

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

by

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As a note concerning this report. Many pictures were part of this report, however, the quality of the photos were so poor, after reproduction by the Survey, as to be useless. They were therefore extracted from the report.

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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. Farther 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. Analysis of the mudstones and insoluble residue studies of the limestone 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 rock 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 (1858) 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 Pawnee and the "Well Rock series" (Bronson Subgroup of present classification) as the Maris de Cygne coal series. This included all rocks now classified as the Pleasanton Group. Hawerth and Kirk (1894) allied the name Laneville Shale to the rocks occupying the interval between the FT. Scott Limestone and the Erie (Winterset-Hertha) Limestone. This term proved unsatisfactory because the Erie Limestone was hard to identify and the grouping was impractical.

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

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 Cygne Shale. This interval was classed as a member of the Marmaton Group.

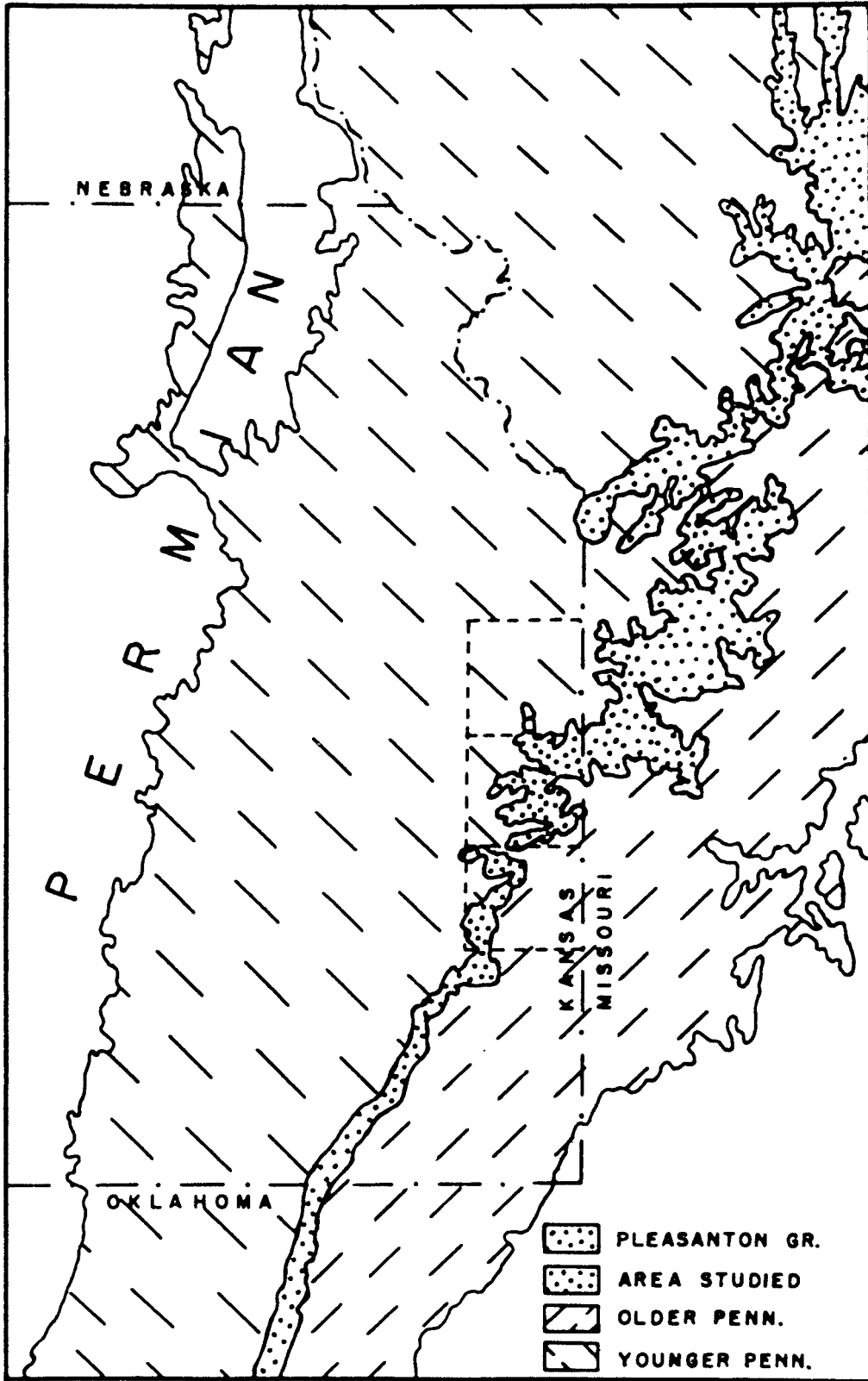


FIGURE 1. Map showing the outcrop pattern of rocks assigned to the Pleasanton Group and the area covered in this report.

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 Helper 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. Cokerman (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 3, in the N½ of Sec. 34, T. 24 S., R. 21 E.

