entire stratigraphic section. Therefore, discussion of the rocks of the Cherokee is limited to those units which are distinctive marker beds and are readily identifiable in the field. Howe (1956, p. 1-132) has published a detailed study of the Cherokee Group of southeastern Kansas.

Cabaniss Formation

Only part of the Cabaniss Formation (Oakes, 1953, p. 1525), the upper major division of the Cherokee Group, crops out in Labette County. A maximum thickness of about 140 feet of the formation is exposed in the southeastern part of the area (P cc on Plate 1).

Chelsea Sandstone Member.--The oldest portion of the Cabaniss exposed in the county consists chiefly of tan, very fine-grained, silty, laminated, quartzose sandstone with yellow clay partings between beds. Locally, lenses of thick-bedded, fine-grained sandstone about 6 feet thick are present. Large scale cross-bedding is common in the lenses. The maximum thickness of the unit, about 30 feet, is exposed in sec. 2, T. 35 S., R. 21 E., on the flanks of the hill at the southern edge of Chetopa. This sandstone is thought to be the Chelsea Sandstone Member (Smith, 1928) of the Cabaniss because of its proximity to the Mineral coal bed which is found about 20 feet above the top of the sandstone at Locality 46 in $SE\frac{1}{2}SW\frac{1}{2}SW\frac{1}{2}$ sec. 33, T. 34 S., R. 21 E.

Mineral coal bed.--At Locality 46, 0.3 foot of bright coal lies above gray underclay containing fossil root impressions and carbonaceous plant remains. Howe (1956, p. 95) in a section measured in $SW\frac{1}{2}NE\frac{1}{2}$ sec. 5, T. 35 S., R. 21 E., described the Mineral coal

(Pierce and Courtier, 1937, p. 69-70) lying below 0.7 foot of dark gray to black limestone. The section at Locality 46 appears to be correlative with Howe's section and thus the coal present is designated Mineral coal. Figure 3 is a peel print of a sample from the base of the overlying limestone. Small brachiopods and abundant algal material are well seen in this print.

The Mineral coal has been extensively mined in open pits in Labette County.

Verdigris Limestone Member.--The next unit above the Mineral coal which can be recognized definitely is the Verdigris Limestone (Smith, in Woodruff and Cooper, 1928). The Verdigris is a distinctive marker bed generally found 50 to 70 feet below the Fort Scott Limestone both on the outcrop (Fig. 4) and in the subsurface.

Two limestone beds, each about 1 foot thick and separated by a gray calcareous shale parting, compose the Verdigris Limestone in Labette County. The Verdigris outcrop shown in Figure 5 is typical of the unit in the area.

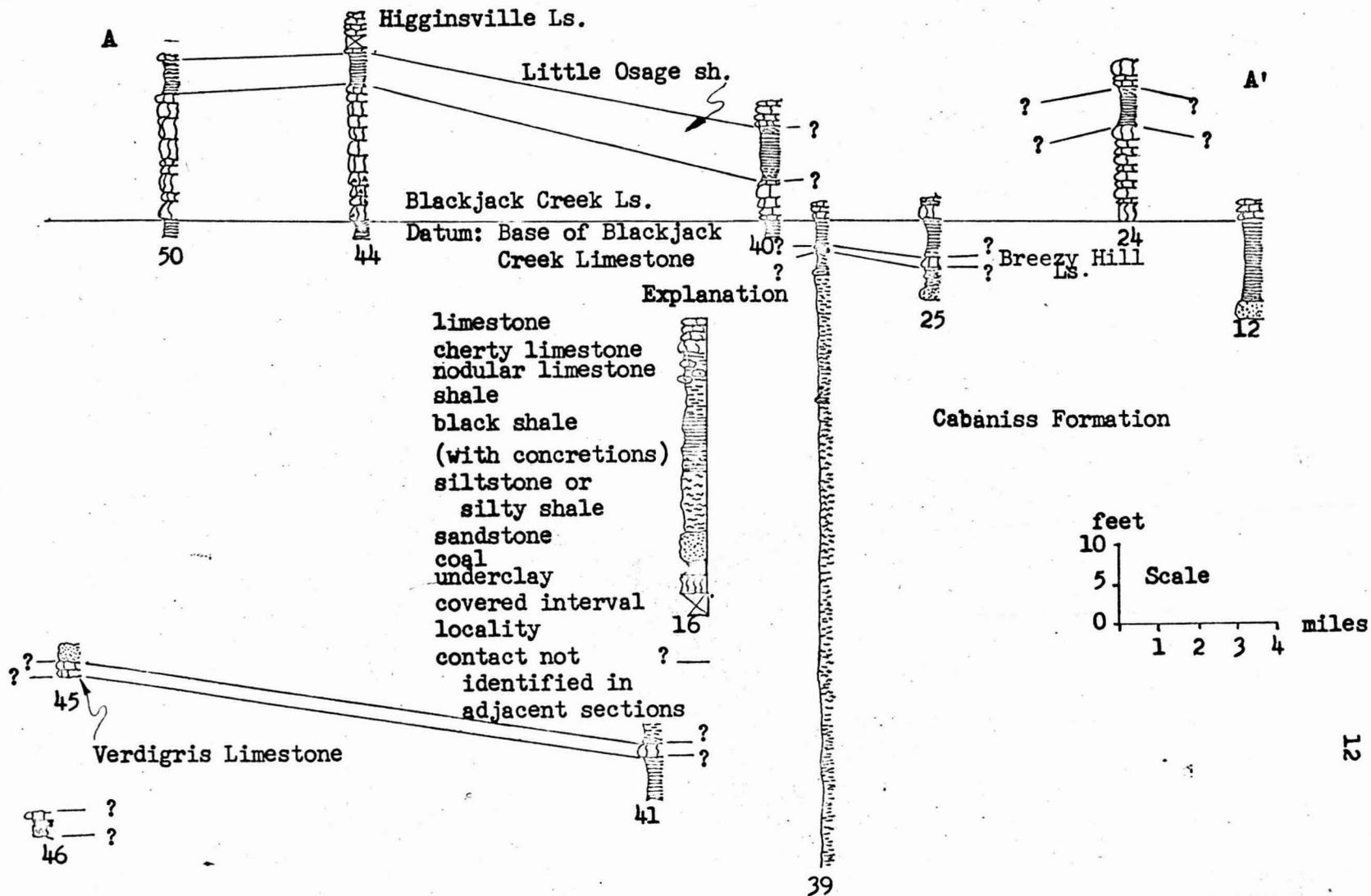
Gray, tan-weathering, very finely-crystalline, medium-bedded limestone is characteristic of the Verdigris in the county. The brachiopod Mesolobus mesolobus is common in the limestone. Figures 6 and 7 are peel prints of limestone from the Verdigris at Localities 41 in $SE\frac{1}{4}SW\frac{1}{4}SW\frac{1}{4}$ sec. 35, T. 33 S., R. 21 E., and 45 in $SW\frac{1}{4}SW\frac{1}{4}SE\frac{1}{4}$ sec. 31, T. 34 S., R. 21 E., respectively. Note the similarity of the two prints.

Rocks of the Cabaniss Formation above the Verdigris Limestone are well exposed only in the vicinity of Oswego in sec. 15, T. 33 S.,



Fig. 3.--Peel print of thin limestone lying above Mineral coal in
SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 33, T. 34 S., R. 21 E. X4

Fig. 4.--Correlation chart of Fort Scott Limestone and adjacent beds.



R. 21 E. In general, the portion of the Cabaniss above the Verdigris consists of about 80 feet of gray to tan, silty shale containing interbedded siltstone laminae and lentils. A zone of tan, blocky shale about 75 feet below the top of the Cabaniss contains many specimens of the pelecypod Pecten pecten. The following section, measured at Locality 39 in $SW\frac{1}{4}SW\frac{1}{4}NW\frac{1}{4}$ sec. 15, T. 33 S., R. 21 E., is typical of the upper part of the Cabaniss:

Locality 39, SW SW NW sec. 15, T. 33 S., R. 21 E.		Thickness, feet
Fort Scott Limestone		
Blackjack Creek Limestone Member		
Limestone, gray, weathers tan, medium-crystalline		2.0
Cabaniss Formation		
Shale, black, platy		3.0
Breezy Hill Limestone Member		
Limestone, buff, silty, nodular		1.7
Unnamed shale		
Shale, grayish-tan, silty		3.0
Siltstone, gray, weathers reddish-brown		1.0
Shale, tan, silty, interbedded gray siltstone		15.0
Silt, tan		0.8
Shale, medium-gray, platy to blocky, silty, lentils of tan siltstone as much as 3 feet thick by 20 feet long		50.0
Shale, dark gray to tan variegated, blocky, <u>Pecten pecten</u> common bedding planes near top		8.0

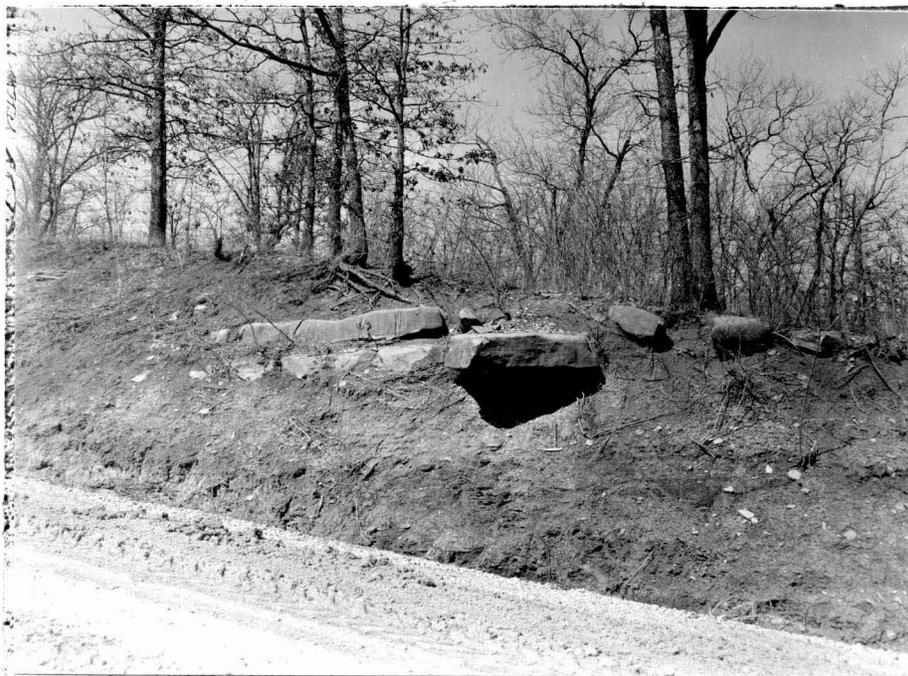


Fig. 5.--Verdigris Limestone at Locality 41 in $SE\frac{1}{4}SW\frac{1}{4}SW\frac{1}{4}$ sec. 35,
T. 33 S., R. 21 E.

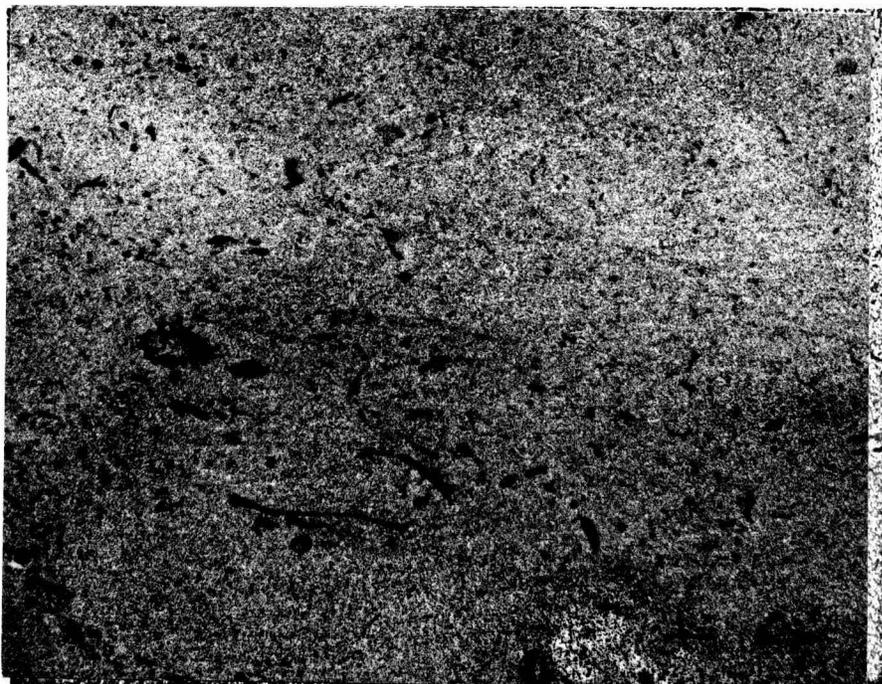


Fig. 6.--Peel print of limestone from base of Verdigris Limestone
at Locality 41. X4

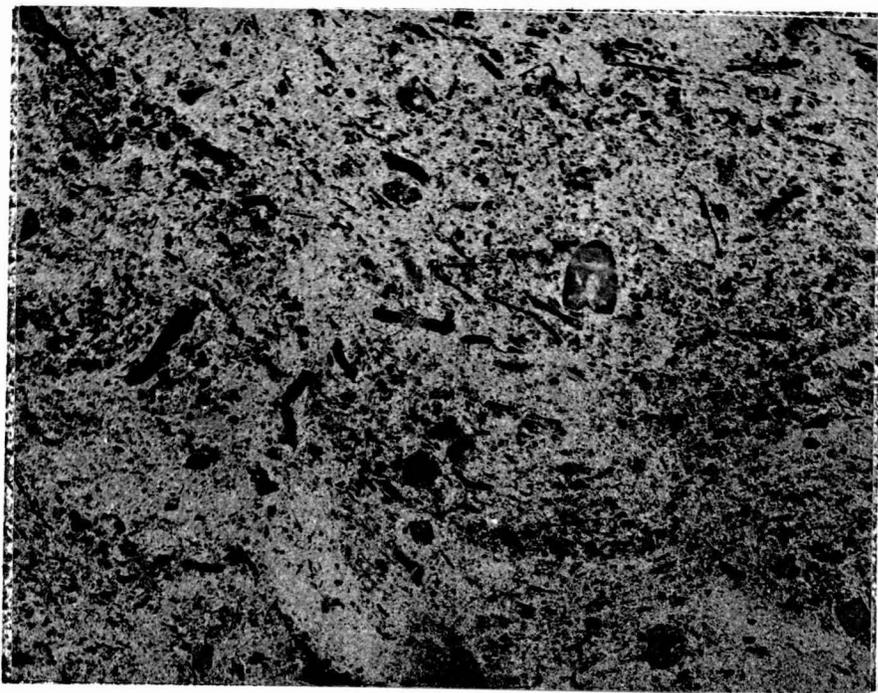


Fig. 7.--Peel print of limestone from base of Verdigris Limestone
at Locality 45 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 31, T. 34 S., R. 21 E.
X4

Breezy Hill Limestone Member.--Nodular, tan, silty limestone is characteristic of the Breezy Hill Limestone (Pierce and Courtier, 1937, p. 33) in the county. Average thickness of the member is about 1.5 feet as seen at Locality 25 in NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 33, T. 32 S., R. 21 E. and Locality 39.

Excello Shale bed.--The black, platy shale at the top of the Cabaniss called Excello by Searight and others (1953, p. 2748) in Missouri is not of member rank in Kansas nomenclature.

Average thickness of the unit in Labette County is about 4 feet. Dark-gray, phosphatic nodules are common in the shale. Some of the nodules are pyritized and others contain fossil fragments as nuclei.

Marmaton Group

Fort Scott Limestone

The Fort Scott Limestone (Bennett, 1896, p. 91) is the lowermost escarpment-forming formation that crops out in Labette County. Three members comprise the Fort Scott, which are, in ascending order, the Blackjack Creek Limestone (Cline, 1941, p. 36), the Little Osage Shale (Jewett, 1941, p. 306), and the Higginsville Limestone (Cline, 1941, p. 36). The maximum observed thickness of the formation is about 28 feet as measured at Locality 44 in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 9, T. 34 S., R. 20 E. The range in thickness of the Fort Scott is shown in Figure 4.

Blackjack Creek Limestone Member.--The Blackjack Creek is generally a medium-gray, medium-bedded limestone throughout the outcrop area. Thickness of the member ranges from about 18 feet at Locality

44 to only 8 feet at Locality 40 in the $SE\frac{1}{4}NW\frac{1}{4}NE\frac{1}{4}$ sec. 21, T. 33 S., R. 21 E. Average observed thickness is about 10 feet.

The texture of the limestone is predominantly very finely-crystalline, but locally the upper portion is earthy in appearance. At some outcrops medium- to coarsely-crystalline calcite concentrations are conspicuous throughout the rock.

Locally in the southern part of the area, nodular, gray chert is seen near the base of the member. This chert is especially conspicuous at Locality 44 where thin stringers of carbonaceous material occur in the lower few feet of the member.

Fusilinids, fragments of bryozoa, crinoid columnals, and the brachiopod Composita are common in the Blackjack Creek, especially in the upper and lower parts of the member.

Little Osage Shale Member. --Thickness of the Little Osage ranges from about 7.0 feet at Locality 40 ($SE\frac{1}{4}SE\frac{1}{4}NE\frac{1}{4}$ sec. 21, T. 33 S., R. 21 E.) to about 4.5 feet at Locality 44 ($SE\frac{1}{4}SE\frac{1}{4}$ sec. 9, T. 34 S., R. 20 E.). The most commonly observed thickness is about 5 feet.

Dark-gray to black, platy shale is the most characteristic lithology of the Little Osage. However, at most outcrops about 1.5 feet of gray, silty shale is seen at the top of the member.

Dark-gray to black, phosphatic nodules are commonly found in the middle of the member. At some localities these nodules contain fossils or fossil fragments and some pyrite. At Locality 50 nearly all the nodules examined contained one or more specimens of the brachiopod Orbiculoidea capuliformis (McChesney).

Higginsville Limestone Member. --A complete section of the Higginsville was not observed in the field. Because of the extensive dip slope formed on the member, a thickness can only be inferred from topographic maps. The average thickness of the Higginsville seems to be about 15 feet. Medium-gray, very finely to medium-crystalline limestone is characteristic of the member. The member is commonly very thick-bedded but locally, thin, undulating beds make up the rock.

Crinoid columnals and numerous small brachiopods are common. At some outcrops, as at Locality 44, thin (1-2 millimeter), horizontal stringers of translucent calcite which may be algal in origin are conspicuous on fresh surfaces.

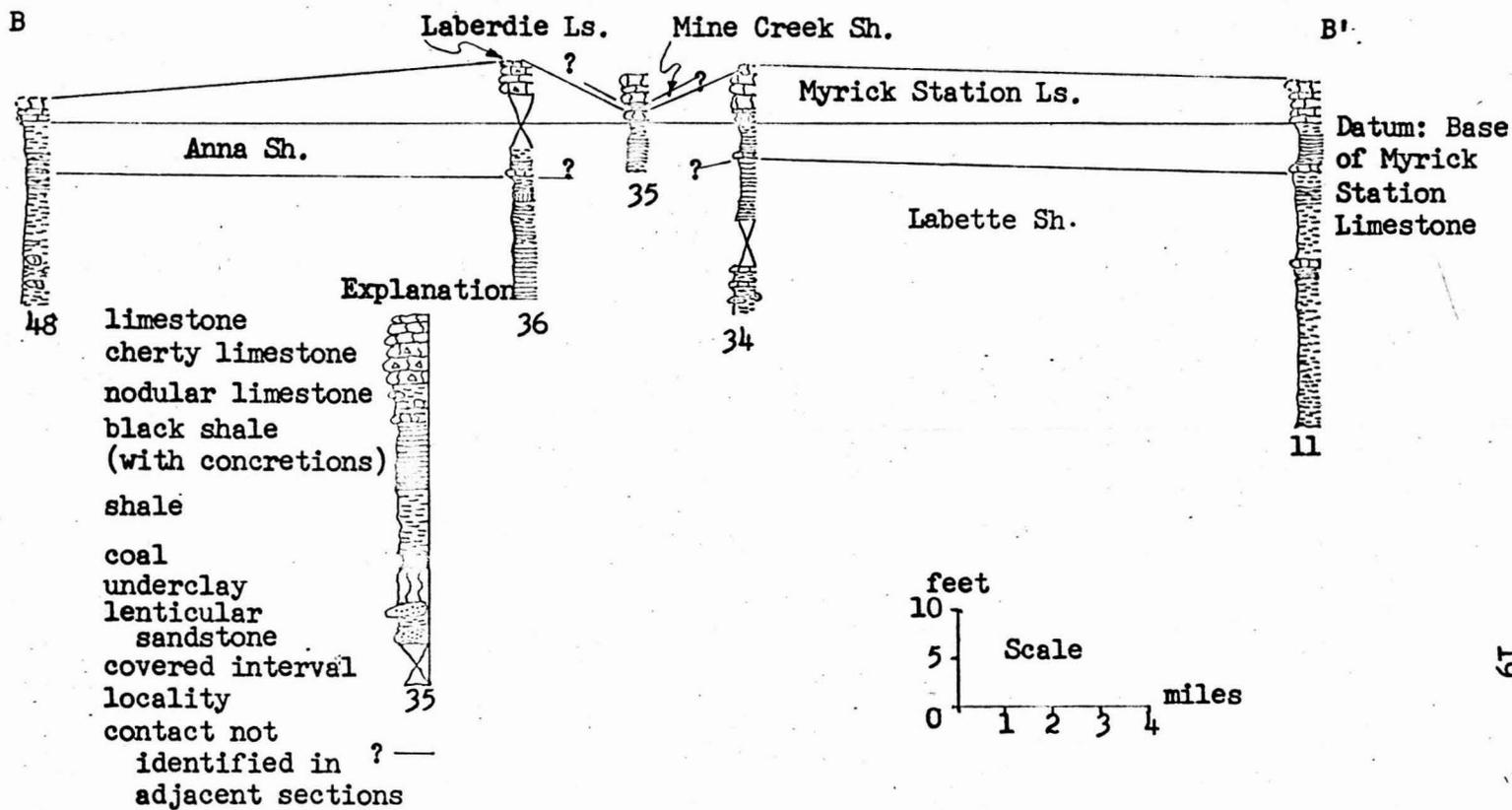
Labette Shale

The Labette Shale (Haworth, 1898, p. 36) in the area conformably overlies the Higginsville Limestone Member of the Fort Scott Limestone. Exposures of a complete section of the Labette are non-existent in the area. The total thickness of the unit, as inferred from partial exposures of the shale and elevations taken from topographic maps, is about 75 feet throughout the outcrop area in Labette County.

