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Stratigraphy of the Pleasanton Group in Miami, Linn, and Bourbon Counties, Kansas

by

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STRATIGRAPHY OF THE PLEASANTON GROUP IN MIAMI, LINN, AND BOURBON COUNTIES, KANSAS

by

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Instructor in charge

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ABSTRACT

The Pleasanton Group is the basal unit of rocks assigned to the Missourian Stage of the Pennsylvanian System of Kansas. In the area studied, Miami, Linn, and Bourbon Counties, Kansas, the Pleasanton Group is represented by three different facies. The northernmost facies, which is found in southeastern Miami County and the northern two-thirds of Linn County, is referred to as the shale-sandstone facies. The second facies is a "flaggy" limestone facies which crops out in southern Linn and northern Bourbon Counties. Further south the Pleasanton section is represented by gray shale, hence the gray shale facies.

A detailed stratigraphic study was made of the three different facies in order to work out the relationships of one facies to another. Size analyses of the sandstones and insoluble residues studies of the limestones were made to give a more complete description of the units studied.

INTRODUCTION

Purpose of Investigation

The purpose of this investigation was to study in detail the stratigraphy and sedimentation of the Pleasanton Group, the basal unit of rocks in Kansas assigned to the Missourian Stage of the Pennsylvanian System. Data derived from this study was used to determine the probable environment of deposition.

Area of Investigation

Pleasanton rocks crop out in the states of Iowa, Missouri, and Kansas. Laterally equivalent rocks in Oklahoma include the lower part of the Coffeyville Formation, Checkerboard Limestone, and the Seminole Sandstone. This report deals with exposures of the Pleasanton Group in southern Miami, Linn, and Bourbon Counties, Kansas. Figure 1 shows the outcrop pattern of the Pleasanton Group and the area studied.

Previous Work

The Pleasanton Group was not known as such in the early days of Kansas geologic exploration. Swallow and Hawn (1863) published the first report on the Carboniferous rocks of Kansas. A few years later Swallow (1866) in his report on the Upper Coal Measures, referred to the beds between the Fusulina and the "Shell Rock series" (Excello Subgroup of present classification) as the Marais de Cygne coal series. This included all rocks now classed as the Pleasanton Group. Haworth and Kirk (1894) applied the name Lanesville Shale to the rocks occupying the interval between the Osawgo (Ft. Scott) Limestone and the Erie (Winterset-Martha) Limestone. This term proved unsatisfactory because the Erie Limestone was hard to identify and the grouping was impractical.

Haworth (1895) was the first person to use the name Pleasanton in a stratigraphic sense, but his Pleasanton did not include exactly the same interval as the Pleasanton of today's usage. Haworth's Pleasanton Shale included the beds between the top of the Fusulina Limestone and the base of the Erie (Winterset-Martha) Limestone. Later Hayes (1900) referred to the same interval as the Marais de Cygne Shale.

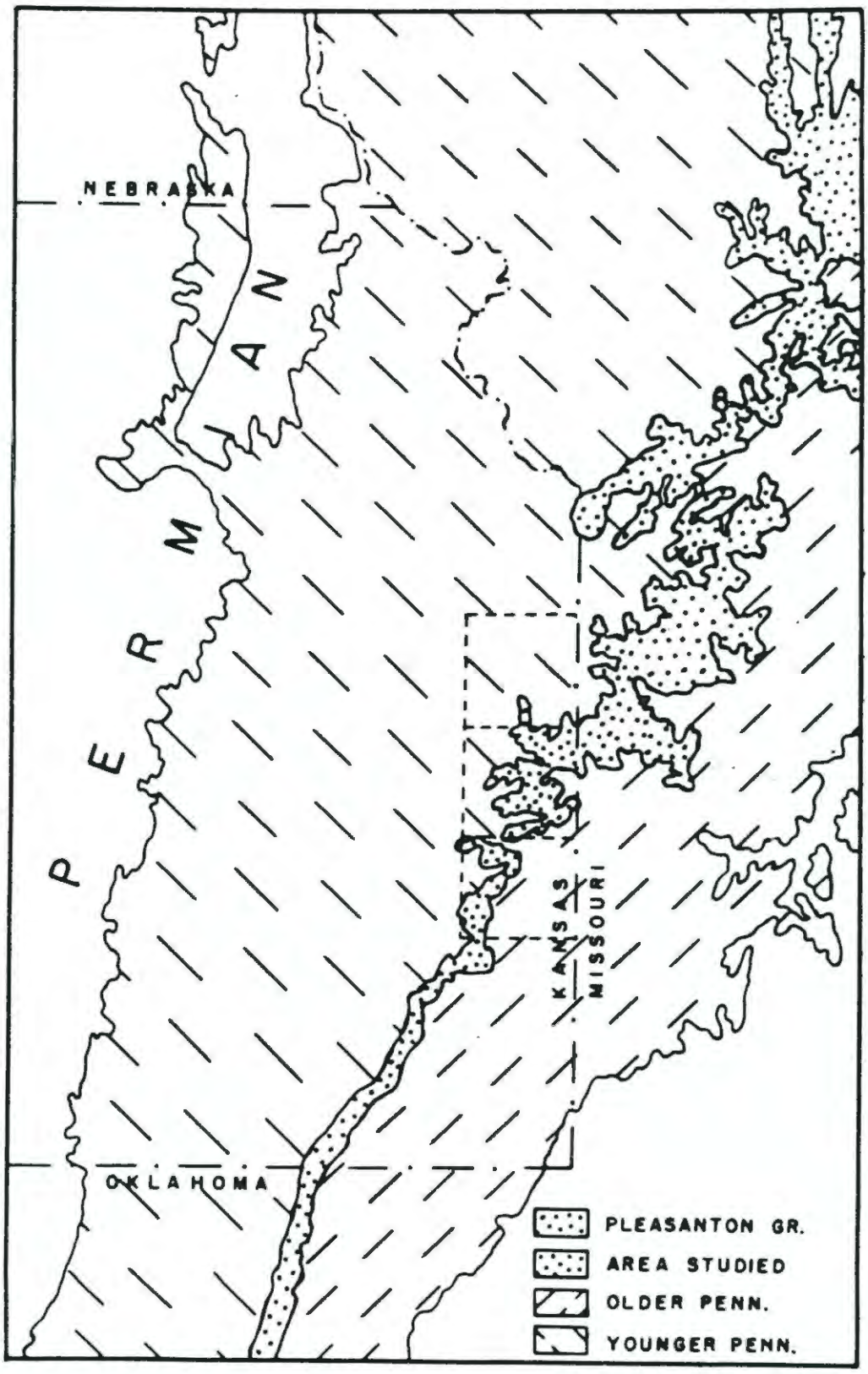

FIGURE 1. Map showing the outcrop pattern of rocks assigned to the Pleasanton Group and the area covered in this report.

Adams (1903) applied the name Dudley shale to the rocks between the top of the Parsons (Altamont-Lenapah) Limestone and the base of the Hertha Limestone. The beds between the Lenapah Limestone and the Hertha Limestone were referred to by Moore (1920) as the La Cygene Shale. This interval was classed as a member of the Marmaton Group.

In the early 1930's Jewett, Moore, and others who worked in eastern Kansas recognized the presence of a regional disconformity between the Desmoinesian and Missourian rocks. It was also recognized that the Hepler Sandstone is a persistent unit at the base of the Missourian Stage.

Moore and Jewett (1932) named the beds between the Swope Formation, and the pre-Missourian disconformity, the Bourbon Group. Ockerman (1935) proposed the name Bourbon Shale for the rocks of the same interval. Newell (1935) called these beds the Bourbon Formation. The type locality of the Bourbon Group is along Kansas Highway No. 3, in the NE¼ of sec. 34, T. 24 S., R. 21 E.

The variation in the span of beds defined as Pleasanton prompted representatives of the state geological surveys of Iowa, Kansas, Nebraska, and Missouri to come to an agreement that the name Pleasanton should be restricted to that interval between the pre-Missourian disconformity and the base of the Hertha Limestone. This interval corresponds to the interval assigned to the Bourbon Group or Bourbon Formation as previously recognized in Kansas. Although the name Bourbon is preferable to Pleasanton for various reasons, the name Pleasanton is used in order to obtain uniform interstate nomenclature. The place of the Pleasanton rocks in the Kansas Geological Survey classification is shown in Table 1. No type locality more definite than "in the vicinity of Pleasanton" has been designated.

Outcrops

The Pleasanton Group as a whole is a slope-forming unit beneath the scarp forming Martha Limestone. Because the Pleasanton is a slope-forming unit, exposures that include the entire Pleasanton section are almost non-existent. The majority of the outcrops are found in cuts along roads and in creek banks. Figure 2 shows a typical occurrence of Pleasanton rocks and why complete sections are scarce. Figure 3 shows the locations of outcrops studied.

Methods of Investigation

A total of nine weeks was spent in the field locating, measuring, and studying exposures. The location for many of these exposures were obtained from the stratigraphic files of the State Geological Survey of Kansas. Numerous exposures listed in the files had been described as long ago as 1935, therefore many of the exposures studied then are now covered.

Fresh samples were collected from all localities at which exposures were measured. These samples were labeled for laboratory study.

Sedimentary analysis: Size analysis of approximately 75 samples of "Rhobtorn" and Kepler Sandstones were made. After examining each sample under a microscope a portion of each sample was disaggregated and used for size determination. The mechanical procedure used in the size analysis was as described by Krumbein and Pettijohn (1938, p. 135-142).

Shale disgregation: A portion of each sample of shale collected in the field was placed in a beaker of water and allowed to soak for several

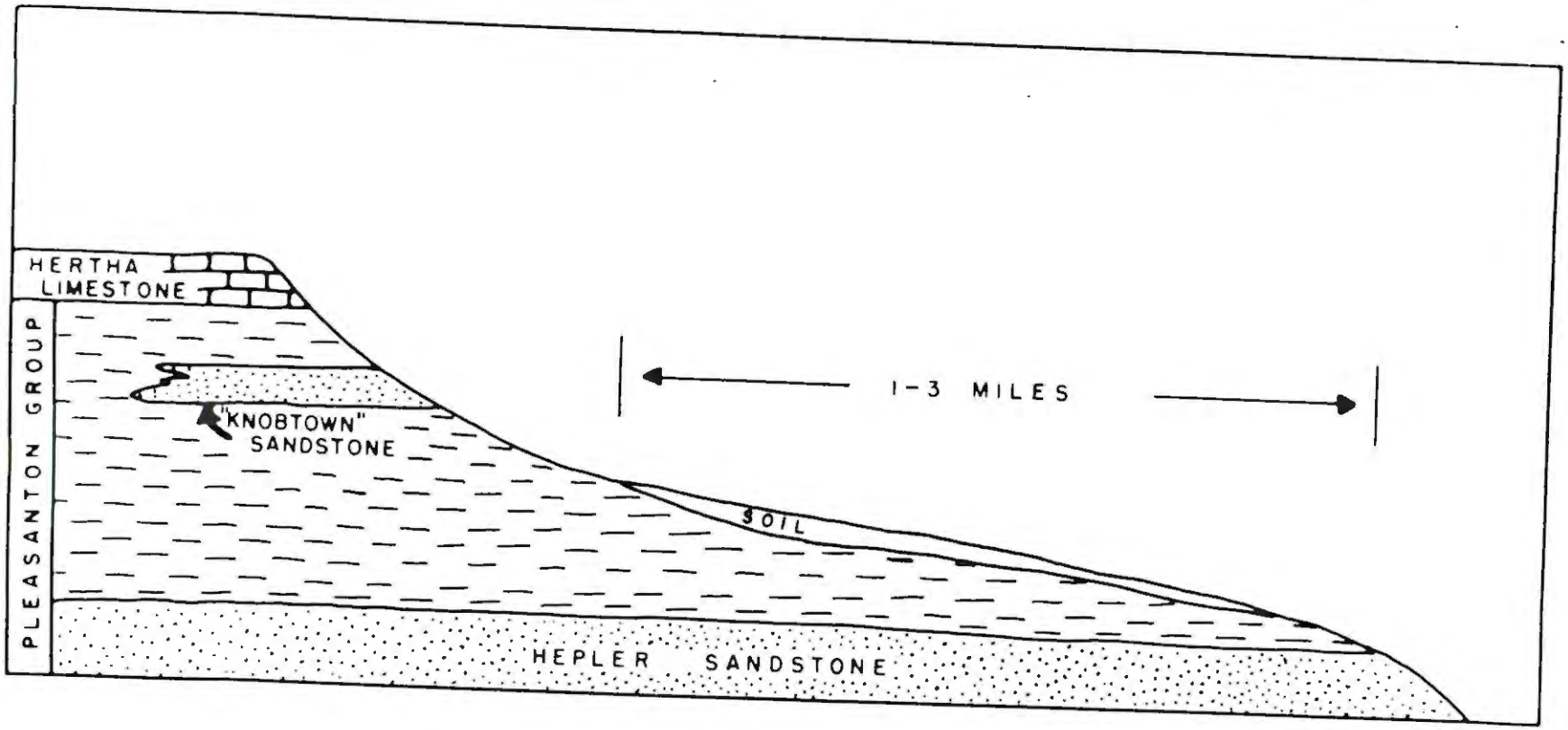

FIGURE 2. Sketch showing characteristic physiographic occurrence of Pleasanton rocks