The variation in the span of the 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 Hertha 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 beds. Figure 2 shows a typical outcrop of Pleasanton rocks and why complete sections are scarce. Figure 3 shows the locations of outcrops studied.

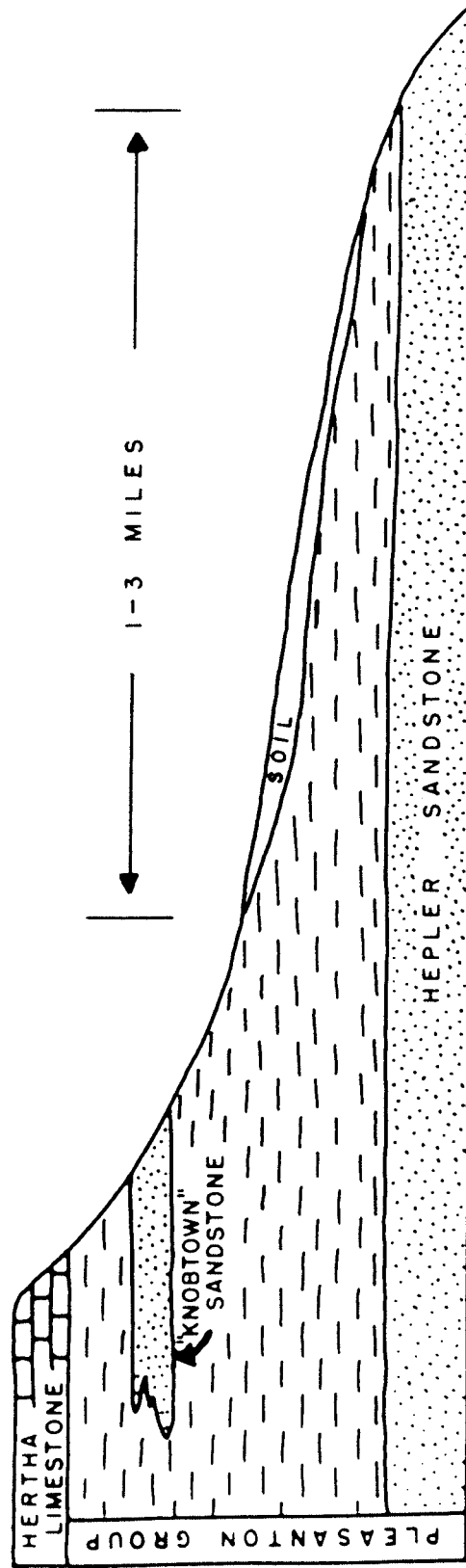


FIGURE 2. Sketch showing characteristic physiographic occurrence of Pleasanton Rocks.