Light greenish-brown shale is the predominant lithology of the Labette Shale. However, in the southern and central part of the area, as at Locality 48 in $SW\frac{1}{4}SW\frac{1}{4}SW\frac{1}{4}$ sec. 10, T. 35 S., R. 19 E. and Locality 36 in $SW\frac{1}{4}SW\frac{1}{4}NW\frac{1}{4}$ sec. 29, T. 33 S., R. 20 E., thin lentils of sandstone and siltstone are common in the upper 20 feet of the shale.

At some outcrops in the northern part of the county a thin coal smut is seen about 15 feet below the base of the Anna Shale Member of the Pawnee Limestone (Fig. 8).

Fig. 8.--Correlation chart of Pawnee Limestone and adjacent beds.



The unit is best exposed in T. 33 S., R. 20 E. In this general area, a zone of fine-grained to very fine-grained, laminated, quartzose sandstone occurs near the middle of the Labette. The bed is best seen at Locality 38 in $NW\frac{1}{2}NW\frac{1}{2}SW\frac{1}{2}$ sec. 33, T. 33 S., R. 20 E. This sandstone may be equivalent to the Englevale Sandstone (Pierce and Courtier, 1935, p. 1061-1064).

Also, in this area at Locality 34 in $SW\frac{1}{2}SW\frac{1}{2}S\frac{1}{2}$ sec. 3, T. 33 S., R. 20 E., two very finely-crystalline, lenticular limestones separated by a few inches of tan, flaky shale lie near the top of the unit.

Pawnee Limestone

Two limestone members and two shale members comprise the Pawnee Limestone (Swallow, 1866, p. 24) in Labette County. The members are, in ascending order, the Anna Shale (Jewett, 1941, p. 316), Myrick Station Limestone (Cline, 1941, p. 37), Mine Creek Shale (Jewett, 1941, p. 318), and Laberdie Limestone (Jewett, 1941, p. 320).

Maximum thickness of the Pawnee in Labette County is probably about 25 feet. This total thickness is not observed anywhere in the county but is inferred from elevations taken from topographic maps and from observations of the thickness in Neosho County near the northern boundary of Labette County (Jungmann, in review).

Anna Shale Member. --The basal member of the Pawnee is nearly everywhere present in the county.

Average thickness of the unit is about 4 feet, although locally, as at Locality 34, in $SW\frac{1}{2}SW\frac{1}{2}SW\frac{1}{2}$ sec. 3, T. 33 S., R. 20 E., the thickness is slightly more than 10 feet.

Black, platy to fissile shale is characteristic of the Anna Shale although at most outcrops a zone of tan, silty shale about 1.5 to 2.0 feet thick, which contains numerous specimens of the brachiopod Mesolobus, is seen at the top of the member. Also, at some localities light-gray, phosphatic nodules are found in the black shale.

At Locality 34 one badly compressed ammonoid cephalopod was found. The specimen was too distorted and weathered to afford any more detailed identification.

Most outcrops of the Anna Shale contain a bed of argillaceous limestone about 0.3 foot thick at the base. This limestone is dark gray, very finely-crystalline, and laminated. Crinoid columnals as much as 1.0 inch in diameter are common in the bed. Figure 9 is a peel print of a sample of this limestone from Locality 36 in $SW\frac{1}{2}SW\frac{1}{2}NW\frac{1}{4}$ sec. 29, T. 33 S., R. 20 E.

Although the Anna Shale is the basal member of the Pawnee, it was found impractical in the field to map the unit because it was not visible on aerial photographs; therefore, on Plate 1, the contact representing the base of the Pawnee Limestone actually occupies the position of the base of the overlying Myrick Station Limestone Member.

Myrick Station Limestone Member.--In Labette County, the Myrick Station Limestone ranges in thickness from about 0.5 foot, as at Locality 35 in $NW\frac{1}{2}NW\frac{1}{2}NW\frac{1}{4}$ sec. 22, T. 33 S., R. 20 E., to as much as 9.0 feet as at Locality 36 in $SW\frac{1}{2}SW\frac{1}{2}NW\frac{1}{4}$ sec. 29, T. 33 S., R. 20 E. The most common thickness observed is about 5.0 feet.

Light-gray to light-tan, very finely-crystalline limestone is the dominant lithology of the Myrick Station. The member is medium-



Fig. 9.--Peel print of limestone at base of Anna Shale at Locality
36, SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 29, T. 33 S., R. 20 E. X4

bedded throughout most of the outcrop area. However, in some localities the unit is thin-bedded with buff to tan clay partings between the beds. Where the member is very thin, as at Locality 35, it is laminated and contains much silt.

Fragments of fenestrate bryozoa and crinoid columnals are distributed uniformly throughout the rock at most outcrops. Figure 10 is a peel print of limestone at the base of the Myrick Station at Locality 34 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 3, T. 33 S., R. 20 E.

Gray, nodular chert, especially abundant at Locality 36 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 29, T. 33 S., R. 20 E., is conspicuous near the base of the unit in the central part of the county.

Mine Creek Shale Member. --The middle shale member of the Pawnee Limestone is not well seen in Labette County and is thought to be missing at most outcrops (Fig. 8). The only clear exposure of the Mine Creek found in the area is at Locality 35 where the unit consists of about 0.5 foot of gray, silty, flaky shale which contains abundant specimens of the brachiopods Hustedia and Punctospirifer.

Laberdie Limestone Member. --The Laberdie is poorly exposed throughout Labette County. Total thickness of the unit as inferred from geologic profiles constructed along U.S. Highway 160 east of Parsons by the Kansas Highway Department is about 17 feet. This thickness is in approximate agreement with the thickness exposed just north of the county line in Neosho County (Jungmann, in review). Thicknesses inferred from topographic maps along the outcrop throughout the county are also of the order of 15 to 20 feet.

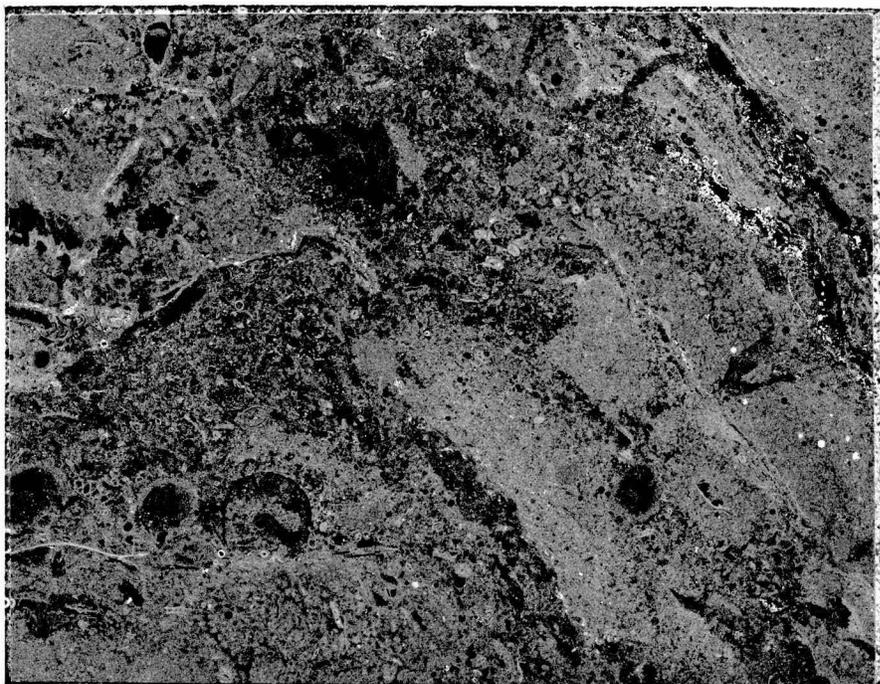


Fig. 10.--Peel print of limestone at the base of the Myrick Station
Limestone at Locality 34 in $SW\frac{1}{4}SW\frac{1}{4}SW\frac{1}{4}$ sec. 3, T. 33 S., R.
20 E. X4

The basal 4 to 6 feet of the unit is light-gray, tan-weathering, medium-crystalline limestone that is medium-bedded at most outcrops. Locally, as at Locality 35 in NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 22, T. 33 S., R. 20 E., isolated colonies of the coral Chaetetes, surrounded by a matrix of very finely-crystalline limestone containing large fusilinids, are common.

The upper 10 to 15 feet of the Laberdie Limestone, although not clearly exposed in the area, seems to be predominantly thin-bedded and of the same general lithology as the basal portion. This statement is based on observations of thin, weathered blocks of Laberdie found as float on the dip slope of the member.

Bandera Shale

The Bandera Shale (Adams, 1903, p. 32) in Labette County is predominantly a sequence of interbedded sandstone, siltstone, and sandy shale. Total thickness of the Bandera ranges from about 70 feet in northern Labette County to nearly 100 feet in the southern part of the county at the Oklahoma boundary (Fig. 11).

At most outcrops of the Bandera in the area, the upper 10 to 15 feet of the formation consists of yellowish-gray variegated, silty shale. Locally, however, in the northern part of the county this interval is composed of lenticular, flaggy, very fine-grained, silty sandstone. Current formed ripple marks are conspicuous at some outcrops of this flaggy sandstone. Near Locality 43 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 36, T. 34 S., R. 18 E., a lenticular sandstone about 1.5 feet thick occurs near the top of the Bandera (Fig. 12).

Fig. 11.--Correlation chart of Altamont Limestone and adjacent beds.

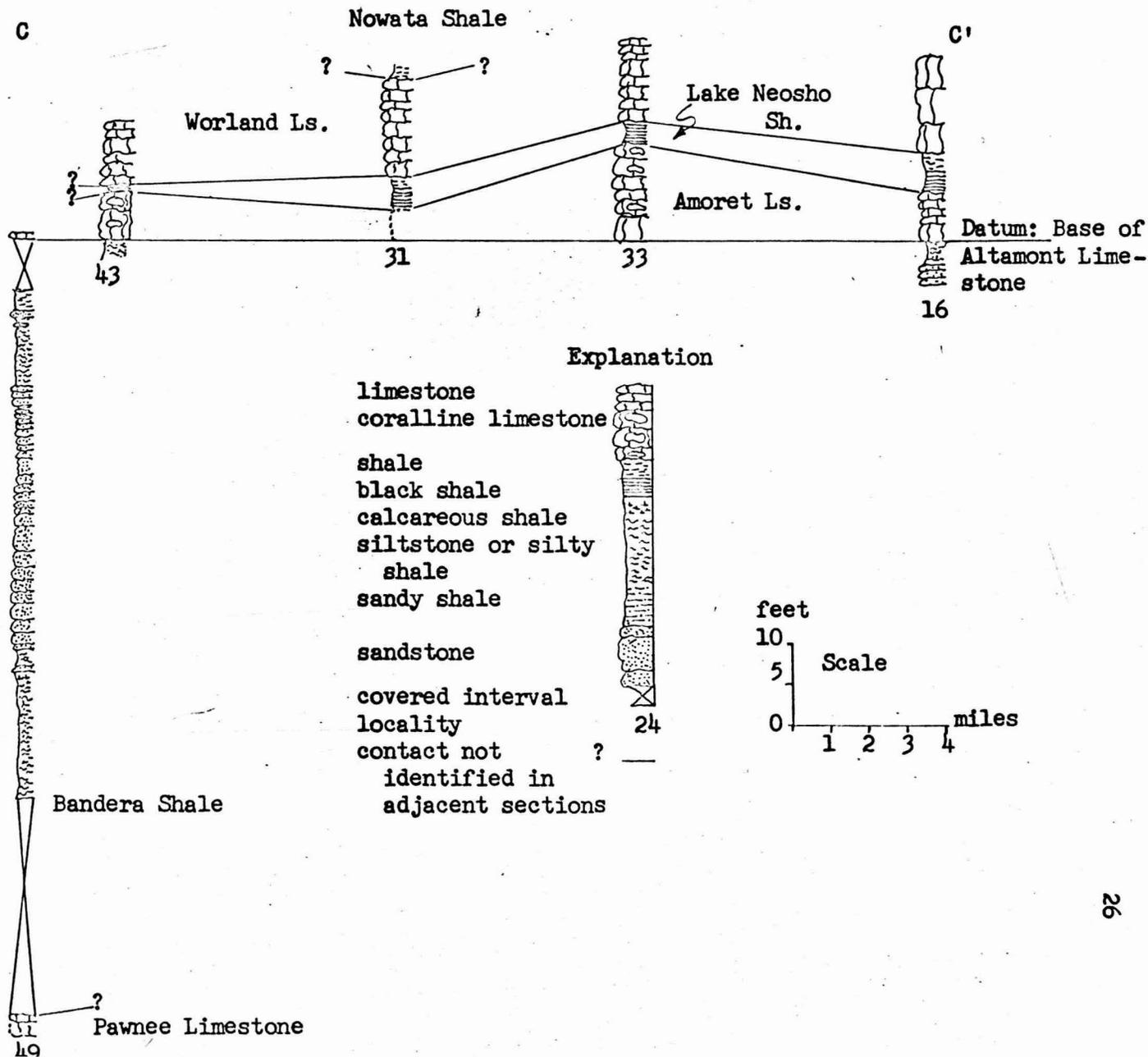




Fig. 12.--Lenticular sandstone near top of Bandera in $SW\frac{1}{4}SW\frac{1}{4}SE\frac{1}{4}$
sec. 36, T. 34 S., R. 18 E.

A zone of very thick-bedded, very fine-grained to medium-grained, reddish-brown, quartzose sandstone nearly 20 feet in thickness is commonly found about 20 to 30 feet below the top of the Bandera. This sandstone body is the "Dennis Sand" referred to by local well drillers.

A stratigraphic section measured along the west line of sec. 17, T. 33 S., R. 19 E. shows the typical lithology of the Bandera in Labette County. The section is as follows:

Locality 49, west line sec. 17, T. 35 S., R. 19 E.

	Thickness, feet
Altamont Limestone	
Amoret Limestone Member	
Limestone, dark gray, very finely-crystalline	1.5
Bandera Shale	
Covered interval	6.0
Shale, yellowish-tan and gray variegated silty, laminated	3.0
Sandstone, tan, very fine- to medium-grained, poorly sorted, well cemented with silt	1.0
Sandstone, lenticular, very fine-grained, silty, laminated at base	2.0
Shale, tan, silty, flaky, siltstone lentils 1-3 feet across	6.0
Sandstone, tan, very fine- to coarse-grained, poorly sorted, medium-bedded at top, thin- bedded to laminated at base	3.0

Bandera Shale (continued)	Thickness, feet
Sandstone, tan, silty shale interbedded	12.0
Sandstone, tan to buff, very fine- to coarse- grained, poorly sorted, very thick-bedded generally with some laminated zones; vertical joints bearing N47°W prominent	17.0
Shale, tan, silty flaky	2.0
Sandstone, tan, very fine- to fine-grained, micaceous	0.8
Shale, tan, silty; nodules of sandstone with included calcite, calcareous near top, some sandstone lentils	15.0

Note: about 30 feet of section covered down to top
of Pawnee Limestone 0.5 mile south.

Altamont Limestone

Three members comprise the Altamont Limestone (Adams, 1896, p. 22) in Labette County. The members are, in ascending order, the Amoret Limestone (Cline and Greene in Groshkopf and McCracken, 1949, p. 17), Lake Neosho Shale (Jewett, 1941, p. 331), and Worland Limestone (Cline, 1941, p. 29).

The Altamont commonly has a thickness of about 18 feet in the area.

Amoret Limestone Member. --Dark- to light-gray, very finely-crystalline, thick- to very thick-bedded limestone about 5 feet thick is characteristic of the Amoret in the northern part of the county.

To the south, as at Localities 33 ($NW\frac{1}{4}NW\frac{1}{4}SW\frac{1}{4}$ sec. 5, T. 33 S., R. 19 E.) and 43 ($SW\frac{1}{4}SW\frac{1}{4}SE\frac{1}{4}$ sec. 36, T. 34 S., R. 18 E.), the Amoret is as thick as 12 feet (Locality 43) and consists almost entirely of colonies of Chaetetes. Very finely-crystalline, light-gray limestone fills the space between the individual coral colonies. This local thickening of the member, coupled with the predominance of Chaetetes in the rock, suggests that locally the Amoret was formed as a bioherm with very fine-grained calcareous mud filling voids between the Chaetetes colonies.

Figure 13, a peel print of a sample from the Amoret at Locality 43, shows the sharp contrast between the coralline material and the very finely-crystalline matrix.

Lake Neosho Shale Member. --The most predominant lithology of the Lake Neosho in the county is black, fissile to platy shale. Thickness of the member ranges from about 6 feet in northern Labette County to 0.5 foot, locally, in the southern part of the county, as at Locality 43 (Fig. 14).

Black to medium-gray phosphatic nodules about 0.5 inch in diameter are abundant throughout the shale in most outcrops. Many of these nodules contain fossil fragments.

Nearly everywhere the upper part of the Lake Neosho is exposed, a zone 0.1 to 1.0 foot in thickness of light-gray, silty, flaky shale is found just below the overlying Worland Limestone Member. Small chonetid brachiopods are common in this zone. Perry and Merriam have reported fistuliporid bryozoa from a site in $SE\frac{1}{4}SE\frac{1}{4}SE\frac{1}{4}$ sec. 1, T. 34

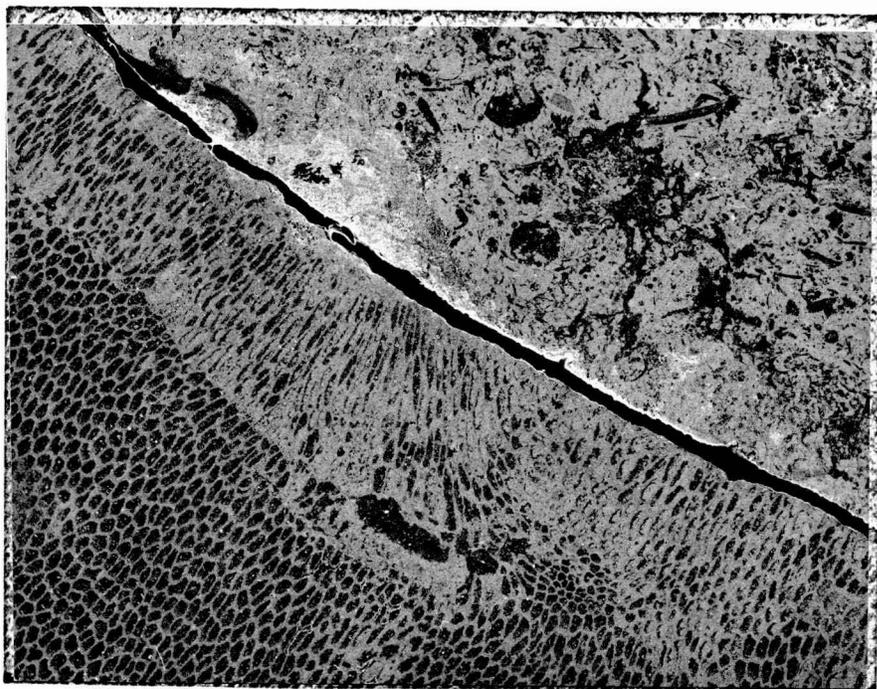


Fig. 13.--Peel print of limestone from middle of Amoret at Locality 43 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 36, T. 34 S., R. 18 E. Note sharp contrast between coralline material and very finely-crystalline limestone. X4



Fig. 14.--Quarry face of Altamont Limestone at Locality 43 in SW $\frac{1}{4}$
SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 36, T. 34 S., R. 18 E. Lake Neosho Shale,
indicated by arrow, is black shale break 0.5 foot thick.

S., R. 19 E. (D. F. Merriam, personal communication).

Vertical jointing is conspicuous on weathered outcrop faces throughout the area. Orientation of the joints is approximately N45°W.

Worland Limestone Member. --Light-gray, tan-weathering, very finely-crystalline, very thick-bedded limestone is the predominant lithology of the Worland in the area. The average thickness of the member is about 8.0 feet but locally, as at Localities 31 and 16 in NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 35, T. 33 S., R. 18 E., and SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 1, T. 32 S., R. 19 E., respectively, the thickness is as much as 12 feet.

Isolated colonies of Chaetetes are found at most exposures of the Worland. Also, dictyoclostid brachiopods and Echinaria, as well as specimens of small pelecypods, are common in the member. Fusilinids are present generally but not abundantly except at Locality 16. In the southern one-third of the area the brachiopod Linoproductus is also conspicuous in the member.

Dark-gray nodules of lithographic limestone are distributed throughout the member at most outcrops.

Locally, where the lower 1 to 3 feet of the Worland is thin-bedded, vugs and fractures filled with transparent, coarsely-crystalline calcite are common.

Nowata Shale

The thickness of the Nowata Shale (Chern, 1910, p. 23) ranges from a minimum of about 6 feet to a maximum of about 15 feet. The greatest thickness is in the southern part of the area.

Light-gray, platy shale is characteristic of the Nowata at most outcrops. Locally, however, as at Locality 17 in $SW\frac{1}{4}SW\frac{1}{4}SW\frac{1}{4}$ sec. 2, T. 32 S., R. 19 E., tan, calcareous shale and tan, silty limestone nodules are found at the top of the Nowata. In the southern part of the area, gray to dark-gray siltstone lentils are commonly seen near the middle of the formation.

Near Mound Valley in the west-central portion of the county, the upper 1.5 to 2.0 feet of the Nowata consists of black, platy shale containing distorted specimens of dictyoclostid brachiopods. This black shale facies is well seen at Locality 26 in $SW\frac{1}{4}SW\frac{1}{4}NW\frac{1}{4}$ sec. 1, T. 33 S., R. 18 E. (Fig. 15).

