KANSAS GEOLOGICAL SURVEY
OPEN-FILE REPORT 62-4

Stratigraphy of the Pleasanton Group in Bourbon,
Neosho, Labette, and Montgomery Counties, Kansas

by

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STRATIGRAPHY OF THE PLEASANTON GROUP IN BOURBON, NEOSHO, LABETTE, AND MONTGOMERY COUNTIES, KANSAS

by

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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.

J. M. Jewett
Instructor in charge

April, 1962

For the department

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

Kansas Geological Survey

Open File Report 1962-04

Missing Page #1

INTRODUCTION

Purpose of Investigation

The purpose of this investigation is to study, in considerable detail, the stratigraphy and sedimentation aspects of the Pleasanton Group. Information derived from this study is used to determine the probably environment of deposition, local and regional variations in stratigraphy, and is the basis of revised stratigraphic nomenclature for the Pleasanton Group.

Previous Work

In the past the Pleasanton Group has had six names applied to it as well as the terms series, shale, formation, and group. The rocks of the Pleasanton Group probably were studied, to a small extent, by Swallow and Hawn (1858). In their Rocks of Kansas the Carboniferous is described simply as "1073 feet (of) coal measures, a continuation of, and probably above, the Upper Coal Series of Missouri". Eight years later Swallow (1866) named the beds between Pawnee Limestone and the "Well Rock Series" (Bronson Subgroup) the Marais des Cygnes coal series. Laneville Shale was the name applied to the interval between Oswego (Fort Scott) Limestone and Erie (Hertha-Winterset) Limestone by Haworth and Kirk (1894). Pleasanton was first used as a stratigraphic name by Haworth (1895). He referred to the beds between the top of the Pawnee Limestone and the base of the Erie Limestone as the Pleasanton Shale. Marais des Cygnes Shale was the name given this same interval by Keyes (1900).

Adams (1903) referred to the interval between Parsons (Altamont-Lenapah) Limestone and the base of the Hertha Limestone as the Dudley Shale. The same interval was termed La Cygne Shale by Moore (1920).

In Missouri Hinds and Greene (1915) defined the interval between Pawnee Limestone and Hertha Limestone as the Pleasanton Formation and the uppermost part of the Des Moines Group.

Bourbon Group was the name given the beds between the pre-Missourian disconformity (base of Hepler) and the base of the Hertha Limestone formation by Moore and Jewett (1932). Ockerman (1935) applied the name Bourbon Shale to this interval but soon afterward Newell (1935) named the same interval the Bourbon Formation. Thus Bourbon was the first stratigraphic name given to the exact span of rocks that now is called Pleasanton Group.

In 1947 the State Geological Surveys of Iowa, Kansas, Nebraska, and Missouri came to an agreement that the interval between the pre-Missourian disconformity and the base of the Hertha Limestone should be named the Pleasanton Group. The name is that of the city of Pleasanton, which is in Linn County, Kansas.

Inasmuch as the name Bourbon originally was used for the exact span of rocks now termed Pleasanton, it is judged proper to regard the type exposure of the Bourbon (Moore and Jewett, 1932) as the true type of the Pleasanton. The type locality is in Bourbon County, Kansas, along Kansas highway No. 3 where the road ascends the bluff of the Marmaton River about one mile south of Uniontown. A type section in the vicinity of Pleasanton, Kansas has not been proposed, and in the author's opinion, no suitable exposures exist in that area.

The Pleasanton Group in Miami, Linn, and Bourbon Counties was studied by Hatcher in the summer and fall of 1960. His observations and conclusions, with the exception of some details published by Jewett (1937), represent the first comprehensive work to be done on

the stratigraphy and sedimentation of the Pleasanton Group.

Area of Investigation

Pleasanton rocks crop out in the states of Iowa, Missouri, Kansas, and Oklahoma. This report includes exposures studied between southern Bourbon County, Kansas and northern Nowata County, Oklahoma. The elevation of the Pleasanton outcrop belt is approximately 980 feet in the northern area, and 780 feet in the southern area. Figure 1 is a map showing the outcrop belt of the Pleasanton Group and the area studied.

Outcrops

Characteristically the Pleasanton is a slope-forming unit found beneath, and sometimes a part of, the Hertha Limestone escarpment. In some areas, especially where black shales are near the top of the section, they along with the Hertha Limestone form an almost vertical cliff. This is best shown in roadcuts or quarries. The lower part of the Pleasanton is exposed in few places and commonly forms a gentle slope.

Most of the exposures studied for this report were found in roadcuts and stream banks. A few sections are in strip-pits where the black shale was mined for road fill.

In west-central Labette County, near Mound Valley, the Hertha Limestone pinches out and the Hertha escarpment ceases to exist. From this area southward the outcrop belt is very difficult to trace and outcrops are almost non-existent due to low relief and vegetative cover. Included on Plate 1 are the locations of the Pleasanton sections that were measured and studied.

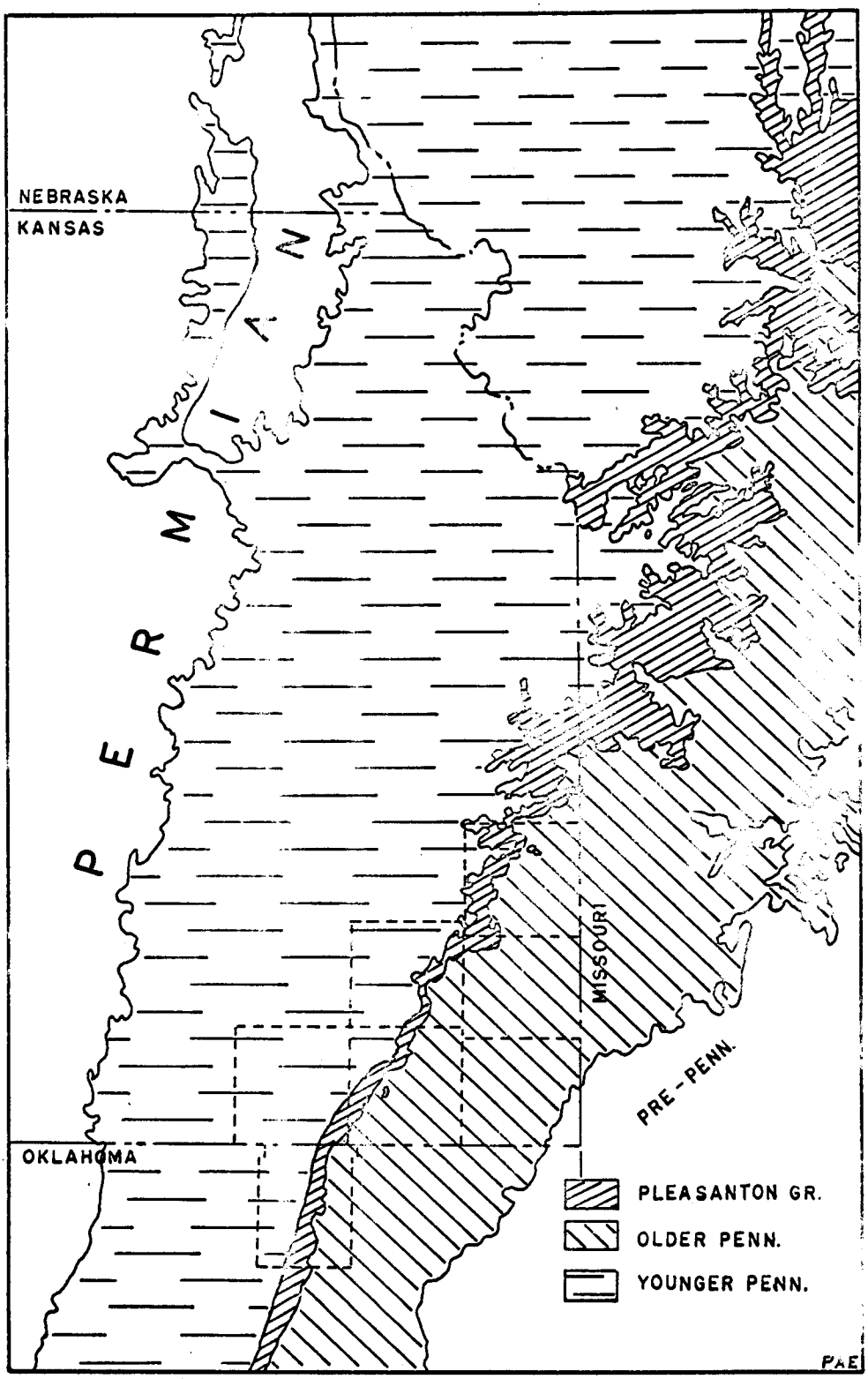


Fig. 1. Map showing outcrop belt of the Pleasanton Group. Area studied is outlined by dashed lines. (After Moore, 1949)

Methods of Investigation

Field techniques: Many of the outcrops measured were located by referring to the published and unpublished stratigraphic sections in the files of the State Geological Survey of Kansas. Several outcrops were found by walking along creeks. All roads in the area of the outcrop belt were traversed and in some instances farmers were questioned to determine if any outcrops could be found on their land.

At each exposure the section was measured and described. Samples at each significant lithologic zone were taken and labeled for laboratory study. Measurements were made by using a steel tape, hand level, and in some instances where horizontal distances were great, by using topographic maps.

Laboratory techniques: The procedures mainly used for the study of samples included, size analysis, studies of acetate peels, insoluble residues, and clay mineralogy.

Limestone units: A technique described by Sternberg and Belding (1942) was used in making acetate peels. Limestone samples were cut and polished and then etched in 10 percent hydrochloric acid for about 15 seconds. The specimen was washed to remove the acid, dried, and then dipped in acetone. After dipping the specimen in acetone it was pressed upon a sheet of acetate and allowed to dry. The acetate was then gently peeled off and used as a photographic negative to make prints which were used for study and as illustrations.

For the preparation of insoluble residues the method described by Ireland (1958) was used. Coarse and fine fraction were separated, their weights and percentages, plus the constituents of the coarse fractions, are included as a table in Appendix B of this report.

Sandstone units: Size analysis of 11 samples of Hepler Sandstone were made. The samples were disaggregated, examined under a microscope and then size determination was made. The general procedure applied is that described by Krumbein and Pettijohn (1938, p. 135-142).

Shale units: Portions of the shale samples were soaked in water for several hours and then boiled for approximately 15 minutes. The turbid water was decanted and the remaining shale dried and studied with a microscope.

Acknowledgments

The writer wishes to thank Dr. J. M. Jewett for his aid and supervision in the preparation of this report. Thanks are also due to Dr. H. A. Ireland and Dr. W. K. Hamblin for their ideas, suggestions, and critical reading of this manuscript. The author wishes to express his appreciation to the State Geological Survey of Kansas, especially Mr. Norman Plummer, of the Ceramics Division, for aid in the preparation of this report. Thanks also go to Ronald R. West for his aid in paleontologic matters.

PHYSIOGRAPHIC AND GEOLOGIC SETTING

The surface Pennsylvanian rocks of Kansas are divided into three stages as is shown in Table 1. The Pleasanton is the lowest group of the Missourian Stage. Figure 1 shows the outcrop belt of both Pleasanton and older and younger Pennsylvanian rocks.