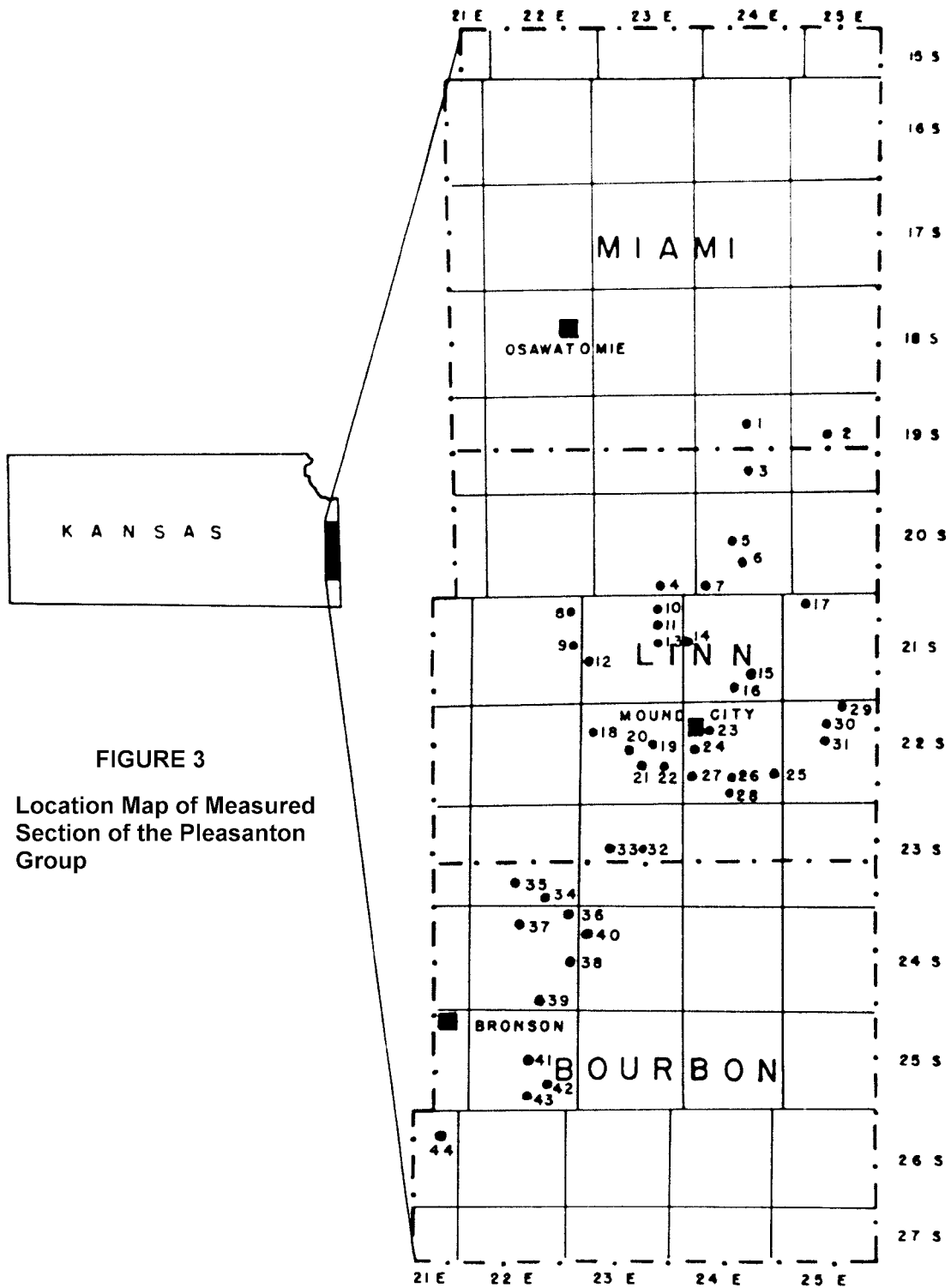


FIGURE 3
 Location Map of Measured
 Section of the Pleasanton
 Group

Methods of Investigation

A total of nine weeks were spent in the field locating, measuring and studying exposures. The location for many of these exposures were obtained from 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 not 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 25 samples of "Knobtown" and Helper Sandstone were made. After examining each sample under a microscope a portion of each sample was dis-aggregated and used for size determination. The general procedure used in the size analysis was as described by Kruabain and Pettijohn (1936, p. 135-142).

Shale dispersal: A portion of each sample of shale collected in the field was placed in a beaker of water and allowed to soak for hours. The sample was then boiled for 60 minutes, after which the turbid water was decanted. The remaining material was then studied.

Insoluble residue preparation: Insoluble residue of each limestone were prepared. The general procedure used in the preparation of the residue is that established 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.

ACKNOWLEDGEMENTS

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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 underlying Helper 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 0 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 rock in Kansas assigned to the Missourian Stage (Table 1). The Pleasanton was named from exposures in Linn and Bourbon Counties, Kansas.

The Helper 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 a 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. Farther 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 case 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 County will be called the "flaggy" limestone facies. The southernmost facies which is found in Bourbon County is referred to as the gray shale facies. All of the above facies lie above the Helper 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.

Table 1

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

Galesburg Shale

Swope Limestone

Ladore Shale

Hertha Limestone

Pleasanton Group

unnamed parts including locally the "Knobtown Sandstone,
Checkerboard Limestone (not definitely identified north
of Labette Co., Kansas)

Helper Sandstone

(regional disconformity)

Desmoinesian Stage

Marmaton Group

Appanoose Subgroup

Holdenville Shale

Lenapah Limestone

Nowata Shale

Altamont Limestone

Bandera Shale

Pawnee Limestone

Labette Shale

Ft. Scott Subgroup

Higginsville Limestone

Little Osage Formation

Blackjack Creek Formation

Cherokee Group

(regional disconformity)