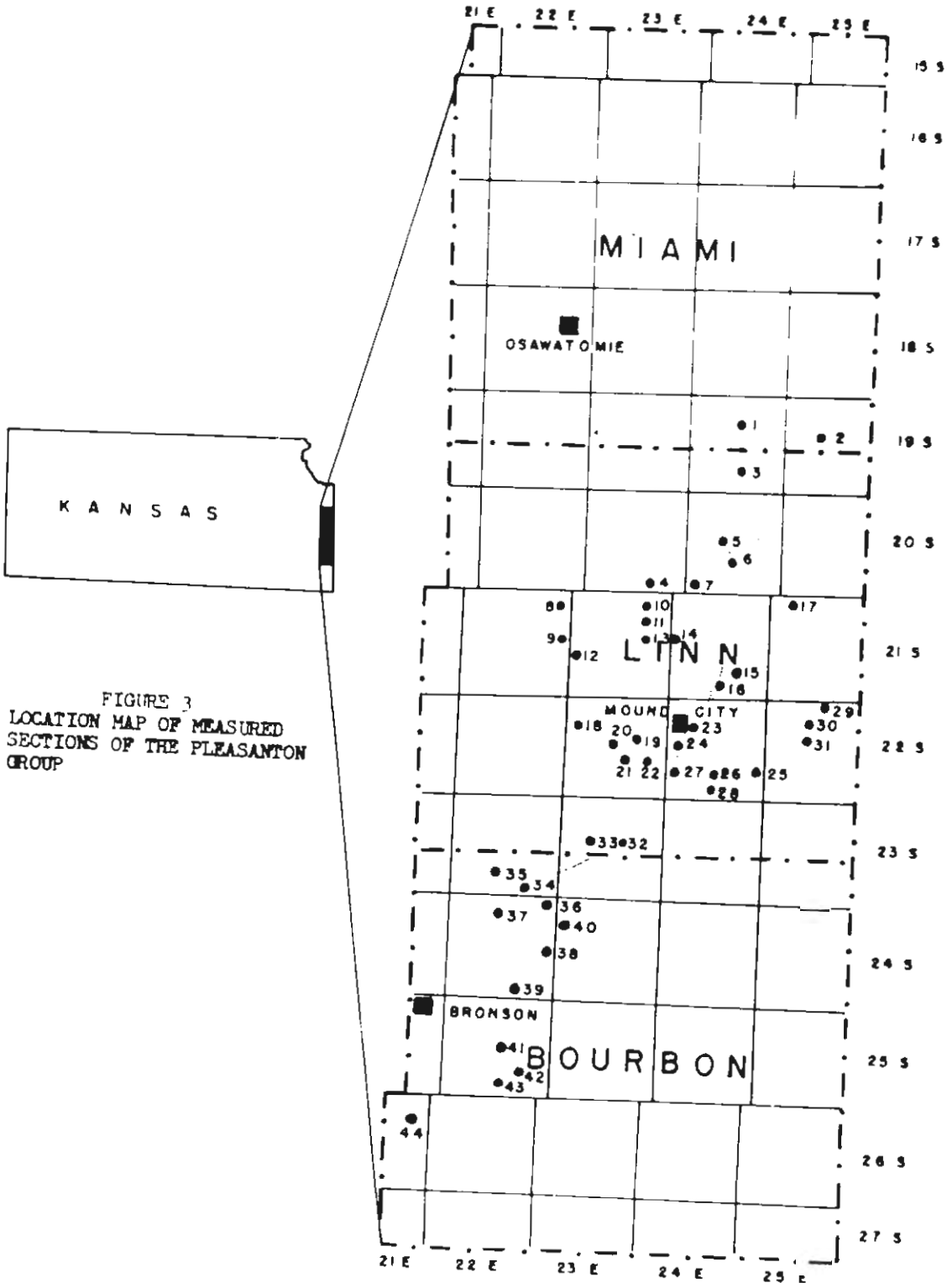

FIGURE 3
LOCATION MAP OF MEASURED SECTIONS OF THE PLEASANTON GROUP

hours. The sample was then boiled for 20 minutes, after which the turbid water was decanted. The remaining material was then studied.

Insoluble residue preparation: Insoluble residues of each sample of limestone were prepared. The general procedure used in the preparation of the residues is that outlined by Ireland (1958). The only deviation from this procedure is that the coarse and fine fractions were separated. The weights and percents of these are included in Appendix B. Description of the fractions constitute Appendix C.

ACKNOWLEDGMENTS

The author wishes to give special thanks to Dr. J. M. Jewett who supervised this thesis and gave freely of his time in the field and during the writing of this thesis. Thanks also go to Dr. H. A. Ireland and Dr. W. E. Hamblin who offered invaluable advice as to the preparation of this report. The financial aid given by the State Geological Survey of Kansas is greatly appreciated.

GENERAL STRATIGRAPHY

Holdenville Shale

The Holdenville Shale (Taft 1901) is the name applied to the Desmoinesian rocks that lie between the Lenapah Limestone and the pre-Missourian disconformity (Table 1). It is the bed which underlies the Pleasanton Group in most cases.

As seen in most outcrops the Holdenville is brown to gray, thin-bedded, and clayey. In a few exposures it is slightly sandy and seems to grade into the overlying Kepler Sandstone which is assigned

to the Missourian Stage. The Holdenville seems to be barren of fossils in the area studied.

The thickness of the Holdenville ranges from zero to about 30 feet. Locally this unit has been removed by pre-Missourian erosion. In several exposures in Linn County the basal Missourian deposits rest upon beds lower in the section than the Holdenville.

Pleasanton Group

The Pleasanton Group is the basal unit of rocks in Kansas assigned to the Missourian Stage (Table 1). The Pleasanton was named from exposures in Linn and Bourbon Counties, Kansas.

The Hepler Sandstone is the basal formation of the Pleasanton Group. It is a sheet-like deposit that is fairly uniform in lithologic character, and lies on a surface of slight relief. In Miami County and the northern two-thirds of Linn County the remainder of the Pleasanton Group is composed of sandstone and shale.

In the southern one-third of Linn County the Pleasanton changes to a "Flaggy" limestone facies. This facies is found only in southern Linn and northern Bourbon Counties. Further south in Bourbon County the Pleasanton changes again. The facies there for the most part is composed of thin-bedded, gray shale and some limestone.

For ease of study and description the Pleasanton was divided into three parts based on the different facies. In this report the Pleasanton sequence in Miami County and the northern two-thirds of Linn County will be referred to as the "shale-sandstone" facies. The facies present in the southern one-third of Linn County and the northern part of Bourbon

Table I

Classification of Pennsylvanian rocks in Kansas

Pennsylvanian System
- Virgilian Stage
- Missourian Stage
  - Pedee Group
  - Lansing Group
  - Kansas City Group
    - Zarah Subgroup
    - Linn Subgroup
    - Bronson Subgroup
      - Dennis Limestone
      - Calhoun Shale
      - Stanton Limestone
      - Lecompton Shale
      - Hertha Limestone
  - Pleasanton Group
    - unnamed parts including locally the "Knobtown" Sandstone
    - Checkerboard limestone (not definitely identified north of Labette Co., 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)

County will be called the "flaggy" limestone facies. The southernmost facies which is found only in southern Bourbon County is referred to as the gray shale facies. All of the above facies lie above the Hepler Sandstone which seems to be continuous throughout the area studied. Figure 4 is a map showing the approximate extent of the three different facies.

The Checkerboard limestone is a thin persistent unit that occurs in the lower part of the Pleasanton, but has not been definitely identified north of Labette County, Kansas. It is a good marker bed in Oklahoma, but pinches out in southeast Kansas.

Hepler Sandstone

The Hepler Sandstone (Jewett 1940, p. 15) is the basal formation of the Pleasanton Group and was named from exposures a short distance north of Hepler in southern Bourbon County, Kansas.

In the area studied the Hepler was found to be of rather uniform lithology: a gray to reddish brown, fine-grained, quartz sandstone. The Hepler contains a calcareous zone in the middle part and in numerous exposures is cross-bedded (Fig. 5). In central Linn County the Hepler was found to be highly charged with asphalt and has been mined in past years for use in road construction (Jewett, 1940, p. 13).

Since the Hepler is rarely seen in conjunction with the remainder of the Pleasanton a complete thickness of this unit is difficult to determine. Thicknesses of the Hepler measured in partial exposures ranged from 10.7 to 25.5 feet, with an overall average of about 12 feet.

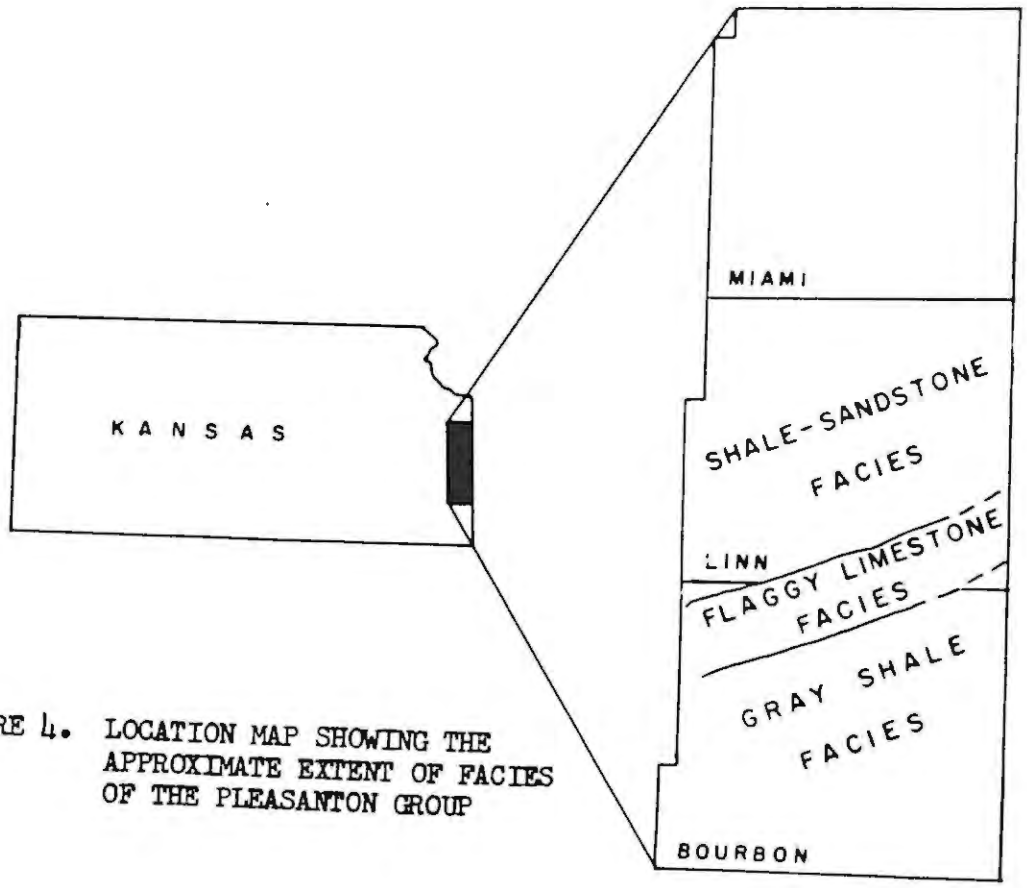

FIGURE 4. LOCATION MAP SHOWING THE APPROXIMATE EXTENT OF FACIES OF THE PLEASANTON GROUP

Fig. 5. Cross-bedded Naylor Sandstone at Location 30(NE¼ sec. 9, T. 22 S., R. 25 E. Linn County).