In general, Pleasanton as well as the remainder of the Pennsylvanian rocks form a series of cuestas or escarpments facing eastward and dipping slightly north of west, usually less than 0.5 degrees. The face slope, of the cuesta formed by the Hertha Limestone, is occupied by Pleasanton rocks. Figure 2 shows the cuesta formed by the Hertha and Pleasanton a short distance north of Locality 2.

Fig. 2. View of cuesta formed by Hertha Limestone and Pleasanton Shale in Bourbon County. Looking north toward the Marmaton River valley from Locality 2.

TABLE 1 Classification of Pennsylvanian Rocks in Kansas
(After Jewett 1959)

Pennsylvanian System

- Virgilian Stage
- Missourian Stage
  - Pedee Group
  - Lansing Group
  - Kansas City Group
    - Zarah Subgroup
    - Linn Subgroup
    - Bronson Subgroup
      - Dennis Limestone
      - Galesburg Shale
      - Swope Limestone
      - Ladore Shale
      - Hertha Limestone
    - Pleasanton Group
      - Unnamed units including locally the "Knobtown" Sandstone
      - Checkerboard Limestone (not definitely identified in northern Kansas)
      - Hepler Sandstone

(regional disconformity)

- Desmoinesian Stage
  - Marmaton Group
    - Holdenville Shale
    - Lenapah Limestone
    - Nowata Shale
    - Altamont Limestone
    - Bandera Shale
    - Pawnee Limestone
    - Labette Shale
    - Fort Scott Limestone
  - Cherokee Group

(regional disconformity)

PROPOSED NOMENCLATURE

The author desires to propose a revised subdivision of the Pleasanton Group. At the present time the Pleasanton is divided into the Hepler Sandstone formation, Checkerboard Limestone formation, and the informal "Knobtown" Sandstone, with the remainder of the sequence referred to as unnamed units, or simply as Pleasanton shale, or as sandstone in the Pleasanton, etc. Table 2 shows the proposed nomenclature used in this thesis.

TABLE 2 Proposed Nomenclature for Kansas Pleasanton Group Rocks

Pennsylvanian System

- Missourian Stage
  - Pleasanton Group
    - Tacket Mound Formation (new formation)
      - Upper shale member
      - Middle limestone member
      - Lower shale member
    - Checkerboard Formation
      - Upper limestone member
      - Middle shale member
      - Lower limestone member
    - Seminole Formation
      - South Mound Member (new member)
      - Hepler Sandstone member (reduced to member)

The Seminole Formation (Taff, 1901) of Oklahoma is defined as including the beds between the Desmoinesian-Missourian disconformity and the base of the Checkerboard Limestone (Moore et al, 1937). In Kansas, this interval is comprised of a shale unit and the underlying Hepler Sandstone formation (Jewett, 1940, p. 8). In this study the author adopts the usage of Seminole Formation for Kansas stratigraphy. The rank of the Hepler is changed from a formation to a member and the overlying shale is given the name, South Mound Member.

The name South Mound is taken from a town located in southeastern Neosho County, Kansas. The type exposure is located about 40 feet north of the east-west section line road, at the center of the south line of sec. 10, T. 30 S., R. 20 E., 1.5 miles northeast of the town of South Mound. For details of this exposure see Appendix A, Locality 9.

The Checkerboard Limestone is retained as a subdivision of the Pleasanton Group with its present formational rank. This formation, or parts of it, can be identified along the outcrop belt for a distance of approximately 40 miles north of the Kansas-Oklahoma line. As will be shown later in this report, it is highly probable that the lower limestone member of this formation extends through Kansas and into Missouri.

The interval between the top of the Checkerboard Limestone formation and the base of the Kansas City Group (Hertha Limestone) is given a new name, the Tacket Mound Formation. This formation is subdivided into a lower shale member, middle limestone member and an upper shale member. The name Tacket Mound Formation is proposed for this unit, as good exposures are found in and around a prominent topographic feature of the same name. Tacket Mound is in north-central Labette County, near Locality 13, in the SW¼ sec. 7, T. 32 S., R. 19 E.

North of the area covered by this report the informally termed "Bourbon Flags" and "Knobtown" Sandstone occupy the same stratigraphic horizon as the Tacket Mound Formation, and are considered facies of this unit.

A subdivision of the Missouri Pleasanton is set forth in a recently published Missouri Survey volume (Howe, 1961, p. 96). In my opinion

this subdivision cannot be applied to the Pleasanton rocks of Kansas for the following reasons; most of this subdivision is based upon units found only in Missouri, and those units which are found in both Kansas and Missouri either have different names or the Kansas units lack the lateral persistence and areal extent sufficient to make them recognizable.

STRATIGRAPHY

Desmoinesian-Missourian Disconformity

The contact between Hepler Sandstone and Holdenville Shale is the disconformity that has been designated (Moore, 1935, p. 68) as the boundary between the Missourian and Desmoinesian Series. These series were later defined as stages by the Kansas Geological Survey.

The Holdenville Shale (Taff, 1901), the uppermost formation in the Desmoinesian Group lies immediately beneath the Pleasanton Group. As recently as 1951, in Kansas and northern Oklahoma, this unit was known as Memorial Shale. Stratigraphers in Oklahoma and Kansas realizing that the Memorial is equivalent to the Holdenville of Oklahoma have now adopted the name Holdenville for the beds which lie between the Lenapah Limestone and the Hepler Sandstone. The type Holdenville exposure is in Hughes County, Oklahoma near the town of Holdenville.

This shale, as seen in most outcrops, is gray, blocky and usually unfossiliferous. In some areas it is slightly silty near the top and seems to grade into the overlying Hepler Sandstone. In many areas it contains a zone of black, highly carbonaceous shale along with a low grade coal and fossil wood. This zone of black shale is confusing as it is very similar in lithology to rock found in the Pleasanton Group.

The thickness of the Holdenville ranges from a featheredge to about 30 feet. In some areas in Linn County, Kansas this unit has been removed by pre-Missourian erosion and basal Missourian rocks rest upon units lower than Holdenville. However, the Holdenville seemingly is present throughout the area studied for this report.

The aforementioned evidence of erosion, plus paleontologic evidence, (Moore, et al, 1951, p. 91) supports placement of the Desmoinesian-

Missourian boundary at the base of the Hepler Sandstone. This disconformity has been traced across Missouri and into Iowa and is believed to be the continuation of the disconformity that lies below the Seminole Formation in Oklahoma (Oakes and Jewett, 1943).

At Locality 18 (Fig. 3) the Hepler Sandstone is absent but a distinct color break occurs within a shale sequence at the stratigraphic position normally occupied by the Hepler Sandstone. The shale above this break is olive gray and weathers light brown. The shale below is gray, weathers light gray, and contains a micro-fossil assemblage (Unit 1, Locality 18, Appendix A) very similar to that found in the Holdenville Shale in west-central Labette County by Ronald R. West (personal communication).

A clay mineralogy study of this shale sequence was conducted with the help of Dr. Ada Swineford and Paul C. Franks of the State Geological Survey of Kansas. By studying the clay mineralogy of the shale sequence it was determined that a weathered zone, such as might be expected at a disconformity, is absent at the top of the shale found below the color break.

The shale both above and below this break is dominantly illitic. In addition there is some variation in the amount and nature of kaolin present. All the samples seemed to contain very small amounts of quartz and feldspar. However, there are differences in mineralogy; the samples from below the color break showed a well defined 14Å chlorite peak on the x-ray traces, while the samples from above showed vermiculite or mixed-layer vermiculite-chlorite as the dominant 14 Å mineral. This difference in lithology plus the previously mentioned paleontologic evidence, and the fact that no sandstone was found in the interval

between Checkerboard and Lenapah limestones, indicates, that the color break is the most logical place, at this exposure, to draw the boundary between Desmoinesian and Missourian rocks.

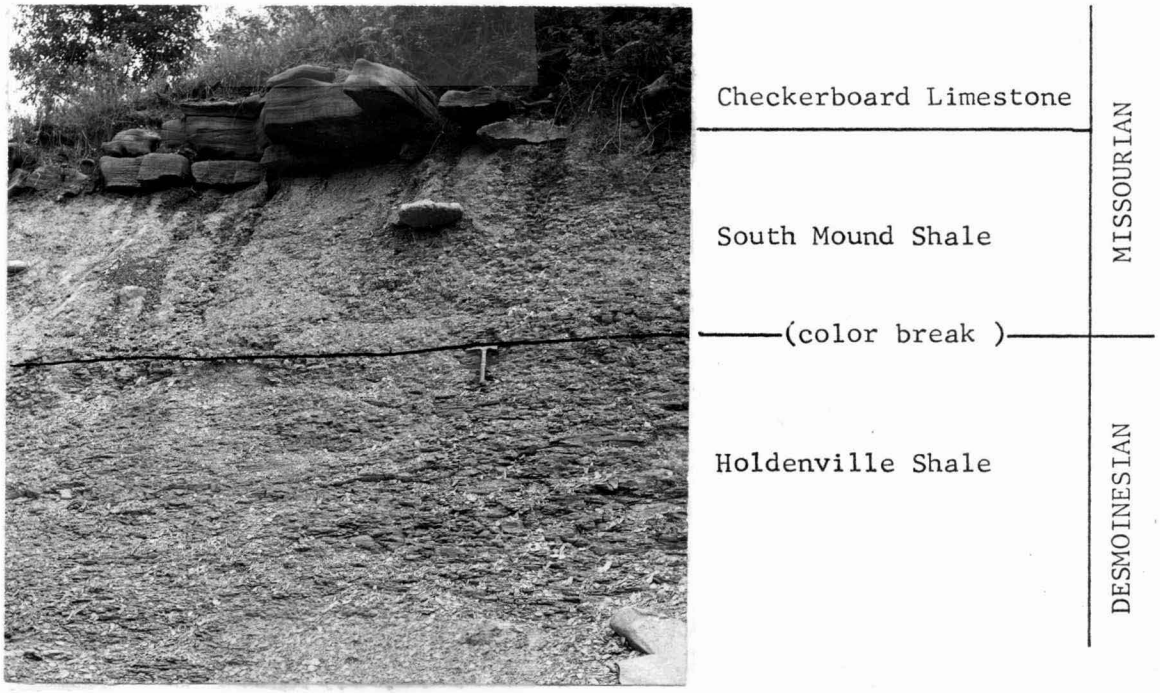


Fig. 3. Desmoinesian-Missourian boundary at Locality 18, 2 miles northeast of Coffeyville, Kansas.

Seminole Formation

The Seminole Formation is considered, in this report, as the lowermost formation of the Pleasanton Group. This unit consists of clastic sediments found between the Desmoinesian-Missourian disconformity and the base of the Checkerboard Formation. Its division into Hepler and South Mound Members is based on lithologic characteristics. In the area studied it ranges in thickness from 1 to 10 feet.

Stratigraphic studies indicate that the Seminole Formation thickens considerably in Oklahoma. South of T. 27 N., in Oklahoma, the Seminole thickens rapidly to 240 feet in the vicinity of Collinsville where the lower part of the formation consists of a conglomerate (Oakes, 1940, p. 23).