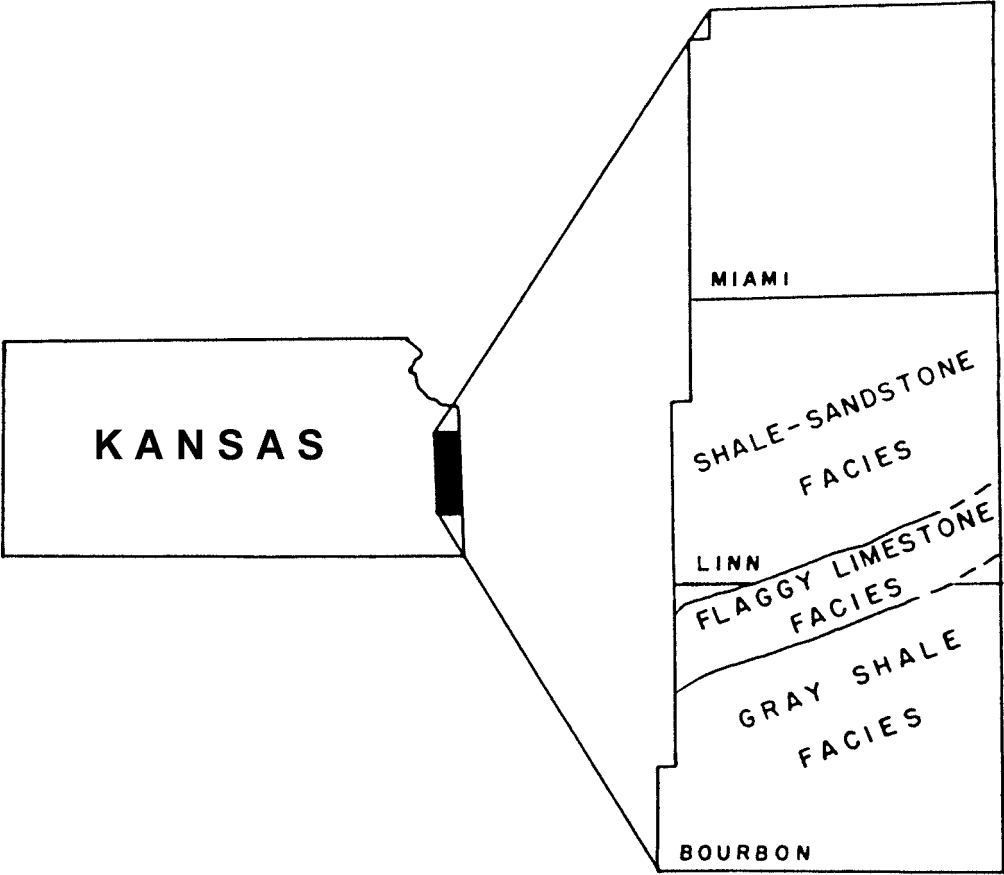


FIGURE 4. Location Map showing the approximate Extent of Facies of the Pleasanton Group

Helper Sandstone

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

In the area studied, the Helper was found to be of rather uniform lithology: a gray to reddish brown, fine grained, quartz sandstone. The Helper contains a calcareous zone in the middle part and in numerous exposures is cross-bedded. In central Linn County the Helper 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 helper is rarely seen in conjunction with the remainder of the Pleasanton a complete thickness of this unit is difficult to determine. Thickness' of the Helper measured in partial exposures ranged from 10.9 to 25.5 feet, with an overall average of about 12 feet.

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 localities there is a significant amount of fine grained, buff, silty, sandstone in the upper part of the sequence. For case 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 southern part of Linn County. Thickness of individual limestone and shale beds range from 0.5 to about 2.0 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 member separated by a shale member. The sequence from top to bottom is : Sniabar Limestone, Mound 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 weathered limestone. Bellerophonid 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 Locality 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 to impossible. The average thickness of the Hertha in this area is about 4.5 feet.

As was mentioned before, the Hertha changes 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 undergoes a facies change in the same area, thus complicating the problem. However, through a detailed study of those 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 had 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 Helper Sandstone rested upon rocks ranging in age from Holdenville to Altamont. This disconformity has been traced across Missouri into Iowa.

Helper Sandstone

The Helper Sandstone (Jewett 1940, p. 15) is the basal formation of the Pleasanton Group and rests with disconformity on underlying Desmoinesian strata. The helper has a rather uniform lithologic character. It is a fine grained, thin bedded, reddish-brown to buff, quartz sandstone. Cross-bedding and ripple marks are exhibited in the Helper at Localities 14 and 17.

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

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

In Linn County in Sec. 25, T. 21 S., R. 24 E., about 1 mile north of Pleasanton, the Helper 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 Helper is exposed and dips to the northwest at approximately 70°. The cause of this structure is as yet unexplained, but has been attributed by some workers to a collapse structure resulting from solution activity in underlying strata.

Size analysis of samples of the Helper showed that its main constituent are grains that range from $\frac{1}{4}$ to $\frac{1}{16}$ millimeters. According to the Wentworth grade scale this is a fine to very fine sandstone. A small percent of the medium sized grains were found in each sample. The four histograms shown in Figure 5 were chosen to show the relationship in grain size from north to south.