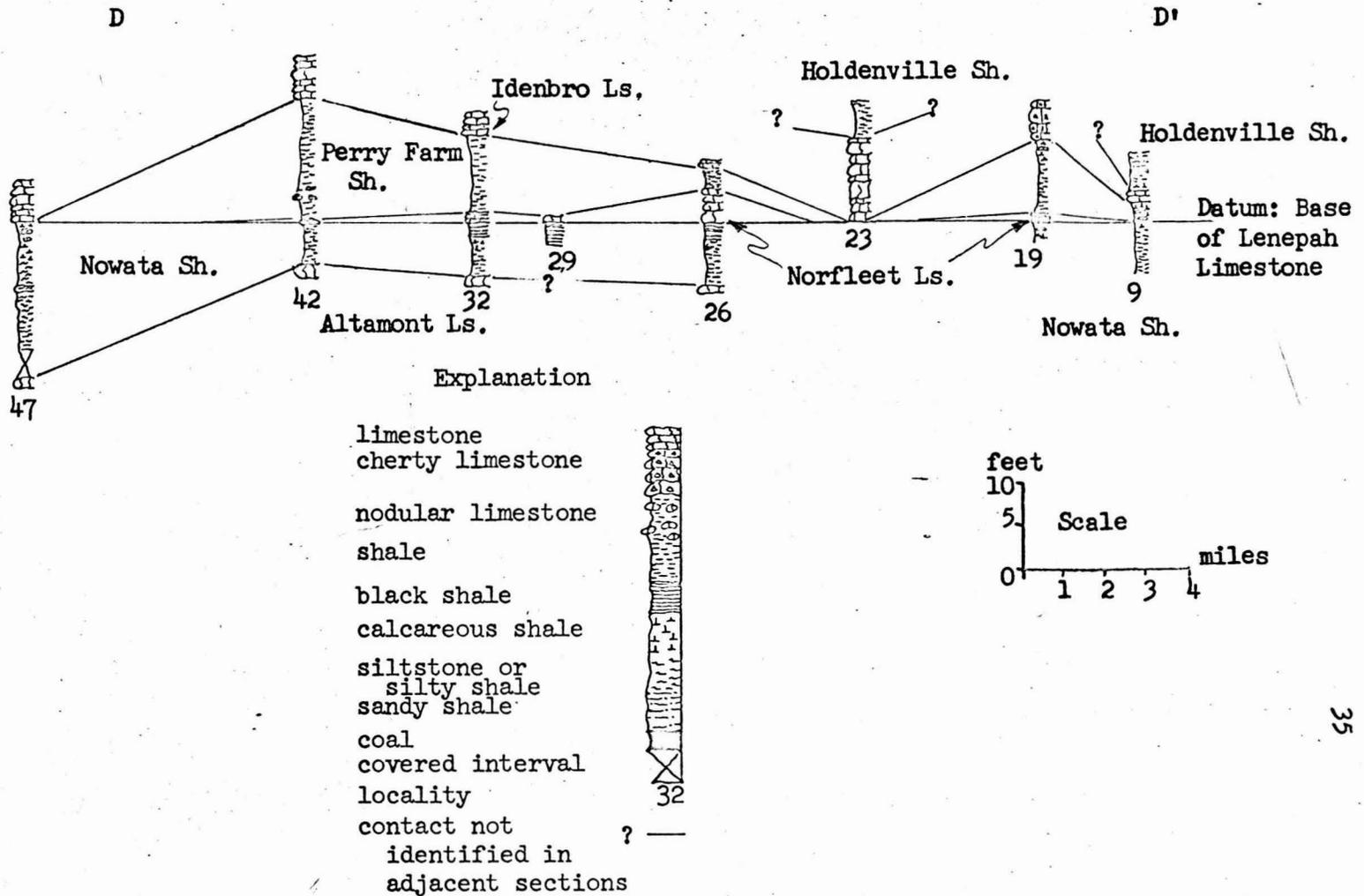
Lenepah Limestone

The Lenepah Limestone (Obern, 1910, p. 23) throughout most of Labette County comprises two limestone members separated by a shale member. These members are, in ascending order, the Norfleet Limestone (Jewett, 1941, p. 338), Perry Farm Shale (Jewett, 1941, p. 339), and Idenbro Limestone (Jewett, 1941, p. 340).

Thickness of the Lenepah ranges from about 20 feet in the southern part of the county, as at Locality 42 in $NW\frac{1}{4}NW\frac{1}{4}NE\frac{1}{4}$ sec. 7, T. 34 S., R. 18 E., to about 4 feet in the north-central part of the area, as at Locality 9 in $SW\frac{1}{4}SW\frac{1}{4}SW\frac{1}{4}$ sec. 26, T. 31 S., R. 19 E. (Fig. 15). The most common thickness of the formation is about 12 feet.

Norfleet Limestone Member. --The Norfleet is a discontinuous unit in Labette County. Where it is present, the member ranges in thickness from 0.3 foot, as at Locality 42, to about 4 feet at Locality 26 in $SW\frac{1}{4}SW\frac{1}{4}SW\frac{1}{4}$ sec. 1, T. 33 S., R. 18 E.

Fig. 15.--Correlation chart of Lenepah Limestone and adjacent beds.



The lithology of the Norfleet varies radically in Labette County. At Locality 26 the member consists of a light-gray, very thick-bedded, medium- to finely-crystalline limestone bed containing numerous dictyoclostid brachiopods, whereas at Locality 42 the Norfleet is represented only by 0.3 foot of dark-gray, very finely-crystalline limestone. In general, the nodular or slabby facies is more common, especially in the northern and southern parts of the county.

Fossils are not plentiful in the Norfleet. Small brachiopods and crinoid columnals are distributed sparsely in the member at some outcrops. Jewett (1945, p. 119) reported plant fossils from the member in the SW $\frac{1}{4}$ sec. 35, T. 32 S., R. 18 E.

Perry Farm Shale Member.---The observed range in thickness of the Perry Farm Shale in Labette County is from 14 feet at Locality 42 to about 2 feet at Locality 9 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 26, T. 31 S., R. 19 E. The most common thickness of the member is about 5 feet.

In general, the shale is light-gray to grayish-tan, although in the west-central part of the county the shale is greenish-gray as at Locality 32 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 35, T. 33 S., R. 18 E.

Calcareous nodules included in grayish-tan, calcareous shale are commonly found in the upper 2 feet of the Perry Farm. These nodules are generally medium-gray and very finely-crystalline. Fossil fragments are incorporated in the nodules at some localities. For example, at Locality 42 small orbiculoid brachiopods were found in nearly all nodules examined in the field.

Fossils are rare in the member, but at Locality 32 numerous compressed specimens of the brachiopod Neospirifer and dictyoclostid

brachiopods are present throughout the shale.

Where the Norfleet Limestone is missing, it is difficult to distinguish between the Perry Farm Shale and the underlying Nowata Shale. At some localities differentiation may be made by assuming the base of the Perry Farm to be at that horizon where calcareous shale grades downward into silty, non-calcareous shale. Where the upper part of the Nowata is calcareous, it is not possible to determine if both the Nowata and the Perry Farm are present.

Idenbro Limestone Member. --The Idenbro Limestone ranges in thickness from about 2 feet at Locality 9 to about 10 feet at Locality 23 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 28, T. 32 S., R. 19 E. The most common thickness of the unit is about 6 feet.

Light-gray, very finely-crystalline, thick-bedded limestone is characteristic of the member throughout most of the area. Locally, in the northern part of the area, as at Locality 9, the Idenbro is slightly silty and it weathers to an earthy texture. In general, the Idenbro is nodular or very thin-bedded in the northern part of the outcrop. Figure 16 is a peel print of the nodular facies of the Idenbro at Locality 9.

In the central part of the county, as at Locality 17 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 2, T. 32 S., R. 19 E., grayish-white chert nodules are conspicuous in the middle of the member.

Throughout the area, wherever the upper surface of the Idenbro is exposed, the limestone develops a smoothly rounded, hummocky surface which has relief of as much as 3 inches.

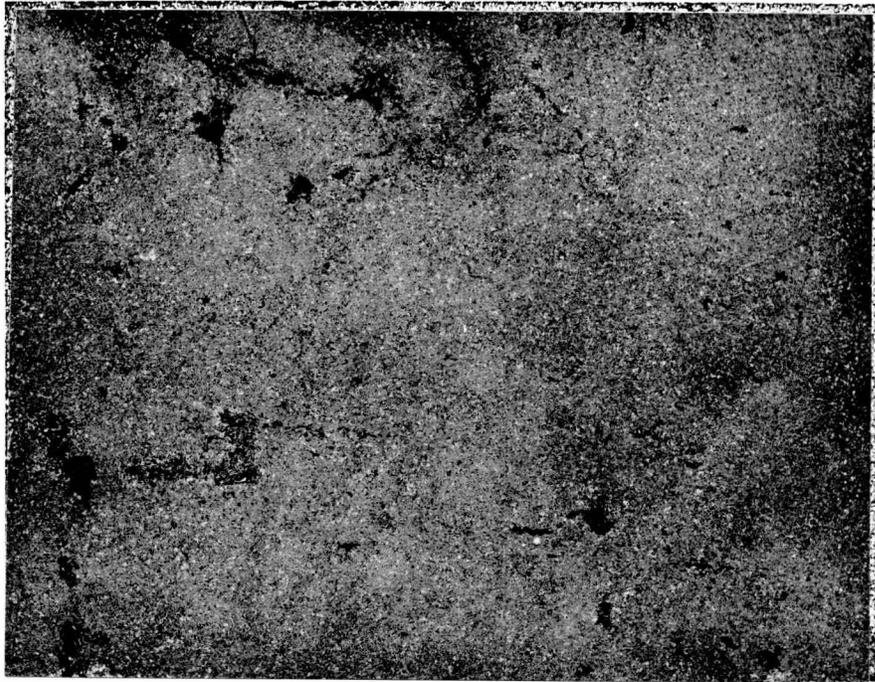


Fig. 16.--Peel print of limestone from nodular facies of Idenbro Limestone at Locality 9 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 26, T. 31 S., R. 19 E. X4

Holdenville Shale

The outcrop of the Holdenville Shale (Taff, 1901) is not continuous in Labette County due to erosion during the time just prior to deposition of the Hepler Sandstone Member of the overlying Seminole Formation.

Thickness of the Holdenville ranges from zero in $SW\frac{1}{2}NW\frac{1}{4}$ sec. 1, T. 32 S., R. 19 E., where Hepler Sandstone rests on the Idenbro Limestone, to about 45 feet at a section measured by Jewett (1945, p. 123) and reexamined by the author in the $NW\frac{1}{4}$ sec. 21, T. 33 S., R. 18 E. Generally, the observed thickness of the Holdenville is about 12 feet.

The basal portion of the Holdenville commonly consists of light-gray, slightly silty, platy to blocky shale as at Locality 23 in $SW\frac{1}{2}SW\frac{1}{2}SW\frac{1}{4}$ sec. 28, T. 32 S., R. 19 E. Locally, as at Locality 9, a coal bed about 0.4 foot thick is found near the middle of a gray to yellowish-gray bed of slightly calcareous, silty shale. At some localities, as at the section mentioned above measured by Jewett, the lower portion of the formation consists of 15 feet of black, platy shale.

Yellowish-gray to greenish-gray clay shale is the characteristic lithology of the middle and upper portions of the Holdenville.

Fossils are rare in the unit but in the $SE\frac{1}{2}SW\frac{1}{4}$ sec. 2, T. 33 S., R. 18 E., the coral Acaciapora austini is abundant in the shale and weathers readily from the outcrop. The brachiopod Mesolobus mesolobus, an index fossil for Demoinesian rocks, is common in the upper few feet of the Holdenville at this locality.

PENNSYLVANIAN SYSTEM-UPPER PENNSYLVANIAN SERIES

Missourian Stage

Moore (1936, p. 70) defined the boundary between Desmoinesian and Missourian rocks in Kansas as being a widespread unconformity across which there is a distinct lithologic change and paleontological break. In Labette County, the base of the Hepler Sandstone (Jewett, 1940, p. 8) is taken as the base of the Missourian Stage.

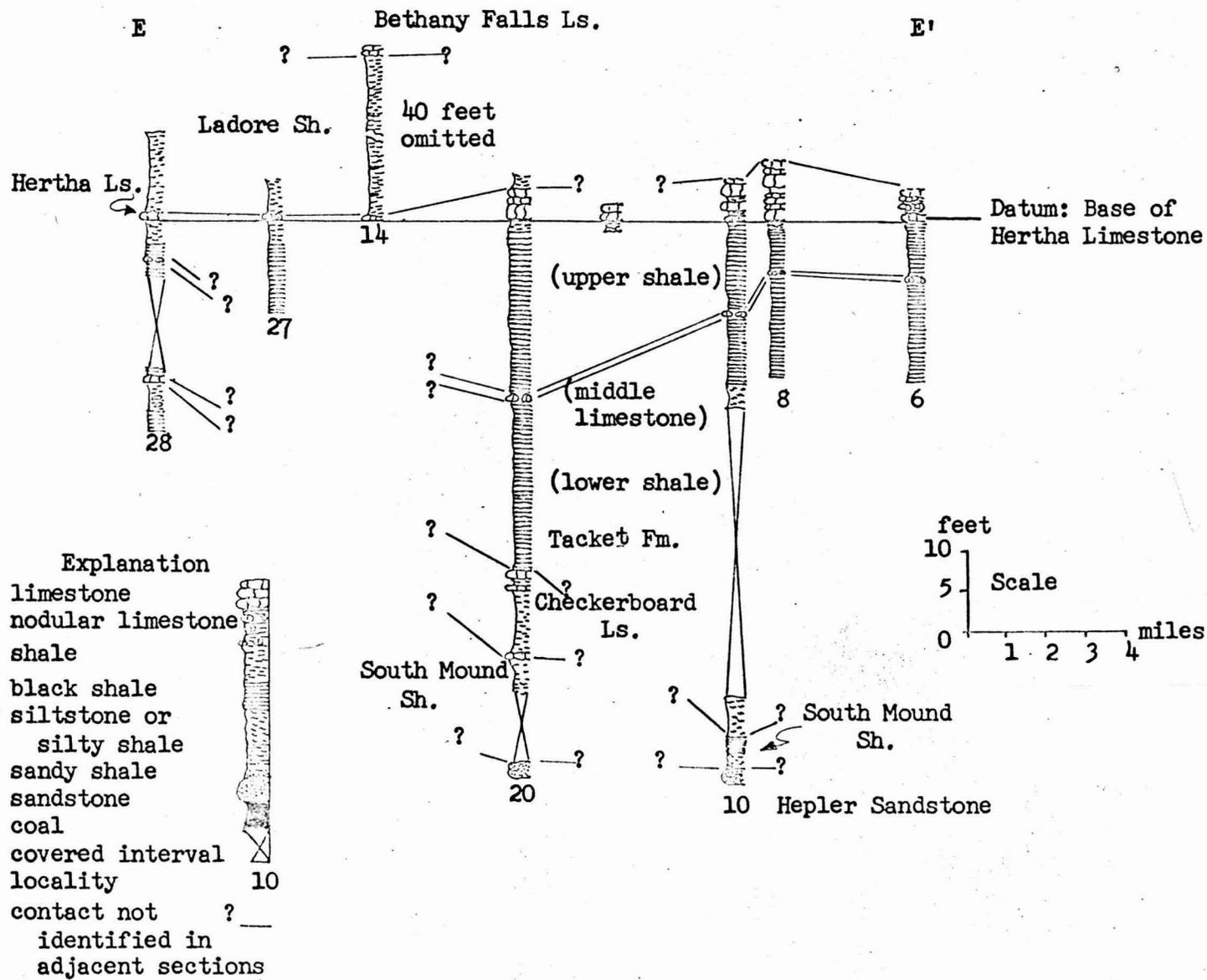
Pleasanton Group

Seminole Formation

It has been shown (Oakes and Jewett, 1943, p. 637) that the Hepler Sandstone (Jewett, 1940, p. 8) is the northward continuation of part of the Seminole Formation (Morgan, 1923) of Oklahoma. Emery used Seminole Formation in his classification of the Pleasanton Group to include two members below the Checkerboard Limestone. The members are, in ascending order, the Hepler Sandstone and the South Mound Shale (Emery, 1962). The thickness of the formation ranges from about 6 feet at Locality 10 in NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 27, T. 31 S., R. 19 E. (Fig. 17) to about 20 feet in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 20, T. 33 S., R. 18 E. In general, the range in thickness of the formation is due to local differences in thickness of the Hepler Member.

Hepler Sandstone Member. --Gray, brown- to reddish-brown weathering, thick-bedded, very fine-grained, quartzose sandstone is characteristic of the Hepler in Labette County. At most outcrops the Hepler contains some silt, and it is generally slightly micaceous.

Fig. 17.--Correlation chart of Hertha Limestone and adjacent beds.



The thickness of the Hepler ranges from 1 foot, as at Locality 30 in NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 27, T. 33 S., R. 18 E., to about 12 feet in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 20, T. 33 S., R. 18 E. About 2 feet is the commonly observed thickness of the member.

In the northern part of the county the Hepler is quite silty and is thin-bedded to laminated as in SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 1, T. 32 S., R. 19 E. In T. 33 S., R. 18 E., a calcareous facies of the Hepler is present. Figure 18 is a peel print of a sample taken from the calcareous facies of the Hepler at Locality 30. The silty, uniform texture of the rock is well illustrated. Calcium carbonate cement is predominant at this locality.

Deposition of the Hepler was upon a widespread erosional surface of gentle relief formed after deposition of the underlying Holdenville Shale. Locally, as in SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 1, T. 32 S., R. 19 E., the Hepler was deposited in topographic lows which had been eroded to a level slightly below the top of the Idenbro Limestone. In other parts of Kansas, as in Linn County to the northeast of Labette County, erosion during pre-Hepler time was deeper and Hepler was deposited upon the Worland member of the Altamont Limestone in local areas (W. J. Seevers, personal communication).

South Mound Shale Member.--The South Mound is poorly seen in Labette County. Where the member is exposed it ranges in thickness from about 12 feet, as at Locality 20 in SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 7, T. 32 S., R. 19 E., to about 4 feet at Locality 10 in NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 27, T. 31 S., R. 19 E. (Fig. 17). The average thickness of the unit is about 5 feet.



Fig. 18.--Peel print of sample from calcareous facies of Hepler Sandstone at Locality 30, $NW\frac{1}{4}NW\frac{1}{4}SW\frac{1}{4}$ sec. 27, T. 33 S., R. 18 E. X4

In general, the South Mound consists of gray to yellowish-gray, platy, slightly silty shale.

At Locality 10 the South Mound consists of 2 feet of black, blocky shale overlain by a coal smut containing much clay which is, in turn, overlain by about 1.5 feet of black, fissile shale. The black, blocky shale at the base of the member is also seen at Locality 28 near the center of the north line of sec. 19, T. 33 S., R. 18 E. At Locality 28, the upper 3 feet of the member is composed of gray, flaky shale containing many flattened siltstone nodules.

Checkerboard Limestone

Oakes and Jewett (1943, p. 635) showed that the Checkerboard Limestone (Oakes, 1940, p. 26) is present in Labette County where it consists of two unnamed limestone members separated by an unnamed shale member, none of which are continuous throughout the whole outcrop area.

The range in thickness of the formation is from about 11 feet measured at Locality 20 to 0.5 foot at Locality 28.

Lower limestone member. --The lower limestone of the Checkerboard is the most persistent unit in the formation. It can be traced from the southeastern part of T. 31 S., R. 19 E. to the southwestern portion of T. 33 S., R. 18 E. A good exposure is also present in a small creek in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 27, T. 33 S., R. 17 E. just west of the Labette County line in Montgomery County.

Very finely-crystalline, dark brownish-gray to tan limestone with many included fossils is characteristic of the member at most outcrops.

Locally, as in SW $\frac{1}{4}$ sec. 28, T. 33 S., R. 18 E., the unit is a coquina of pelecypods, brachiopods, high-spired gastropods, and coral fragments tightly cemented with very finely-crystalline carbonate material.

The commonly observed thickness of the member is about 0.8 foot but at Locality 30 in NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 27, T. 33 S., R. 18 E., the unit consists of 6 feet of medium-bedded, gray, medium-crystalline limestone containing "pockets" of coquina. Figure 19 is a peel print made from a sample taken about 1.0 foot above the base of the lower member at Locality 30.

Middle shale member.--At most outcrops where the shale member of the Checkerboard is seen, it is represented by less than 0.5 foot of grayish-yellow, blocky shale. However, at Locality 30 the unit consists of about 8 feet of gray, platy to blocky shale.

Upper limestone member.--Brown to brownish-gray, very finely-crystalline, fossiliferous limestone is characteristic of the upper member of the Checkerboard. The faunal assemblage appears to be nearly identical to that of the lower member with the exception that fewer high-spired gastropods are seen in the upper member.

The most commonly observed thickness of the unit is about 1 foot. At Locality 20, however, two limestones, each 0.8 foot thick separated by 0.3 foot of tan, calcareous shale, comprise the member.

Although all members of the Checkerboard seem to be missing in Labette County north of the southern tier of sections in T. 31 S., R. 19 E., the formation is seen in southern Neosho County. Therefore, it



Fig. 19.--Peel print of limestone from the base of the lower member of the Checkerboard at Locality 30, $NW\frac{1}{4}NW\frac{1}{4}SW\frac{1}{4}$ sec. 27, T. 33 S., R. 18 E. X4

is possible that the Checkerboard does exist in T. 31 S., R. 19 E., as a thin, imperceptible carbonate zone in the lower part of the Pleasanton Group.

Tacket Formation

Two shale members separated by a limestone member comprise the Tacket Formation. The members are unnamed and are defined as the lower shale member, middle limestone member, and upper shale member. Maximum thickness of the formation is about 63 feet at Locality 10 in NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 27, T. 31 S., R. 19 E. (Fig. 17). The average thickness is about 40 feet.

Lower shale member. --The average thickness of the lower shale member of the Tacket Formation is about 15 feet (Emery, 1962). Locally, as at Locality 20 in SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 7, T. 32 S., R. 19 E., it is as thick as 24 feet.