Hepler Sandstone member : The basal unit of the Pleasanton Group is the Hepler Sandstone. In the area studied the Hepler is an extremely fine-grained, well-sorted sandstone and in some instances nearly a siltstone. It is a thin to medium-bedded, reddish-brown to gray-brown, slightly micaceous, quartz sandstone. The Hepler is not cross-bedded to any great degree and ripple marks were not observed. Compass readings taken at two places where cross-bedding was found indicate paleocurrents in a southwesterly direction. Thickness in the area studied ranges from a featheredge to 5 feet.

Fig. 4. Thin-bedded Hepler Sandstone overlying Holdenville Shale at Locality 5, 5 miles northeast of Erie, Kansas.

The Hepler in southern Kansas is in general much thinner than that to the north. Hatcher (1961) reports a maximum thickness of approximately 25 feet for the Hepler in Bourbon, Linn and Miami

Counties. The maximum observed thickness in southern Kansas is 5 feet with an average of 2.2 feet. A marked decrease in grain size accompanies the thinning. Size analysis of the Hepler in the area studied shows that the largest percentage of grains range in size from 1/8 to less than 1/16 mm. In the area north of that covered by this report average grain size ranged from 1/4 to 1/16 mm.

Histograms (Fig. 5) show the predominance of grains in the very fine sand and silt size ranges, and the moderate to well sorted characteristics of the Hepler. No significant directional trends in grain size decrease or increase, were noted from studying histograms of all the Hepler samples. Cumulative curves of all sandstone samples were drawn and the sorting coefficients, which average 2.10, were calculated. These coefficients are given in Appendix C. According to the classification of Trask (1932), all these samples are either well or moderately sorted.

The Hepler is a very persistent sheet-like deposit and is found along almost the entire outcrop belt of the Pleasanton Group. Its widespread occurrence and horizontal bedding seem to rule out a fluvial origin. In the area covered by this report the Hepler Sandstone is in the author's opinion, a tidal flat deposit. The petrology of the Hepler and its gross characteristics best fit the quartz-muscovite type of sandstone described by Dapples (1947), "These are sediments which appear to have accumulated chiefly in an invironment associated with large alluviating rivers emptying into regions of extensive tidal flats. These sediments are more areally restricted and thinner than other platform deposits." Orientation of cross-bedding and decrease in grain size to the south indicate the source area of

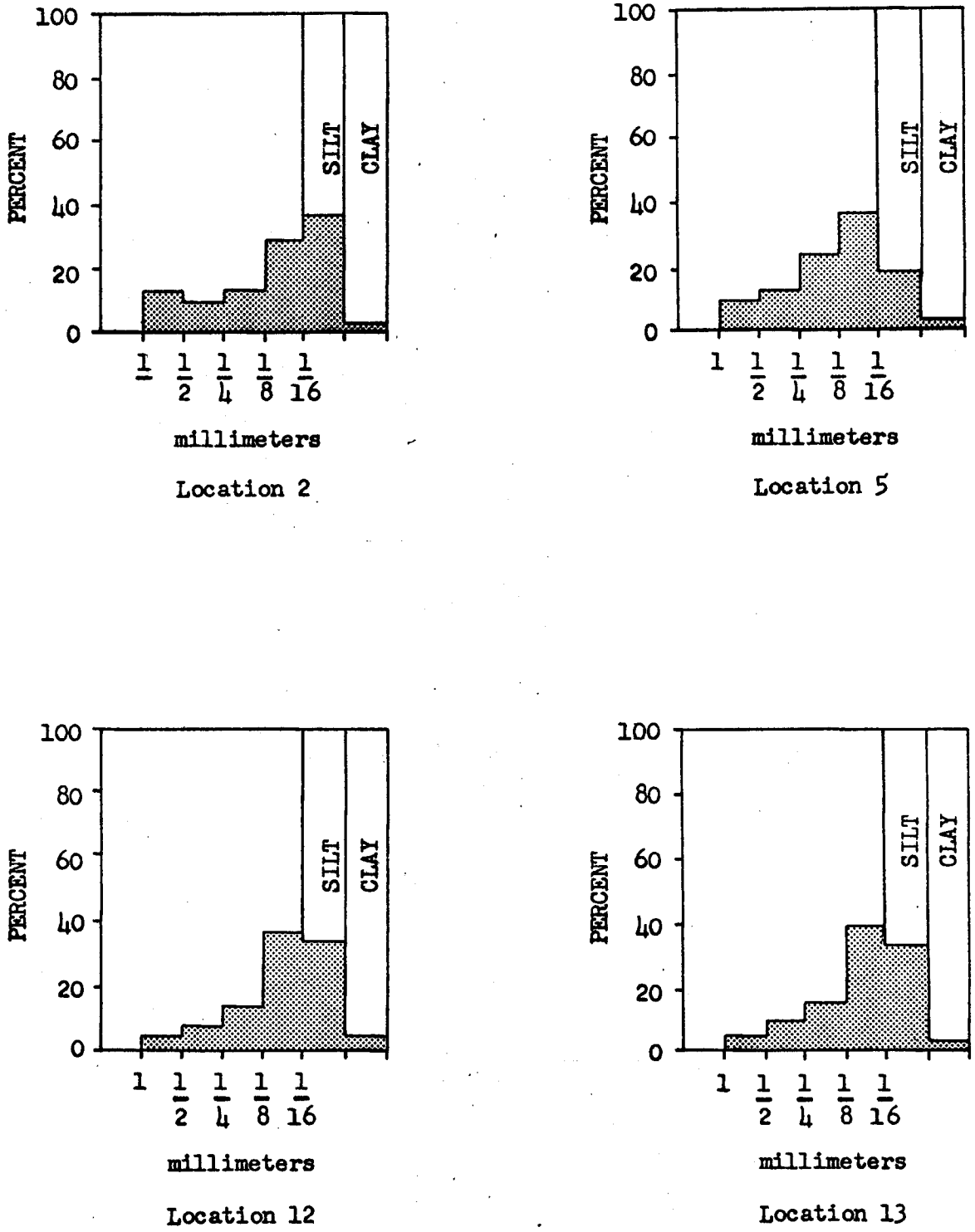


Fig. 5. Histograms prepared from samples of the Hepler Sandstone.

the Hepler to be northeast of the present line of outcrop. Neritic influence to the southwest is indicated by the presence of brachiopods found in the Hepler by Jewett (1945, p. 122) near the CSL, sec. 2, T. 33 S., R. 18 E., in Labette County, Kansas. Deeper water was probably to the west, as is indicated by the predominence of marine sediments found in the subsurface Pleasanton.

South Mound Member : The South Mound Member of the Seminole Formation occupies the interval between the top of the Hepler Sandstone and the base of the Checkerboard Limestone. This unit is mainly a gray clay shale which is rather silty in some localities. A very thin, low grade, lignitic coal is found along with black shale at Locality 12. In the area studied thickness of the member ranges from 0.3 to 10 feet. This shale seemingly is unfossiliferous with the exception of its occurrence at Locality 18 in Montgomery County (Fig. 3). At this Locality a thin, discontinuous, nodular limestone is present 1.5 feet below the lower Checkerboard. The shale above this limestone contains Derbyia crassa, Punctospirifer, Neospirifer, Composita, and crinoid fragments.

This unit represents the beginning of the first definite marine depositional phase of the Pleasanton Group. It was probably deposited in deeper water than the Hepler as is shown by the presence of marine fossils at some localities. The coal and black shale in the lower part of this unit at Locality 12, perhaps indicate short-lived costal swamp conditions. Marine conditions continued to develop during the time of deposition of this unit "setting the stage" for the deposition of the marine limestone of the overlying Checkerboard Formation.

Checkerboard Formation

The Checkerboard Limestone (Hutchison, 1911, p. 157) comprises two thin limestones separated by dark-gray calcareous shale. The lower limestone is the most persistent member and has a very distinct lithology. Prior to this investigation Checkerboard had been recognized, in Kansas, only as far north as T. 31 S. The author has been able to trace the lower member farther north, to the center of T.29S., and it is very probable that this member exists even farther north. Jewett (1945, Pl. 4) found a limestone which he tentatively correlated with the Checkerboard in T. 23 S. A unit very similar to lower Checkerboard, and in the same stratigraphic position, is found in Missouri where it is called the Exline Limestone. Figure 6 shows a complete section of the Checkerboard Formation.

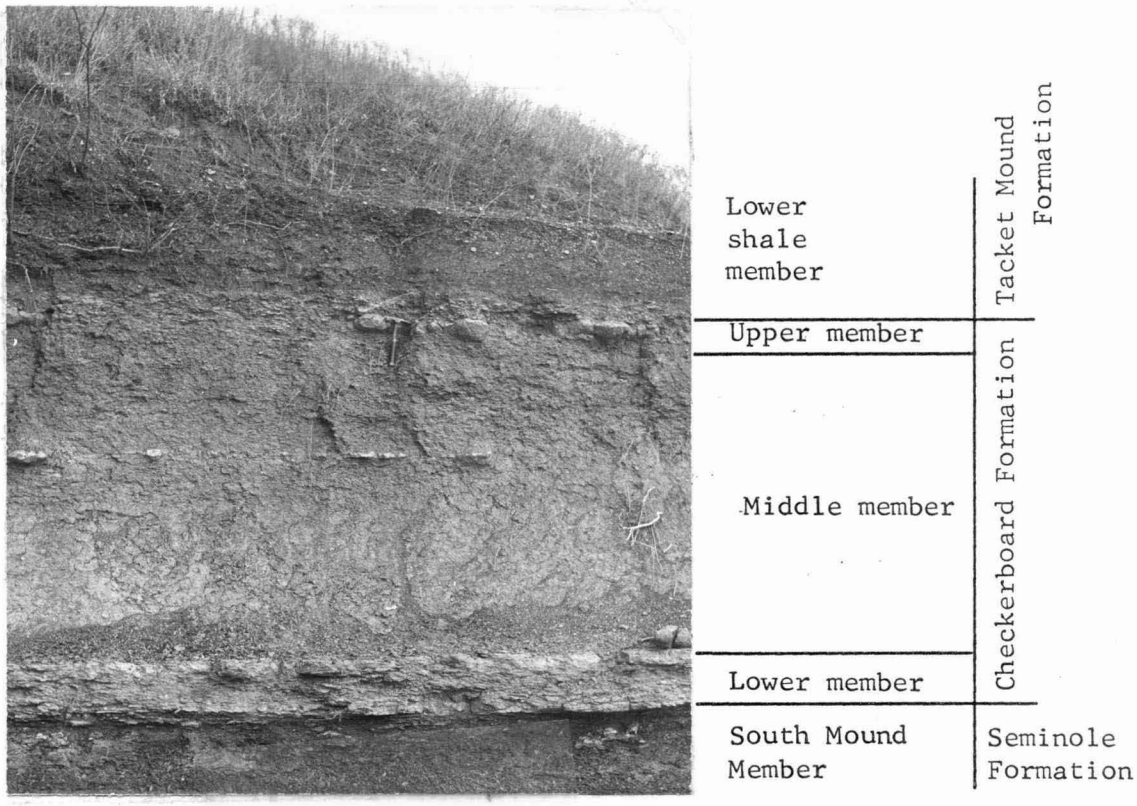


Fig. 6. Checkerboard Formation at Locality 19, approximately 7 miles south of South Coffeyville, Oklahoma.