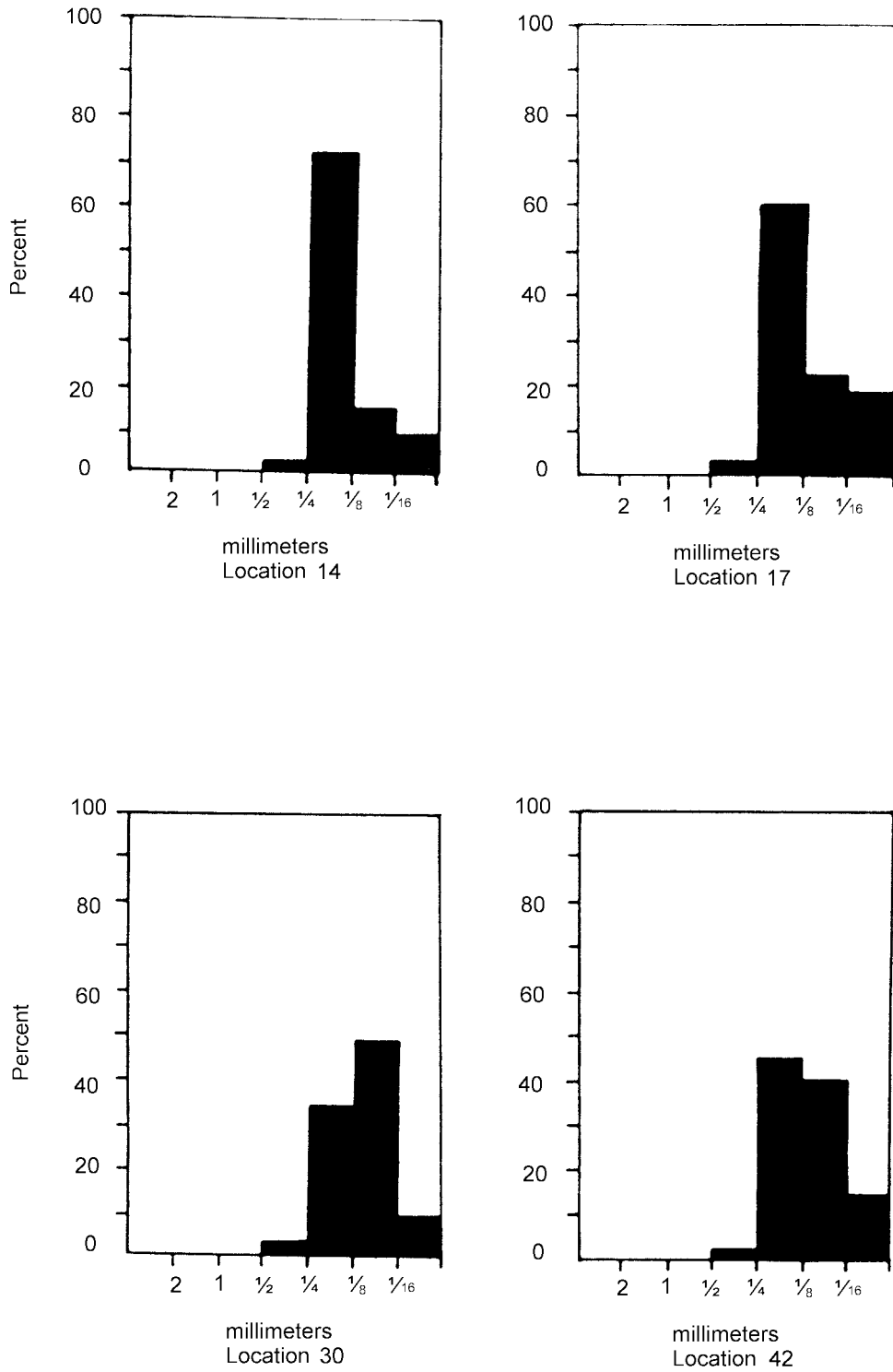


FIGURE 5. Histograms prepared from samples of Helper Sandstone

The Helper 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 Helper 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. String concretionary structures are very abundant in this unit. No fossils were found in this unit over an area covered by the study. The contact between the lower shale unit and the Helper Sandstone was seen at Locality 17. In this exposure the Helper 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 upwards into the “Knobtown” Sandstone is seen at Locality 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 Locality 17.

“Knobtown” Sandstone Unit. 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 McQueen and Green (1938). For the most part the “Knobtown” is buff, thin bedded to massive, very fine grained, quartz sandstone.