Black, blocky to fissile shale with limonite staining on bedding planes is the predominant lithology of the member. Dark-gray, phosphatic nodules as much as 0.5 inch in diameter are common in the upper part of the member.

At Locality 10 about 5 feet of tan siltstone interbedded with tan shale containing a few plant remains is found about 4 feet above the Hepler Sandstone. The Checkerboard is apparently missing at this outcrop. Therefore, if the black shale present above the Hepler at this locality is equivalent to the South Mound Shale, the tan siltstone and shale are in the lower part of the lower member of the Tacket. If this is so, then the total thickness of the basal member of the Tacket is about 50 feet.

Middle limestone member. --The middle limestone member (Emery, 1962) of the Tacket is present throughout Labette County. Dark-gray, very finely-crystalline to micro-crystalline nodules of slightly silty limestone are typical of the member. The average dimensions of the nodules are uniformly about 1 foot in diameter by about 0.4 foot in thickness. Bedding planes of the black shale above and below the limestone are continuous and curve around the nodules.

Megafossils are absent from the limestone but Emery (1962, p. 41) reported fragments of arenaceous Foraminifera in the nodules from some localities in the county.

Upper shale member. --Thickness of the upper shale member (Emery, 1962), ranges from about 20 feet as at Locality 20 to approximately 5 feet at Locality 10. The average thickness is about 8 feet.

The characteristic lithology of the upper member is black, fissile to platy shale. Vertical joints are conspicuous in the shale at most outcrops.

At nearly all exposures the upper 1 to 3 feet of the member consist of gray to yellowish-gray, flaky shale which contains some specimens of dictyoclostid brachiopods, the pelecypod Aviculopecten, and numerous crinoid columnals.

Kansas City Group--Bronson Subgroup

Hertha Limestone

Throughout most of the outcrop of the Hertha Limestone (Adams, 1903, p. 35) in Kansas, the formation consists of two limestone members separated by a shale member. In Labette County only the lowermost

member, the Critzer Limestone (Jewett, 1932, p. 99) is identified and it is not continuous throughout the area.

Critzer Limestone Member. --The Critzer becomes progressively thinner from north to south in the area. Southwest of Locality 28 near the center of the north line of sec. 19, T. 33 S., R. 18 E., the member cannot be identified. This thinning from 6 feet at Locality 8 in NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 21, T. 31 S., R. 19 E., to 0.5 foot at Locality 28 is shown graphically in Figure 17. The basal contact of the Hertha shown on Plate 1 southwest of this locality is inferred from topography.

North of Locality 20 in SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 7, T. 32 S., R. 19 E., the Critzer is generally gray to dark-gray, medium-bedded, very finely- to medium-crystalline, slightly silty limestone. Clay shale partings are common between beds. This lithology is well seen at Locality 8, Locality 10 in NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 27, T. 31 S., R. 19 E., and Locality 20 in SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 7, T. 32 S., R. 19 E.

Where the Critzer is very thin, as at Locality 28, the unit consists of brownish-gray, medium-crystalline, nodular limestone containing numerous crinoid fragments and small brachiopods (Fig. 20).

Ladore Shale

The thickness of the Ladore Shale (Adams, 1904, p. 18) increases from north to south in Labette County. Along the north line of sec. 20, T. 31 S., R. 19 E., the Ladore has a thickness of about 40 feet, whereas at Locality 14 in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 27, T. 32 S., R. 18 E., the total thickness is nearly 60 feet (Fig. 17).



Fig. 20.--Peel print of limestone from base of Hertha Limestone at
Locality 28, center north line sec. 19, T. 33 S., R. 18 E.
X4

In general, the lithology of the Ladore is light-gray to bluish-gray shale throughout. At Locality 14, thin coal lentils are common near the middle of the shale. Limonite staining on bedding planes and sparsely distributed ironstone concretions are found throughout the unit. Locally, as seen northwest of Mound Valley at Locality 15 in $SW\frac{1}{2}NW\frac{1}{2}SW\frac{1}{2}$ sec. 34, T. 32 S., R. 18 E., the upper 6 feet of the Ladore consists of tan, platy, slightly calcareous shale with interbedded lenses of very fine-grained, quartzose sandstone.

At many outcrops of the Ladore, a thin zone of yellow, clay shale containing fragments of fenestrate bryozoa and numerous crinoid columnals is seen at the top of the shale. Plants fossils are found locally near the base of the unit, as at Locality 14.

Swope Limestone

Over much of the outcrop of the Swope Limestone (Newell, 1935, p. 36) in Kansas, two limestone members separated by a shale member comprise the formation. In Labette County, only the upper member, the Bethany Falls Limestone (Broadhead, 1865, p. 320), is identified.

Bethany Falls Limestone Member. --The maximum observed thickness of the Bethany Falls is 11.0 feet at Locality 5 in $NE\frac{1}{2}NE\frac{1}{2}NW\frac{1}{2}$ sec. 32, T. 31 S., R. 18 E. Although the member is not well exposed north of this locality, the thickness of the unit in the northern part of T. 31 S., R. 19 E. is thought to be about the same. This inference is based on a section measured in 1960 by the author in $SE\frac{1}{2}SW\frac{1}{2}$ sec. 33, T. 30 S., R. 19 E., Neosho County, where the Bethany Falls is slightly more than 10 feet thick. The most commonly observed thickness of the member is about 5 feet.

The characteristic lithology of the Bethany Falls is light- to dark-gray, medium-crystalline, thin-bedded limestone. Locally, as at Locality 4 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 29, T. 31 S., R. 18 E., the lower portion of the member is thick-bedded; yellowish-gray clay partings are commonly found between beds.

Bluish-gray chert nodules are found in some exposures within a few inches of the base of the member. Coarsely-crystalline calcite is common in fractures and vugs in the limestone.

Large crinoid columnals (0.2-0.5 inch in diameter) are present at the top and bottom of the member at many localities. Differential weathering has removed much of the limestone matrix from around these fossil fragments so as to cause the columnals to stand out in relief on the rock. Figure 21, a peel print of limestone from the base of the member at Locality 4, shows the abundance of the crinoid columnals.

Galesburg Shale

The Galesburg Shale (Adams, 1903, p. 36) in Labette County is predominantly a sequence of interbedded sandstone, siltstone, shale and sandy shale, containing discontinuous coal lentils. Only one member, the Dodds Creek Sandstone (Jewett, in Moore, 1932, p. 99), is named.

The thickness of the Galesburg is uniformly about 60 feet. Locality 1 in NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 16, T. 31 S., R. 18 E., and Locality 4 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 29, T. 31 S., R. 18 E. are the specific outcrops from which the composite thickness is inferred.

The lower portion of the Galesburg, a zone about 25 feet thick beneath the Dodds Creek Sandstone, is composed chiefly of tan,

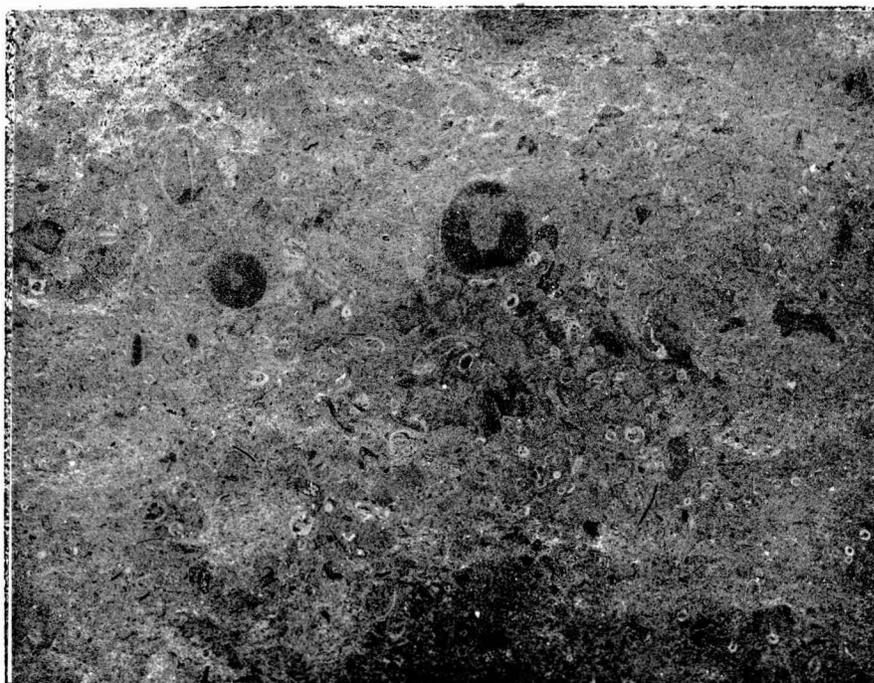


Fig. 21.--Peel print of limestone from base of Bethany Falls Limestone
at Locality 4, SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 29, T. 31 S., R. 18 E. X4

laminated, silty to sandy shale with very fine- to medium-grained, quartzose sandstone lenses interbedded.

The sandy nature of the lower part of the Galesburg is responsible for a subtle topographic bench at the base of the formation. Because of this bench, the base of the formation is mappable over much of the outcrop area (Plate 1).

Dodds Creek Sandstone Member. --Gray, reddish-brown to tan-weathering, very thick-bedded, very fine- to medium-grained, quartzose sandstone is characteristic of the Dodds Creek Sandstone in the area. In general, the sandstone also contains much silt.

Thickness of the member ranges from about 6 feet at Locality 13 in NW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 7, T. 32 S., R. 18 E., to as much as 36 feet at Locality 4.

Cross-bedding is not evident in the field but extremely small-scale cross-bedding may be seen on polished surfaces of samples taken from the member at some outcrops.

A coal lentil 0.5 foot thick lies below the Dodds Creek at some outcrops, as at Locality 13 and in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 32, T. 31 S., R. 18 E.

That portion of the Galesburg above the Dodds Creek consists predominantly of tan, silty shale with included lenticular sandstone bodies. Locally, as at Locality 1, fragments of bryozoa and a few crinoid columnals are found immediately below the overlying Canville member of the Dennis Limestone.

The most commonly observed thickness of the upper part of the Galesburg is about 30 feet.

Dennis Limestone

Two limestone members separated by a shale member comprise the Dennis Limestone (Adams, 1903, p. 36), throughout most of the outcrop area in Labette County. The members are, in ascending order, the Canville Limestone (Jewett, 1932, p. 102), Stark Shale (Jewett, 1932, p. 102), and Winterset Limestone (Tilton and Bain, 1897, p. 517).

Maximum thickness of the formation is about 25 feet as seen along the west line of sec. 9, T. 31 S., R. 18 E.

There is little topographic expression of the Dennis in Labette County in contrast to the general situation to the north along the outcrop in Kansas. The reason for this lack of topographic expression is thought to be that headward erosion of Big Hill Creek has not yet incised deeply enough into the formation to produce much relief.

Canville Limestone Member. --The Canville Limestone is not continuous in Labette County. Where it is present, as at Locality 1 in NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 16, T. 31 S., R. 18 E., dark-gray, medium-bedded, very finely-crystalline limestone is characteristic of the member. Southwest of Locality 3, the Canville is not present as noted at the outlier of the Dennis Limestone in the SW $\frac{1}{4}$ sec. 36, T. 32 S., R. 17 E., where the Winterset member rests on the Galesburg Shale.

Fossils are rare in the bed, but at some exposures a few small brachiopods are seen in the upper 1 foot.

Stark Shale Member. --The Stark Shale is identifiable only where the Canville is present, *i.e.*, at Localities 1 and 3.

Black, fissile shale about 2 feet in thickness is characteristic of the Stark. At Locality 1, gray phosphatic concretions are abundant

in a zone of gray, calcareous shale about 0.3 foot thick which lies at the top of the member.

Winterset Limestone Member. --The Winterset Limestone is the only member of the Dennis which is continuous in Labette County.

Maximum thickness of the member occurs near the northern boundary of the county along the west line of sec. 9, T. 31 S., R. 19 E. where about 20 feet of limestone is exposed. At most outcrops south of this location the member is 5 to 10 feet in thickness.

The member is characteristically composed of thin- to medium-bedded, medium-gray, very finely-crystalline limestone. Yellow clay partings between beds are fairly common in the unit. Reddish-brown mottling, probably due to iron oxide inclusions, are nearly always present on unweathered surfaces of the rock.

Light-gray to white, angular chert nodules are common throughout the unit at most outcrops.

Where the dip slope of the member is exposed, as northeast of the village of Dennis in T. 31 S., R. 18 E., a hummocky, smoothly-rounded surface is developed on the limestone.

Along the outcrop of the Winterset in Labette County, a characteristic reddish-brown soil is developed on the member wherever it lies near ground surface.

Kansas City Group-Linn Subgroup

Cherryvale Shale

Outcrops of the Cherryvale Shale (Haworth, 1898, p. 47) in Labette County are limited to parts of townships T. 31 S., R. 17 E. and T. 31

S., R. 18 E. Here erosional outliers with relief of as much as 110 feet above the surrounding terrain are supported by the lower part of the Chanute Shale.

The Cherryvale, overlain by the Drum Limestone, is found on the flanks of these outliers. Gray to tan variegated, platy, very silty shale about 70 feet thick is the common lithology of the formation. At Locality 2 in SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 18, T. 31 S., R. 18 E., a zone of brown, laminated, very fine-grained, quartzose sandstone about 3 feet thick is seen at the base of the unit. Limonite concretions are distributed uniformly throughout the formation.

To the north in Neosho, Allen, Bourbon, Linn, and Miami counties, Kansas, as many as five members may be identified in the Cherryvale in some localities. These members are, in ascending order, the Fontana Shale, Block Limestone, Wea Shale, Westerville Limestone, and Quivira Shale. In Labette County an environment suitable for carbonate deposition apparently did not occur during Cherryvale time and thus no correlatives of the Block or Westerville exist. In Labette County no differentiation into members is possible, but it is likely that the lower, middle, and upper portions of the Cherryvale are correlative with the Fontana Shale, Wea Shale, and Quivira Shale, respectively.

Drum Limestone

Only the lower member of the Drum Limestone (Adams, 1903, p. 27, 118) is present in Labette County. This member is thought to be the Cement City Limestone (Hinds and Greene, 1915, p. 27, 118).

Cement City Limestone Member. --The Cement City consists of a single bed of brown, dark-brown weathering, very finely-crystalline, silty

limestone about 2 feet thick (Fig. 22).

Small brachiopods are common near the middle and top of the member. On the outcrop the Drum contains local concentrations of algal material in the form of thin stringers of translucent calcite, slightly convex upward, which are very similar to those described by Harbaugh in the Plattsburg Limestone (1959, p. 303). Fenestrate bryozoa, crinoid columnals and the pelecypod Myalina are common throughout the limestone. Figure 23 is a peel print of limestone from the middle of the Cement City at Locality 2 in $SW\frac{1}{4}SW\frac{1}{4}SE\frac{1}{4}$ sec. 18, T. 31 S., R. 18 E.

Chanute Shale

Only a few feet of the basal part of the Chanute Shale (Haworth and Kirk, 1894, p. 109) are exposed in the area. The formation is seen only overlying the Drum Limestone on the erosional outliers in T. 31 S., R. 17 and 18 E. The maximum thickness of the Chanute exposed in the county is about 30 feet.

Light-tan to gray, sandy to silty, laminated shale is characteristic of the lower 20 feet of the Chanute. Lenses of brownish tan, very fine-grained, thick-bedded sandstone are seen in this lower zone at most outcrops.

The upper 10 feet of the exposed part of the Chanute consists of lenticular bodies of very fine-grained, very thick-bedded, silty, quartzose sandstone. These lenses are interbedded in silty shale similar to that of the basal part of the formation.

That part of the Chanute Shale present in LaBette County appears to be correlative with the Noxie Sandstone Member (Newell, 1932, p. 92)



Fig. 22.--Typical exposure of Drum Limestone at Locality 2, SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 18, T. 31 S., R. 18 E.

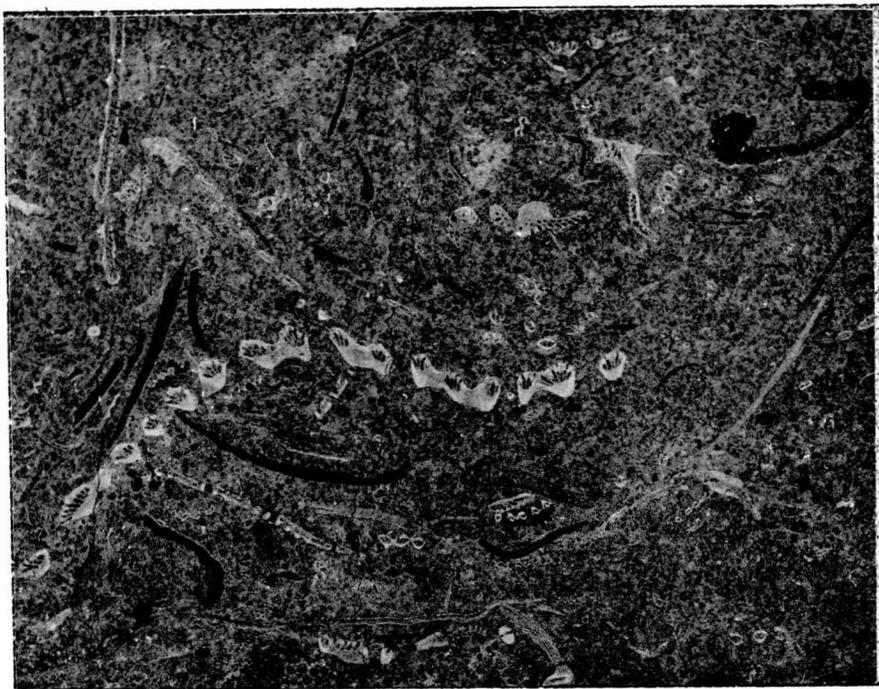


Fig. 23.--Peel print of limestone from middle of Cement City(?)
Limestone Member of Drum Limestone at Locality 2, SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 18, T. 31 S., R. 18 E. X4

found locally at the base of the formation to the north in Neosho County (Jungmann, in review).

NEOGENE SYSTEM--PLEISTOCENE SERIES

Lower Pleistocene Subseries

Kansan(?) Stage

Deposits of medium, angular to subrounded chert pebbles in a matrix of reddish-brown clay are found locally along Neosho River in eastern Labette County. Thickness of these deposits is generally less than 3 feet. The areal extent of these deposits is limited to several erosional remnants of a few hundred square feet each. Because of the small areal extent of the deposits, they are not mapped on Plate 1.

The age of these deposits is tentatively given as Kansan. This age designation is based on their altitude above the flood plain of Neosho River, *i.e.*, about 30 feet, and general lithologic nature. These deposits appear to be quite similar to those of the Emporia Terrace (Moore, Jewett, and O'Connor, 1951, p. 6) in the vicinity of Emporia, Lyon County, Kansas. Also, the author and other members of the Kansas Geological Survey have traced the Emporia Terrace surface along Neosho River from near the type area in Lyon County to the southern boundary of Kansas. This surface is generally from 20 to 30 feet above the flood plain. Therefore, until further work in correlation of the Pleistocene deposits of Neosho River valley is done, or definite paleontologic evidence to the contrary is found, it does not seem unreasonable to tentatively identify these deposits as Kansan in age.

Upper Pleistocene Subseries

Illinoisan Stage

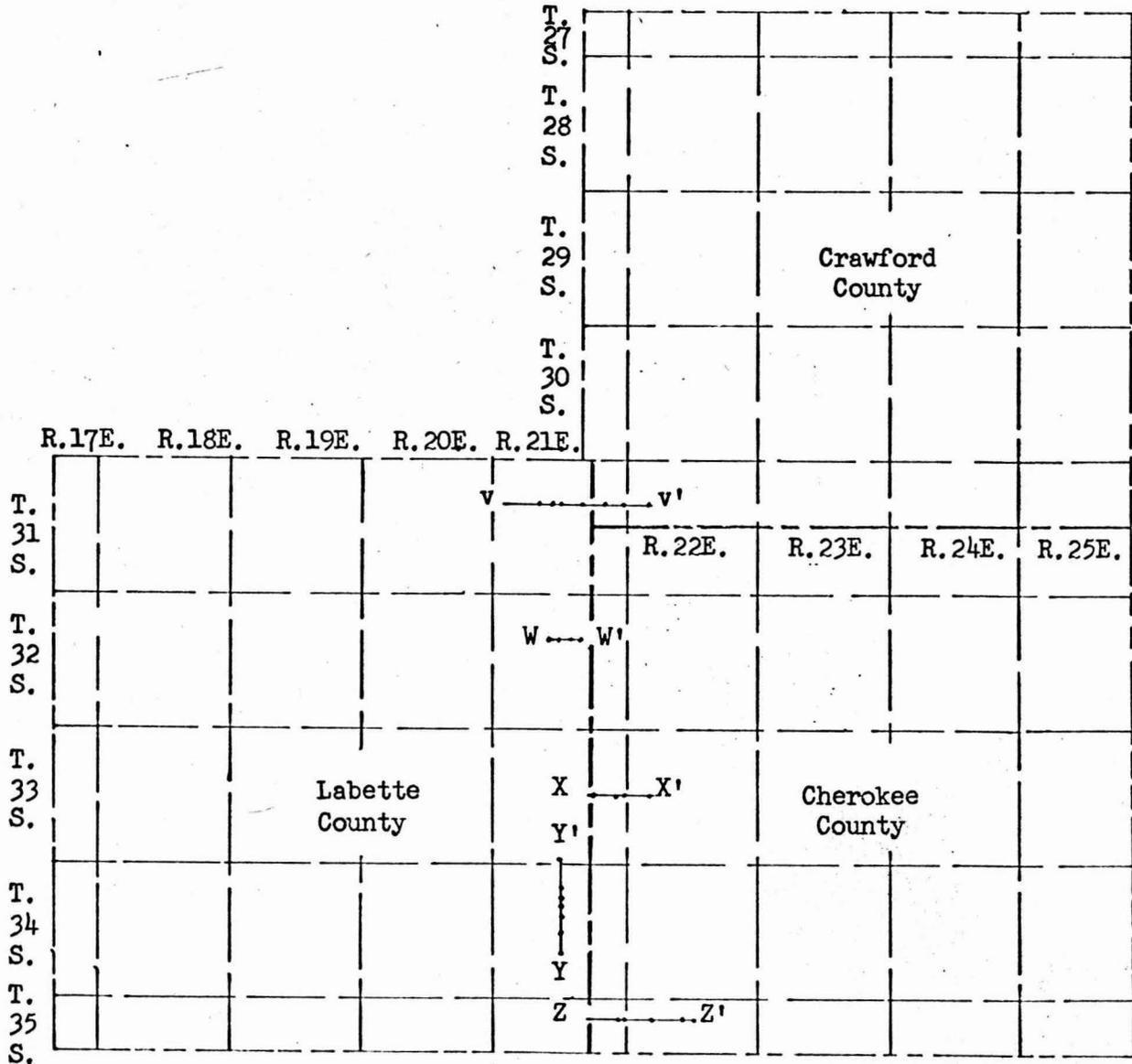
The most conspicuous geomorphic feature in Neosho River valley, exclusive of the present flood plain, is a discontinuous terrace with 8 to 15 feet of relief above the flood plain. The terrace is also evident along parts of Labette Creek in the eastern part of the area and in Big Hill Creek in western Labette County. Deposits comprising this terrace are considered as Illinoisan in age and are shown on Plate 1 as Nti.