Shale-sandstone Facies

From the northernmost outcrop in Miami County to the southern part of Linn County the Pleasanton Group is composed of shale and sandstone with the latter being the predominate lithology. The shale that composes most of the Pleasanton sequence is gray to tan, blocky, and thin-bedded. At numerous locations there is a significant amount of fine-grained, buff, silty, sandstone in the upper part of the sequence. For ease of study, this facies was broken down into the lower shale unit "Knobtown" Sandstone, and upper shale unit. Fossils are extremely scarce in this facies, but do occur in the upper part of the Pleasanton and in the "Knobtown" Sandstone at a few localities.

"Flaggy" Limestone Facies

The descriptive term, "flaggy" limestone facies, is here applied to a sequence of interbedded limestone and shale. This facies is found in a narrow band across the northern part of Bourbon County and the northern part of Linn County. Thicknesses of individual limestone and shale beds range from 0.5 to about 2 feet. The limestone that occurs in this sequence is quite distinctive, in that it is dark gray, hard, sublithographic, and contains very few fossils.

Gray Shale Facies

In the southern two-thirds of Bourbon County the Pleasanton Group is composed of gray shale with a minor amount of limestone. The shale which composes most of the gray shale facies is gray, blocky, and thin-bedded. Beds of limestone like that seen in the "flaggy" limestone facies, except that it is nodular and seems discontinuous.

Hertha Limestone

The Hertha Limestone (Adams 1903) is the basal formation of the Kansas City Group and overlies the Pleasanton rocks. In Miami and Linn Counties the Hertha is represented by two limestone members separated by a shale member. The sequence from top to bottom is; Spicher Limestone, Pound City Shale, and Critzer Limestone. In Bourbon County the Hertha is represented by one limestone bed which is considerably different from any lithology seen in Miami or Linn County.

Since the Critzer Limestone of Miami and Linn Counties, and the Hertha Limestone of Bourbon County are units that directly overlie the Pleasanton Group it was desirable to study them in detail to determine the genetic relationships to the Pleasanton rocks.

The Critzer Limestone ranges from a brown, hard, massive, limestone to a buff, soft, rubbly weathering limestone. Bellerophontid gastropods are numerous in some places. The average thickness of the Critzer is 4.5 to 5.0 feet, but as much as 9.2 feet was measured at Location 16.

In southern Linn and northern Bourbon Counties the Hertha undergoes an abrupt change and members of the Hertha are no longer identifiable. In this area the Hertha is brown to gray, hard, thin-bedded, and quite fossiliferous. The fossils are in the form of fragments which make identification difficult or impossible. The average thickness of the Hertha in this area is about 4.5 feet.

Particular attention was paid to the contact between the Hertha and the Pleasanton. At the majority of exposures the contact is rather sharp. Similarly sharp contacts are found quite often in the Pennsylvanian rocks of Kansas. In some isolated cases the Pleasanton grades upward into the Critzer Limestone.

As was mentioned before the Hertha changes rather abruptly in southern Linn County. This abrupt facies change and the scarcity of exposures in the area cause difficulty in studying the exact relationships of the Hertha and the Pleasanton. The Pleasanton similarly goes through a facies change in the same area, thus complicating the problem. However, through a detailed study of these units, a satisfactory interpretation of their relationships was gained.

DETAILED STRATIGRAPHY

Disconformity between Desmoinesian and Missourian Rocks

A widespread disconformity occurs between rocks assigned to the Desmoinesian Stage and those assigned to the Missourian Stage. This disconformity is indicated by a faunal break and physical evidence (Moore, R.C., et al, 1951, p. 91). As has been stated before, the physical evidence indicating the disconformity was not recognized until the early 1930's. At this time workers in the area observed that the Kepler Sandstone rested upon rocks ranging in age from Bolsaville to Altamont. Figure 6 shows the Kepler Sandstone overlying the Bolsaville Shale. This disconformity has been traced across Missouri into Iowa.

Fig. 6. Kepler Sandstone overlying Desmoinesian strata. Line marks the base of the Missourian Stage. Location 17 (sec. 25, T. 21 S., R. 25 E.)

Kepler Sandstone

The Kepler Sandstone (Jewett 1941, p. 15) is the basal formation of the Pleasanton Group and rests with disconformity on underlying Pennsylvanian strata. The Kepler has a rather uniform lithologic character. It is a fine-grained, thin-bedded, reddish-brown to buff, quartz sandstone. The thin-bedded nature of this unit is shown in Figure 7. Cross-bedding and ripple marks are exhibited in the Kepler at Locations 14 and 17.

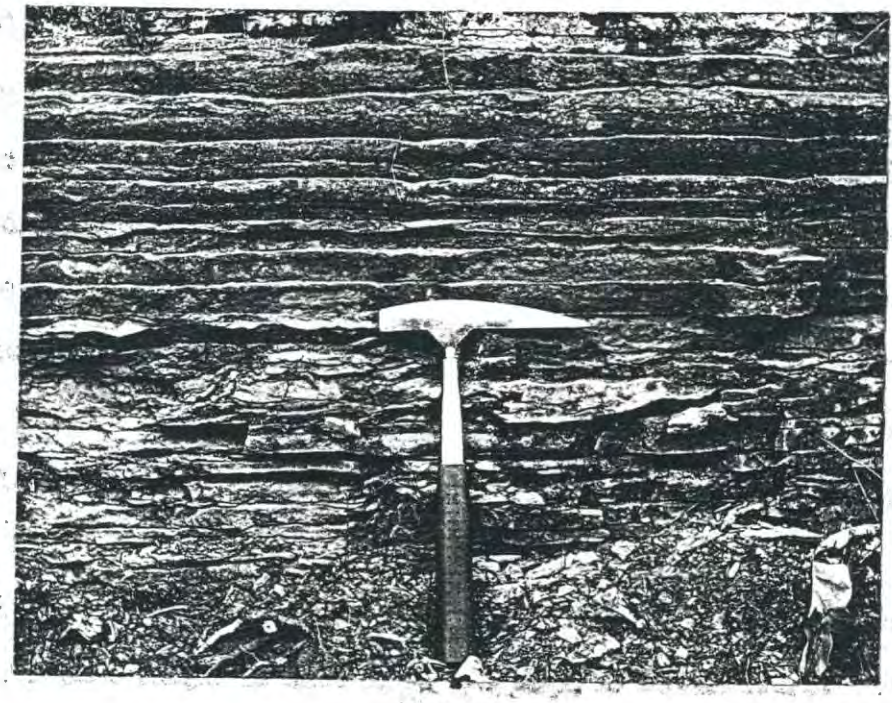

Fig. 7. Thin-bedded Kepler Sandstone at Location 30 (NE¼ Sec. 9, T. 22 S., R. 25 E., Linn County)

A thin persistent calcareous zone is present in the middle part of the Hepler. This zone is a calcareous sandstone in Linn County but grades to a sandy limestone in Bourbon County. Farther south the Hepler thins and becomes more calcareous. In this area the Hepler contains brachiopods. This probably marks a minor marine transgression in early Missourian time which extended as far north as Miami County, Kansas.

In the area studied the Hepler was not found in conjunction with the remainder of the Pleasanton section, except in a few cases. In most cases exposures of the Hepler were found several miles from the more nearly complete Pleasanton exposures. The maximum thickness of the Hepler measured in the partial exposures was 25.5 feet at Location 9.

In Linn County in sec. 25, T. 21 S., R. 24 E., about 1 mile north of Pleasanton, the Hepler is highly charged with asphalt. It has been mined here in past years for use in road construction. In a stream near the quarry, the Hepler is exposed and dips to the northeast at approximately 7° degrees. The cause of this structure is as yet unexplained, but has been attributed by some workers to a collapse structure resulting from solution of underlying strata. Figure 8 shows the dipping Hepler beds at the location given above.

Size analysis of samples of the Hepler showed that its main constituents are grains that range in size from 1/4 to 1/16 millimeters. According to the Wentworth grade scale this is a fine to very fine sandstone. A small percent of medium-sized grains was found in each sample. The four histograms shown in Figure 9 were chosen to show the reduction in grain size from north to south.

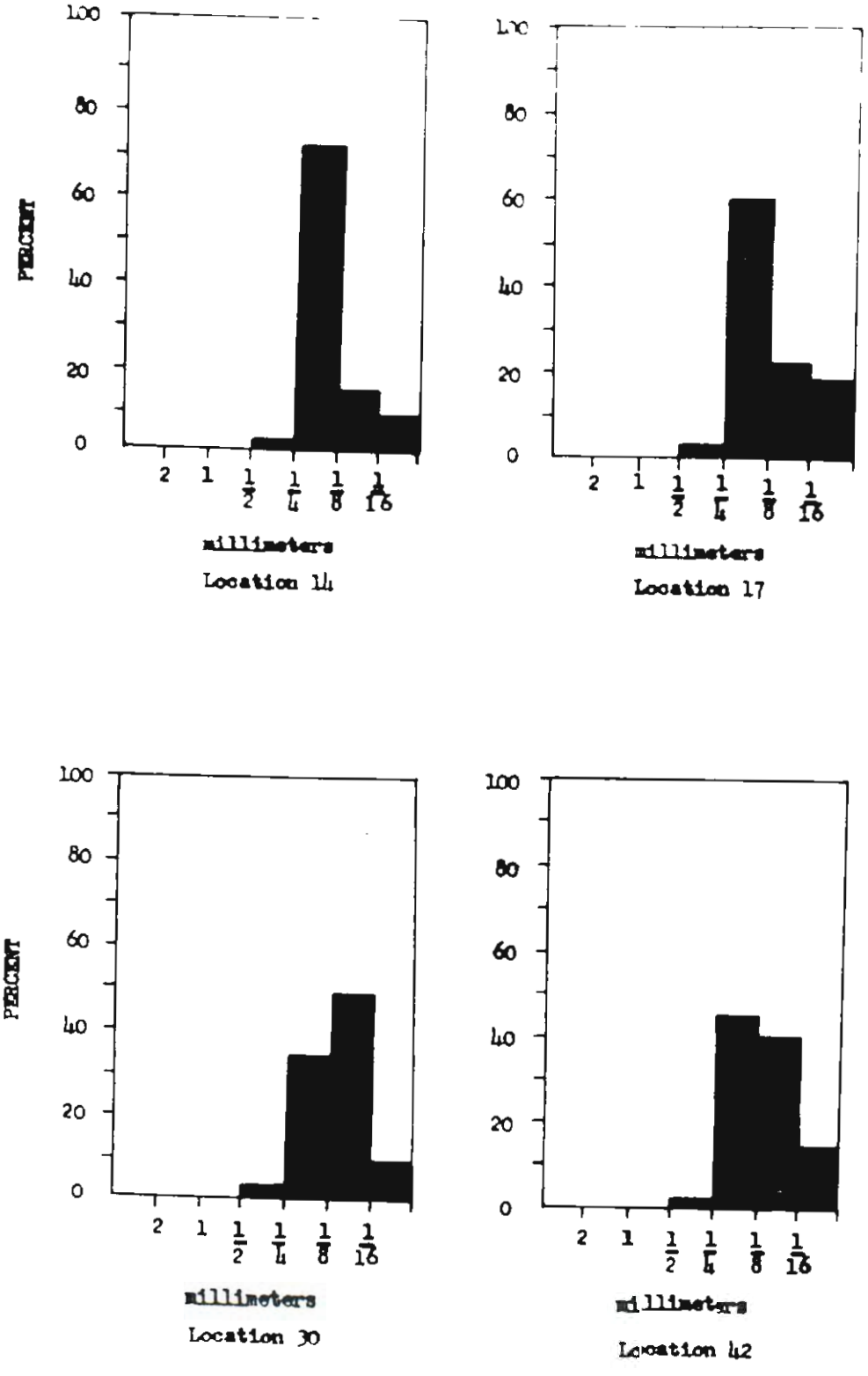

FIGURE 9. Histograms prepared from samples of the Hepler Sandstone

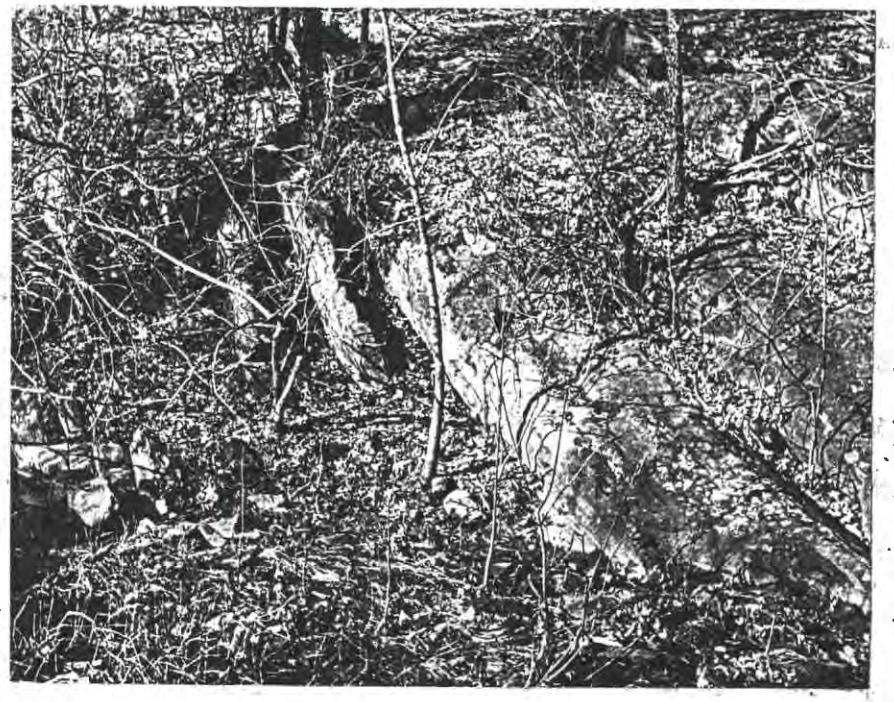

Fig. 6. Beds of the Hoplar Sandstone dipping steeply to the north-northwest in sec. 25, T. 25 S., R. 24 E., Linn County.