Lower limestone member : The lower member of the Checkerboard Formation is a gray, brown-weathering, thin-bedded limestone. In some localities it is almost a coquina of gastropods and crinoid fragments, in others it contains an abundance of brachiopods along with other fossil fragments. Thickness of this unit ranges from a featheredge to 2 feet.

At Locality 18 the lower Checkerboard is a cross-bedded, fragmental limestone. Figure 7 shows the unit where it is badly weathered, particularly along the bedding planes, which gives a false impression of excessive dip and thickness. The Checkerboard shown in figure 3 (page 15), only 100 feet west of the outcrop shown in figure 7, is not as badly weathered and gives a true picture of its actual thickness. A peelprint and a photograph of the lower Checkerboard are shown in figures 8 and 9.

Insoluble residues of this unit contain abundant arenaceous Foraminifera. (See Appendix B, sample numbers 8/3, 13/4, 15/8, 18/3 and 19/4).

Fig. 7. Cross-bedded Checkerboard Limestone at Locality 18, 2 miles northeast of Coffeyville, Kansas.

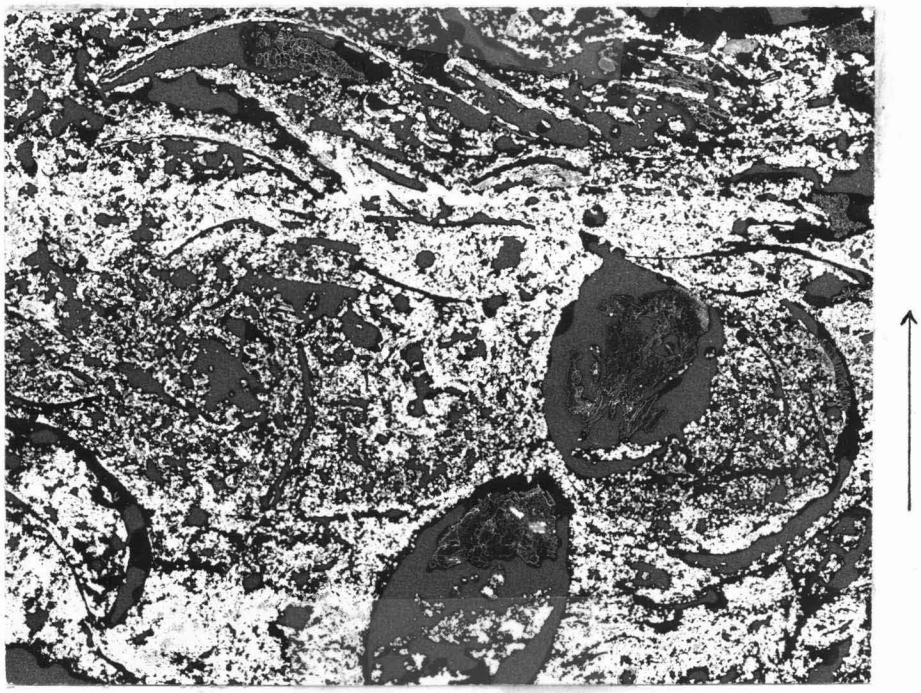


Fig. 8. Peel-print of lower Checkerboard Limestone at at Locality 8. Note abundance of brachiopods, especially Composita. X 3.

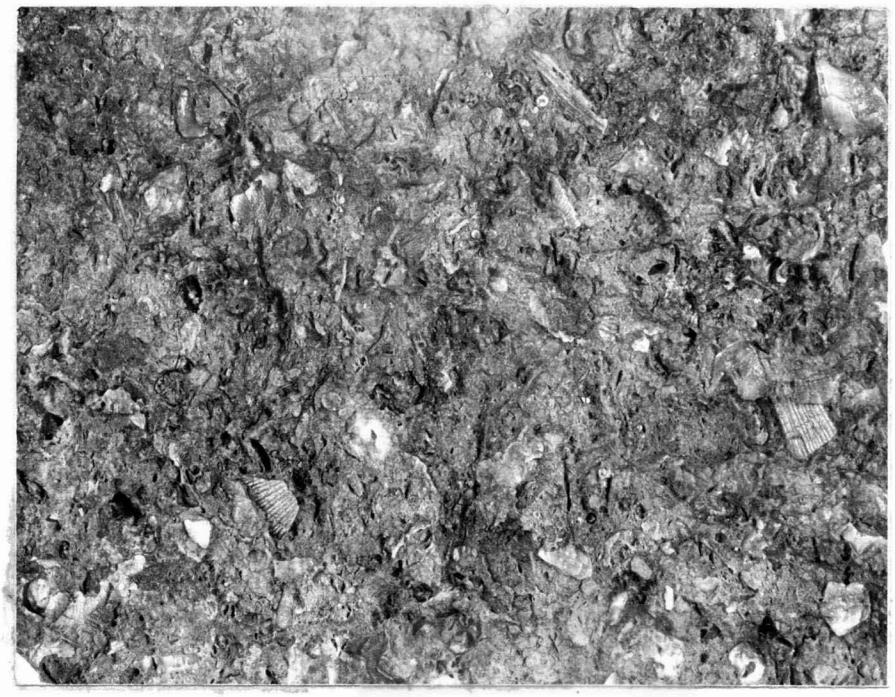


Fig. 9. Photograph of weathered upper surface of lower Checkerboard Limestone at Locality 18. Note abundance of fossil fragments. X 1.

Middle shale member: This unit, which is usually poorly exposed, ranges in thickness from a featheredge to about 8 feet. It is a dark-gray, blocky to platy, clay shale and is quite fossiliferous. At Locality 19 in Nowata County, Oklahoma this unit is very fossiliferous and contains abundant brachiopods; Derbyia, Composita, Juresania and Hustedia.

Upper limestone member: The upper limestone member is an impure, gray, brown-weathering, fine-grained, nodular limestone which contains brachiopods, gastropods, and, in some localities, abundant arenaceous Foraminifera. The thickness of this unit ranges from a featheredge to 0.8 feet.

The Checkerboard Limestone, particularly the lower limestone, was probably deposited in somewhat deeper water than the remainder of the Pleasanton. This is indicated by the presence of marine fossils in both the lower Checkerboard and the overlying shale. To the north the lower Checkerboard becomes more silty and clayey which indicated shallower water. At Locality 18 this limestone is a cross-bedded, fragmental, limestone, which indicates shallow water with considerable current action.

The upper member of rather impure limestone represents a pause in the deposition of clastics after the formation of the middle shale, and prior to renewed clastic deposition which formed the overlying Tacket Mound Formation.

Tacket Mound Formation

Tacket Mound is the uppermost formation of the Pleasanton Group. This unit consists mainly of clastic sediments which occupy the interval between the top of the Checkerboard Limestone and the base of the Hertha Limestone. Its division into the lower shale, middle limestone, and upper shale members is based on lithologic characteristics. Its thickness ranges from approximately 25 to 50 feet. Figure 10 shows a typical exposure of the upper part of the Tacket Mound Formation.

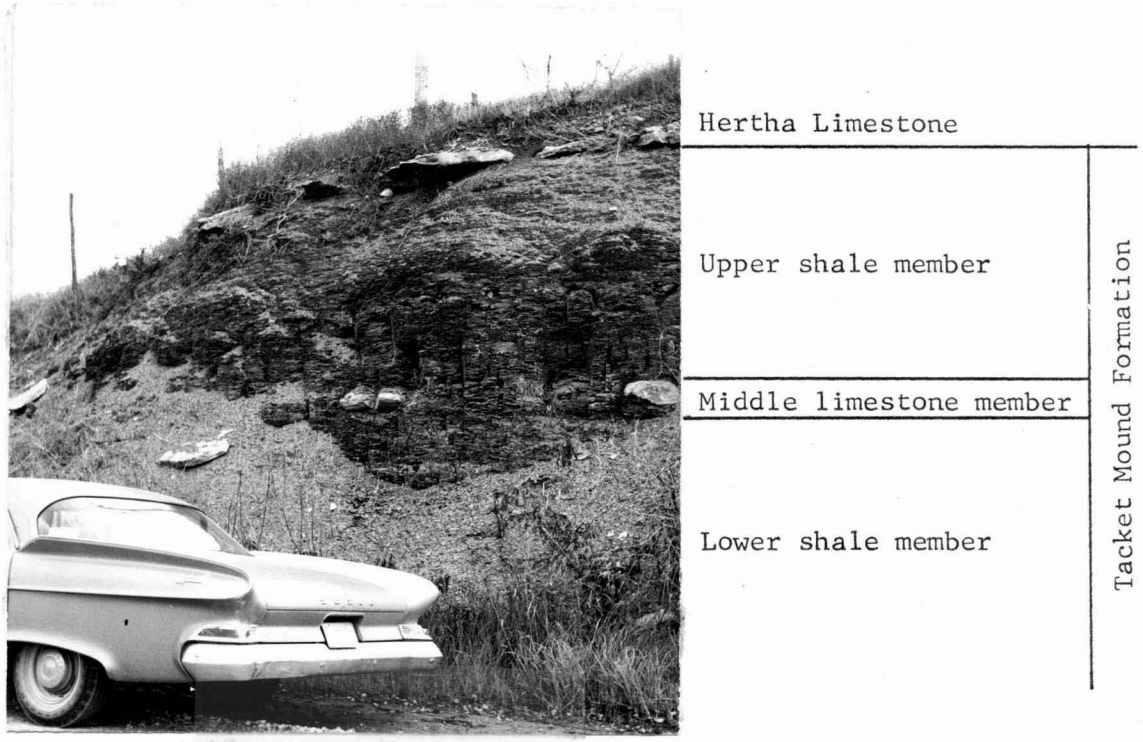


Fig. 10. Hertha Limestone and upper part of the Tacket Mound Formation at Locality 12, 1 mile southwest of Parsons, Kansas.

Lower shale member : The thickness of this member ranges greatly, with the average being 20 feet. This unit is composed of both gray clay shale, and black, fissile, highly carbonaceous shale which commonly contains phosphatic nodules. In two localities the gray shale facies contains sandstone and siltstone lenses which do not seem to

be laterally persistent to any great extent. These sandstones and siltstones apparently are the product of a mixed marine and non-marine environment. They contain impressions of crinoid columnals, brachiopods, and pelecypods, but also contain plant remains and have other characteristics of non-marine sediments.

At Locality 3 the gray shale contains a thin, dark-gray limestone which is very similar to the so-called "Bourbon Flags" found in the Pleasanton Group farther north in Bourbon County. At Localities 13 and 15 the entire interval making up this member is composed of black shale.

Middle limestone member : This limestone is a nodular, dark-gray, fine-grained, nearly lithographic limestone, which breaks with a conchoidal fracture and is often petroliferous. Thickness ranges from 0.4 to 0.8 feet. Megascopic fossils are almost completely lacking but insoluble residues usually contain abundant arenaceous Foraminifera as well as other microfossils.