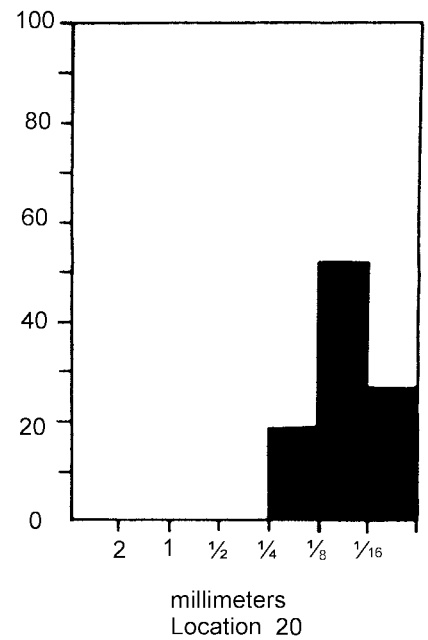
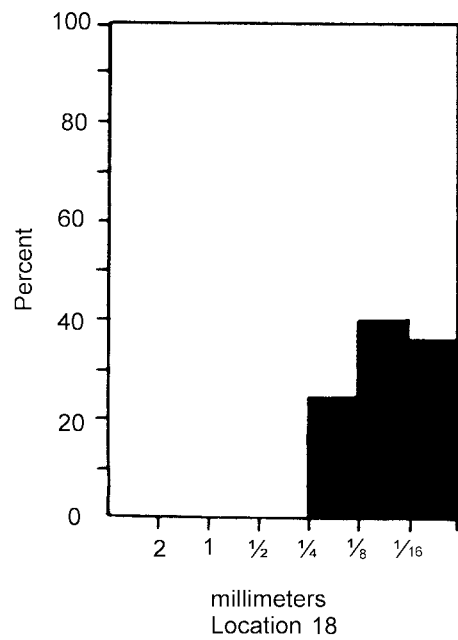
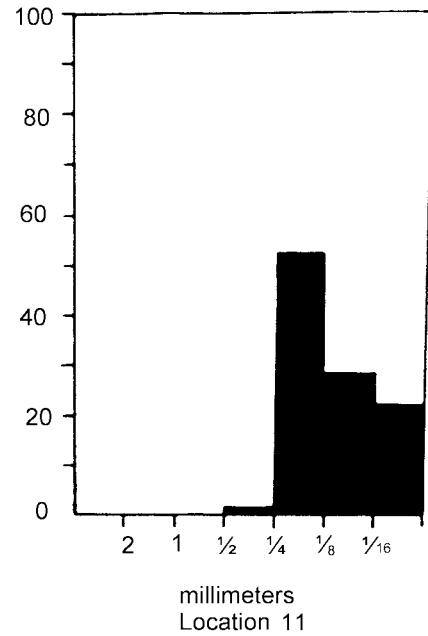
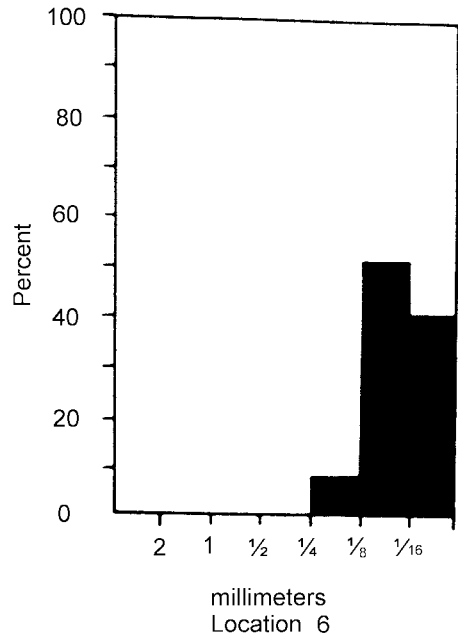


FIGURE 6. Histograms prepared from samples of the “Knobtown” Sandstone

At Localities 9, 20 and 22, the middle part of the “Knobtown” is light gray, hard, thin bedded and calcareous. The calcareous zones average about one foot in thickness.

The “Knobtown” was found to be cross-bedded at two Locations. At Location 1 the cross-strata were marked by a band of ferruginous material along the bedding planes. A shaley siltstone break within the “Knobtown” at locality 8 shows a small scale cross-bedding outlined by carbonaceous material.

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 Locality 9. Fragments of spiriferid brachiopods were found in this calcareous sandstone. At Locality 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 was small bits of carbonaceous plant matter. The uppermost part of the “Knobtown” at Locality 20 is soft, brown, thin bedded, and contains a mixture of fossils.

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 limy nodules. That is usually found within a few inches of the base of the overlying Hertha Limestone.

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 Localities 4, 5, 6, 11 and 12. Chonetid brachiopods were found to be fairly abundant at other locations. At Locality 8 impressions of ostracode *Bellinella* were located. These occur in a zone which contains crinoids and plant fragments, about 5 feet below the base of the Hertha Limestone.

The relationship of the upper shale unit to the Hertha 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 Hertha Limestone. A good example of this is at Locality 6 where the unit is 11.5 feet thick and calcareous throughout the entire thickness. At localities 16, 23 and 24 a sharp contact between the Pleasanton and the overlying Critzer Limestone is seen.

The contact between the upper shale unit and the "Knobtown" is rather sharp in most cases. At locality 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 sandstones.

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

"Flaggy" Limestone Facies

In southern Linn and northern Bourbon Counties the Pleasanton Group assumes a carbonate aspect. The Pleasanton of this area is composed of alternating beds of shale and limestone. 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 residue of these beds ranged from 4.5% to 9.3% by weight. All insoluble residue of these limestones are composed, for the most part, silt and clay with a minor amounts of pyrite present in almost every 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 predominant 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 Hertha Limestone at only Locality 32 and 35. At these locations there is approximately 0.7 foot of brown shale separating the Hertha Limestone from the first limestone bed of 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 Locality 37.

Gray Shale Facies

The gray shale facies of the Pleasanton Group is found only in Bourbon County, Kansas from T. 35 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. 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 foot thick. The second variation is a thin, discontinuous 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 0.5 to 0.7 foot in thickness, and contains a few scattered brachiopods. Insoluble residue of this limestone were composed of silt and clay for the most part with minor amounts of pyrite. Appendix C shows constituents of the insoluble residue of these limestones.

The only location where abundant fossils were found was Locality 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 *Dairdia* and a few broken ramose bryozoan fragments.

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

CONCLUSIONS

The shale-sandstone facies of the Pleasant 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 Pleasant Group in Missouri and Iowa (Cline, 1940) 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 sediment, 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 the sequence. Currents in this environment or supply of clastic 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 residue would seem to indicate that some sort of a reducing environment existed at the time of the deposition of the limestone.