The terrace surface, although discontinuous, has been traced from the type area of the Wiggam Terrace (O'Connor and others, 1953, p. 6) of Illinoisan age in Lyon County to the southern boundary of Kansas by the author and other members of the Kansas Geological Survey. As yet no paleontologic evidence has been found which can be used to date the terrace more precisely.

As the valley of Neosho River includes parts of Crawford and Cherokee counties in this area of Kansas, reconnaissance for mapping purposes and test-hole drilling for stratigraphic information was performed in both these counties. Therefore, the cross sections in Figures 25, 26, 27, and 29 necessarily are extended beyond the eastern boundary of Labette County. An index map showing the locations of the geologic cross sections is given in Figure 24.

Thickness of the deposits ranges from 7 feet (Fig. 25) to as much as 36 feet in test hole 33-22-20bb (Fig. 27). However, the most commonly observed thickness is about 20 feet.

Fig. 24.--Index map showing location of cross sections shown on Figures 25, 26, 27, 28, and 29.



In general, the terrace deposits are composed of a basal deposit of fine to medium chert pebbles in a matrix of tan silt containing much clay which is overlain by a layer of tan to gray silt containing large amounts of included clay. Thickness of the gravel layer ranges from a few inches to as much as 12 feet as in test hole 32-21-10dd (Fig. 26). Locally, as in test hole 33-21-33dd located north of Labette Creek (Fig. 28) chert pebbles are found distributed throughout the terrace deposits. It is likely that this is a result of an abundance of chert in a local source area such as the outcrop of Fort Scott Limestone.

Wisconsinan and Recent Stages

Deposits of Recent Age in Labette County are limited to bar accumulations in present stream channels and a thin, discontinuous veneer of sediments on the flood plain of the stream valleys. Deposits of Wisconsinan age are those sediments lying between the flood plain and the bedrock floor of the valley. For purposes of discussion in this report, deposits of Recent and Wisconsinan Ages are considered together.

Thickness of the deposits ranges from 19 feet at test holes 31-21-16ab and 34-21-15bc (Fig. 25) to about 33 feet as in test holes 32-21-9cd (Fig. 26) and 33-21-14dc (Fig. 27). The average thickness is about 25 feet.

Lithology of the Wisconsinan and Recent material is practically indistinguishable from that of the Illinoian terrace deposits. In general, however, the younger deposits contain slightly more sand and

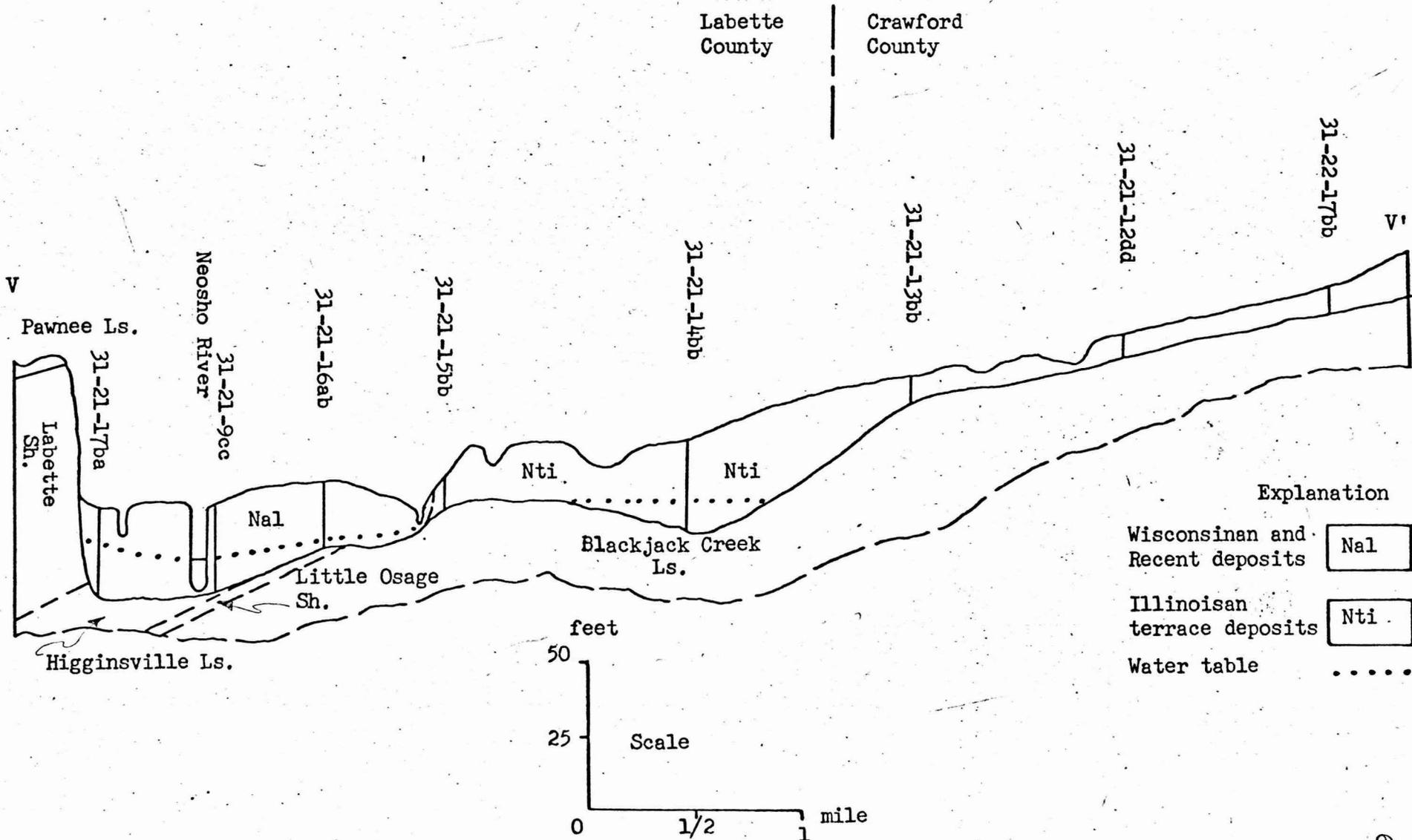


Fig. 25.--Geologic cross section V-V' showing Pleistocene deposits along Neosho River in northeastern Labette county.

Fig. 26.--Geologic cross section W-W' showing Pleistocene deposits along Neosho River east of Montana, Labette County.

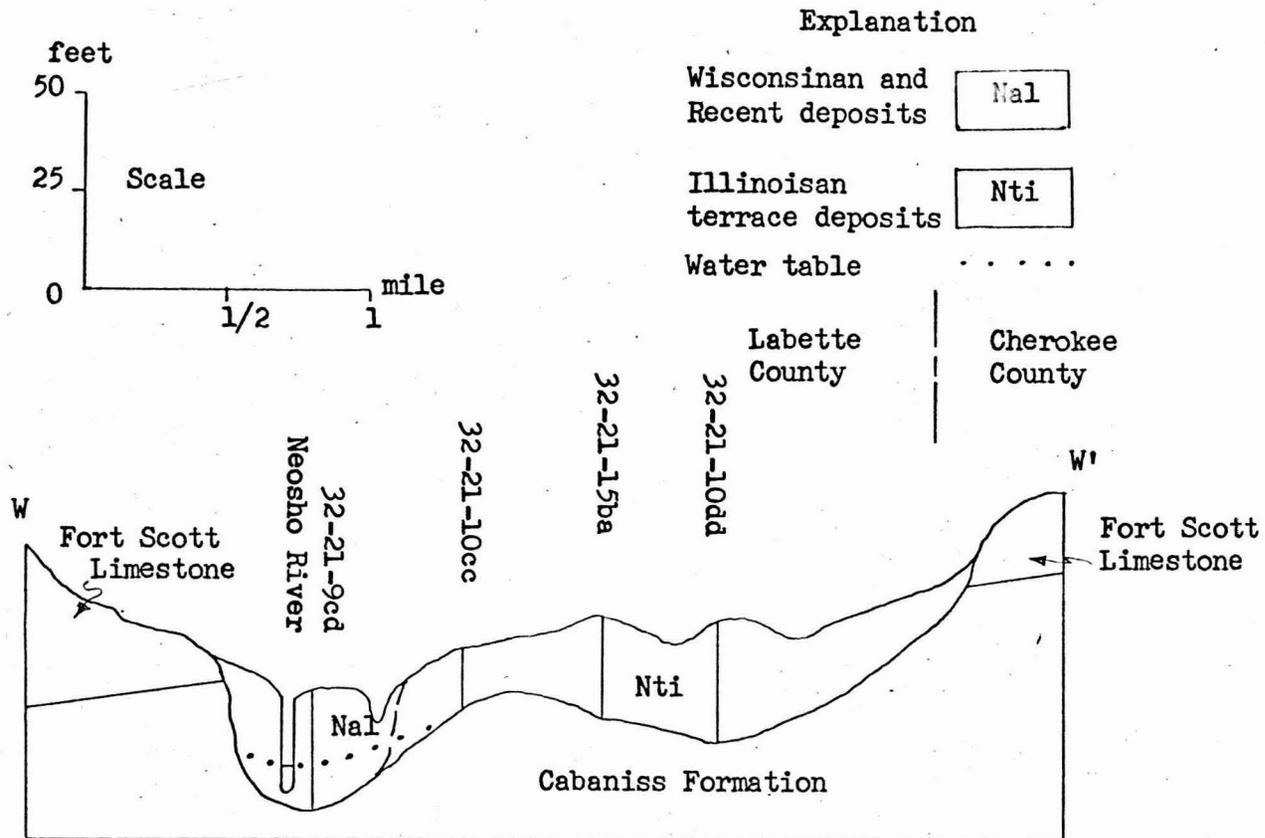


Fig. 27.--Geologic cross section X-X' showing Pleistocene deposits along Neosho River east of Oswego, Labette County.

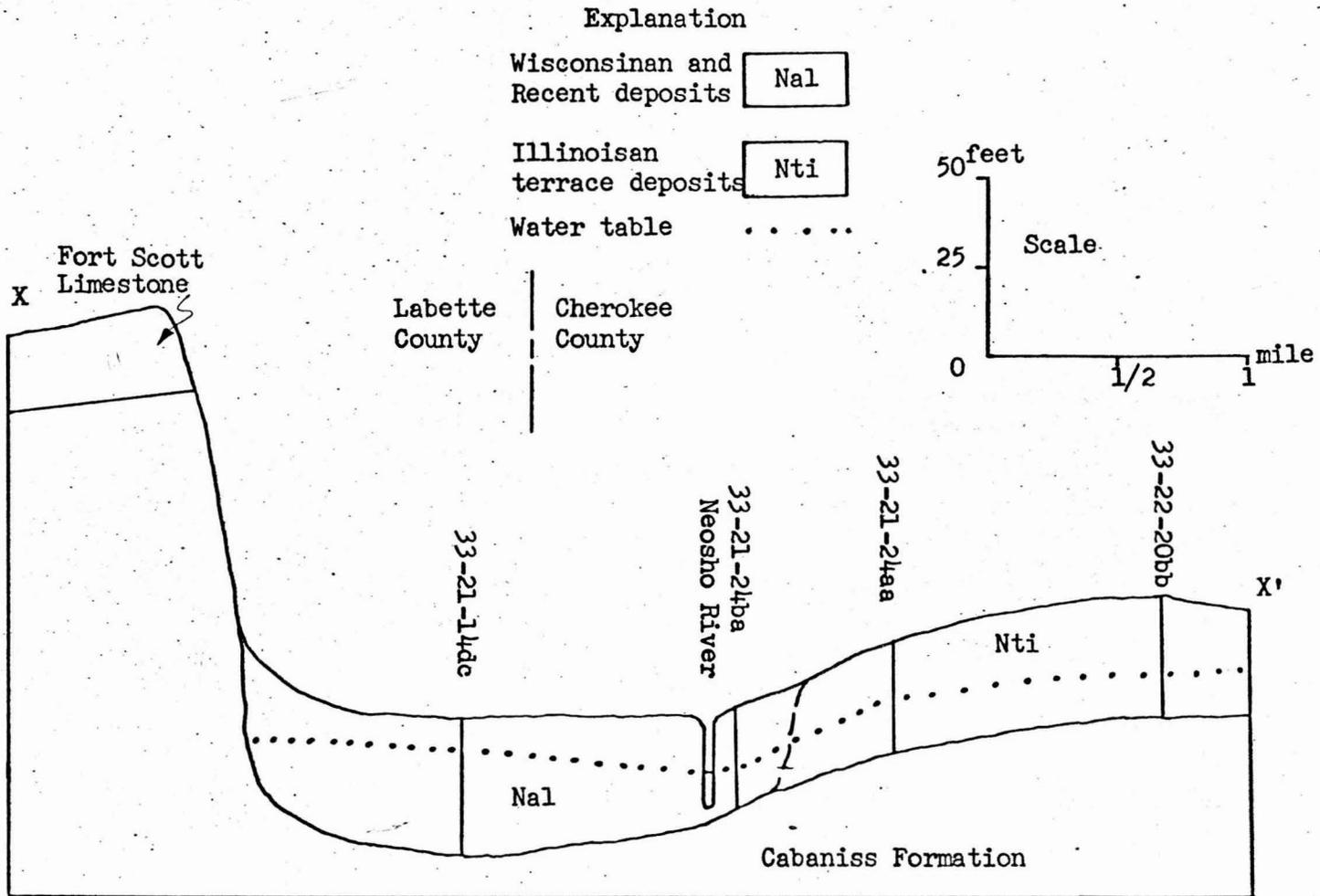


Fig. 28.--Geologic cross section Y-Y' showing Pleistocene deposits along Labette Creek north of Chetopa, Labette County.

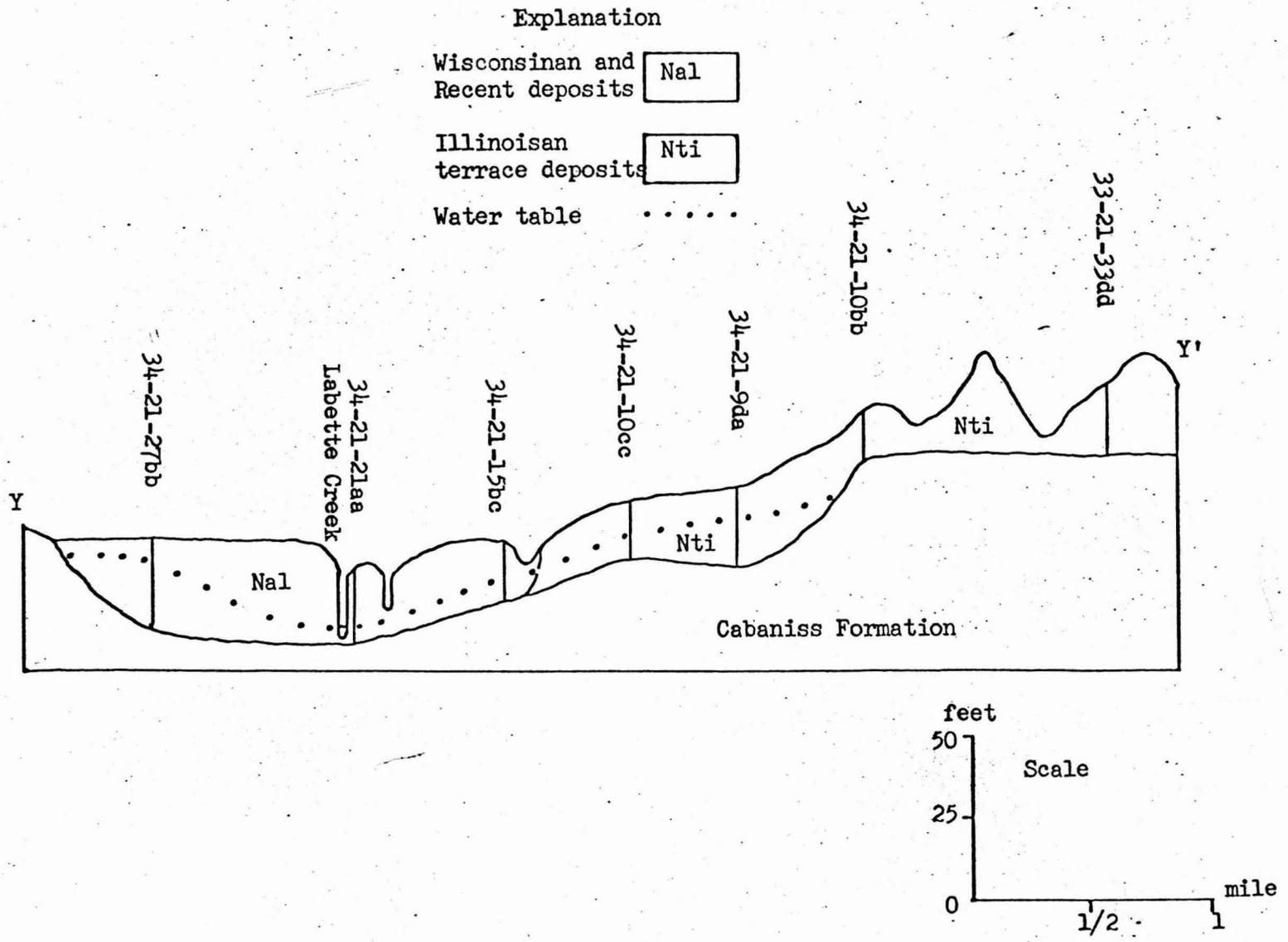
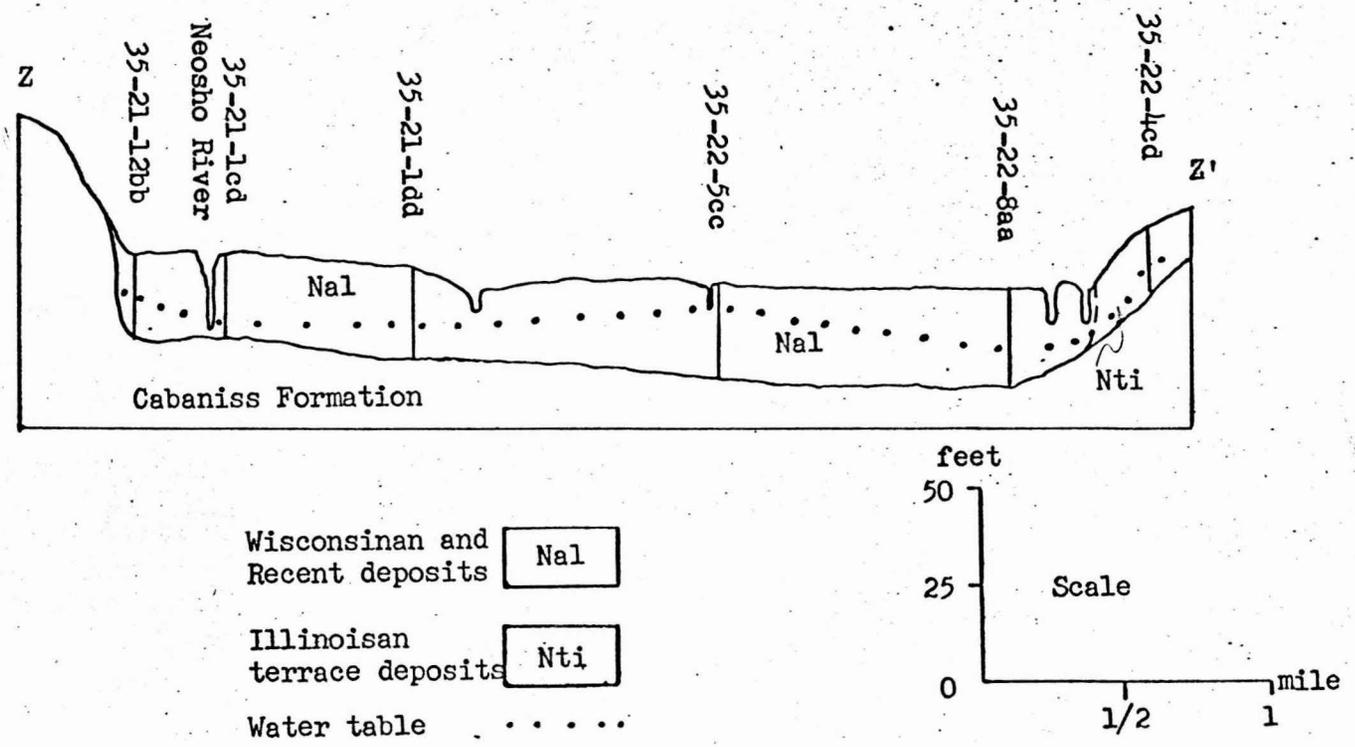


Fig. 29.--Geologic cross section Z-Z' showing Pleistocene deposits along Neosho River east of Chetopa, Labette County



coarse chert pebbles and less clay and silt than do the Illinoisan deposits. This is evident from the sample logs in Appendix II and is also inferred from the fact that water wells drilled in Wisconsinan and Recent deposits generally yield more water than do wells in the Illinoisan deposits.