A particularly interesting microfossil assemblage was found in the insoluble residue of this limestone at Locality 9. With the exception of minor amounts of pyrite the entire residue is made up of siliceous and arenaceous fossils and fragments, including, Ammodiscus, Ammovertella and Tolypammina, along with very small gastropods and fragments of small pelecypods.

Upper shale member : South of T. 29 S. the bulk of this unit is made up of black, fissile, highly carbonaceous shale, usually containing zones of phosphatic nodules. According to Runnels et al (1953) these nodules contain high amounts of phosphate and calcium carbonate as well as minor amounts of uranium and flourine. The black shales are

radioactive, but not to any significant degree. In some localities the shale and the nodules contain rather high amounts of iron sulfide.

With the exception of Polygnathus and impressions of Aviculopecten, found at Locality 4, the black shales are quite barren of fossils.

The remainder of this unit consists of a gray, blocky or platy clay shale. This gray shale occupies the entire interval at Localities 1, 2, and 9. At some localities a gray, platy, fossiliferous shale, less than 1 foot thick, is found immediately beneath the Hertha Limestone.

The gray and black shales of the lower and upper members of the Tacket Mound Formation represent deposits in a near-shore environment. Perhaps an offshore bar was formed and a logoonal environment was created by this restriction. A lagoonal environment would account for the concentration of large amounts of organic matter necessary for the formation of the black shale, and the very dark, bituminous, nodular, middle limestone. As the sea trangressed this area and the water became deeper, restricted conditions ceased to exist. North of T. 28 S. where the Pleasanton is predominantly gray shale containing a few sandstone lenses, the restricted conditions apparently did not exist.

SUMMARY

The Pleasanton Group can be subdivided into the following three formations, named in ascending order; 1. the Seminole Formation, made up of the Hepler Sandstone member and South Mound Member; 2. the Checkerboard Formation, comprised of a lower limestone member, middle shale member and upper limestone member; and 3. the Tacket Mound Formation, consisting of a lower shale member, middle limestone member and an upper shale member. The names South Mound and Tacket Mound are given to previously unnamed intervals. The name Seminole is taken from Oklahoma usage and applied to Kansas stratigraphy exactly as it is applied in Oklahoma. The rank of Hepler Sandstone has been changed from formation to member.

The Pleasanton is composed mainly of clastic sediments which represent mechanically weathered detritus derived from the land to the north and east and deposited in shallow seas which advanced northward, over Kansas, after a period of emergence.

The Hepler Sandstone seems to be a tidal flat deposit. There is evidence that Hepler sediments came from a northeasterly direction. The Hepler is a very persistent unit found along the entire outcrop belt with the exception of one small area northeast of Coffeyville, Kansas. Here the Hepler Sandstone is absent and the Desmoinesian-Missourian boundary is placed below a color break which occurs in a shale sequence. This boundary is defined on the basis of a clay mineralogy study, plus paleontologic and stratigraphic evidence.

The Checkerboard Limestone represents the most dominant marine phase of Pleasanton deposition. The lower limestone member of the

Checkerboard can be recognized as far north as T. 29 S. and has been tentatively identified, even farther north, in T. 23 S. It is highly probable that it exists across eastern Kansas and into Missouri.

The dominantly clastic Tacket Mound Formation represents deposits of a near-shore marine environment with fluctuating restricted to non-restricted conditions, this is particularly true south of T. 28 S.

SELECTED REFERENCES

Abernathy, G. E., 1940, Oil and gas in Montgomery County, Kansas: Kansas Geol. Survey, Bull. 31.

Adams, G. I., Girty, G. H., and White, D., 1903, Stratigraphy and paleontology of the Upper Carboniferous rocks of the Kansas section: U. S. Geol. Survey, Bull. 211, p. 175-181.

American Commission on Stratigraphic Nomenclature, 1961, Code of stratigraphic nomenclature: Amer. Assoc. of Petroleum Geologists, Bull., V. 45, p. 645-665.

Bloesch, E., 1928, Oil and gas in Oklahoma, Nowata and Craig Counties: Oklahoma Geol. Survey, Bull. No. 40-EE.

Cline, L. M. and Greene, F. C., 1950, A stratigraphic study of the Upper Marmaton and Lowermost Pleasanton Groups, Pennsylvanian of Missouri: Missouri Geol. Survey and Water Resources, Report of Investigations No. 12.

Dalton, J. A., Swineford, A. and Jewett, J. M., 1958, Clay minerals at a Pennsylvanian disconformity: Proceedings of Fifth National Conference on Clays and Clay Minerals, Publication 566, p. 242-252.

Dapples, E. C., 1947, Sandstone types and their associated depositional environments: Jour. Sed. Petrology, V. 17, p. 91-100.

Dott, R. H., 1927, Pennsylvanian paleogeography: Oklahoma Geol. Survey, Bull. No. 40-J.

Dunbar, C. O., and Condra, G. E., 1932, Brachiopoda of the Pennsylvanian System in Nebraska: Nebraska Geol. Survey, Bull. 5.

Grohskopf, J. G., and McCracken, E., 1949, Insoluble residues of some Paleozoic formations of Missouri, their preparation, characteristics and application: Missouri Geol. Survey, Report of Investigation No. 10.

Hatcher, D. A., 1961, Stratigraphy of the Pleasanton Group in Miami, Linn and Bourbon Counties, Kansas: Masters Thesis, University of Kansas, (unpublished).

Haun, J. D., and LeRoy, L. W., 1958, Subsurface geology in petroleum exploration (A symposium): Colorado School of Mines, Golden, Colorado, p. 33-41.

Haworth, E., and Kirk, M. Z., 1894, Kansas University Quart., V. 2, p. 108.

Haworth, E., 1895, Kansas University Quart., V. 3, p. 274.

Haworth, E., 1898, Stratigraphy of the Kansas Coal Measures: Kansas Geol. Survey, Bull. 3, p. 33-41.

Hedberg, H. D., 1954, Procedure and terminology in stratigraphic classification: Int. Geol. Cong., 19th Algeria, C. R. sec. 13, f. 13, p. 205-233.

Hinds, H., and Greene, F. C., 1915, Mo. Bur. Geol. and Mines, V. 13.

Howe, W. B., 1961, The stratigraphic succession in Missouri: Missouri Geol. Survey and Water Resources, V. XL, second series.

Hutchison, L. L., 1911, Preliminary report of the rock asphalt, asphaltite, petroleum, and natural gas in Oklahoma: Oklahoma Geol. Survey Bull. 2, p. 157.

Ireland, H. A., 1947, Terminology for insoluble residues: Amer. Assoc. of Petroleum Geologists Bull., V. 31, p. 1479-1490.

_____, 1956, Upper Pennsylvahian arenaceous Forminifera from Kansas: Jour. of Paleontology, V. 30, No. 4, p. 831-864.

Jewett, J. M., 1937, Lateral changes in the Lower Missourian beds of southeastern Kansas: Guide Book, Eleventh Annual Field Conference, Kansas Geol. Society, p. 55.

_____, 1940, Oil and gas in Linn County, Kansas: Kansas Geol. Survey, Bull. 30, p. 8.

_____, 1941, Classification of the Marmaton Group, Pennsylvanian, in Kansas: Kansas Geol. Survey, Bull. 38.

_____, 1945, Stratigraphy of the Marmaton Group, Pennsylvanian, in Kansas: Kansas Geol. Survey, Bull. 58.

_____, 1959, Graphic column and classification of rocks in Kansas: Kansas Geol. Survey.

Keyes, C. R., 1900, Iowa Acad. Sci., Proc., V. 7, p. 84.

Krumbein, W. C., 1947, Shales and their environmental significance: Jour. of Sed. Petrology, V. 17, No. 3, p. 101-108.

_____, and Pettijohn, P. J., 1938, Manual of sedimentary petrography: D. Appleton-Century Co. Inc., N. Y., p. 135-145.

_____, and Sloss, L. L., 1955, Stratigraphy and sedimentation: W. H. Freeman and Co.

Moore, R. C., 1920, Kansas Geol. Survey, Bull. 6,pt. 2, p. 28.

_____, and Jewett, J. M., 1932, Guide Book, Sixth Annual Field Conference, Kansas Geol. Society, p. 99.

Moore, R. C., 1935, Stratigraphic classification of the Pennsylvanian rocks of Kansas: Kansas Geol. Survey, Bull. 22.

_____, Newell, N. D., Dott, R. H., and Borden, J. L., 1937, Definition and classification of the Missouri Subseries of the Pennsylvanian Series in northeastern Oklahoma: Guide Book, Eleventh Annual Field Conference, Kansas Geol. Society.

Moore, R. C., 1949, Divisions of the Pennsylvanian System in Kansas: Kansas Geol. Survey, Bull. 83 p. 69-74.

_____, Lalicker, C. G., and Fisher, A. G., 1952, Invertebrate fossils: McGraw-Hill Book Co. Inc.

Newell, N. D., 1935, Kansas Geol. Survey, Bull. 21, p. 21.

Oakes, M. C., 1940, Geology and mineral resources of Washington County, Oklahoma: Oklahoma Geol. Survey Bull. No. 62.

_____, and Jewett, J. M., 1943, Upper Desmoinesian and Lower Missourian rocks in northeastern Oklahoma and southeastern Kansas: Amer. Assoc. of Petroleum Geologists Bull., V. 27, p. 632-640.

Ockerman, J. W., 1935, Kansas Geol. Survey, Bull. 20, p. 20.

Rich, J. L., 1951, Probable fondo origin of Marcellus-Ohio-New Albany-Chattanooga bituminous shales: Amer. Assoc. of Petroleum Geologists Bull., V. 35, p. 2017-2040.

Runnels, R. T., 1952, Oil shale in Kansas: Kansas Geol. Survey, Bull. 96, part 3.

_____, 1953, Composition of some uranium bearing phosphate nodules from Kansas shales: Kansas Geol. Survey, Bull. 102, part 3.

Sloss, L. L., 1947, Environments of limestone deposition: Jour. of Sed. Petrology, V. 17, No. 3, p. 109-133.

Sternberg, R. M., and Belding, H. F., 1942, Dry-Peel technique: Jour. of Paleontology, V. 16, No. 1, p. 135-136.

Swallow, G. C., and Hawn, F., 1858, The rocks of Kansas: Extract from Trans. Acad. Sci., St. Louis, V. I., No. 2.

Swallow, G. C., 1866, Preliminary report: Kansas Geol. Survey, p. 22-24.

Taft, J. A., 1901, U.S.G.S. Coalgate folio, No. 74.

Twenhofel, W. H., 1939, Environments of origin of black shales: Amer. Assoc. of Petroleum Geologists Bull., V. 23, No. 8.

_____, 1950, Principles of sedimentation: McGraw-Hill Book Co. Inc.

APPENDIX A

DETAILED STRATIGRAPHIC SECTIONS

The units and members described below are in stratigraphic order, from the top down. In each county the stratigraphic sections are arranged in order of section, township and range.

Stratigraphic Sections in Bourbon County, Kansas

Locality 1: NE¼ SW¼ sec. 12, T. 26 S., R. 21 E., below spillway at county lake.