The Kepler is described by many who worked in the area as a sheet of sandstone. It is a very persistent unit and is found in Kansas from Miami county southward into Oklahoma where it is known as part or all of the Seminole Formation. This widespread occurrence and the even-bedded nature of this unit seem to rule out a fluvial origin.

Shale-Sandstone Facies

Lower shale unit: The lower shale unit lies between the top of the Kepler Sandstone and the base of the "Knobtown" Sandstone and is composed of a monotonous sequence of buff, thin-bedded, micaceous shale with minor amounts of silt. Strange concretionary structures are very abundant in this unit (Fig. 10). No fossils were found in this unit over the area covered by this study. The contact between the lower shale unit and the Kepler Sandstone was seen at Location 17. In this exposure the Kepler grades upward into the lower shale unit. This gradation is rather gradual and takes place throughout a zone of 3 to 4 feet.

A complete gradation of the lower shale unit upward into the "Knobtown" Sandstone is seen at Location 13. Here the upper part of the "Knobtown" is massive, but the lower part is thin-bedded and grades downward into the lower shale unit through approximately 24 feet of interbedded shale and sandstone. Nowhere in the area studied was a complete thickness of the lower shale unit encountered. The maximum thickness measured at a partial exposure was approximately 35 feet at location 17.

Fig. 10. Concretionary structures found in the lower shale unit of the shale-sandstone facies at Location 16(SE. sec. 27, T. 21 S., R. 24 E.)

"Knobtown" Sandstone

The "Knobtown" sandstone is a unit of variable thickness, but consistent lithology which occurs locally in the upper part of the Pleasanton Group. It was described from exposures in the Kansas City area by Jewett and Crozon (1938). For the most part the "Knobtown" is buff, thin-bedded to massive, very fine-grained, quartz sandstone. At Locations 9, 20, and 22, the middle part of the "Knobtown" is light gray, hard, thin-bedded, and calcareous. These calcareous zones average about one foot in thickness. Figures 11 and 12 show the "Knobtown" sandstone in a typical occurrence.

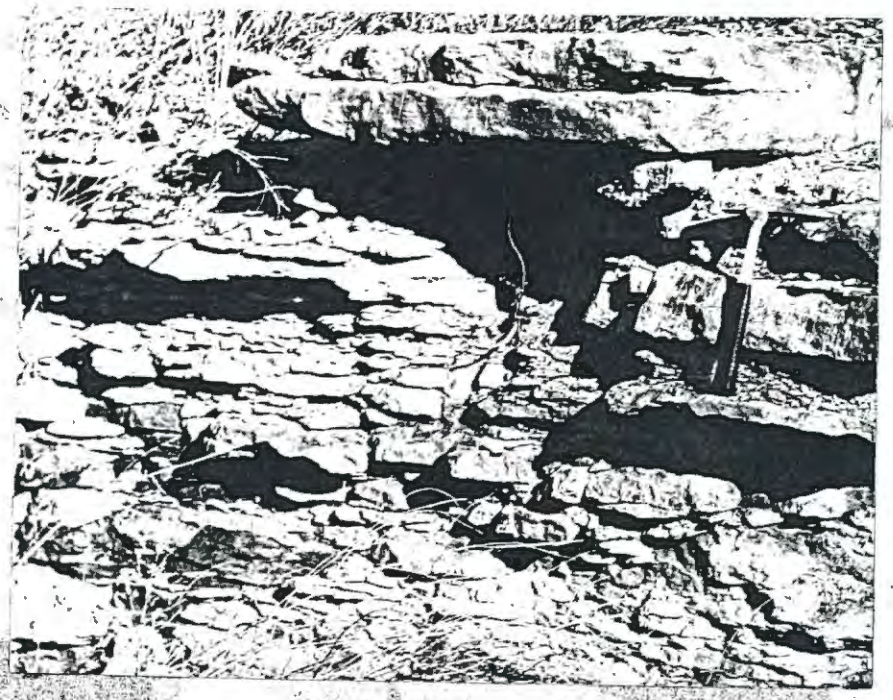

Fig. 11. Thin-bedded "Knobtown" Sandstone at Location 23 (SW¼ sec. 8, T. 22 S., R. 24 E., Linn County)

Fig. 12. "Knobtown" Sandstone at Location 24(NE¼ sec. 18, T. 22 S., R. 24 E., Linn County)

The "Knobtown" was found to be cross-bedded at two locations. At location 1 the cross-strata were capped by a band of ferruginous material along the bedding planes (Fig. 13). A shaly siltstone break within the "Knobtown" at location 8 shows a small scale cross-bedding outlined by carbonaceous material (Fig. 14).

Fig. 13. Cross-laminations in the "Knobtown" Sandstone outlined by a band ferruginous material along the bedding planes, Location 1 (sec. 10, T. 19 S., R. 24 E., Miami County).

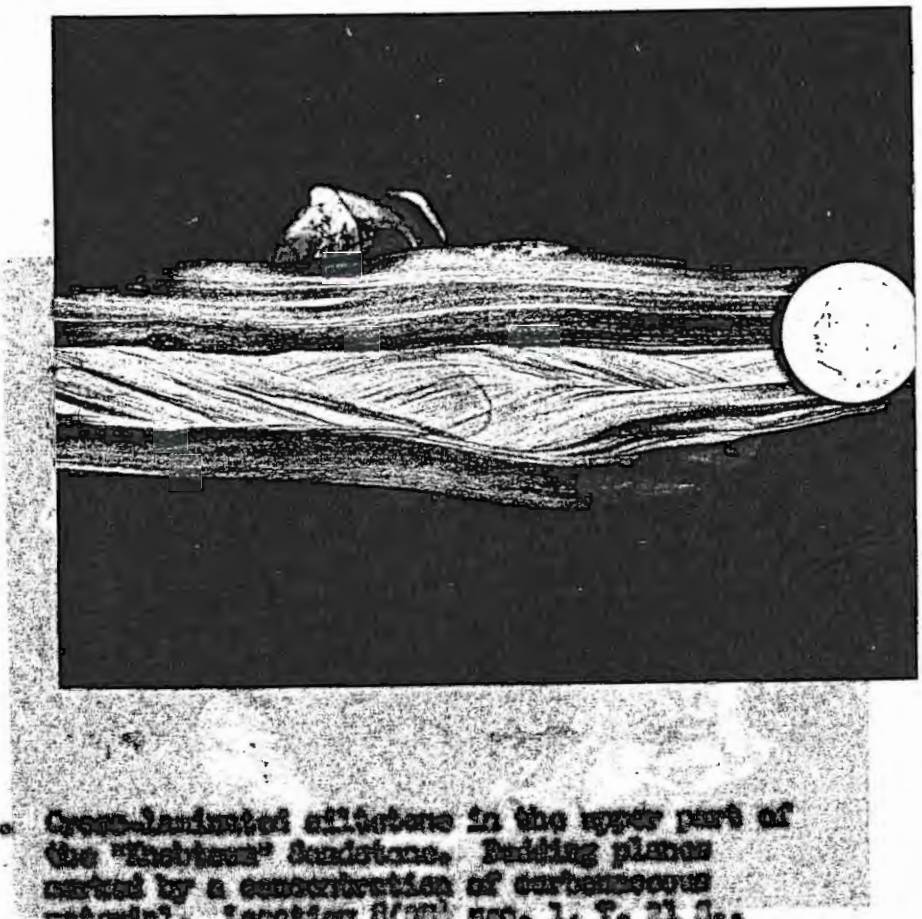

Fig. 14. Cross-laminated siltstone in the upper part of the "Knobtown" sandstone. Bedding plane marked by a concentration of carbonaceous material. Location 6(SW) sec. 1, T. 21 S., R. 22 E., Linn County)

Although barren of invertebrate fossils in most of the exposures studied, at two localities the "Knobtown" contained poorly preserved brachiopods. Gray calcareous sandstone composes the entire "Knobtown" section at location 9. Fragments of spiriferid brachiopods were found in this calcareous sandstone. At location 22, about 3 feet below the top of the "Knobtown", a gray calcareous zone contained one specimen of an orbiculoid brachiopod. Associated with this brachiopod were small bits of carbonaceous plant matter. The uppermost part of the "Knobtown" at location 20 is soft, brown, thin-bedded, and contains a mixture of

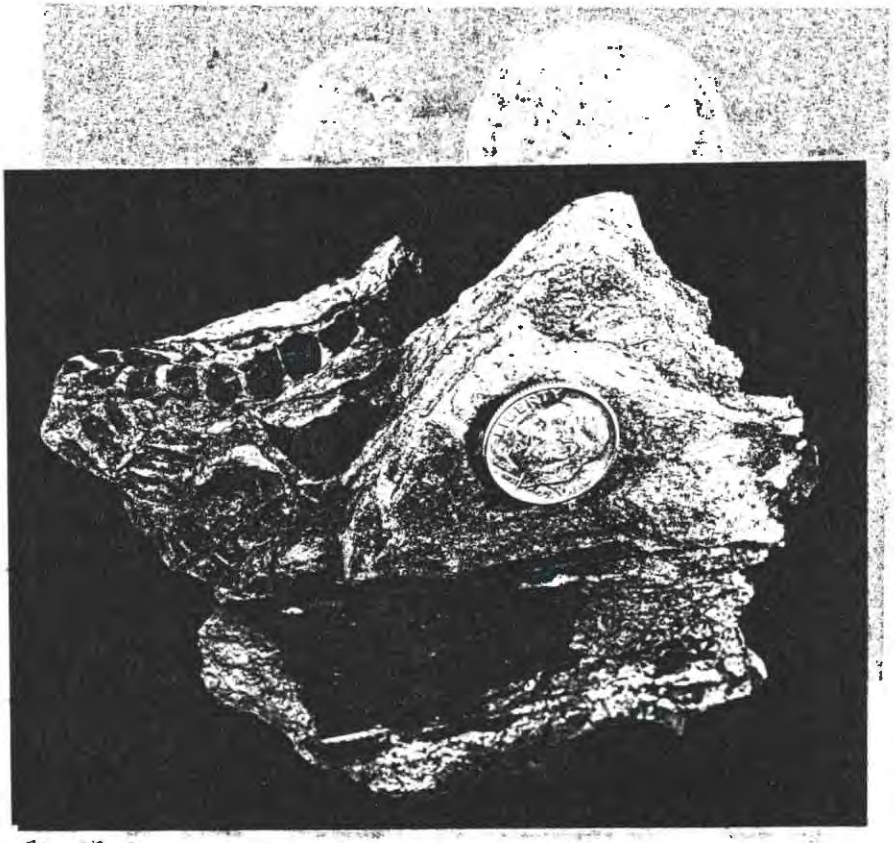

Fig. 15. Plant fragments in the upper part of the "Knobtown" Sandstone at Location 23(SE) sec. 8, T. 22 S., R. 24 E., Linn County).