STRUCTURAL GEOLOGY

REGIONAL STRUCTURE

The geologic structure which is most conspicuous in Labette County is the Prairie Plains Monocline (Prosser and Beede, 1904, p. 5) of post-Permian age. This structure imparts a northwest dip of about 25 feet per mile to Pennsylvanian rocks of the county.

The Cherokee Basin, a northward extension of the McAlester Basin of Oklahoma, does not affect the attitude of the bedrock in the county. However, the gently southward sloping floor of this basin is thought to be primarily responsible for the general increase in thickness of Pennsylvanian rocks from north to south in the county.

LOCAL STRUCTURE

Only minor departures from the regional dip are seen in Labette County except in the vicinity of Mound Valley. Here, near Locality 26 in $S\frac{1}{2}SW\frac{1}{4}NW\frac{1}{4}$ sec. 1, T. 33 S., R. 18 E., the Lenepah Limestone dips about $10^{\circ}SW$.

The apparent anticlinal structures in T. 34 S., R. 18 E., and R. 19 E. (Plate 1) are erosional features. Here the gradients of the several streams in the area are parallel, or nearly so, to the regional dip. Minor positive flexures in the Altamont Limestone, almost unmeasurable in the field, have been eroded to expose the underlying Bandera Shale.

REFERENCES

- Adams, G. I., 1896, A geologic section from Galena to Wellington, Kansas: Kansas Univ. Geol. Survey, v. 1, p. 16-30.
- _____, 1904, Economic geology of the Iola quadrangle, Kansas: U.S. Geol. Survey Bull. 238, p. 1-83, maps.
- _____, Girty, G. H., and White, David, 1903, Stratigraphy and paleontology of the upper carboniferous rocks of the Kansas section: U.S. Geol. Survey Bull. 211, p. 1-123.
- Bennett, J., 1896, Geologic section along the Missouri Pacific Railway from State line, Bourbon County, to Yates Center: Kansas Univ. Geol. Survey, v. 1, p. 86-98.
- Broadhead, G. C., 1866, Coal measures in Missouri: St. Louis Acad. Sci. Trans., v. 2, p. 311-333.
- Cline, L. M., 1941, Traverse of upper Des Moines and lower Missouri series from Jackson County, Missouri, to Appanoose County, Iowa: Am Assoc. Petrol. Geologists Bull. v. 25, no. 1, p. 23-72.
- _____, and Greene, F. C., in J. G. Grohskopf and Earl McCracken 1949: Missouri Geol. Survey and Water Resources Report Inv. 10, p. 1-39.
- Dott, R. H., 1928, Pennsylvanian paleogeography: Oklahoma Geol. Survey Bull. 40, v. 1, p. 51-69.
- Dunbar, C. O., and Rodgers, John, 1957, Principles of stratigraphy: John Wiley and Sons, New York, p. 1-356.
- Emery, P. A., 1962, Stratigraphy of the Pleasanton Group in Bourbon, Neosho, Labette and Montgomery counties, Kansas: Unpublished masters thesis, Univ. of Kansas.
- _____, Hatcher, D. A., and Jewett, J. M., The Pleasanton Group in Kansas: Kansas Geol. Survey Bull., in review.
- Greene, F. C., 1933, Oil and gas pools of western Missouri: Missouri Bur. Geol. and Mines, 57th biennial report, appendix 2, p. 1-68.
- Harbaugh, J. W., 1959, Marine bank development in Plattsburg Limestone (Pennsylvanian), Neodesha-Fredonia area, Kansas: Kansas Geol. Survey Bull. 134, pt. 8, p. 291-331.
- Haworth, E., 1898, Special report on coal: Kansas Geol. Survey, v. 3, p. 1-347.

- _____, and Bennett, J., 1908, History of geologic field work in Kansas: Kansas Univ. Geol. Survey, v. 9, p. 42-56.
- _____, and Kirk, M. Z., 1894, A geologic section along the Neosho River from the Mississippian formation of the Indian Territory to White City, Kansas: Kansas Univ. Quart. 2, p. 104-115.
- Hinds, Henry, 1912, Coal deposits of Missouri: Missouri Bur. Geol. and Mines, 2nd series, V. 11, p. 1-503.
- _____, and Greene, F. C., 1915, The stratigraphy of the Pennsylvanian Series in Missouri: Missouri Bur. Geol. and Mines, 2nd series, v. 13, p. 1-407.
- Howe, Wallace, 1956, Stratigraphy of pre-Marmaton Desmoinesian (Cherokee) rocks in southeastern Kansas: Kansas Geol. Survey Bull. 123, p. 1-132.
- Ingram, R. L., 1954, Terminology for the thickness of stratification and parting units in sedimentary rocks: Geol. Soc. Amer. Bull. v. 65, p. 937-938.
- Jewett, J. M., 1932, Brief discussion of the Bronson Group in Kansas: Kansas Geol. Soc. Guidebook, 6th Annual Field Conference, p. 99-104.
- _____, 1940, Oil and gas in Linn County, Kansas: Kansas Geol. Survey Bull. 30, p. 1-29.
- _____, 1941, Classification of the Marmaton Group in Kansas: Kansas Geol. Survey Bull. 38, pt. 11, p. 285-344.
- _____, 1945, Stratigraphy of the Marmaton Group, Pennsylvanian, Kansas: Kansas Geol. Survey Bull. 58, p. 1-148.
- Jungmann, W. L., Geology and ground-water resources of Neosho County, Kansas: Kansas Geol. Survey Bull., in review.
- McKee, E. D., and Weir, G. W., 1953, Terminology for stratification in sedimentary rocks: Geol. Soc. Amer. Bull., v. 64, p. 381-389.
- _____, 1949, Divisions of the Pennsylvanian System in Kansas: Kansas Geol. Survey Bull. 83, p. 1-203.
- Moore, R. C., 1936, Stratigraphic classification of the Pennsylvanian rocks of Kansas: Kansas Geol. Survey Bull. 22, p. 1-256.
- _____, Frye, J. C., Jewett, J. M., Lee, Wallace, and O'Connor, H. G., 1951, Kansas Rock Column: Kansas Geol. Survey Bull. 89, p. 1-132.

- _____, Jewett, J. M., and O'Connor, H. G., 1951, Rock formations of Chase County, Kansas: Kansas Geol. Survey, v. 11, pt. 1, p. 1-16.
- Morgan, G. D., 1923, Oklahoma Geol. Survey Cir. 12 in Stonewall Quadrangle, Pontotoc County.
- Newell, N. D., 1932, A reclassification of the Pennsylvanian System in the northern midcontinent region, in Moore, R. C., 1932: Kansas Geol. Soc. Guidebook, 6th Annual Field Conference, p. 79-98.
- _____, 1935, Geology of Johnson and Miami counties, Kansas: Kansas Geol. Survey Bull. 21, pt. 1, p. 1-150.
- Oakes, M. C., 1940, Geology and mineral resources of Washington County, Oklahoma: Oklahoma Geol. Survey Bull. 62, p. 1-208.
- _____, 1953, Krebs and Cabaniss groups of Pennsylvanian age in Oklahoma: Am. Assoc. Petrol. Geol. Bull., v. 37, p. 1523-1526.
- _____, and Jewett, J. M., 1943, Upper Desmoinesian and Lower Missourian rocks in northeastern Oklahoma and southeastern Kansas: Am. Assoc. Petrol. Geol. Bull. v. 27, p. 632-640.
- O'Connor, H.G., Geology and ground-water resources of Montgomery County, Kansas: Kansas Geol. Survey Bull., in preparation.
- _____, Goebel, E. D., and Plummer, Norman, 1953, Geology, mineral resources, and ground-water resources of Lyon County, Kansas: Kansas Geol. Survey, v. 12, p. 1-59.
- Chern, D. W., 1910, Stratigraphy of the older Pennsylvanian rocks of northeastern Oklahoma: Oklahoma State Univ. Research Bull. 4, p. 1-40, map.
- Payne, T. G., 1942, Stratigraphical analysis and environmental reconstruction: Am. Assoc. Petrol. Geol. Bull., v. 26, p. 1697-1770.
- Pierce, W. G., and Courtier, W. H., 1935, Englevale channel sandstone of Pennsylvanian age, southeastern Kansas: Am. Assoc. Petrol. Geol. Bull., v. 19, no. 7, p. 1061-1068.
- Searight, W. V., and others, 1953, Classification of the Desmoinesian (Pennsylvanian) of the northern Midcontinent: Am. Assoc. Petrol. Geol. Bull., v. 37, p. 2747-2749.
- Seevers, W. J., Geology and ground-water resources of Cherokee County, Kansas: Kansas Geol. Survey Bull., in preparation.

- _____, and Jungmann, W. L., 1963, Terrace development-Marais des Cygnes and Neosho River valleys: Kansas Acad. Sci. Trans., v. 66, no. 3, p. 393-397.
- Swallow, G. C., 1866, Preliminary report of the Geological Survey of Kansas, p. 1-198.
- Taff, J. A., 1901, U.S. Geological Survey Coalgate Folio no. 74.
- Tilton, J. L., and Bain, H. F., 1897, Geology of Madison County, Iowa: Iowa Geol. Survey, v. 7, p. 489-539.
- Woodruff, E.G., and Cooper, C. L., 1928, Geology of Rogers County, Oklahoma: Oklahoma Geol. Survey Bull. 40-J, p. 1-24, and geologic map by C. D. Smith

APPENDIX I

DESCRIPTIONS OF MEASURED SECTIONS

Measured sections in the following appendix are arranged in order according to section, township, and range. Those sections which have been included in the text have been so noted, e.g., Locality 49, in text, page 28.

Locality 1, NW NW NW sec. 16, T. 31 S., R. 18 E. (Measured by J. M. Jewett; reexamined by author.)

	Thickness, feet
Dennis Limestone	
Winterset Limestone Member	
Limestone, light-gray, weathers grayish-tan, very finely-crystalline, thin- to medium-bedded, some gray chert	5.0
Stark Shale Member	
Shale, black, platy to fissile, gray shale at top with phosphatic nodules	2.0
Carville Limestone Member	
Limestone, dark-gray with light-gray mottling, thick-bedded	2.0
Galesburg Shale	
Sandstone, tan, silty at top with fragments of crinoids and fenestrate bryozoans	5.0
Sandstone, brownish-red, very fine- to medium- grained, medium-bedded, small-scale ripple marks	4.0

Locality 2, SW SW SE sec. 18, T. 31 S., R. 18 E.

	Thickness, feet
Chanute Shale	
Noxie(?) Sandstone Member	
Shale, light-tan, silty and sandy, some thick-bedded lenticular sandstone near top	30.0
Drum Limestone	
Cement City(?) Limestone Member	
Limestone, brown, weathers dark-brown, finely- crystalline, algal, many brachiopods	1.8
Cherryvale Shale	
Shale, gray, silty, platy; about 3 feet of thin-bedded, very fine-grained sandstone near base	70.0
Dennis Limestone	
Winterset Limestone Member	
Limestone, light-gray, cherty (a few inches exposed)	

Locality 3, NW SW NW sec. 22, T. 31 S., R. 18 E.

	Thickness, feet
Dennis Limestone	
Winterset Limestone Member	
Limestone, light tan, weathers dark brown, silty, medium-bedded; crinoid columnals, spiriferid and chonetid brachiopods	2.5

Stark Shale		
Shale, dark-gray to black, platy		1.0
Carville Limestone		
Limestone, dark-gray, semi-lithographic, conchoidal fracture		1.0
Galesburg Shale		
Shale, dark-gray, platy, weathers into long splinters		2.5
Shale, light-tan, silty, slightly calcareous		2.0
Shale, light-gray, silty, calcareous		2.0
Locality 4, SW SW SE sec. 29, T. 31 S., R. 18 E.		
		Thickness, feet
Galesburg Shale		
Dodds Creek Sandstone Member		
Sandstone, brown, very fine- to medium-grained, very thick-bedded		14.0
Sandstone, brownish-red, very fine-grained, thin-bedded		5.0
Sandstone, brown, thin-bedded; yellowish-brown, silty shale at top		5.0
Sandstone, brownish-red, medium-bedded; tan, silty shale at top		2.0
Sandstone, brownish-red, very thick-bedded, tan, silty shale at top		5.0
Sandstone, brownish-red, very thick-bedded, some cross-bedding; gray, silty shale at top		5.0

Unnamed shale		
Shale, yellowish gray, micaceous, silty, thinly laminated		5.0
Shale, gray, micaceous; silty and sandy near top		11.0
Swope Limestone		
Bethany Falls Limestone Member		
Limestone, light-gray, weathers tan, very thin-bedded, crinoidal		0.5
Shale, grayish-tan, calcareous		0.5
Limestone, grayish-tan, medium- to coarsely-crystalline, medium-bedded		1.2
Shale, tan		0.1
Limestone, gray, weathers tan, thick-bedded, crinoidal, some bluish-gray chert near top		2.0
Locality 5, NE NE ^{N, see P. 51} SW sec. 32, T. 31 S., R. 18 E.		
		Thickness, feet
Galesburg Shale		
Sandstone, brownish-red, very fine- to medium-grained, laminated to very thick-bedded		40.0
Swope Limestone		
Bethany Falls Limestone Member		
Limestone, light-gray, weathers tan, very finely- to medium-crystalline, thin-bedded, some chert near base and in middle		11.0

Ladore Shale		
Shale, yellowish-gray, some silt near top, limonitic concretions common throughout		22.0
Locality 6, NE NE NW sec. 2, T. 31 S., R. 19 E.		
		Thickness, feet
Hertha Limestone		
Limestone, light-gray, weathers yellowish-tan, medium-crystalline; many crinoid columnals and small brachiopods		2.5
Tacket Formation		
Upper shale member		
Shale, light greenish-gray		0.5
Shale, black, fissile to blocky		6.0
Middle limestone member		
Limestone, dark-gray to black, weathers yellowish- brown, very finely-crystalline, silty, nodular		1.0
Lower shale member		
Shale, black, fissile to blocky, limonite staining on bedding planes		12.0
(lower 8 feet not well seen)		
Locality 7, west line of sec. 19, T. 31 S., R. 19 E.		
		Thickness, feet
Galesburg Shale		
Sandstone, brown, thin-bedded to laminated, slightly silty		14.0
Shale, brownish-yellow, silty and sandy, blocky		8.0

Locality 8, NE NE NE sec. 21, T. 31 S., R. 19 E.

Thickness,
feet

Hertha Limestone

Critzer Limestone Member

Limestone, gray, weathers yellowish-tan, medium-crystalline, some transparent calcite stringers, crinoid columnals	2.5
Shale, yellowish-gray, flaky, calcareous	0.5
Limestone, gray, weathers tan, thin-bedded, earthy	1.5
Limestone, gray, weathers brown, medium-crystalline, thick-bedded; <u>Marginifera</u> , crinoid columnals common	1.5

Tacket Formation

Upper shale member

Shale, grayish-tan, flaky	0.7
Shale, black, platy to fissile, gray at top	5.5

Middle limestone member

Limestone, dark-gray, weathers tan, very finely-crystalline, silty, nodular	1.0
---	-----

Lower shale member

Shale, black, fissile to platy, limonite staining on bedding planes	12.0
---	------

Locality 9, SW SW NW sec. 26, T. 31 S., R. 19 E.

Thickness,
feet

Holdenville Shale

Shale, gray, silty to sandy, flaky to blocky	2.0
Coal, some small branches included	0.4

Shale, yellowish-gray, platy, slightly calcareous at bottom	2.0
Lenepah Limestone	
Idenbro Limestone Member	
Limestone, tan, weathers brownish-yellow, earthy, very finely-crystalline on fresh surfaces, nodular	1.9
Perry Farm Shale Member	
Shale, light-gray, platy, calcareous, limestone nodules at top	2.0
Nowata Shale	
Shale, gray, blocky	6.0
Locality 10, NW NW NE sec. 27, T. 31 S., R. 19 E.	
	Thickness, feet
Hertha Limestone	
Critzler Limestone Member	
Limestone, medium-gray, weathers tan, medium- crystalline, medium-bedded at top, thin-bedded at bottom; large crinoid columnals, brachiopods, bryozoa common; gray flaky shale parting near base	5.0
Tacket Formation	
Upper shale member	
Shale, light yellowish-tan, blocky, dictyoclostid brachiopods, pelecypods, productid spines, and small crinoid columnals common	0.6

Shale, black, blocky to platy, limonite staining, much carbonaceous material	10.5
Middle limestone member	
Limestone, dark bluish-gray, very finely-crystalline, silty, nodular	0.9
Lower shale member	
Shale, black, fissile, phosphatic nodules 0.5 inch in diameter	8.0
Siltstone, tan, slightly sandy, some tan shale	3.0
Covered interval	35.0
Siltstone, tan, some tan shale, few plant remains in lower part	5.0
Seminole Formation	
South Mound Shale Member	
Shale, black, fissile	1.5
Coal, clayey, some flattened branches	0.3
Shale, light-gray, platy to blocky	2.0
Hepler Sandstone Member	
Sandstone, gray, weathers brownish-red, calcareous cement, thin-bedded, slightly micaceous, sand, mostly very fine-grained quartz	2.0
Locality 11, NW NE NW sec. 17, T. 31 S., R. 21 E.	
	Thickness, feet
Pawnee Limestone	
Myrick Station Limestone Member	
Limestone, light-gray to light-tan, weathers buff,	

very finely- to medium-crystalline, medium-bedded, many crinoid columnals	3.0
Anna Shale Member	
Shale, light grayish-tan, flaky, silty, many <u>Mesolobus</u>	0.9
Shale, black, platy, fissile at top, small brachiopods (1-4 mm in diameter)	3.0
Limestone, medium-gray, weathers tan, silty, very finely-crystalline, few small brachiopods	0.2
Shale, grayish-tan, grades down into black, flaky, silty shale	0.6
Shale, black, phosphatic nodules, platy but blocky at bottom	2.0
Shale, light grayish-tan, silty, platy	6.0
Limestone, dark-gray, shaly, very finely-crystalline, crinoidal	0.7
Shale, grayish-tan, silty	0.3
Coal, vitrain conspicuous	0.4
Labette Shale	
Shale, brown and yellow variegated, blocky	15.0
Locality 12, SW SW SW sec. 26, T. 31 S., R. 21 E.	
	Thickness, feet
Fort Scott Limestone	
Blackjack Creek Limestone Member	
Limestone, light gray, weathers buff, very finely- crystalline, medium-bedded	6.0

Cabaniss Formation

Excello shale bed

Shale, black, blocky	10.0
----------------------	------

Unnamed sandstone

Sandstone, gray, weathers tan, thick-bedded	4.0
---	-----

Locality 13, NW NE NE sec. 7, T. 32 S., R. 18 E.

Thickness,
feet

Galesburg Shale

Sandstone, tan, silty, laminated	15.0
----------------------------------	------

Dodds Creek Sandstone Member

Sandstone, gray, weathers tan, very thick-bedded, fine-grained, well sorted	6.0
--	-----

Coal, some vitrain	0.5
--------------------	-----

Unnamed shale

Shale, grayish-tan, silty and sandy, laminated	6.0
--	-----

Shale, tan, sandy; some sandstone, lenticular, gray, weathers reddish-brown, very fine- to medium-grained, poorly sorted	15.0
--	------

Locality 14, SE SE sec. 27, T. 32 S., R. 18 E.

Thickness,
feet

Swope Limestone

Bethany Falls Limestone Member

Limestone, medium-gray, weathers yellowish-tan, medium-crystalline, uneven bedding	3.0
---	-----

Ladore Shale	
Shale, yellowish-gray to medium-gray, limonite staining, some lenticular coals 0.5 foot thick, fossil plants near base	60.0
Hertha Limestone	
Limestone, light-gray, finely-crystalline	0.4
Locality 15, SW NW SW sec. 34, T. 32 S., R. 18 E.	Thickness, feet
Swope Limestone	
Bethany Falls Limestone Member	
Limestone, gray, weathers tan, medium-crystalline, badly weathered	1.0
Ladore Shale	
Shale, tan, silty, platy, slightly calcareous; some lentils of very fine-grained quartzose sandstone near top	6.0
Shale, light-gray and tan, variegated, silty, platy	14.0
Locality 16, SE SE SE sec. 1, T. 32 S., R. 19 E.	Thickness, feet
Altamont Limestone	
Worland Limestone Member	
Limestone, gray, weathers reddish-brown, small concentrations of dark-gray, very finely- crystalline limestone in matrix of finely- crystalline limestone, thick- to very thick-bedded;	

many fragments of bryozoa, robust fusilinids, small dictyocestid brachiopods, large <u>Echinaria</u> , some minute pelecypods, stylolites common	12.0
Lake Neosho Shale Member	
Shale, black, platy to fissile, phosphatic nodules in upper 2 feet	5.0
Amoret Limestone Member	
Limestone, light-gray, very finely-crystalline, some isolated colonies of <u>Chaetetes</u>	6.0
Bandera Shale	
Shale, grayish-tan, silty	3.0
Sandstone, brownish-red, very fine-grained, flaggy	2.0
Locality 17, SW SW SW sec. 2, T. 32 S., R. 19 E.	
	Thickness, feet
Lenepah Limestone	
Idenbro Limestone Member	
Limestone, light-gray, wavy-bedded, chert nodules abundant	5.0
Perry Farm Shale Member	
Shale, tan to gray, greenish-gray at bottom, upper 2 feet calcareous with limestone nodules, blocky	9.0
Norfleet Limestone Member	
Limestone, dark-gray, very finely-crystalline, nodular, many shale partings between nodules, <u>Marginifera</u>	

fairly abundant	1.5
Nowata Shale	
Shale, tan to brown, blocky, calcareous, limestone nodules	2.0
Locality 18, SW SW SW sec. 4, T. 32 S., R. 19 E.	Thickness, feet
Hertha Limestone	
Limestone, light-tan, very finely-crystalline, dendritic manganese staining common, calcite cleavage faces give shiny fresh surface; weathers to a marly texture	0.8
Tacket Formation	
Shale, yellowish-tan, platy	0.3
Locality 19, SE SE SE sec. 4, T. 32 S., R. 19 E.	Thickness, feet
Seminole Formation	
Hepler Sandstone Member	
Sandstone, brownish-red, medium-bedded, fine-grained at base, very fine-grained at top, calcareous cement	4.0
Locality 20, SE SE SW sec. 7, T. 32 S, R. 19 E.	Thickness, feet
Ladore Shale	
Shale, gray, silty, calcareous	1.0

Hertha Limestone

Limestone, gray, weathers dark-brown, very finely-crystalline, thick-bedded at bottom, thin-bedded at top, many Echinaria

4.0

Tacket Formation

Upper shale member

Shale, gray, flaky

0.4

Shale, black, fissile, phosphatic nodules at bottom

20.0

Middle limestone member

Limestone, dark-gray, weathers brown, very finely-crystalline, nodular

0.8

Lower shale member

Shale, black, fissile

4.0

Covered interval

16.0

Shale, black, fissile

4.0

Checkerboard Formation

Upper limestone member

Limestone, dark-gray, weathers buff, silty, very finely-crystalline; high-spired gastropods, Derbyia, Composita, dictyoclostid brachiopods, abundant, nodular

0.8

Shale, light-tan, blocky, platy, slightly calcareous

0.3

Limestone, gray, very finely-crystalline, nodular

0.8

Middle shale member

Shale, gray, platy to blocky, not well seen

8.0

Cov 15

0.8

45.2 ft

CB

A?