		Feet
Bronson Subgroup		
Hertha Limestone		
10.	Limestone, light gray weathers tan, very thick bedded, contains crinoids and abundant corals.....	4.0
9.	Shale, light gray, platy, calcareous....	1.0
8.	Limestone, gray weathers tan, cherty, contains brachiopods and crinoids.....	4.5
7.	Shale, yellow to brown, blocky.....	0.9
6.	Limestone, dark gray, very fine grained, unfossiliferous.....	0.5
5.	Shale, yellow near top, gray at base, blocky.....	1.5
4.	Limestone, very fine grained, bluish gray weathers tan.....	0.7
Pleasanton Group (Total thickness exposed, 26.1 feet)		
Tacket Mound Formation		
Upper shale member		
3.	Shale, light gray, blocky, hard, small amounts of mica, unfossiliferous, concretions 10.5 feet from top containing $CaCO_3$ and FeS_2, calcareous zone near top.....	15.7
Middle limestone member		
2.	Limestone, nodular, dark gray weathers yellow gray, iron stained, very fine grained.....	0.4

Lower shale member

1. Shale, light gray, blocky, unfossiliferous..... 10.0

Locality 2: SE¼ sec. 4 and SW¼ sec. 3, T. 27 S., R. 22 E., north side of State Highway 39, down faceslope of escarpment.

Bronson Subgroup
Hertha Limestone

7. Limestone, gray weathers yellow to brown, contains brachiopods and crinoids, poorly exposed..... 2.0

Pleasanton Group (Total thickness exposed, 101.5 feet)
Tacket Mound Formation
Upper shale member

6. Shale, gray weathers yellow, blocky, contains bryozoan fragments and indistinct brachiopod impressions..... 26.0

Middle limestone member

5. Limestone, nodular, bluish gray weathers light gray, choncoidal fracture, very fine grained, slightly silty, a few arenaceous Foraminifera, Tolypammina and fragments..... 0.5

Lower shale member

4. Shale, gray, blocky, unfossiliferous..... 2.0

3. Shale, gray, mostly covered..... 68.0

Seminole Formation
Hepler Sandstone member

2. Sandstone, light brown weathers gray-brown, top 3 feet thin bedded, bottom 2 feet medium bedded and slightly calcareous, some minor cross-bedding near top, limonitic cement, moderately sorted, slightly micaceous, mineral content made up almost entirely of quartz, largest percentage of grains are less than 1/16 mm in diameter, grains are frosted, sub-rounded to sub-angular, sphericity of 0.5..... 5.0

Marmaton Group
Holdenville Shale

1. Shale, gray weathers yellow, blocky, silty..... 3.0

Stratigraphic Sections in Neosho County, Kansas

Locality 3: SW¼ sec. 27 and SE¼ sec. 28, T. 27 S., R. 21 E., north side of road cut at top of hill and down the creek bank to the north. Hepler is at second bridge west of hilltop.

Bronson Subgroup
Hertha Limestone

13. Limestone, gray weathers yellow brown, very poorly exposed..... 2.0

Pleasanton Group (Total thickness exposed, 58.3 feet)
Tacket Mound Formation
Upper shale member

12. Shale, gray, clayey and blocky, mostly covered..... 12.0

11. Shale, black, fissile, highly carbonaceous, contains phosphatic nodules 1-2 cm in diameter..... 3.0

Middle limestone member

10. Limestone, nodular, bluish gray, weathers gray, choncoidal fracture, very fine grained, silty, contains a few arenaceous Foraminifera fragments..... 0.8

Lower shale member

9. Shale, black, fissile, carbonaceous, contains phosphatic nodules..... 2.0

8. Shale, gray weathers light gray, clayey and blocky..... 8.0

7. Limestone, gray weathers yellow, fine grained, slightly silty, contains crinoid fragments, brachiopod fragments and gastropods..... 0.3

6. Shale, yellow - gray, platy to blocky, silty..... 2.0

5. Sandstone, gray weathers yellow, thin bedded, poorly sorted, calcareous, contains brachiopod fragments, plant remains..... 0.2

4. Shale, yellow and gray, blocky, slightly silty..... 3.0

3. Sandstone, gray weathers tan, thick bedded, poorly sorted..... 2.0

2. Covered interval..... 22.0

Seminole Formation
Hepler Sandstone member

1. Sandstone, light brown weathers gray, medium bedded, well cemented, calcareous cement, well sorted, small amounts of garnet and muscovite, mainly quartz, sub-rounded, slightly frosted, sphericity 0.7, average grain size is 1/8 mm..... 3.0

Locality 4: Center NE¼ sec. 11, T. 28 S., R. 20 E., along east bluff of small stream.

Bronson Subgroup
Hertha Limestone

4. Limestone, gray weathers tan, badly weathered, poorly exposed..... 2.0

Pleasanton Group (Total thickness exposed, 12.9 feet)
Tacket Mound Formation
Upper shale member

3. Shale, black, fissile, highly carbonaceous, contains phosphatic nodules 1-2 cm in diameter, impressions of Aviculopecten, and conodont Polygnathus..... 6.0

Middle limestone member

2. Limestone, nodular, bluish gray weathers light brown, very fine grained, conchoidal fracture, silty, unfossiliferous, petroliferous... 0.4

Lower shale member

1. Shale, black, fissile, highly carbonaceous..... 6.5

Locality 5: CNL sec. 19, T. 28 S., R. 21 E., south side of road.

Pleasanton Group
Seminole Formation
Hepler Sandstone member

2. Sandstone, brown weathers reddish brown, thin bedded, poorly cemented by limonite, well sorted, contains very minor amount of muscovite, remainder of rock made up of quartz, largest percentage of grains 1/16 mm in diameter, grains are slightly frosted, sub-angular to sub-rounded sphericity of 0.7..... 3.0

Marmaton Group
Holdenville Shale

1. Shale, platy, clayey, gray weathers yellow, unfossiliferous..... 3.5

Locality 6: NW¼ SW¼ sec. 17, T. 29 S., R. 20 E., east side of creek, north of bridge.

Bronson Subgroup
Hertha Limestone

6. Limestone, light to dark gray, thick to medium bedded, contains brachiopods and numerous calcite veins near top..... 2.5

Pleasanton Group (Total thickness exposed, 6.6 feet)
Tacket Mound Formation
Upper shale member

5. Shale, gray, calcareous, platy, contains pelecypod fragments, Rhombopora..... 1.5

4. Shale, very calcareous, dark gray weathers tan, contains Ammodiscus, impressions of Chonetina, and fragments of bryozoa, crinoids, ecinoid spines and plate fragments..... 0.2

3. Shale, black, fissile, highly carbonaceous, contains phosphatic nodules..... 2.5

Middle limestone member

2. Limestone, nodular, bluish gray weathers dark gray, very fine grained, conchoidal fracture, contains arenaceous Foraminifera fragments..... 0.4

Lower shale member

1. Shale, black, fissile, highly carbonaceous..... 2.0

Locality 7: SE¼ SE¼ sec. 17, T. 29 S., R. 20 E., north side of road cut on State Highway 57.

Bronson Subgroup
Hertha Limestone

6. Limestone, light to dark gray, thick to medium irregular beds, contains brachiopods, crinoids and calcite veins near top..... 4.0

Pleasanton Group (Total thickness exposed, 13.5 feet)
Tacket Mound Formation
Upper shale member

5. Shale, gray weathers yellow, platy, contains Composita, Pecten, and fragments of bryozoa, pelecypods and brachiopods..... 1.0

4. Shale, black, fissile, highly carbonaceous, contains phosphatic nodules..... 2.0

Middle limestone member

3. Limestone, nodular, very fine grained, nearly lithographic, bluish gray weathers gray, very hard, conchoidal fracture, a few arenaceous Foraminifera fragments, petroliferous..... 0.5

Lower shale member

2. Shale, black, fissile, highly carbonaceous, contains phosphatic nodules 0.5-1 cm in diameter, iron stains near top, Chonetes partly replaced by pyrite..... 7.0

1. Shale, dark gray, blocky, calcareous zone near top with some poorly developed nodular limestone..... 3.0

Locality 8: Composite section from SE¼ sec. 29 and SW¼ sec. 28, T. 29 S., R. 20 E., note, Checkerboard exposure is in front of farm house on east side of N-S county road in NW¼ SW¼ sec. 28.

Bronson Subgroup
Hertha Limestone

5. Limestone, light gray weathers yellow, contains brachiopods and crinoids..... 1.5

Pleasanton Group (Total thickness exposed, 31.0 feet)
Tacket Mound Formation

4. Covered interval..... 25.0

Checkerboard Limestone
Lower limestone member

3. Limestone, gray weathers light yellow, very fossiliferous, sandy, medium to thin bedded, contains bryozoa, crinoids, many brachiopods; Composita and Derbyia..... 2.0

Seminole Formation
South Mound Member

2. Covered interval..... 2.0

Hepler Sandstone member

1. Sandstone, dark gray weathers brown, thin to medium bedded, well sorted, very minor amount of mica, mainly quartz, average grain size is 1/8 mm, grains are sub-rounded to sub-angular, frosted, sphericity of 0.7..... 2.0

Locality 9: Composite section: road cut CWL sec. 10, and north of road CSL sec. 10, T. 30 S., R. 20 E.

Bronson Subgroup
Hertha Limestone

13. Limestone, badly weathered, gray weathers tan, contains, corals, brachiopods and crinoids..... 2.0

Pleasanton Group (Total thickness exposed 31.8 feet)
Tacket Mound Formation
Upper shale member

12. Shale, dark gray weathers light gray, blocky, silty, unfossiliferous..... 5.0

Middle limestone member

11. Limestone, nodular, bluish gray weathers brown, very hard, very fine grained, contains abundant microfossils (see insoluble residue 9/11)..... 0.8

Lower shale member

10. Shale, dark gray weathers gray, blocky..... 4.5

9. Shale, black, platy to fissile, carbonaceous, contains phosphatic nodules 0.5 - 1 cm in diameter..... 3.5

8. Shale, platy, gray weathers yellow, high iron content..... 2.0

7. Sandstone, light brown, medium bedded, well sorted, calcareous near top, micaceous near base, contains impressions, of crinoid columnals, brachiopods and pelecypods..... 2.0

6. Siltstone, yellow gray weathers light brown, very thin bedded..... 1.5

5. Shale, gray weathers light brown, platy and hard, slightly silty near top, bottom 5 feet contains a few silty lenses..... 11.0

Checkerboard Limestone
Lower limestone member

4. Limestone, gray weathers brown, thin bedded, fossiliferous, very sandy, contains crinoids, brachiopods; Composita, arenaceous Foraminifera; Ammovertella and fragments..... 0.4

Seminole Formation
South Mound Member

3. Shale, gray weathers brown, silty, contains limonitic concretions..... 0.3

Hepler Sandstone member

2. Sandstone, light gray weathers dark brown, medium bedded, well cemented calcareous cement, moderately sorted, small amount of muscovite, mainly quartz, most grains less than 1/8 mm in diameter, sub-rounded to sub-angular, slightly frosted, sphericity 0.5..... 0.8

Marmaton Group
Holdenville Shale

1. Shale, gray weathers yellow-gray, platy to blocky, very silty..... 3.0

Stratigraphic Sections in Labette County, Kansas

Locality 10: NE¼ NW¼ sec. 2, T. 31 S., R. 19 E., small quarry, south side of road.