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, is that it may have been a slightly reducing environment. This is indicated by the presence of pyrite in insoluble residues of the limestone beds of this sequence.

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

The disconformity between the rocks of the 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 Helper is a shaley 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 directions 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, SE¼, Sec. 10, T. 19 S., R. 24 E.

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

Location 2: C Sec. 16, T. 19 S., R. 25 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 7. Limestone, brown, massive, hard, contains gastropods and brachiopods9.5

Pleasanton Group (Exposed 30.5 feet)

- 6. Shale, brown, thin bedded, partially covered.....9.5
- “Knobtown” Sandstone
- 5. Sandstone, brown, thin bedded silty1.0
- 4. Sandstone and siltstone interbedded, thin bedded, micaceous.....9.5
- 3. Shale, brown, thin bedded, silty, contains plant fossils11.3
- 2. Siltstone, brown, blocky, silty shale, concretions in lower part.....3.8
- 1. Sandstone, buff to brown, thin bedded, silty1.9

Stratigraphic sections in Linn County, Kansas

Location 3: NE¼, NW¼, Sec. 27, T. 19 S., R. 24 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 4. Limestone, brown, massive, soft, rubbly weathered, a few brachiopods.....1.5

Pleasanton Group

- 3. Shale, brown to gray, thin bedded, poorly preserved brachiopods10.8

“Knobtown” Sandstone

- 2. Sandstone, brown, thin bedded, cross-bedded, some carbonized wood fragments present in upper part.....3.2
- 1. Shale, brown to gray, thin bedded, blocky, silty6.7

Location 4: C Sec. 34, T. 20 S., R. 23 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 3. Limestone, brown, massive, uneven base4.2

Pleasanton Group (Exposed 33.3 feet)

- 2. Shale, gray to brown, thin bedded, calcareous, chonetid brachiopods, and crinoid fragments.....20.3
- 1. Siltstone and shale, brown, thin bedded, micaceous, concretions in lower part13.0

Location 5: C E½ , Sec. 16, T. 20 S., R. 24 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 4. Limestone, brown, rubbly weathering, nodular at base3.7

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 part35.5

Location 6: SE¼, Sec. 22, T. 20 S., R. 24 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 4. Limestone, gray, massive, hard, sharp basal contact2.5

Pleasanton Group (Exposed 49.7 feet)

- 3. Shale, brown, calcareous, thin bedded, chonetid
brachiopods, crinoid fragments, and poorly
preserved pelecypods11.6

“Knobtown” Sandstone

- 2. Sandstone, brown, massive, silty14.1
- 1. Sandstone and siltstone interbedded, brown, thin
bedded, micaceous.....24.0

Location 7: SE¼, 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 bellarophon gastropods3.2

Pleasanton 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, sandy34.5

Location 8: SE cor. Sec. 1, T. 21 S., R. 22 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 4. Limestone, brown, massive rubbly2.0

Pleasanton Group (Exposed 24.4 feet)

- 3. Shale, brown, blocky, thin bedded, contains chonetid brachiopods, bryozoan fragments and the ostracode *Mollinalla*18.0
- 2. Siltstone and sandstone interbedded, thin laminae of of carbonaceous shale which are cross-bedded, abundant plant remains6.4
- 1. Sandstone, brown, massive, micaceous2.0

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

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 4. Limestone, brown, massive, rubbly, impure3.4

Pleasanton Group (Exposed 29.4 feet)

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

“Knobtown” Sandstone

- 2. Sandstone, brown to gray, thin bedded, calcareous, contains fragments of spiriferid brachiopods and carbonized plant remains1.4
- 1. Shale, brown, thin bedded, silty, carbonaceous material concentrated along bedding planes6.0

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

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 2. Limestone, gray, massive, hard, contains productid brachiopods and gastropods.....3.2

Pleasanton Group (Exposed 23.4 feet)

- 1. Shale, brown, thin bedded, calcareous, limy nodules, contains brachiopods, Derbela and Composita23.4

Location 11. SW¼, SE¼, Sec. 11, T. 22 S., R. 23 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

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

Pleasanton Group (Exposed 48.3 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

“Knobtown” Sandstone

- 3. Sandstone, brown, thin bedded to massive, silty, ripple marks in upper part6.3
- 2. Covered interval
- 1. Siltstone and shale interbedded, tan to gray, sandy, Carbonaceous material along bedding plane.....16.5

Location 12. NW¼, SW¼, Sec. 19, T. 21 S., R. 23 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 3. Limestone, brown, massive, irregular base, gastropods4.5

Pleasanton Group (Exposed 60.7 feet)

- 2. Shale, gray to brown, blocky, slightly calcareous, contains chonetid brachiopods, crinoid fragments in upper part5.7
- 1. Siltstone and shale interbedded, gray to buff, blocky, sandy, contains concretions61.0

Location 13. NE¼, Sec. 23, T. 21 S., R. 23 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

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

Pleasanton Group (Exposed 98.3 feet)