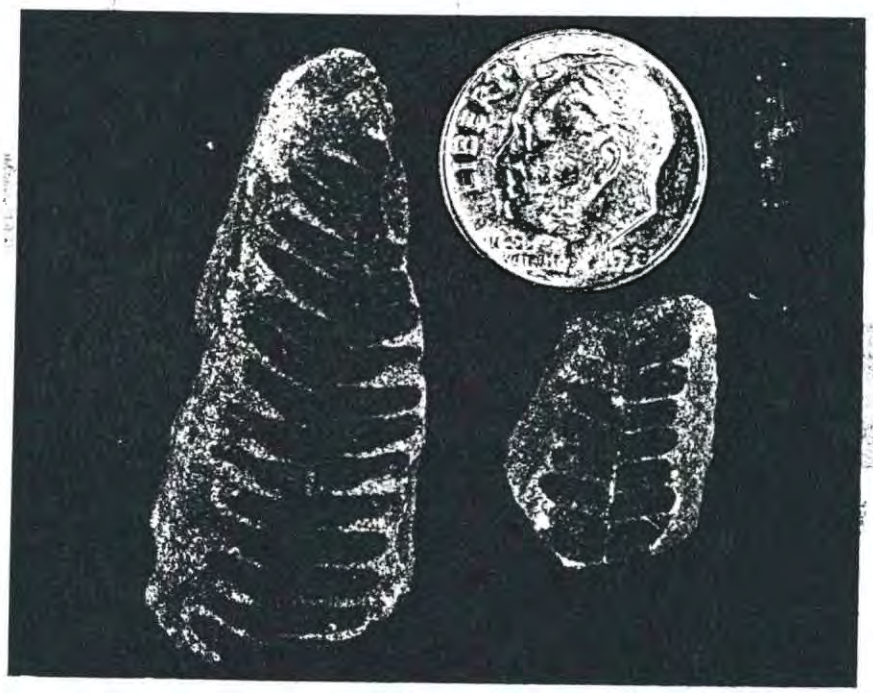

Fig. 16. Small plant fossils found in the upper part of the "Knobtown" Sandstone at location 9(SE, sec 1, T. 21 S., R. 22 E., Linn County)

Upper Shale Unit

The upper shale unit includes the strata between the top of the "Knobtown" Sandstone and the top of the Pleasanton Group. This unit like other units already discussed has a uniform lithologic character. It is a gray to brown, thin-bedded shale. The only variation in its lithologic character is a calcareous shale with lime nodules. That is usually found within a few inches of the base of the overlying Hertha Limestone.

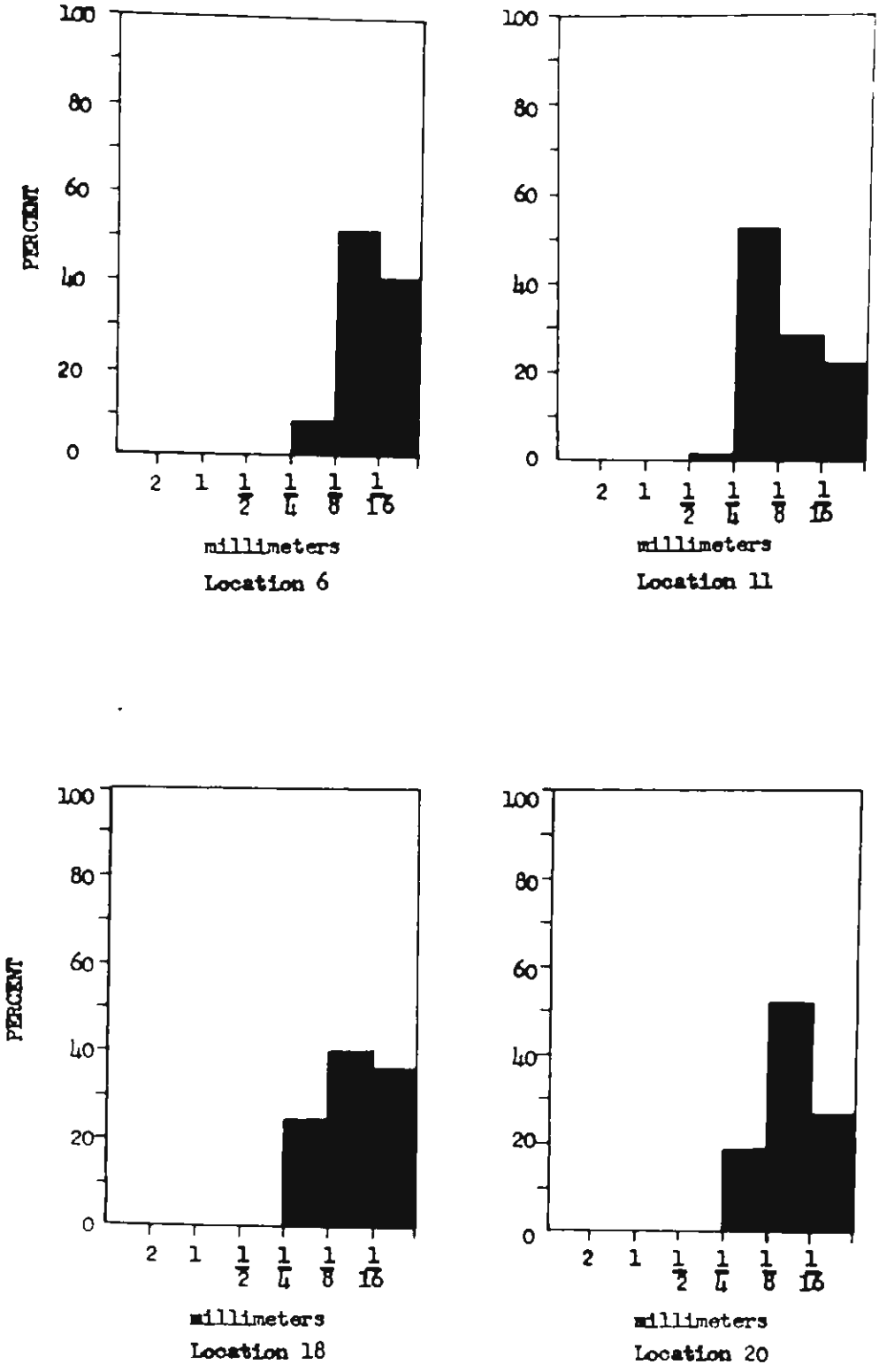

FIGURE 17. Histograms prepared from samples of the "Knobtown" Sandstone

Various invertebrate fossils were found in the upper part of the upper shale unit. Impressions of very small clams are associated with chonetid brachiopods and crinoid fragments at locations 4, 5, 6, 11, and 12. Chonetid brachiopods were found to be fairly abundant at other locations. At location 3 impressions of the ostracode Bollidella were found. These occur in a zone which contains crinoid and plant fragments, about 3 feet below the base of the Bartha Limestone.

The relationship of the upper shale unit to the Bartha Limestone is locally gradational. The gradation takes place through a zone of calcareous nodules in the upper 2 to 3 feet of the upper shale unit. In a few exposures this unit has impure calcareous nodules throughout a zone extending from the top of the "Knobtown" Sandstone upward to the base of the Bartha Limestone. A good example of this is at location 6 where the unit is 11.5 feet thick and calcareous throughout its entire thickness. At locations 16, 23, and 24 a sharp contact between the Pleasanton and overlying Critzer Limestone is seen (Fig. 18).

The contact between the upper shale unit and the "Knobtown" is rather sharp in most cases. At location 2 an exception to this statement is seen. Here the "Knobtown" grades upward into the upper shale unit through a zone of interbedded siltstone and sandstone.

The thickness of the upper shale unit ranges from 2 feet at location 16 to approximately 14 feet at location 1, and has an average thickness of about 7 feet.

"Pleasanton" Limestone Facies

In southern Linn and northern Bourbon Counties the Pleasanton Group assumes a carbonate aspect. The Pleasanton of this area is composed of

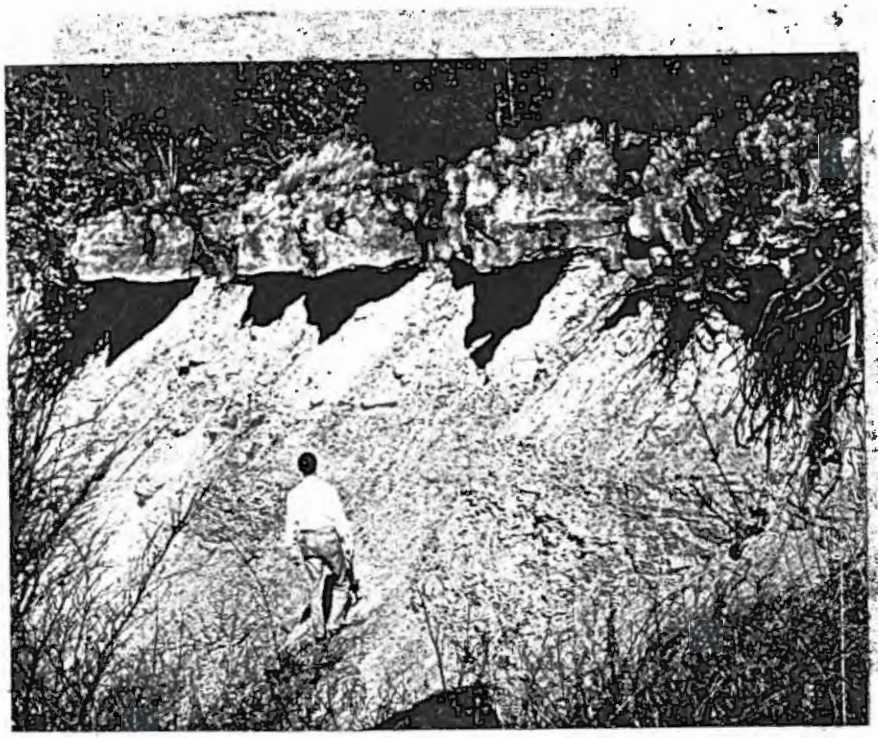

Fig. 18. Critser limestone overlying shale of the Pleasanton Group at location 23(SW¼ sec. 8, T. 22 S., R. 24 E., Linn County).

alternating beds of shale and limestone (Fig. 19). This limestone and shale sequence is approximately 35 feet thick and grades downward to a tan, blocky shale of unknown thickness. The limestone beds of this sequence are dark gray, dense, hard, thin to medium bedded and relatively unfossiliferous. The thickness of the individual beds of limestone range from 0.5 to 1.5 feet.

There was some variation in the amount of insoluble residue present in each sample of limestone. Insoluble residues of these beds ranged from 4.5 percent to 9.3 percent by weight. All insoluble residues of these limestones are composed of, for the most part, silt and clay with a minor amount of pyrite present in almost every

Fig. 19. Alternating beds of limestone and shale typical of the "flaggy" limestone facies. Location 37 (SE¼ sec. 4, T. 24 S., R. 22 E., Bourbon County)

sample. There is a slight increase in argillaceous material in the limestone downward in the section. In the lower part of the section the limestone beds become thinner and shale is the predominate lithology. The shale intervals in this facies range from 0.4 to 2.3 feet in thickness. They are thin-bedded, partly calcareous, and are from buff to gray in color. There seems to be a sharp break between the shale beds and the beds of limestone. Only scattered small brachiopods were found in the limestone beds of this sequence. These are small and difficult or impossible to identify. No fossils were found in the shale intervals.

The "flaggy" limestone facies was seen in contact with the Bartha Limestone at only Locations 32 and 35. At these locations there is approximately 0.7 feet of brown shale separating the Bartha Limestone from the first limestone bed in the Pleasanton. The entire thickness of the "flaggy" limestone facies was not seen at any location. The maximum thickness measured was approximately 55 feet at Location 37.

Gray Shale Facies

The gray shale facies of the Pleasanton Group is found only in Bourbon County, Kansas from T. 25 S. to T. 26 S. Southwestward in Neosho County most of the Pleasanton Group is composed of black platy shale with minor carbonate content.

As the name implies the gray shale facies is mainly a gray to tan, thin-bedded, blocky shale (Fig. 20). There are two minor variations from this lithology. The first is a thin bed of black platy shale which occurs about 10 to 15 feet below the top of the Pleasanton and ranges from 0.5 to 1.0 feet thick. The second variation is a thin, discontinous bed of dark-gray limestone which lies directly underneath the black platy shale, and is very similar to the limestone found in the "flaggy" limestone facies. This limestone bed ranges from 0.4 to 0.7 feet in thickness, and contains a few scattered brachiopods. Insoluble residues of this limestone were composed of silt and clay for the most part with a minor amount of pyrite. Appendix C shows constituents of the insoluble residues of these limestones.