Bronson Subgroup
Hertha Limestone

4. Limestone, gray weathers yellow, badly weathered, contains brachiopods and crinoids..... 2.0

Pleasanton Group (Total thickness exposed, 9.8 feet)
Tacket Mound Formation
Upper shale member

3. Shale, black, fissile, highly carbonaceous..... 5.0

Middle limestone member

2. Limestone, nodular, dark gray weathers yellow-brown, very fine grained, silty, a few arenaceous Foraminifera fragments..... 0.8

Lower shale member

1. Shale, black, fissile, highly carbonaceous, iron stained..... 4.0

Locality 11: NE¼ sec. 21, T. 31 S., R. 19 E., entrance to Parsons Country Club.

Bronson Subgroup
Hertha Limestone

5. Limestone, gray weathers light brown, thick to medium bedded with thin shale breaks, contains crinoids, brachiopods, Composita..... 5.0

Pleasanton Group (Total thickness exposed, 10.9 feet)
Tacket Mound Formation
Upper shale member

4. Shale, gray weathers yellow, calcareous, contains Cancrinella, impressions of pelecypod shell fragments, crinoid plates and columnals..... 0.4

3. Shale, very dark gray, carbonaceous, platy near top and more fissile near base..... 5.5

Middle limestone member

2. Limestone, nodular, bluish-gray weathers to dark brown, very fine grained, arenaceous Foraminifera fragments..... 0.5

Lower shale member

1. Shale, black, fissile, highly carbonaceous..... 4.5

Locality 12: Composite section NW¼ NE¼ sec. 27, road cut, south side and SW¼ NW¼ sec. 26, east side of road, T. 31 S., R. 19 E.

Bronson Subgroup
Hertha Limestone

12. Limestone, gray weathers brown, thick to medium bedded with small shale breaks, contains, crinoids, brachiopods and bryozoans..... 4.5

Pleasanton Group (Total thickness exposed, 66.4 feet)
Tacket Mound Formation
Upper shale member

11. Shale, light gray to yellow, platy, calcareous, contains Dictyoclastus, Aviculopecten, impressions of crinoid columnals, productid shell fragments and spines..... 0.4

10. Shale, dark gray, blocky to platy, carbonaceous..... 5.0

9. Shale, black, fissile, highly carbonaceous..... 5.0

Middle limestone member

8. Limestone, nodular, bluish gray weathers gray, very fine grained, conchoidal fracture, slightly silty, petroliferous..... 0.8

Lower shale member

7. Shale, black, fissile, highly carbonaceous, contains phosphatic nodules with high iron content, very hard..... 7.0

6. Covered interval..... 42.0

T6.

Seminole Formation
South Mound Member

5. Shale, black, fissile, highly carbonaceous..... 2.0

4. Coal, lignitic, very low grade, high sulfur content..... 0.3

3. Shale, light gray blocky, clayey, contains plant remains..... 2.4

Hepler Sandstone member

2. Sandstone, gray weathers brownish gray, medium bedded, loosely cemented, calcareous cement, well sorted, slightly micaceous, quartz makes up remainder of rock, average grain size is 1/16 mm in diameter, grains are sub-rounded to sub-angular, sphericity of 0.5..... 1.5

Marmaton Group
Holdenville Shale

1. Shale, gray, blocky to platy, limonitic..... 3.0

Locality 13: Composite section, road cut and ditch along west side of NW¼ sec. 17 and in stream SW¼ SE¼ sec. 7, T. 32 S., R. 19 E.

Bronson Subgroup
Hertha Limestone

12. Limestone, gray weathers brown, thick to thin bedded, contains crinoids, brachiopods and corals..... 4.0

Pleasanton Group (Total thickness exposed, 61.4 feet)
Tacket Mound Formation
Upper shale member

11. Shale, black, fissile, carbonaceous, contains phosphatic nodules near base... 19.0

Middle limestone member

10. Limestone, nodular, gray weathers light gray, very fine grained, conchoidal fracture, silty..... 0.5

Lower shale member

9. Shale, black, fissile, iron stained at top, much of interval covered..... 20.5

Checkerboard Limestone
Upper limestone member

8. Limestone, nodular, fine grained, brown weathers light brown, medium bedded, slightly silty, contains gastropods, Derbyia, Composita, and other brachiopod fragments, also a few arenaceous Foraminifera fragments..... 0.8

7. Shale, blocky, yellow calcareous..... 0.2

6. Limestone, nodular, thick bedded, fine grained, brown weathers light brown..... 0.6

Middle shale member

5. Shale, gray, blocky, mostly covered..... 8.0

Lower limestone member

4. Limestone, reddish-gray, weathers light brown, thin bedded, contains, Derbyia crassa, Composita, Aviculopectin, gastropods and bryozoan fragments, and arenaceous Foraminifera (see insoluble residue 13/4)..... 0.8

Seminole Formation
South Mound Member

3. Shale, gray, platy to blocky..... 3.0

2. Covered interval..... 7.0

Hepler Sandstone member

1. Sandstone, reddish-brown weathers gray, medium bedded, limonitic cement, well sorted, very minor amounts of muscovite and garnet, mainly quartz, average grain size 1/16 mm in diameter, frosted, sub-rounded to sub-angular, sphericity of 0.5..... 1.0

Locality 14: CSL SE¼ sec. 5, T. 33 S., R. 18 E., shale pit, north side of road.

Bronson Subgroup
Hertha Limestone

2. Limestone, dark gray weathers yellow, very hard, contains crinoids, brachiopods, fine grained..... 0.4

Pleasanton Group
Tacket Mound Formation
Upper shale member

1. Shale, black, fissile, highly carbonaceous, contains phosphatic nodules, iron stained..... 5.0

Locality 15: NE¼ sec. 10, T. 33 S., R. 18 E., north side of creek 0.3 mile west of bridge over Pumpkin Creek.

Pleasanton Group (Total thickness exposed, 12.6 feet)
Checkerboard Limestone
Middle shale member

9. Shale, gray, blocky, slightly silty..... 4.0

Lower limestone member

8. Limestone, gray weathers brownish gray, thin bedded, contains Composita, Aviculopecten, abundant gastropods, Ammovertella, crinoid and arenaceous Foraminifera fragments..... 0.8

Seminole Formation
South Mound Member

7. Shale, gray, platy, silty..... 7.0

Hepler Sandstone member

6. Sandstone, gray weathers brownish gray, well cemented, calcareous cement, well sorted, slightly micaceous, mainly quartz, grains are sub-rounded to sub-angular, average grain size is 1/8 mm, sphericity of 0.5..... 0.8

Marmaton Group
Holdenville Shale

5. Shale, black, platy, carbonaceous..... 0.5

4. Coal, lignitic, fossil wood..... 0.4

3. Underclay, gray to yellow..... 0.8

2. Shale, gray, blocky, ls nodules 1-2 cm in diameter..... 1.0

1. Limestone, thin bedded, slaby, very silty..... 2.0

Locality 16: NW¼ sec. 21, T. 33 S., R. 18 E., along road, east side.

Pleasanton Group (Total thickness exposed, 12.9 feet)
Tacket Mound Formation
Lower shale member

5. Shale, light gray weathers yellow blocky..... 3.0

Checkerboard Limestone
Upper limestone member

4. Limestone, nodular, gray weathers brown, very fine grained, silty..... 0.4

Middle shale member

3. Shale, black, fissile, carbonaceous, contains phosphatic nodules..... 4.0

2. Covered interval..... 5.5

Marmaton Group
Idenbro Limestone

1. Limestone, gray weathers light gray, contains brachiopods and crinoids..... 3.0

Locality 17: CWL sec. 28, T. 33 S., R. 18 E., road ditch, east side.

Pleasanton Group
Seminole Formation
Hepler Sandstone member

4. Sandstone, brown weathers dark brown, very thin bedded to thin bedded, minor amount of muscovite, remainder of rock made up of quartz, largest percentage of grains are 1/16 mm in diameter, slightly frosted, sub-angular to sub-rounded, sphericity of 0.7..... 3.5

Marmaton Group
Holdenville Shale

3. Shale, gray, blocky, clayey..... 0.5

2. Coal, lignitic, fossil wood..... 0.3

1. Shale, yellow-gray, blocky, clayey..... 0.4

Stratigraphic Section in Montgomery County, Kansas

Locality 18: NE¼ SE¼ sec. 19, T. 34 S., R. 17 E., Claymore south bank of Spring Creek 100 feet west of ford.

Pleasanton Group (Total thickness exposed, 7.0 feet)
Checkerboard Limestone
Lower limestone member

3. Limestone, light gray weathers brownish gray, cross-bedded, slabby where weathered, thick to thin bedded, contains abundant gastropods, crinoidal material, brachiopods and arenaceous Foraminifera..... 2.0

Seminole Formation
South Mound Member

2. Shale, olive gray weathers light brown, blocky, small nodular limestone zone 1.5 feet below top, interval above this limestone contains Derbyia crassa, Punctospirifer, Neospirifer, Composita and crinoid fragments, interval below generally unfossiliferous..... 5.0

Marmaton Group
Holdenville Shale

1. Shale, dark gray, blocky, calcareous, slightly micaceous, minor amounts of pyrite, limey nodules with high Fe content near base, contains abundant microfauna; bellerphontid gastropods, crinoid plates and columnals, Foraminifera; Bathysiphan Ammodiscus, Ammovertella. Echinoid and brachiopod spines, brachiopod and pelecypod shell fragments, ramose bryozoans, low and high spired gastropods, ostracod; Bairdia, holothurian sclerites and sieve plates..... 8.0

Stratigraphic Section measured in Nowata County, Oklahoma

Locality 19: NE¼ sec. 25, T. 28 N., R. 15 E., 0.3 mile west of bridge, north bank of creek.

Pleasanton Group (Total thickness exposed, 16.4 feet)

Tacket Mound Formation

Lower shale member

7. Shale, black, fissile, highly carbonaceous, contains phosphatic nodules 0.5 - 1 cm in diameter..... 3.5

Checkerboard Limestone

Upper limestone member

6. Limestone, nodular, gray weathers light brown, fine grained, slightly silty, contains Juresania, Derbyia, gastropods and arenaceous Foraminifera..... 0.4

Middle shale member

5. Shale, dark gray weathers gray, blocky to platy, calcareous, contains abundant Derbyia, Composita, Juresania and some pelecypods. Thin nodular limestone near top..... 5.5

Lower limestone member

4. Limestone, bluish gray weathers brown, crumbly, and slabby, slightly silty, contains crinoid fragments, bryozoans, and brachiopods including Derbyia, arenaceous Foraminifera and other siliceous fossil fragments..... 0.5

Seminole Formation

South Mound Member

3. Shale, gray, calcareous, grades upward into overlying limestone..... 0.5

2. Shale, bluish gray, clayey above, silty below, thin coal lens near top.... 2.0

Hepler Sandstone member

1.	Sandstone, gray weathers brown, micaceous, medium bedded, well sorted, mainly quartz, average grain size 1/16 mm, sub-rounded to sub-angular, sphericity of 0.5.....	4.0

APPENDIX B

TABLE OF WEIGHT, PERCENTAGE, AND CONSTITUENTS OF INSOLUBLE RESIDUES

*Sample Number	Total Residue		Fine Fraction		Coarse Fraction		Constituents of Coarse Fraction	
	Grams	Percent	Grams	Percent	Grams	Percent	Percent	Description of sample
2/5	6.40	21.3	6.00	20.0	0.40	1.3	98	silt and clay
							2	pyrite
								a few arenaceous Foraminifera (Tolypammina and fragments)
3/10	8.36	27.8	5.00	16.7	3.36	11.1	99	silt and clay
								trace of pyrite
								trace of arenaceous Foraminifera fragments
4/2	10.16	33.9	5.49	14.9	4.67	19.0	99	silt and clay
								trace of pyrite
								trace of muscovite
6/2	1.29	4.3	1.06	3.5	0.23	0.8	90	silt and clay
							3	pyrite
							2	arenaceous Foraminifera fragments
							5	carbonaceous material

*The locality and unit numbers correspond with those of the measured sections in Appendix A. The first number is that of the location, the second number designates the unit number. For geographical location of the measured sections see Plate 1.