119

5.3

Lower limestone member	
Limestone, gray, weathers reddish-brown, very finely-	
crystalline, gastropods, pelecypods, bryozoan	
fragments abundant	0.8
Seminole Formation	
South Mound Shale Member	
Shale, gray, platy, some silt	4.0
Covered interval	8.0
Hepler Sandstone Member	
Sandstone, gray, weathers reddish-brown, very fine-	
grained, some limonitic cement, laminated,	
quartzose	2.0
Locality 21, SW SW NW sec. 19, T. 32 S., R. 19 E.	Thickness,
	feet
Tacket Formation	
Lower shale member	
Shale, black, platy	30.0
Checkerboard Limestone	
Lower limestone member	
Limestone, brown, weathers tan, very finely-	
crystalline	0.75
Limestone, light-brown, some dark-gray zones,	
very finely-crystalline; many small brachiopods,	
some small crinoid columnals	0.8

Locality 22, NE NE NW sec. 20, T. 32 S., R. 19 E.		Thickness, feet
Seminole Formation		
Hepler Sandstone Member		
Sandstone, reddish-brown, blocky, very fine-grained, quartzose		2.0
Holdenville Shale		
Shale, light grayish-green to yellowish-tan, silty, blocky		8.0
Locality 23, SW SW SW sec. 28, T. 32 S., R. 19 E.		Thickness, feet
Holdenville Shale		
Shale, light-gray, platy, slightly silty		4.0
Lenepah Limestone		
Idenbro Limestone Member		
Limestone, gray, weathers yellowish-gray, thick- bedded, very finely-crystalline		10.0
Locality 24, NE NE NE sec. 8, T. 32 S., R. 21 E. (Measured by J. M. Jewett; reexamined by author.)		Thickness, feet
Fort Scott Limestone		
Higginsville Limestone Member		
Limestone, light-gray, very finely- to medium- crystalline, thin-bedded, many brachiopods		3.0
Little Osage Shale Member		
Shale, black, fissile, top 1.5 feet, light gray		5.0

Blackjack Creek Limestone Member	
Limestone, medium-gray, medium-bedded, medium-crystalline; many colonies of <u>Chaetetes</u>	12.0
Locality 25, NW SW SW sec. 33, T. 32 S., R. 21 E.	
	Thickness, feet
Fort Scott Limestone	
Blackjack Creek Limestone Member	
Limestone, gray, thin, undulating beds, upper part covered	1.0
Limestone, brownish-gray, weathers yellowish-brown, thick-bedded, <u>Composita</u> , crinoid columnals, and fusulinids abundant	2.0
Cabaniss Formation	
Excello shale bed	
Shale, black, platy to fissile, abundant phosphatic concretions, some pyritized, upper 0.5 foot yellow clay	4.0
Unnamed shale	
Shale, yellow, calcareous with limestone concretions	0.5
Breezy Hill Limestone Member	
Limestone, buff, weathers brown, sandy	1.5
Unnamed siltstone	
Siltstone, gray, sandstone nodules with calcareous cement at top	2.0
Unnamed sandstone	
Sandstone, tan, fine-grained, thick-bedded	2.0

Locality 26, SW SW NW sec. 1, T. 33 S., R. 18 E.

Thickness,
feet

Lenepah Limestone

Idenbro Limestone Member

Limestone, light- to dark-gray, medium-crystalline,
weathers to earthy texture; dictyoclostid brachiopods
common

6.0

Perry Farm Shale Member

Shale, yellowish-tan, silty, calcareous, laminated

7.0

Norfleet Limestone Member

Limestone, light-gray, weathers yellowish-tan,
medium-crystalline, very thick-bedded; dictyoclostid
brachiopods common

4.0

Nowata Shale

Shale, black, fissile, compressed dictyoclostid
brachiopods

2.0

Shale, tan, blocky, calcareous

4.5

Altamont Limestone

Worland Limestone Member

Limestone, light-gray, weathers very light gray,
very finely-crystalline with coarsely-crystalline
stringers of calcite, hummocky surface developed
on weathered upper surface

1.0

Locality 27, SE SE NE sec. 5, T. 33 S., R. 18 E.

	Thickness, feet
Ladore Shale	
Shale, light greenish-gray, silty, flaky	4.0
Hertha Limestone	
Limestone, dark-gray, weathers tan, very finely- crystalline, nodular	0.4
Tacket Formation	
Upper shale member	
Shale, brownish-black, silty, flaky	3.0
Shale, dark-gray to black, conchoidal fracture on fresh surfaces, weathers platy	8.0

Locality 28, center north line of sec. 19, T. 33 S., R. 18 E.

	Thickness, feet
Ladore Shale	
Shale, gray, limonitic concretions (not well seen)	10.0
Hertha Limestone	
Limestone, brownish-gray, weathers brown, irregular contact at base, medium-crystalline, weathers to earthy texture	0.5
Tacket Formation	
Upper shale member	
Shale, gray, silty	3
Shale, black, blocky to fissile	1.5

Middle limestone member		
Limestone, dark-gray, very finely-crystalline, nodular		0.5
Lower limestone member		
Shale, black, fissile, limonite staining on bedding planes		2.0
Covered interval		12.0
Shale, black, fissile		1.0
Checkerboard Limestone		
Lower limestone member		
Limestone, dark-gray, weathers brown, very finely- crystalline, stringers of very finely crystalline calcite. silt nodules about 1.0 inch in diameter throughout; many high-spired gastropods		0.5
Seminole Formation		
South Mound Shale Member		
Shale, medium-gray, flaky, some flattened siltstone nodules		3.0
Shale, black, blocky		3.0
Locality 29, SW SW SE sec. 23, T. 33 S., R. 18 E.		
		Thickness, feet
Lenepah Limestone		
Norfleet Limestone Member		
Limestone, light-gray with light-brown mottling, finely-crystalline, laminated; a few small brachiopods and crinoid columnals seen		1.0

Nowata Shale	
Shale, dark-gray, platy, vertical joints prominent	2.5
Locality 30, NW NW SW sec. 27, T. 33 S., R. 18 E.	
	Thickness, feet
Checkerboard Formation	
Lower limestone member	
Limestone, medium-gray, weathers dark-gray, medium- bedded, medium-crystalline; locally, a coquina of crinoid columnals, brachiopods and high-spired gastropods	6.0
Seminole Formation	
South Mound Shale Member	
Shale, light yellowish-tan, calcareous, limestone lentils	2.0
Covered interval (probably shale)	8.0
Hepler Sandstone Member	
Sandstone, light-tan, weathers brown, very fine- grained, silty, calcareous cement	1.0
Covered interval	6.0
Lenepah Limestone	
Idenbro Limestone Member	
Limestone, light-gray, weathers medium-gray, semi- lithographic	1.0

Locality 31, NW NW NW sec. 35, T. 33 S., R. 18 E. (Measured by J. M. Jewett; reexamined by author.)

	Thickness, feet
Nowata Shale	
Shale, black, fissile	1.5
Altamont Limestone	
Worland Limestone Member	
Limestone, dove-gray, weathers very light-gray, semi-lithographic, thin-bedded in lower 2.0 feet	6.0
Shale, gray, flaky	0.1
Limestone, dove-gray, very finely crystalline; some small brachiopods	6.0
Lake Neosho Shale Member	
Shale, gray, slightly calcareous, some brachiopods	0.5
Shale, black, platy to fissile	3.0

Locality 32, SW SW SW sec. 35, T. 33 S., R. 18 E.

	Thickness, feet
Lenepah Limestone	
Idenbro Limestone Member	
Limestone, light-gray, weathers grayish-tan, very finely-crystalline, iron oxide mottling on broken surfaces, thin-bedded; dictyoclostid brachiopods locally near base	3.0
Perry Farm Shale Member	
Shale, greenish-gray to tan, blocky; many dictyoclostid brachiopods and <u>Neospirifer</u> , badly compressed	9.5

Norfleet Limestone Member	
Limestone, dark-gray, weathers brownish-tan, very finely-crystalline, laminated, some transparent, very finely-crystalline calcite stringers	1.0
Nowata Shale	
Shale, black, fissile; dictyoclostid brachiopods at top	1.5
Shale, grayish-tan, slightly calcareous, silty, blocky	4.0
Altamont Limestone	
Worland Limestone Member	
Limestone, light-gray, weathers white, upper surface appears algal	1.0
Locality 33, NW NW SW sec. 5, T. 33 S., R. 19 E.	
	Thickness, feet
Altamont Limestone	
Worland Limestone Member	
Limestone, light-gray, weathers into nodular blocks (not well seen)	10.0
Lake Neosho Shale Member	
Shale, black, fissile, phosphatic nodules, a few inches of gray, flaky shale at top	3.0
Amoret Limestone Member	
Limestone, light gray, very finely-crystalline material filling voids between numerous colonies of <u>Chaetetes</u>	12.0

Locality 34, SW SW SW sec. 3, T. 33 S., R. 20 E.

Thickness,
feet

Pawnee Limestone

Myrick Station Limestone Member

Limestone, light-gray, weathers buff, very finely-crystalline; brachiopods, crinoid columnals and bryozoan fragments	4.0
Limestone, light-gray, weathers brown, earthy, tan clay parting above	0.7

Anna Shale Member

Shale, yellow, flaky, abundant <u>Mesolobus</u>	0.8
Shale, black, fissile	3.0
Limestone, gray, earthy, crinoidal	0.4
Shale, black, fissile	3.0
Shale, black, platy; ammonoid cephalopod 3 inches in diameter	3.0
Covered interval	5.0

Labette Shale

Limestone, gray, weathers buff, silty	0.6
Shale, tan, flaky	0.3
Limestone, brown, finely-crystalline, silty	0.4
Shale, tan, silty, some lenses of very fine-grained sandstone a few inches thick	2.0

Locality 35, NW NW NW sec. 22, T. 33 S., R. 20 E. (Measured by J. M. Jewett; reexamined by author.)

	Thickness, feet
Pawnee Limestone	
Laberdie Limestone Member	
Limestone, gray, thin undulating beds; <u>Chaetetes</u> , fusilinids	2.0
Limestone, light-gray, weathers tan, very finely- to medium-crystalline, thin undulating beds	2.0
Mine Creek Shale Member	
Shale, gray, flaky; <u>Punctospirifer</u> and <u>Hustedia</u> common	0.55
Myrick Station Limestone Member	
Limestone, dark-gray, weathers light-tan, laminated; abundant crinoid columnals	.25-0.5
Anna Shale Member	
Shale, gray, black mottling, flaky	2.2
Shale, black, fissile, phosphatic concretions	1.5
Shale, gray, platy to flaky	0.6

Locality 36, SW SW NW sec. 29, T. 33 S., R. 20 E.

	Thickness, feet
Pawnee Limestone	
Myrick Station Limestone Member	
Limestone, gray, medium-crystalline, much gray chert	4.0
Covered interval	5.0
Anna Shale Member	
Shale, gray and yellow variegated	1.5

	101
Shale, black, platy, phosphatic nodules	1.0
Limestone, brownish-gray, silty, laminated; crinoid columnals up to 1.0 inch in diameter	0.4
Shale, tan, earthy, almost lignitic	0.8
Coal, soft	0.2
Underclay, gray, plastic	0.2
Labette Shale	
Shale, brownish-gray, blocky	10.0
 Locality 37, NW NW SW sec. 29, T. 33 S., R. 20 E.	
	Thickness, feet
Pawnee Limestone	
Myrick Station Limestone Member	
Limestone, gray, cherty, rubbly	5.0
Anna Shale Member	
Shale, light greenish-gray, silty, sandy in top 3.0 feet, siltstone nodules throughout shale	20.0
 Locality 38, NW NW SW sec. 33, T. 33 S., R. 20 E.	
	Thickness, feet
Labette Shale	
Sandstone, tan to reddish-brown, fine-grained to very fine-grained, silty, laminated with yellow clay partings between laminations	3.0
Shale, light grayish-tan, silty and sandy, flaky to platy, some interbedded lenticular sandstone	20.0

Locality 39, in text, page 12.

Locality 40, SE NW NE sec. 21, T. 33 S., R. 21 E.

	Thickness, feet
Fort Scott Limestone	
Higginsville Limestone Member	
Limestone, medium-gray, weathers yellowish-tan; medium-crystalline, medium- to thick-bedded; abundant small brachiopods and crinoid columnals in upper part	3.0
Little Osage Shale Member	
Shale, yellowish-gray, silty, platy	0.7
Shale, gray, platy	0.2
Shale, yellowish-tan, silty, platy	0.5
Shale, dark-gray, tan stringers, platy	1.0
Shale, very dark-gray, platy to slabby, phosphatic concretions 0.5 to 3.0 inches in diameter	3.0
Shale, dark-gray, platy, sulphurous staining near base, lower 1.0 foot is earthy with no bedding seen	1.5
Blackjack Creek Limestone Member	
Limestone, light-gray, weathers tan, very finely- crystalline, top and middle weathers earthy; many small brachiopods, thick-bedded	8.0
Cabaniss Formation	
Excello shale bed	
Shale, black, platy	2.0

Locality 41, SE SW SW sec. 35, T. 33 S., R. 21 E.		
		Thickness, feet
Kansan(?) terrace deposits		
	Pebbles, medium to coarse, angular to subrounded, red clay matrix	3.0
Cabaniss Formation		
Unnamed shale		
	Shale, yellowish-tan, silty, some very fine-grained sandstone laminations	3.0
Verdigris Limestone Member		
	Limestone, dark-gray, weathers tan, very finely- crystalline	1.0
	Shale, gray, calcareous	0.2
	Limestone, gray, weathers tan, very finely- crystalline; <u>Mesolobus mesolobus</u> , crinoid fragments abundant	1.0
Unnamed shale		
	Shale, black, platy	6.0
Locality 42, NW NW NE sec. 7, T. 34 S., R. 16 E.		
		Thickness, feet
Lenepah Limestone		
Idenbro Limestone Member		
	Limestone, medium-gray, weathers tan, very finely- crystalline, medium-bedded, yellow clay partings between beds, coarsely-crystalline, vug-filling calcite common	5.0

Perry Farm Shale Member		
Shale, upper 6 feet covered; lower 8 feet, shale, grayish-green, blocky; limestone nodules containing <u>Orbiculoidea</u>		14.0
Norfleet Limestone Member		
Limestone, dark-gray, very finely-crystalline, silty, nodular		0.3
Shale, gray, blocky		4.5
Altamont Limestone		
Worland Limestone Member		
Limestone, gray, weathers white; flaky, nodular at top		1.0 exposed
Locality 43, SW SW SE sec. 36, T. 34 S., R. 18 E.		
		Thickness, feet
Altamont Limestone		
Worland Limestone Member		
Limestone, medium-gray, weathers yellowish-tan, very finely-crystalline, medium-bedded; some isolated colonies of <u>Chaetetes</u> , abundant <u>Linoproductus</u> , lower contact undulating		8.0
Lake Neosho Shale Member		
Shale, black, platy, phosphatic nodules, slightly calcareous at top; compressed <u>Derbyia</u> common		0.5
Amoret Limestone Member		
Limestone, light-gray, very finely-crystalline; <u>Chaetetes</u> forms nearly whole bed; lower 2.0 feet		

is medium gray and finely-crystalline	6.0
Bandera Shale	
Shale, tan, silty and sandy, laminated	2.0
<p>Locality 44, SE SE sec. 9, T. 34 S., R. 20 E. (Measured by J. M. Jewett; reexamined by author.)</p>	
	Thickness, feet
Fort Scott Limestone	
Higginsville Limestone Member	
Limestone, light-gray, weathers tan, medium-bedded, undulating bedding, very finely-crystalline throughout except for coarsely-crystalline calcite stringers	3.5
Covered interval	2.0
Limestone, gray, medium-crystalline	0.5
Little Osage Shale Member	
Shale, black, fissile	4.6
Blackjack Creek Limestone Member	
Limestone, light-gray, weathers tan, very finely- crystalline, very thick-bedded; fusilinids	7.5
Limestone, medium-gray, a little chert, some stringers of carbonaceous material	10.0
Cabaniss Formation	
Excello shale bed	
Shale, black, platy to fissile	2.0 exposed

Locality 45, SW SW SE sec. 31, T. 34 S., R. 21 E.	Thickness, feet
Cabaniss Formation	
Unnamed sandstone	
Sandstone, brownish-red, laminated	3.0
Verdigris Limestone Member	
Limestone, medium-gray, weathers tan, very finely- crystalline, medium-bedded; abundant <u>Mesolobus</u> <u>mesolobus</u>	2.0
Locality 46, SE SW SW sec. 33, T. 34 S., R. 21 E.	Thickness, feet
Cabaniss Formation	
Limestone, dark-gray, laminated, very finely- crystalline, many small brachiopods	1.0
Coal, bright	0.3
Underclay, gray, silty, root impressions, carbonaceous plant remains	1.0
Locality 47, SE SE NE sec. 11, T. 35 S., R. 17 E.	Thickness, feet
Lenepah Limestone	
Idenbro Limestone Member	
Limestone, light-gray, weathers tan, finely-crystalline, blocky	5.0
Nowata Shale	
Shale, grayish-yellow, calcareous, flaky, limestone nodules near top	5.5

Siltstone, dark-gray	1.8
Siltstone, grayish-tan, calcareous	0.3
Siltstone, dark-gray, calcareous	2.0
Siltstone, yellowish-tan	1.9
Shale, dark-gray, blocky	3.0

Locality 48, SW SW SW sec. 10, T. 35 S., R. 19 E.

Thickness,
feet

Pawnee Limestone

Myrick Station Limestone Member

Limestone, grayish-tan, medium-bedded, irregular

base 1.5

Anna Shale Member

Shale, light yellowish-brown, silty, platy 3.0

Shale, black, platy, fissile in bottom 1.0

foot, phosphatic nodules, limestone nodules 12.0

Locality 49, in text, page 28.

Locality 50, NW NW NW sec. 1, T. 35 S., R. 20 E.

Thickness,
feet

Fort Scott Limestone

Higginsville Limestone Member

Limestone, rubbly remnants 0.5

Little Osage Shale

Shale, black, platy to fissile, limonite staining on

bedding planes, phosphatic concretions contain

Orbiculoidea capuliformis

6.0

Blackjack Creek Limestone Member

Limestone, light-gray, weathers tan to reddish-brown,
very finely-crystalline, earthy near base;

fusilinids common

16.0

Cabaniss Formation

Excello shale bed

Shale, black, platy

1.0

APPENDIX II

LOGS OF TEST HOLES

Given on the following pages are logs of 29 test holes drilled in Labette, Crawford, and Cherokee counties by the U.S. Geological Survey and the Kansas Geological Survey.

31-21-9cc.--Sample log of test hole in $SW\frac{1}{4}$ $SW\frac{1}{4}$ sec. 31, T. 31 S.,
R. 21 E., beside tree on north side of cabin; augered June 13,
1963. Altitude of land surface, ± 835 feet; depth to water 17.00
feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium	3	3
Soil, black, silty	3	3
Silt, brownish-black, clayey	15	18
Sand, gray, very fine, silty	8	26
Sand, gray, very fine to medium, fine to coarse chert pebbles, silty	2	28
PENNSYLVANIAN--Desmoinesian		
Higginsville Limestone		
Limestone, gray		28

31-21-12dd.--Sample log of test hole in $SE\frac{1}{4}$ $SE\frac{1}{4}$ sec. 12, T. 31 S.,
R. 21 E., 50 feet north of black top on west shoulder of road;
augered June 13, 1963. Altitude of land surface, ± 890 feet;
dry hole.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Illinoisan terrace deposits	3	3
Soil, reddish-brown	3	3
Clay, reddish-brown, some fine chert pebbles	4	7

PENNSYLVANIAN--Desmoinesian

Blackjack Creek Limestone

Limestone, gray		7
-----------------	--	---

31-21-13bb.--Sample log of test hole in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T. 31 S., R. 21 E.; augered June 13, 1963. Altitude of land surface ± 875 feet; dry hole.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Illinoisian terrace deposits		
Soil and road fill	4	4
Clay, reddish-yellow, fine limestone pebbles	3	7

PENNSYLVANIAN--Desmoinesian

Blackjack Creek Limestone

Limestone, gray		7
-----------------	--	---

31-21-15bb.--Sample log of test hole in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 15, T. 31 S., R. 21 E., under tree on east side of road about 25 feet north of utility pole; augered June 13, 1963. Altitude of land surface ± 842 feet; dry hole.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Illinoisian terrace deposits		
Soil, black	2	2
Silt, brownish-red, clayey	1	3
Silt, light-brown, clayey	3	6

Sand, yellowish-brown, very fine sand, clayey, brown, medium chert pebbles	2	8
PENNSYLVANIAN--Desmoinesian		
Blackjack Creek Limestone		
Limestone, gray		8
31-21-16ab.--Sample log of test hole in NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 16, T. 31 S., R. 21 E., east of hedgerow about 50 feet south of L-intersection; augered June 13, 1963. Altitude of land surface \pm 835 feet; depth to water 10.0 feet.		
	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium		
Soil, brown	4	4
Silt, reddish-brown, silty, medium to coarse chert pebbles at 12 feet	10	14
Silt, sandy, coarse chert pebbles	5	19
PENNSYLVANIAN--Desmoinesian		
Little Osage Shale		
Shale, gray	0.5	19.5

31-21-17ba.--Sample log of test hole in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 17, T. 31 S., R. 21 E., on west side of road about 30 feet southwest of fence corner; augered June 13, 1963. Altitude of land surface ± 835 feet; depth to water 10.6 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium		
Soil, medium-brown	3	3
Silt, medium-brown, clayey	10	13
Silt, dark-gray, clayey	5	18
Silt, dark-gray, clayey, some fine chert pebbles	11	29

PENNSYLVANIAN--Desmoinesian

Higginsville Limestone

Limestone, gray		29
-----------------	--	----

31-22-17bb.--Sample log of test hole in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 17, T. 31 S., R. 22 E., Crawford County, on east shoulder of road about 100 feet southeast of cemetery; augered June 13, 1963. Altitude of land surface ± 906 feet; dry hole.