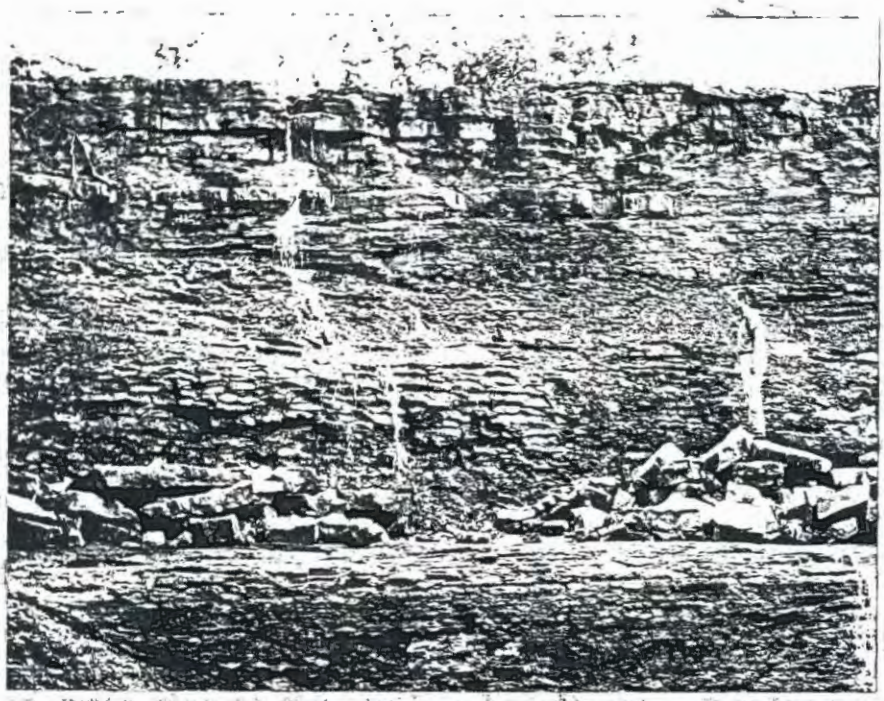

Fig. 20. Blocky shale typical of the gray shale facies. Location 4h(NW) sec. 19, T. 36 S., R. 21 E., Bourbon County)

The only location where abundant fossils were found was location 40. Here a zone 4.5 to 5.0 feet below the top of the Pleasanton contains abundant chonetid brachiopods which are very well preserved and easy to collect, as they occur in a soft shale. Also present are numerous specimens of the ostracode Bairdia and a few broken ramose bryozoan fragments.

The gray shale facies was not seen in contact with the Hepler Sandstone. At location 40 approximately 90 feet of section was measured without reaching the Hepler Sandstone. This section represents the maximum thickness encountered in this study.

CONCLUDED

The shale-sandstone facies of the Pleasanton Group is for the most part non-marine. Plant remains found in this sequence seem to indicate that it was deposited in an environment that was in proximity to a land mass. The "Knobtown" Sandstone is sporadic in its occurrence, both laterally and vertically. This would seem to indicate that it is not one sand body, but rather a number of separate lenses deposited by a sluggish stream meandering on a topography of low relief. Studies made of the Pleasanton Group in Missouri and Iowa (Cline, 1960) show an increase in grain size to the north and northeast. Conglomerates and channeling are found in northwestern Missouri and in southern Iowa. This along with facts derived from this study such as, the configuration of the facies studied, in the author's opinion, seem to indicate that the sediments were transported from the north and northeast. The absence of current-produced structures, the fine-grained aspect of the sediments, and the amount of mica in the upper and lower shale units would seemingly indicate that currents were very weak where these sediments were deposited.

The environment in which the "flaggy" limestone facies was deposited was probably marine as indicated by the carbonate content and scattered brachiopods found in this sequence. Currents in this environment or supply of clastics varied from time to time since there is an interbedding of limestone and shale. During the deposition of the carbonates the currents were probably very weak, and the supply of clastics was very small, while at other times the currents were strong and supply of clastics was enough to predominate over the carbonate deposition. The scarcity of fossils in this sequence seems to indicate that the environment was inhospitable to normal marine life.

It may have been inhospitable for two reasons that seem apparent. The first is that the seas in which the limestones were deposited were probably muddy or at least the bottom was muddy and inhibited life. This is pointed out by the fact that the limestones of this facies contain very much argillaceous material. The second reason is that the amount and persistence of pyrite found in the insoluble residues would seem to indicate that some sort of a reducing environment existed at the time of the deposition of the limestones.

Since the gray shale facies is almost barren of fossils, with one exception, it would seem that the environment in which these shales were deposited was not favorable to normal marine life. The fact that this was an area of predominately clastic deposition may be the main reason for the scarcity of fossils. Another possible reason for the scarcity of fossils is the one proposed for the "flaggy" limestone facies, that is may have been a slightly reducing environment. This is indicated by the presence of the black platy shale in the upper part of this sequence and the presence of pyrite in insoluble residues of the limestone beds of this sequence.

Several facts seem to indicate that the Kepler Sandstone passes to a more marine facies to the south. These facts are: (1) size analyses show a slight reduction in grain size from north to south in the area studied. (2) the calcareous content of the Kepler increases to the south (3) there are slight indications that the Kepler thins to the south (4) marine brachiopods are found in the Kepler to the south in Labette County, Kansas.

The disconformity between the rocks of Missourian age and rocks of Desmoinesian age is hard to identify in the field. At some locations the physical evidence for a stratigraphic break is absent. The absence of fossils in the Holdenville Shale directly below the Missourian in most cases makes the task of recognizing the disconformity very difficult. In some cases the Holdenville is a sandy shale and the overlying Hepler is a shaly sandstone. This along with a lack of physical evidence would seem to indicate that the break between the Missourian and Desmoinesian was very minor in this area and was due more to non-deposition than to uplift and post-Desmoinesian erosion.

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APPENDIX A

DETAILED STRATIGRAPHIC SECTIONS

The following stratigraphic sections are arranged according to consecutive land sections in each township, in Miami County (secs. 1-2), in Linn County (secs. 3-33), and in Bourbon County (secs. 34-44).

Stratigraphic sections in Miami County, Kansas

Location 1: NE¼ SW¼ sec. 10, T. 19 S., R. 24 E.

	Feet
Bronson Subgroup	
Martha Limestone	
Critzer Limestone member	
5. Limestone, brown, massive, soft, impure.....	4.2
Plowerton Group (Exposed 30.5 feet)	
4. Shale, grey to tan, blocky, thin-bedded, calcareous nodules in upper part, poorly preserved brachiopods.....	13.5
"Bethany" Sandstone	
3. Sandstone, tan, thin-bedded to massive, cross-bedded, silty, micaceous, plant fragments.....	1.5
2. Siltstone, grey to brown, blocky, sandy.....	2.5
1. Sandstone and siltstone interbedded, thin-bedded, micaceous, plant fragments.....	21.0

Location 2: SE. sec. 16, T. 19 S., R. 25 E.

Bronson Subgroup	
Martha Limestone	
Critzer Limestone member	
7. Limestone, brown, massive, hard, contains gastropods and brachiopods.....	

Plowanton Group (Exposed 39.0 feet) ... 9.5

6. Shale, brown, thin-bedded, partially covered "Knobtown" Sandstone 1.0

5. Sandstone, brown, thin-bedded, silty 9.5

4. Sandstone and siltstone interbedded, thin-bedded, micaceous 11.3

3. Shale, brown, thin-bedded, silty, contains plant fragments 3.3

2. Siltstone, brown, blocky, silty shale, concretions in lower part 1.9

1. Sandstone, buff to brown, thin-bedded, silty .....

Stratigraphic sections in Linn County, Kansas

Location 1½ NE¼ NE¼ sec. 27, T. 19 S., R. 24 E.

Bronson Subgroup
Hertha Limestone
Critzer Limestone member 1.8

b. Limestone, brown, massive, soft, rubbly weathering, a few brachiopods .....

Plowanton Group 10.8

3. Shale, brown to gray, thin-bedded, poorly preserved pelecypods .....

"Knobtown" Sandstone

2. Sandstone, brown, thin-bedded, cross-bedded, some carbonized wood fragments present in upper part 6.7

1. Shale, brown to gray, thin-bedded, blocky, silty .....

Location 1½ SW. sec. 34, T. 20 S., R. 23 E.

Bronson Subgroup
Hertha Limestone
Critzer Limestone member 4.2

3. Limestone, brown, massive, uneven beds.

Pleasanton Group (Exposed 33.3 feet)

2. Shale, grey to brown, thin-bedded, calcareous, abundant brachiopods and crinoid fragments..... 20.3

1. Siltstone and shale, brown, thin-bedded, micaceous, concretions in lower part..... 13.0

Location 5: C½ sec. 16, T. 20 S., R. 24 E.

Branson Subgroup
Hertha Limestone
Critzer Limestone member

4. Limestone, brown, rubbly weathering, nodular at base..... 3.7

Pleasanton Group (Exposed 55.2 feet)

3. Shale, brown to yellow, calcareous, poorly preserved pelecypods in the upper part..... 10.8

"Knobtown" Sandstone

2. Sandstone, brown to buff, massive, ferruginous, micaceous..... 8.9

1. Sandstone and siltstone interbedded, some concretions in lower part..... 35.5

Location 6: SW¼ sec. 22, T. 20 S., R. 24 E.

Branson Subgroup
Hertha Limestone
Critzer Limestone member

4. Limestone, grey, massive, hard, sharp basal contact..... 2.5

Pleasanton Group (Exposed 49.7 feet)

3. Shale, brown, calcareous, thin-bedded, abundant brachiopods, crinoid fragments, and poorly preserved pelecypods..... 11.6

"Knobtown" Sandstone

2. Sandstone, brown, massive, silty..... 14.1

1. Sandstone and siltstone interbedded, brown, thin-bedded, micaceous..... 24.0

Location 7: SE, sec. 31, T. 20 S., R. 24 E.

Bronson Subgroup
Hertha Limestone
Critzer Limestone member

4. Limestone, brown, massive, impure, contains a few productid brachiopods and bellerophon gastropods..... 3.2

Plowmanton Group (Exposed 47.2 feet)

3. Shale, gray to brown, blocky, contains chonetid brachiopods..... 8.0

"Knobtown" Sandstone

2. Sandstone, gray to buff, thin-bedded, silty, micaceous, soft..... 4.7

1. Siltstone and shale interbedded, gray to brown, thin-bedded, sandy..... 31.5

Location 24: SE cor. sec. 1, T. 21 S., R. 23 E.

Bronson Subgroup
Hertha Limestone
Critzer Limestone member

4. Limestone, brown, massive, sandy..... 2.0

Plowmanton Group (Exposed 24.4 feet)

3. Shale, brown, blocky, thin-bedded, contains chonetid brachiopods, bryozoan fragments, and the ostracode Bollidella..... 13.0

2. Siltstone and sandstone interbedded, thin laminae of carbonaceous shale which are cross-bedded, abundant plant remains..... 8.4

1. Sandstone, brown, massive, micaceous..... 3.0

Location 9: C sec. 13, T. 21 S., R. 22 E.

Bronson Subgroup
Hertha Limestone
Critter Limestone member

4. Limestone, brown, massive, rubbly, impure..... 3.4

Pleasanton Group (Exposed 29.4 feet)

3. Shale, brown, thin-bedded, contains poorly preserved brachiopods and crinoid fragments in upper part..... 22.0

"Knobtop" Sandstone

2. Sandstone, brown to grey, thin-bedded, calcareous, contains fragments of spiriferid brachiopods and carbonized plant remains..... 1.4

1. Shale, brown, thin-bedded, silty, carbonaceous material concentrated along bedding planes..... 6.0

Location 10: NE. sec. 2, T. 21 S., R. 23 E.

Bronson Subgroup
Hertha Limestone
Critter Limestone Member

2. Limestone, grey, massive, hard, containing productid brachiopods and gastropods..... 3.2

Pleasanton Group (Exposed 23.4 feet)

1. Shale, brown, thin-bedded, calcareous, limy nodules, contains brachiopods Derbyia, Composita, and Neospirifer..... 23.4

Location 11: SW¼ SW¼ sec. 11, T. 21 S., R. 23 E.