Appendix B Continued

*Sample Number	Total Residue		Fine Fraction		Coarse Fraction		Constituents of Coarse Fraction	
	Grams	Percent	Grams	Percent	Grams	Percent	Percent	Description of sample
7/3	4.37	14.6	3.20	10.7	1.17	3.9	99	silt and clay trace of pyrite a few arenaceous Foraminifera fragments
8/3	9.17	30.6	6.08	20.3	3.09	10.3	80 15 3 1 1	quartz sand arenaceous Foraminifera, (Ammovertella and fragments) muscovite pyrite limonite
9/4	12.28	40.9	5.60	18.7	6.68	22.2	99	quartz sand trace of limonite trace of muscovite
9/11	3.80	12.7	3.66	12.2	0.14	0.5	99	siliceous and arenaceous fossils and fragments; Ammodiscus, Ammovertella and Tolypammina, many fragments of small gastropods, and pelecypods. trace of pyrite and muscovite
10/2	10.08	33.6	4.30	14.3	5.78	19.3	99	silt and clay a few arenaceous Foraminifera fragments a few internal molds of gastropods composed of glauconite

Appendix B Continued

*Sample Number	Total Residue		Fine Fraction		Coarse Fraction		Constituents of Coarse Fraction	
	Grams	Percent	Grams	Percent	Grams	Percent	Percent	Description of sample
11/2	2.69	8.9	2.54	8.5	0.15	0.5	95	silt and clay
							4	pyrite a few arenaceous Foraminifera fragments a few small quartz grains
12/8	9.09	30.3	6.95	23.2	2.14	7.1	99	silt and clay trace of muscovite
13/4	2.79	9.3	1.86	6.2	0.93	3.1	98	arenaceous Foraminifera, (Ammovertella and fragments)
							1	silt and clay trace of euhedral quartz crystals trace of muscovite
13/8	6.75	21.8	4.99	16.5	1.58	5.3	97	silt and clay
							2	limonite a few arenaceous Foraminifera fragments
13/10	11.15	37.2	9.00	30.0	2.15	7.2	99	silt and clay
							1	pyrite
14/2	4.80	16.0	3.59	12.0	1.21	4.0	96	silt and clay
							3	pyrite
							1	siliceous crinoid and Foraminifera fragments

Appendix B Continued

*Sample Number	Total Residue		Fine Fraction		Coarse Fraction		Constituents of Coarse Fraction	
	Grams	Percent	Grams	Percent	Grams	Percent	Percent	Description of sample
15/8	1.80	6.0	1.48	4.9	0.32	1.1	49	silt and clay
							48	arenaceous Foraminifera, (Ammovertella and fragments)
							2	carbonaceous material
							1	pyrite
16/4	10.22	34.0	8.43	28.1	1.79	5.9	99	silt and clay
							1	limonite
18/3	1.97	6.6	1.25	4.2	0.72	2.4	95	limonite, amorphous, spongy
							4	arenaceous Foraminifera, (Ammovertella and fragments)
							1	muscovite
19/4	5.76	19.2	4.32	14.4	1.44	4.8	98	arenaceous Foraminifera and other siliceous fossil fragments
							2	limonite
19/6	6.04	20.1	5.81	19.3	0.23	0.8	98	arenaceous Foraminifera, (Ammovertella and fragments)
							1	pyrite
							1	pyrititized Foraminifera and sponge spicules

APPENDIX C

PERCENT CHART OF SIZE ANALYSIS OF THE HEPLER SANDSTONE

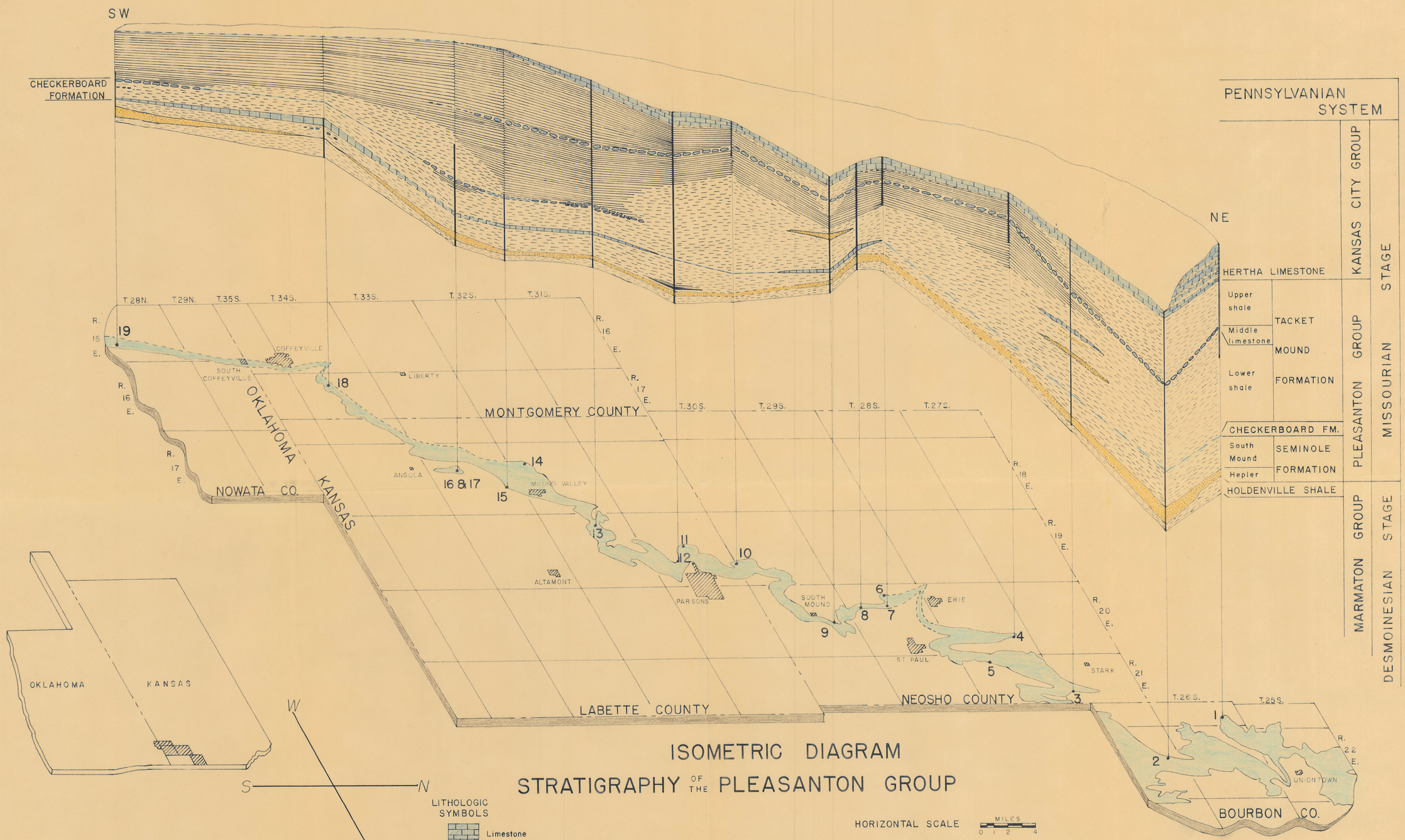
Wentworth Grade Scale	Sample No. 2/2		Sample No. 3/1		Sample No. 5/2	
	Weight Percent	Cumulative Percent	Weight Percent	Cumulative Percent	Weight Percent	Cumulative Percent
1-1/2 mm	12.27	12.27	8.14	8.14	8.55	8.55
1/2-1/4 mm	8.67	20.94	16.66	24.80	11.81	20.36
1/4-1/8 mm	12.31	33.25	25.00	49.80	24.12	44.48
1/8-1/16 mm	29.04	62.29	24.00	73.80	36.18	80.66
1/16-1/256 mm	36.58	98.87	24.02	97.82	16.79	97.45
less than 1/256 mm	1.13	100.00	2.18	100.00	2.55	100.00
Sorting Coefficient	So = 2.59		So = 2.01		So = 2.10	

Wentworth Grade Scale	Sample No. 8/1		Sample No. 9/2		Sample No. 12/2	
	Weight Percent	Cumulative Percent	Weight Percent	Cumulative Percent	Weight Percent	Cumulative Percent
1-1/2 mm	10.87	10.87	7.53	7.53	4.53	4.53
1/2-1/4 mm	15.50	26.37	7.36	14.89	6.93	11.46
1/4-1/8 mm	13.77	40.14	6.04	20.39	12.88	24.34
1/8-1/16 mm	32.01	72.15	25.62	46.55	35.94	60.28
1/16-1/256 mm	23.61	95.76	46.73	93.28	34.76	95.04
less than 1/256 mm	4.24	100.00	6.72	100.00	4.96	100.00
Sorting Coefficient	So = 2.01		So = 2.84		So = 1.75	

Wentworth Grade Scale	Sample No. 13/1		Sample No. 15/6		Sample No. 17/4	
	Weight Percent	Cumulative Percent	Weight Percent	Cumulative Percent	Weight Percent	Cumulative Percent
1-1/2 mm	2.60	2.60	5.90	5.90	6.75	6.75
1/2-1/4 mm	8.65	11.25	15.50	21.40	6.97	13.72
1/4-1/8 mm	14.80	26.05	24.27	45.67	21.44	35.16
1/8-1/16 mm	37.96	64.01	23.72	69.39	41.90	77.06
1/16-1/256 mm	34.39	98.40	29.11	98.50	21.68	98.74
less than 1/256 mm	1.60	100.00	1.50	100.00	1.26	100.00
Sorting Coefficient	So = 1.75		So = 2.13		So = 1.74	

PLATE I

62-4



ISOMETRIC DIAGRAM
STRATIGRAPHY OF THE PLEASANTON GROUP

LITHOLOGIC SYMBOLS

- Limestone
- Shale
- Black shale
- Nodular limestone
- Sandstone
- Coal

OUTCROP PATTERN

•8 LOCATION OF MEASURED SECTION

HORIZONTAL SCALE MILES 0 1 2 4

VERTICAL SCALE FEET 0 5 10 20

Heavy vertical line designates actual measured section

Philip A Emery

Kansas Geological Survey
Open-file Report 62-4
plate 1