	Thickness, feet	Depth, feet
NEOGENE-Pleistocene		
Illinoisan terrace deposits		
Soil, black, road fill	3	3
Clay, yellow, slightly silty	5	8

PENNSYLVANIAN--Desmoinesian

Blackjack Creek Limestone

Limestone, gray		8
-----------------	--	---

32-21-9cd.--Sample log of test hole in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 9, T. 32 S., R. 21 E., in driveway into field near large oak tree; augered June 14, 1963. Altitude of land surface ± 823 feet; depth to water 18.0 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium		
Soil, brown, silty	4	4
Silt, medium-brown, silty	15	19
Silt, yellowish-brown, sandy	5	24
Silt, yellowish-brown, medium chert pebbles	9	33

PENNSYLVANIAN--Desmoinesian

Cabaniss Formation

Limestone, dark-gray		33
----------------------	--	----

32-21-10cc.--Sample log of test hole in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 10, T. 32 S., R. 21 E., 20 feet east of T-intersection on north shoulder of road; augered June 14, 1963. Altitude of land surface ± 834 feet; dry hole.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Illinoisan terrace deposits		
Clay, yellowish-brown, some limonite mottling	3	3

Clay, yellowish-brown, limonite mottling		
some silt at 7 feet	5	8
Clay, light yellowish-brown, slightly		
silty, some brown, medium chert pebbles	5	13
Sandy, yellowish-gray, very fine, clayey,		
some brown, medium chert pebbles	2	15

PENNSYLVANIAN--Desmoinesian

Cabaniss Formation

Limestone, gray		15
-----------------	--	----

32-21-10dd.--Sample log of test hole in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 10, T. 32 S.,
R. 21 E., 20 feet north of intersection on west shoulder of road;
augered June 14, 1963. Altitude of land surface \pm 840 feet; dry hole.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Illinoisian terrace deposits		
Soil, brown, clayey	3	3
Silt, yellowish-brown, clayey, fine chert pebbles	5	8
Silt, yellowish-brown, gray clay stringers	5	13
Silt, yellowish-brown, red and gray clay stringers, some brown, angular, medium chert pebbles	5	23
Silt, brown, clayey, many brown, fine to coarse chert pebbles	5	28
Sand, very fine, some bluish-black clay, few fine chert pebbles	2	30

PENNSYLVANIAN--Desmoinesian

Cabaniss Formation

Limestone		30
-----------	--	----

32-21-14bb.--Sample log of test hole in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 14, T. 32 S.,
R. 21 E.; augered June 13, 1963. Altitude of land surface \pm 854
feet; depth to water, 20.81 feet.

	Thickness, feet	Depth, feet
--	--------------------	----------------

NEOGENE--Pleistocene

Illinoisan terrace deposits

Road fill	4	4
Silt, light-brown, clayey	2	6
Silt, light yellowish-brown	9	15
Silt, yellowish-tan	14	29
Silt, yellowish-tan, fine to medium chert pebbles	3	32

PENNSYLVANIAN--Desmoinesian

Blackjack Creek Limestone

Limestone, gray		32
-----------------	--	----

32-21-15ba.--Sample log of test hole in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 15, T. 32 S.,
R. 21 E., on south shoulder of road; augered June 14, 1963.
Altitude of land surface \pm 840 feet; dry hole.

	Thickness, feet	Depth, feet
--	--------------------	----------------

NEOGENE--Pleistocene

Illinoisan terrace deposits

Soil, road fill	4	4
Clay, yellow	5	9
Clay, yellow, silty	5	14
Silt, tan, sandy, some fine to medium chert pebbles	8	26

PENNSYLVANIAN--Desmoinesian

Cabaniss Formation

Limestone		26
-----------	--	----

33-21-14dc.--Sample log of test hole in SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 14, T. 33 S.,

R. 21 E., about 75 yards north of highway on west shoulder of road;
augered June 20, 1963. Altitude of land surface \pm 809 feet; depth
to water 7.1 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium		
Road fill	3	3
Silt, brownish-gray, clayey	20	23
Silt, medium-gray, clayey, some medium sand	8	31
Silt, medium-gray, clayey, some fine sand and fine pebbles	2.5	33.5
PENNSYLVANIAN--Desmoinesian		
Cabaniss Formation		
Limestone, gray	0.5	34
Shale, gray	0.5	34.5

33-21-24aa.--Sample log of test hole in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 24, T. 33 S., R. 21 E., on southwest corner of intersection 20 feet west of north-south road; augered June 20, 1963. Altitude of land surface, ± 823 feet; depth to water 15.2 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Illinoisan terrace deposits		
Silt, brownish-gray, clayey	3	3
Silt, yellowish-brown, orange and gray clay stringers	5	8
Silt, yellowish-brown, clayey	5	13
Clay, yellowish-brown	5	18
Clay, yellowish-brown, medium chert pebbles	5	23
Clay, yellowish brown, silty, medium sand and medium pebbles	5	28
PENNSYLVANIAN--Desmoinesian		
Cabaniss Formation		
Shale, black	1	29
Limestone		29

33-21-24ba.--Sample log of test hole in NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 24, T. 33 S., R. 21 E., 150 yards east of railroad trestle on south shoulder of road; augered June 20, 1963. Altitude of land surface ± 800 feet; depth to water 15.5 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent deposits		
Silt, dark-brown, clayey	4	4
Silt, yellowish-red, clayey	5	9
Silt, reddish-brown, sandy, fine chert pebbles	5	14
Pebbles, coarse, sandy silt matrix	11	25
PENNSYLVANIAN--Desmoinesian		
Cabaniss Formation		
Shale, dark bluish-gray		25
33-21-33dd.--Sample log of test hole in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 33, T. 33 S., R. 21 E., 150 feet west of highway on south shoulder of road; augered June 18, 1963. Altitude of land surface \pm 848 feet; dry hole.		
	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Illinoisan terrace deposits		
Soil, medium-brown, silty	3	3
Silt, yellowish-brown, clayey, few fine rounded chert pebbles	9	12
Silt, yellowish-brown, clayey, fine to medium, angular to rounded chert pebbles	1	13
Silt, yellow, clayey, fine to coarse, rounded to subangular, brown chert pebbles	7	20

Silt, light-brown, clayey, many fine to coarse chert pebbles	1	21
Silt, yellowish-brown, clayey fine to medium, tabular brown chert pebbles	1	22

PENNSYLVANIAN--Desmoinesian

Cabaniss Formation

Shale, dark gray	1	23
------------------	---	----

33-22-20bb. --Sample log of test hole in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 20, T. 33 S.,
R. 20 E., 50 feet south of intersection on east side of road;
augered June 20, 1963. Altitude of land surface \pm 832 feet;
depth to water 20.3 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Illinoian terrace deposits		
Road fill and brown silt	4	4
Silt, grayish-yellow, clayey	5	9
Silt, light yellow, clayey	5	14
Silt, yellowish-brown, clayey, fine sand at bottom	15	29
Silt, tan, sandy, some fine pebbles at 30 feet	7	36
PENNSYLVANIAN--Desmoinesian		
Cabaniss Formation		
Shale		36

34-21-9da.--Sample log of test hole in NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 9, T. 34 S.,
R. 21 E.; augered June 18, 1963. Altitude of land surface ± 818
feet; depth to water 10.4 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Illinoian terrace deposits		
Soil, dark-brown, clayey	4	4
Clay, light-gray	5	9
Silt, yellowish-gray, clayey	5	14
Silt, yellow, sandy and silty	5	19
Silt, yellow, sandy, fine to coarse chert pebbles	8	27

PENNSYLVANIAN--Desmoinesian

Cabaniss Formation

Shale, bluish-gray	1	28
--------------------	---	----

34-21-10bb.--Sample log of test hole in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 10, T. 34 S.,
R. 21 E., 50 feet east of intersection on south shoulder of road;
augered June 18, 1963. Altitude of land surface ± 841 feet; dry hole.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Illinoian terrace deposits		
Silt, medium-brown, clayey, fine to medium, angular to rounded chert pebbles	3	3
Silt, yellowish-brown, clayey, some very		

coarse sand, brown; fine to medium chert pebbles at 7 feet	5	8
Silt, yellowish-brown, clayey, many fine to medium, angular chert pebbles	4	12
PENNSYLVANIAN--Desmoinesian		
Verdigris(?) Limestone		
Limestone		12
34-21-10cc.--Sample log of test hole in SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 10, T. 34 S., R. 21 E., 30 feet north of road and 8 feet west of utility pole; augered June 18, 1963. Altitude of land surface \pm 810 feet; depth to water 11.8 feet.		
	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Illinoisan terrace deposits		
Silt, medium-brown, clayey	3	3
Silt, yellow, brown clay mottling, few very fine chert pebbles	5	8
Silt, light yellowish-brown, clayey, few very coarse sand grains	5	13
Silt, yellowish-brown, clayey, some very fine sand; medium chert pebbles at 16 feet	5.5	18.5
PENNSYLVANIAN--Desmoinesian		
Cabaniss Formation		
Shale, gray, sandy		18.5

34-21-15bc.--Sample log of test hole in SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 15, T. 34 S.,
R. 21 E., on east side of highway about 40 feet from slab:
augered June 18, 1963. Altitude of land surface \pm 820 feet; depth
to water 10.4 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium		
Clay, dark brownish-gray, silty, some gray stringers of very fine sand at 4 feet	8	8
Silt, light brown, clayey, some gray stringers of very fine sand	5	13
Silt, dark greenish-gray, clayey, fine to medium pebbles of limestone, black shale and chert	6	19
PENNSYLVANIAN--Desmoinesian		
Cabaniss Formation		
Shale, light gray, sandy	4	23

34-21-21aa.--Sample log of test hole in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 21, T. 34 S.,
R. 21 E., in clearing about 250 feet west of highway; augered
June 18, 1963. Altitude of land surface \pm 790 feet; depth to
water 17.2 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium		
Silt, yellowish-brown, sandy	9	9

Silt, dark-brown, clayey	5	14
Clay, dark-brown	5	19
Silt, yellowish-gray, sandy	2	21

PENNSYLVANIAN--Desmoinesian

Cabaniss Formation

Shale		21
-------	--	----

34-21-27bb.--Sample log of test hole in NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 27, T. 34 S., R. 21 E., 100 feet east of highway on south shoulder of road; augered June 18, 1963. Altitude of land surface \pm 800 feet; depth to water 5.5 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium		
Silt, dark brownish-gray, clayey, some very coarse chert sand	3	3
Silt, brownish-gray, clayey	5	8
Silt, light yellowish-brown, clayey, some gray stringers of very fine sand	5	13
Silt, brown, clayey, fine to coarse subangular chert pebbles	5	18
Pebbles, brown chert, fine to coarse, some brown silt and clay	7	25
PENNSYLVANIAN--Desmoinesian		
Cabaniss Formation		
Shale, gray, sandy	1	26
Limestone		26

35-21-1cd. --Sample log of test hole in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 1, T. 35 S., R. 21 E., on west shoulder of road opposite abandoned barn; augered June 18, 1963. Altitude of land surface \pm 790 feet; depth to water 17.0 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium		
Silt, reddish-brown, clayey	14	14
Silt, light-brown, sandy, fine chert pebbles at 17 feet	5	19
Pebbles, fine, much brown silt	2	21
PENNSYLVANIAN--Desmoinesian		
Cabaniss Formation		
Shale		21

35-21-1dd. --Sample log of test hole in SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 1, T. 35 S., R. 21 E., on west shoulder of road 100 feet north of intersection; augered June 18, 1963. Altitude of land surface \pm 786 feet; depth to water 14.5 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium		
Silt, brownish-black, clayey	3	3
Silt, brown, clayey, some medium chert pebbles	5	8
Silt, brown, clayey	13	21

Sand, gray, very fine, medium to coarse

chert pebbles	2	23
---------------	---	----

PENNSYLVANIAN--Desmoinesian

Cabaniss Formation

Shale, light-gray	0.5	23.5
-------------------	-----	------

35-21-12bb.--Sample log of test hole in NW $\frac{1}{2}$ NW $\frac{1}{2}$ sec. 12, T. 35 S.,
R. 21 E., near the end of trail leading to river; augered
June 18, 1963. Altitude of land surface \pm 790 feet; depth to
water 11.3 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium		
Silt, grayish-brown, clayey	4	4
Silt, medium-brown, clayey	5	9
Silt, medium-brown, sandy	12	21

PENNSYLVANIAN--Desmoinesian

Cabaniss Formation

Shale		21
-------	--	----

35-22-4cd.--Sample log of test hole in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 4, T. 35 S.,
R. 22 E., on north shoulder of road west of intersection; augered
June 19, 1962. Altitude of land surface \pm 795 feet; depth to water
8.5 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Illinoisan terrace deposits		

Silt, gray, clayey	6	6
Sand, yellow, silty, fine to medium chert pebbles	9.5	15.5

PENNSYLVANIAN--Desmoinesian

Cabaniss Formation

Shale		15.5
-------	--	------

35-22-5cc.--Sample log of test hole in $Sw\frac{1}{4}$ $Sw\frac{1}{4}$ sec. 5, T. 35 S.,
R. 22 E., 2 feet west of U.S.G.S. benchmark; augered June 19,
1963. Altitude of land surface 782 feet; depth to water 5.0 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium		
Clay, dark brown	4	4
Silt, dark-brown, clayey	10	14
Silt, light-yellowish-brown, sandy	5	19
Pebbles, medium to coarse, fine sand	6.5	25.5

PENNSYLVANIAN--Desmoinesian

Cabaniss Formation

Coal		25.5
------	--	------

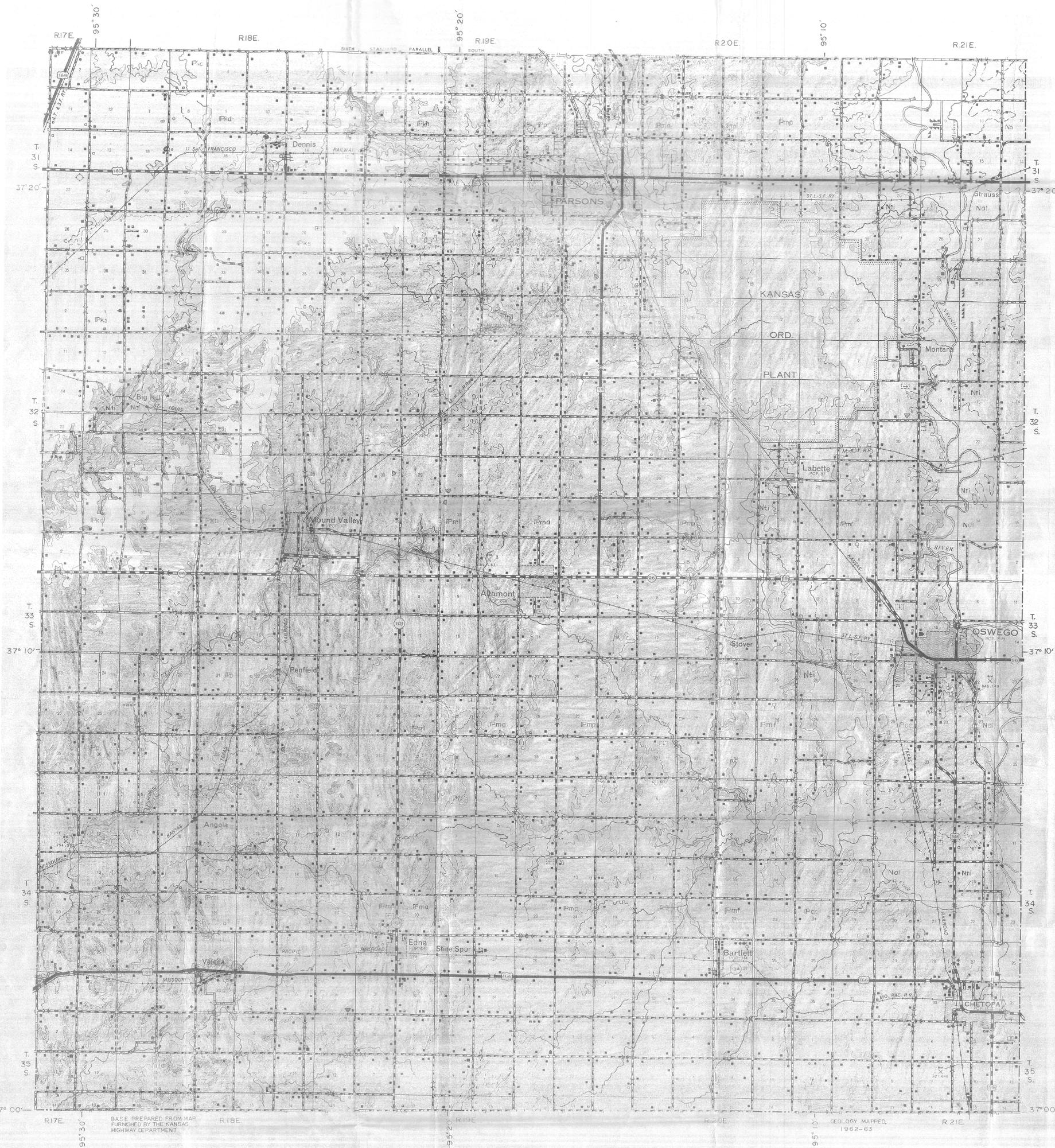
35-22-8aa.--Sample log of test hole in $NE\frac{1}{4}$ $NE\frac{1}{4}$ sec. 8, T. 35 S.,
R. 22 E., on south shoulder of road about 200 yards west of
bridge; augered June 19, 1963. Altitude of land surface \pm 782 feet;
depth to water 15.00 feet.

	Thickness, feet	Depth, feet
NEOGENE--Pleistocene		
Wisconsinan and Recent alluvium		
Clay, dark-brown, silty, orange mottling	3	3
Clay, dark brownish-gray, hard, silty, orange mottling	5	8
Silt, dark-brown, clayey, hard	5	13
Silt, chocolate-brown, clayey, few coarse sand grains	5	18
Silt, yellowish-brown, clayey	3	21
Silt, dark-brown, many fine to coarse chert pebbles, much very fine to coarse chert sand	4	25
PENNSYLVANIAN--Desmoinesian		
Cabaniss Formation		
Shale, gray	1	26
Limestone		26

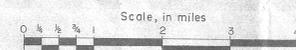
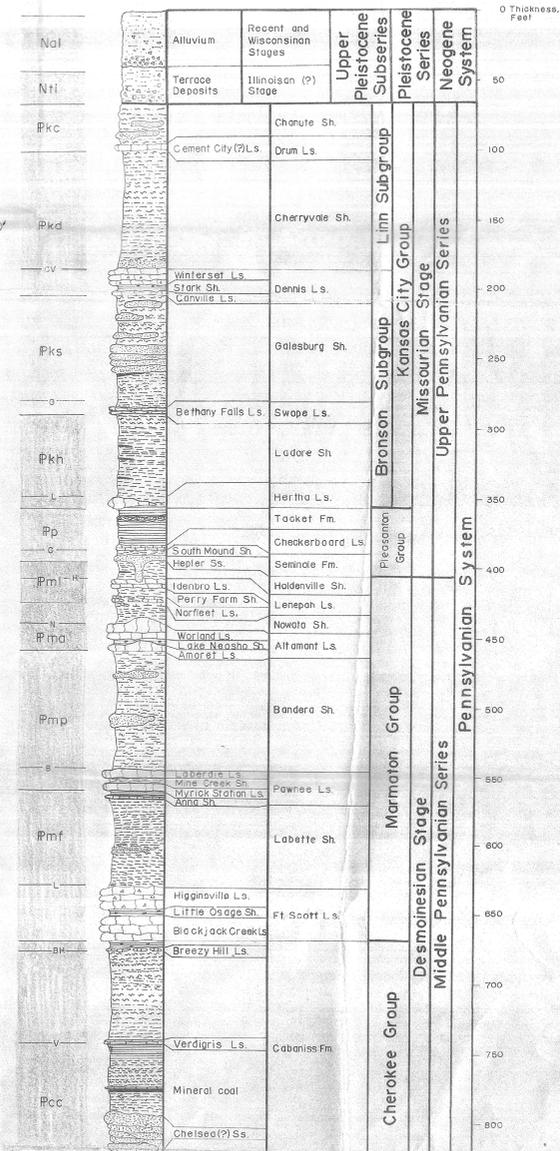
AREAL GEOLOGY OF LABETTE COUNTY, KANSAS

by
William L. Jungmann

PLATE I



Generalized stratigraphic column of outcropping rocks



EXPLANATION

KEY TO LITHOLOGY

- Fill and sand (horizontal lined)
- Gravel
- Shale
- Block shale (with concretions)
- Sandy shale
- Silty shale or siltstone
- Calcareous shale
- Sandstone
- Coal
- Limestone
- Cherty limestone
- Nodular limestone

- Observable contact
- Approximate or inferred contact
- Concealed contact
- Quarry
- Sand or gravel pit
- Reseasonal dwelling
- U.S. Highway
- State Highway
- County Highway

True north
Magnetic north
Approximate mean declination, 1954

BASE PREPARED FROM MAP
FURNISHED BY THE KANSAS
HIGHWAY DEPARTMENT

GEOLOGY MAPPED,
1962-63