Bronson Subgroup
Hertha Limestone
Critter Limestone member

6. Limestone, brown, massive, contains productid brachiopods and gastropods..... 3.1

Plansanton Group (Exposed 40.3 feet)

5. Shale, brown, blocky, calcareous, contains chonetid brachiopods, crinoid fragments, and poorly preserved pelecypods..... 8.0

4. Siltstone, brown to buff, thin-bedded, contains concretions..... 17.5

"Bachtown" Sandstone

3. Sandstone, brown, thin-bedded to massive, silty, ripple marks in upper part..... 6.3

2. Covered interval

1. Siltstone and shale interbedded, tan to gray, sandy, carbonaceous material along bedding planes..... 16.5

Location 12: NE¼ SW¼ sec. 19, T. 21 S., R. 23 E.

Bronson Subgroup
Bertha Limestone
Critzer Limestone member

3. Limestone, brown, massive, irregular base, bellerophon gastropods..... 4.5

Plansanton Group (Exposed 60.7 feet)

2. Shale, gray to brown, blocky, slightly calcareous, contains chonetid brachiopods, and crinoid fragments in upper part..... 5.7

1. Siltstone and shale interbedded, gray to buff, blocky, sandy, contains concretions... 41.0

Location 13: NE¼ sec. 23, T. 21 S., R. 23 E.

Bronson Subgroup
Bertha Limestone
Critzer Limestone member

6. Limestone, brown to gray, massive, sharp basal contact, contains gastropods..... 3.4

Plansanton Group (Exposed 98.3 feet)

5. Shale, gray to brown, blocky, calcareous..... 6.2

4. Covered interval

3. Siltstone, gray to buff, thin-bedded, blocky, micaceous, contains concretions..... 21.0

"Knobtown" Sandstone

2. Sandstone, brown, thin-bedded, thin shale partings..... 6.1

1. Sandstone and siltstone interbedded, brown, thin-bedded, scattered plant remains..... 65.0

Location 14: C sec. 19, T. 21 S., R. 24 E.

Pleasanton Group
Hepler Sandstone

2. Sandstone, reddish-brown, thin to medium bedded, trace of glauconite along bedding planes, ferruginous..... 10.5

Marmaton Group
Labette Limestone

1. Limestone, gray, sandy, contains productid and orbiculoid brachiopods..... 1.5

Location 15: SW¼ NW¼ sec. 26, T. 21 S., R. 24 E.

Marmaton Subgroup
Martin Limestone
Critzer Limestone

6. Limestone, brown, massive, mostly covered except for the lower 2 feet..... 4.0

Pleasanton Group

5. Shale, brown, thin-bedded, micaceous, slightly calcareous..... 1.0

4. Covered interval..... 4.5

3. Siltstone, brown, shaly to sandy, thin-bedded, micaceous..... 9.3

"Knobtown" Sandstone

2. Sandstone, brown to dark brown, silty, micaceous, highly carbonaceous in the lower part..... 13.0

1. Siltstone and shale, bluish gray to buff,

thin-bedded, micaceous, sandy, contains concretions..... 26.0

Location 16: NE. sec. 27, T. 21 S., R. 24 E.

Bronson Subgroup
Hartha Limestone
Critter Limestone member

5. Limestone, brown, massive, sharp basal contact, contains productid brachiopods..... 8.8

Pleasanton Group (Exposed 65.1 feet)

4. Shale, buff, thin-bedded, sandy, micaceous..... 1.0

"Redbeds" Sandstone

3. Sandstone, buff to gray, thin-bedded to massive, carbonaceous material along rolling planes, micaceous..... 5.8

2. Sandstone and siltstone interbedded, brown to gray, thin-bedded, micaceous..... 17.0

1. Siltstone and shale interbedded, buff, thin-bedded, numerous concretions..... 42.0

Location 17: S sec. 5, T. 22 S., R. 25 E.

Bronson Subgroup
Hartha Limestone
Critter Limestone member

5. Limestone, brown, massive, hard, contains fossils and some pentagonals..... 9.2

Pleasanton Group

4. Covered slope..... 87.0

3. Shale, brown, blocky, slightly calcareous..... 5.5

Kepler Sandstone

2. Sandstone, gray to buff, thin-bedded, calcareous, cross-bedded, gets siltier down section..... 10.9

Marmaton Group
Holdenville Shale

1. Shale, gray to buff, blocky, limonitic concretions..... 9.7

Location 18: NE¼ SE¼ sec. 7, T. 22 S., R. 23 E.

Bronson Subgroup
Martha Limestone
Critzer Limestone member

4. Limestone, light gray, massive, nobby weathering, contains gastropods..... 3.0

Pleasanton Group (Exposed 35.9 feet)

5. Shale, brown to gray, thin-bedded, silty, micaceous..... 11.5

"Mastopora" Sandstone

4. Sandstone, brown to buff, massive to thin-bedded, silty, plant fragments numerous..... 9.7

3. Siltstone and sandstone interbedded, brown, thin-bedded, micaceous..... 6.0

2. Covered interval..... 3.5

1. Sandstone and siltstone interbedded, brown to gray, blocky, carbonaceous material along bedding planes..... 5.2

Location 19: SE¼ sec. 24, T. 22 S., R. 23 E.

Bronson Subgroup
Martha Limestone
Critzer Limestone member

4. Limestone, brown to gray, massive, sharp basal contact, contains productid brachiopods..... 4.2

Pleasanton Group (Exposed 64.3 feet)

3. Shale, gray to buff, thin-bedded, silty, calcareous, contains abundant bryozoa and poorly preserved pelecypods..... 4.5

"Knobtown" Sandstone

2. Sandstone, brown to gray, thin-bedded, silty, calcareous..... 6.6

1. Siltstone and shale interbedded, brown, thin-bedded, sandy streaks, containing concretions..... 53.0

Location 20: NE1 sec. 15, T. 22 S., R. 23 E.

Bronson Subgroup
Martha Limestone
Critzer Limestone member

4. Limestone, brown, massive, sharp basal contact, abundant gastropods..... 4.0

Pleasanton Group (Exposed 62.1 feet)

3. Shale, gray to brown, blocky, contains chonetid brachiopods in upper part..... 11.5

"Knobtown" Sandstone

2. Sandstone, brown to gray, thin-bedded to massive, an orbiculoid brachiopod near the top in a calcareous zone..... 11.6

1. Siltstone and shale interbedded, brown, thin-bedded, sandy..... 45.0

Location 21: NW sec. 23, T. 22 S., R. 23 E.

Bronson Subgroup
Martha Limestone
Critzer Limestone member

5. Limestone, brown, massive, hard, nodular at the base..... 4.5

Pleasanton Group (Exposed 62.1 feet)

4. Shale, gray to brown, blocky, slightly calcareous, contains poorly preserved crinoid fragments in upper part..... 13.0

"Knobtown" Sandstone

3. Sandstone, gray to buff, thin-bedded, silty... 4.2

2. Sandstone, gray, thin-bedded, calcareous, contains carbonized wood fragments..... 3.9

1. Siltstone, brown, blocky, micaceous, contains abundant carbonaceous material..... 41.0

Location 22: NW1 sec. 24, T. 22 S., R. 23 E.

Bronson Subgroup
Martha Limestone
Critzer limestone member

4. Limestone, brown to gray, massive, hard, contains bellerophon gastropods..... 3.7

Pleasanton Group (Exposed 60.1 feet)

3. Shale, gray to brown, blocky, contains choncid brachiopods in upper part..... 11.5

"Knobtown" Sandstone

2. Sandstone, brown to gray, thin-bedded to massive, an orbiculoid brachiopod in calcareous zone near the top..... 11.6

1. Siltstone, brown, blocky, sandy..... 45.0

Location 23: SE¼ sec. 6, T. 22 S., R. 24 E.

Bronson Subgroup
Martha Limestone
Critzer Limestone member

7. Limestone, brown, massive, sharp basal contact..... 3.1

Pleasanton Group (Exposed 86.3 feet)

6. Shale, gray, thin-bedded, silty..... 1.0

5. Sandstone, brown to buff, thin-bedded, silty, soft..... 2.0

4. Siltstone, brown to gray, blocky, contains abundant plant material..... 37.3

"Knobtown" Sandstone

3. Sandstone, thin-bedded, silty, cross-bedded... 30.5

2. Siltstone, brown to gray, thin-bedded, micaceous..... 25.5

1. Sandstone, light gray, hard, calcareous, only top exposed, thickness not determined..... ?

Location 24: NW¼ sec. 13, T. 22 S., R. 24 E.

Bronson Subgroup
Hartha Limestone
Caliche limestone member

6. Limestone, brown, massive, cliffy..... 6.7

Pleasanton Group (Exposed 62.0 feet)

7. Shale, gray to brown, blocky, slightly calcareous, containing channel breccia lenses and caliche fragments in upper part..... 2.5

"Thackery" Sandstone

4. Sandstone, gray to brown, thin-bedded, silty, micaceous..... 4.5

5. Sandstone and siltstone interbedded, micaceous, contains concretions..... 12.0

4. Covered interval..... 7.0

3. Sandstone, brown, massive, slightly calcareous. 11.0

2. Siltstone, brown, thin-bedded, micaceous..... 58.0

1. Sandstone, gray, hard, calcareous, only top exposed, thickness undetermined..... ?

Location 25: NE¼ sec. 25, T. 22 S., R. 24 E.

Bronson Subgroup
Hartha Limestone
Caliche limestone member

3. Limestone, light gray, massive, hard..... 3.1

2. Covered interval..... 4.0

Pleasanton Group

1. Limestone, dark gray, dense, shale partings... 16.0

2. Sandstone, dark gray, thin-bedded, soft, argillaceous..... 1.5

Marathon Group
Length Limestone

1. Limestone, gray, hard, sandy..... 1.0

Location 30: NE¼ sec. 9, T. 22 S., R. 25 E.

Pleasanton Group
Kepler Sandstone

3. Sandstone, reddish-brown, thin-bedded, cross-bedded in upper part, upper surface ripple marked..... 8.7

2. Sandstone, brown, thin-bedded, cross-bedded..... 1.8

1. Sandstone, buff, thin-bedded, grades downward to sandy siltstone..... 15.6

Location 31: NW sec. 16, T. 22 S., R. 25 E.

Pleasanton Group (Exposed 37.2 feet)

2. Limestone, dark gray, medium-bedded, thin shale partings, conchoidal fracture..... 6.2

1. Shale, gray, blocky, soft..... 31.0

Location 32: SE¼ NE¼ sec. 15, T. 23 S., R. 23 E.

Bronson Subgroup
Bertha Limestone

3. Limestone, gray, massive, cherty [illegible]..... 4.6

Pleasanton Group (Exposed 24.0 feet)

2. Limestone, dark gray, hard, medium-bedded, interbedded with gray, calcareous shale..... 15.0

1. Shale, gray to brown, thin-bedded, slightly calcareous..... 9.0

Location 33: NE¼ sec. 16, T. 23 S., R. 23 E.

Bronson Subgroup
Hartha Limestone
Collinsr Limestone member

2. Limestone, brown, thin-bedded, impure, sparsely fossiliferous..... 1.1

Pleasanton Group (Exposed 25.0 feet)

1. Siltstone, brown to gray, thin-bedded, containing crinoid fragments..... 25.0

Location 34: NE¼ sec. 26, T. 23 S., R. 22 E.

Bronson Subgroup
Hartha Limestone

3. Limestone, dark gray, thin-bedded, coarse crystalline, numerous fossil fragments..... 3.7

2. Covered interval..... 5.0

Pleasanton Group (Exposed 30.0 feet)

1. Limestone and shale interbedded, limestone is dark gray, hard, dense, and beds range from 1 to 1.5 feet. shale is brown to gray, calcareous, beds range from .2 to 1.0 feet in thickness..... 30.0

Location 35: NE¼ sec. 27, T. 23 S., R. 22 E.

Bronson Subgroup
Hartha Limestone

3. Limestone, gray, massive, numerous fossil fragments..... 3.7

Pleasanton Group (Exposed 35.0 feet)

2. Limestone and shale interbedded, limestone is dark gray, dense, medium-bedded, and shale is brown to gray, thin-bedded, calcareous..... 25.0

1. Shale, brown to gray, thin-bedded, silty..... 10.0

Location 33: SE¼ sec. 16, T. 23 S., R. 23 E.

Bronson Subgroup
Martha Limestone
Critser Limestone member

2. Limestone, brown, thin-bedded, impure, sparsely fossiliferous..... 3.1

Pleasanton Group (Exposed 25.0 feet)

1. Siltstone, brown to gray, thin-bedded, contains crinoid fragments..... 25.0

Location 34: NE¼ sec. 26, T. 23 S., R. 22 E.

Bronson Subgroup
Martha Limestone

3. Limestone, dark gray, thin-bedded, coarse crystalline, numerous fossil fragments..... 3.7

2. Covered interval..... 5.0

Pleasanton Group (Exposed 30.0 feet)

1. Limestone and shale interbedded, limestone is dark gray, hard, dense, and beds range from 1 to 1.5 feet. Shale is brown to gray, calcareous, beds range from .2 to 1.0 feet in thickness..... 30.0

Location 35: NE¼ sec. 27, T. 23 S., R. 22 E.

Bronson Subgroup
Martha Limestone

3. Limestone, gray, massive, numerous fossil fragments..... 3.7

Pleasanton Group (Exposed 35.0 feet)

2. Limestone and shale interbedded, limestone is dark gray, dense, medium-bedded, and shale is brown to gray, thin-bedded, calcareous..... 25.0

1. Chalk, brown to gray, thin-bedded, silty..... 10.0

Location 36: NW¼ sec. 1, T. 24 S., R. 22 E.

Pleasanton Group (Exposed 19.9 feet)

4. Shale, brown, thin-bedded, calcareous..... 5.2

3. Shale, dark brown to black platy, hard, weathers brown..... 0.7

2. Shale, brown, thin-bedded, calcareous, poorly preserved brachiopods and pelecypods in upper part..... 2.0

1. Limestone and shale interbedded, limestone dark gray, dense, hard, a few small brachiopods, weathers brown. Shale, brown to gray, thin-bedded, calcareous..... 12.0

Location 37: NE¼ SE¼ sec. 4, T. 24 S., R. 22 E.

Bronson Subgroup
Hartha Limestone

3. Limestone, gray to buff, thin wavy bedded, numerous fossil fragments..... 2.1

2. Covered interval..... 1.0

Pleasanton Group

1. Limestone and shale interbedded, limestone dark gray, dense, hard, beds range from 0.5 to 2.0 feet in thickness and contain a few brachiopods and small gastropods. Shale is brown to gray, thin-bedded, calcareous, beds range from 0.2 to 1.5 feet in thickness..... 51.0

Location 38: SW¼ sec. 12, T. 24 S., R. 22 E.

Bronson Subgroup
Hartha Limestone

7. Limestone, gray, hard, thin-bedded, fossil fragments..... 3.0

Pleasanton Group

6. Shale, brown, blocky, thin-bedded..... 1.0

5. Covered interval..... 12.0

4. Shale, brown, blocky, grades to black shale below..... 7.2

3. Shale, black, platy, hard, carbonaceous..... 1.2

2. Limestone, dark gray, nodular, discontinuous, contains a few small brachiopods..... 0.8

1. Shale, brown, thin-bedded, calcareous..... 5.8

Location [illegible] sec. [illegible], T. 24 S., R. 22 E.

Bronson Subgroup
Martha Limestone

7. Limestone, gray to brown, massive, contains [illegible]..... 4.0

Plenmonton Group (Exposed 11.9 feet)

6. Shale, brown, thin-bedded, silty..... 5.0

5. Covered interval..... 3.0

4. Shale, brown, blocky, contains orbiculoid brachiopods and some polyzoans..... 1.1

3. Shale, black, hard, platy..... 0.8

2. Limestone, dark gray, nodular, discontinuous... 0.7

1. Shale, brown, blocky, calcareous, silty..... 1.5

Location [illegible] sec. 6, T. 24 S., R. 23 E.

Bronson Subgroup
Martha Limestone

4. Limestone, gray to brown, massive, numerous fossil fragments..... 4.0

Plenmonton Group (Exposed 8.6 feet)

7. Shale, brown to yellow, soft, silty, contains brachiopod [illegible] and the orbiculoid [illegible]..... 4.5

6. Shale, brown, thin-bedded, calcareous, some fossil fragments..... 0.4

5. Shale, black, platy, hard..... 2.2

4. Limestone, dark gray, hard, dense, discontinuous..... 0.5

Location 43: SE¼ NW¼ sec. 24, T. 25 S., R. 22 E.

Brownson Subgroup
Martin Limestone

6. Limestone, gray, hard, thin-bedded..... 2.0

Plasmanton Group (Exposed 71.0 feet)

5. Shale, gray to brown, thin-bedded, partially covered..... 18.0

4. Covered interval, appears to have a few beds of limestone cropping out..... 16.0

3. Shale, gray to brown, thin-bedded, silty..... 5.0

2. Limestone, dark gray, impure, thin-bedded, contains a few fossil fragments..... 2.5

1. Shale, dark gray to brown, thin-bedded, silty, calcareous in part..... 45.5

Location 44: NW¼ sec. 13, T. 26 S., R. 21 E.

Brownson Subgroup
Martin Limestone

2. Limestone, gray to brown, massive, very fossiliferous, hard..... 6.5

Plasmanton Group

1. Shale, medium gray, blocky, partly calcareous, a few scattered limy nodules..... 27.0

APPENDIX B

WEIGHT CHART OF THE INSOLUBLE RESIDUES OF THE PLEASANTON GROUP

"Flaggy" Limestone Facies

Sample Number	Total Residue		Coarse Fraction		Fine Fraction	
	Grams	Percent	Grams	Percent	Grams	Percent
31-1	2.79	6.0	1.02	2.6	1.77	4.3
32-2	2.74	6.0	.51	1.3	2.23	5.5
32-3	3.90	9.7	.63	1.6	3.27	8.1
34-1	2.33	6.6	.72	1.8	1.61	4.8
34-2	1.80	4.5	.56	1.4	1.24	3.1
34-3	3.72	7.7	.73	1.8	2.85	5.9
35-1	2.29	5.5	.85	2.1	1.37	3.4
36-2	3.40	8.5	1.05	2.6	2.35	5.9
36-3	3.38	8.5	1.11	2.8	2.27	5.7
37-1	3.21	8.1	.60	1.5	2.61	6.6
37-2	3.70	9.3	.65	1.6	3.05	7.7
37-3	3.73	9.3	.78	1.9	2.95	7.4

Gray Shale Facies

Sample Number	Total Residue		Coarse Fraction		Fine Fraction	
	Grams	Percent	Grams	Percent	Grams	Percent
32-1	4.57	11.4	.85	2.1	3.72	9.3
33-2	4.67	11.7	.66	1.6	4.01	7.7
40-2	4.76	11.9	.87	2.1	3.89	9.8
41-1	2.91	7.3	.15	.4	2.76	6.9

Note: All samples weighed 40 grams before digestion in acid. The numbering system for the samples is as follows: the first number is the location number; the second number (1, 2, or 3) is the sample number, 1 being in the upper part of the section, 2 in the middle part, and 3 in the lower part.

APPENDIX C

Constituents of the coarse fraction of the insoluble residues of the Pleasanton Group.

"Flaggy" Limestone Facies

33-1 97% silt and clay
3% pyrite
Trace muscovite
Trace sponge spicules

33-2 97% silt and clay
3% pyrite

33-3 99% silt and clay
Trace pyrite

34-1 99% silt and clay
Trace pyrite

34-2 98% silt and clay
2% pyrite
Trace muscovite
A few arenaceous foram fragments

34-3 100% silt and clay

36-1 98% silt and clay
2% pyrite

36-2 99% silt and clay
Trace pyrite
Trace rounded quartz grains

36-3 99% silt and clay
Trace pyrite
Trace muscovite

37-1 99% silt and clay
1% pyrite
Trace muscovite
A few arenaceous foram fragments

37-2 99% silt and clay
1% pyrite

37-3 98% silt and clay
2% pyrite

Gray Mule Facies

[illegible]	97%	silt and clay
	3%	pyrite
[illegible]	98%	silt and clay
	2%	pyrite
[illegible]	97%	silt and clay
	3%	pyrite
[illegible]	[illegible]	silt and clay

APPENDIX B

Percent Chart of Size Analyses

"Kaybonne" Sandstone

Wentworth Grade Scale	Sample No. 1-2 Weight Percent	Sample No. 1-2 Cumulative Percent	Sample No. 8-1 Weight Percent	Sample No. 8-1 Cumulative Percent	Sample No. 11-1 Weight Percent	Sample No. 11-1 Cumulative Percent
1/2-1/4 mm	2.0	2.0			4.0	4.0
1/4-1/8 mm	32.1	34.1	8.9	8.9	47.9	51.9
1/8-1/16 mm	35.0	69.1	50.8	59.7	28.0	79.9
less than 1/16 mm	30.4	99.5	39.9	99.5	20.1	100.0

Wentworth Grade Scale	Sample No. 11-2 Weight Percent	Sample No. 11-2 Cumulative Percent	Sample No. 15-1 Weight Percent	Sample No. 15-1 Cumulative Percent	Sample No. 15-2 Weight Percent	Sample No. 15-2 Cumulative Percent
1/2-1/4 mm	2.1	2.1	3.1	3.1		
1/4-1/8 mm	50.0	52.1	31.0	34.1	30.6	30.6
1/8-1/16 mm	26.0	78.1	40.1	74.2	30.0	60.6
less than 1/16 mm	21.5	99.6	25.2	99.4	39.6	99.6

"Knobtown" Sandstone

Wentworth Grade Scale	Sample No. 11-1 Weight Percent	Sample No. 11-1 Cumulative Percent	Sample No. 11-2 Weight Percent	Sample No. 11-2 Cumulative Percent	Sample No. 11-5 Weight Percent	Sample No. 11-5 Cumulative Percent
1/2-1/4 mm					2.0	2.0
1/4-1/8 mm	16.6	16.6	19.5	19.5	15.5	17.5
1/8-1/16 mm	54.6	71.2	43.0	62.5	44.0	61.5
less than 1/16 mm	28.5	99.7	37.1	99.6	38.0	99.5

Wentworth Grade Scale	Sample No. 12-1 Weight Percent	Sample No. 12-1 Cumulative Percent	Sample No. 21-1 Weight Percent	Sample No. 21-1 Cumulative Percent	Sample No. 21-4 Weight Percent	Sample No. 21-4 Cumulative Percent
1/2-1/4 mm	2.6	2.6			1.0	1.0
1/4-1/8 mm	18.9	21.5	30.3	33.3	18.5	19.5
1/8-1/16 mm	29.8	51.3	28.1	61.1	37.0	56.5
less than 1/16 mm	48.1	99.4	38.9	99.7	43.0	99.5

Kepler Sandstone

Wentworth Grade Scale	Sample No. 11-1 Weight Percent	Sample No. 11-1 Cumulative Percent	Sample No. 11-2 Weight Percent	Sample No. 11-2 Cumulative Percent	Sample No. 17-1 Weight Percent	Sample No. 17-1 Cumulative Percent
1/2-1/4 mm	2.6	2.6	1.6	1.6	2.1	2.1
1/4-1/8 mm	71.4	74.0	73.9	75.5	73.4	75.5
1/8-1/16 mm	14.9	88.9	12.3	88.8	15.4	90.9
less than 1/16 mm	10.6	99.5	10.7	99.5	8.4	99.3

Kepler Santiago

Wentworth Grade Scale	Sample No. [illegible] Weight Percent	Sample No. [illegible] Cumulative Percent	Sample No. [illegible] Weight Percent	Sample No. [illegible] Cumulative Percent	Sample No. [illegible] Weight Percent	Sample No. [illegible] Cumulative Percent
1/2-1/4 mm	2.0	2.0	2.8	2.2		
1/4-1/8 mm	63.5	65.5	50.2	52.9	42.1	42.1
1/8-1/16 mm	21.2	86.7	39.2	92.0	42.4	84.5
less than 1/16 mm	13.3	99.7	7.8	99.2	15.1	99.6

Wentworth Grade Scale	Sample No. [illegible] Weight Percent	Sample No. [illegible] Cumulative Percent	Sample No. [illegible] Weight Percent	Sample No. [illegible] Cumulative Percent	Sample No. [illegible] Weight Percent	Sample No. [illegible] Cumulative Percent
1/2-1/4 mm	2.5	2.5	2.0	2.0	2.0	2.0
1/4-1/8 mm	35.5	38.0	40.2	42.2	42.0	44.0
1/8-1/16 mm	48.8	86.8	43.1	90.3	43.6	87.4
less than 1/16 mm	13.3	99.1	8.9	99.2	12.6	99.4