- 5. Shale, gray to brown, blocky, calcareous3.4
- 4. Covered interval
- 3. Siltstone, gray to buff, thin bedded, blocky, micaceous,

contains concretions21.0

“Knobtown” Sandstone

2. Sandstone, brown, thin bedded, thin shale partings6.1

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

Helper Sandstone

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

Marmaton Group

Lenapah Limestone

1. Limestone, gray, sandy, contains productids and orbiculoid brachiopods1.5

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

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

6. Limestone, brown, massive, mostly covered except for the lower 2 feet4.0

Pleasanton Group

5. Shale, brown, thin bedded, micaceous, slightly calcareous1.0

4. Covered interval4.5

3. Siltstone, brown, shaley to sandy, thin bedded, micaceous9.3

“Knobtown” Sandstone

- 2. Sandstone, brown to dark brown, silty, micaceous, highly carbonaceous in lower part13.0
- 1. Siltstone and shale, bluish gray to buff, thin bedded, micaceous, sandy, contains concretions.....26.0

Location 16. NE¼, Sec. 27, T. 21 S., R. 24 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 5. Limestone, brown, massive, sharp basal contact, contains productid brachiopods8.8

Pleasanton Group (Exposed 65.8 feet)

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

“Knobtown” Sandstone

- 3. Sandstone, buff to gray, thin bedded to massive, carbonaceous material along bedding 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. C, Sec. 5, T. 21 S., R. 25 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 5. Limestone, brown, massive, hard, contains *Osagia* and some gastropods9.2

Pleasanton Group

- 4. Covered slope67.0
- 3. Shale, brown, blocky, slightly micaceous5.5

Helper Sandstone

- 2. Sandstone, gray to buff, thin bedded, calcareous,
cross-bedded, get siltier down section10.0

Marmaton Group

Holdenville Shale

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

Location 18. NE¼, SE¼, Sec. 5, T. 22 S., R. 23 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 6. Limestone, light gray, massive, rubbly weathered.
contains gastropods.....3.0

Pleasanton Group (Exposed 35.9 feet)

- 5. Shale, brown to gray, thin bedded, silty, micaceous11.5

“Knobtown” Sandstone

- 4. Sandstone, brown to buff, massive to thin bedded, silty,
plant fragments numerous9.7
- 3. Siltstone and sandstone interbedded, brown, thin bedded
micaceous.....6.0
- 2. Covered interval3.5
- 1. Sandstone and siltstone interbedded, brown to gray, blocky,
carbonaceous material along bedding planes.....5.8

Location 19. Sec. 14, T. 22 S., R. 23 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 4. Limestone, brown to gray, massive, sharp basal contact, contains productid brachiopods4.2

Pleasanton Group (Exposed 64.3 feet)

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

“Knobtown” Sandstone

- 2. Sandstone, brown to gray, thin bedded, silty, calcareous6.8
- 1. Siltstone and shale interbedded, brown, thin bedded, sandy streaks, contains concretions53.0

Location 20. Sec. 15, T. 22 S., R. 23 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 4. Limestone, brown, massive, sharp basal contact, abundant gastropods4.0

Pleasanton Group (Exposed 68.1 feet)

- 3. Shale, gray to buff, blocky, contains chonetid brachiopods in the upper part.....11.5

“Knobtown” Sandstone

- 2. Sandstone, brown to gray, thin bedded to massive, orbiculoid brachiopods near top in a calcareous zone11.6
- 1. Siltstone and shale interbedded, brown, thin bedded, sandy 45.0

Location 21. NW¼, Sec. 23, T. 22 S., R. 23 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

5. Limestone, brown, massive, hard, nodular on top.....4.5

Pleasanton Group (Exposed 62.1 feet)

4. Shale, gray to brown, blocky, slightly calcareous, contains
in the upper part.....11.5

“Knobtown” Sandstone

3. Sandstone, gray to buff, thin bedded, silty4.2

2. Sandstone, gray, thin bedded, calcareous, contains
carbonized wood fragments3.9

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

Location 22. NW Line, Sec. 24, T. 22 S., R. 23 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

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

Pleasanton Group (Exposed 68.1 feet)

3. Shale, gray to brown, blocky, contains chonetid
brachiopods in the upper part11.5

“Knobtown” Sandstone

2. Sandstone, brown to gray, thin bedded to massive,
orbiculoid brachiopods near top.....11.6

1. Siltstone, brown, blocky, sandy45.0

Location 23. SE¼, Sec. 8, T. 22 S., R. 24 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

7. Limestone, brown to gray, massive, shape basal contact.....3.1

Pleasanton Group (Exposed 86.3 feet)

6. Shale, gray, thin bedded, silty1.0

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

4. Siltstone, brown to gray, blocky, contains abundant
plant material37.7

“Knobtown” Sandstone

3. Sandstone, thin bedded, silty, cross-bedded30.5

2. Siltstone, brown to gray, thin bedded, micaceous25.5

1. Sandstone, light gray, hard, calcareous, only top
exposed, thickness unknown

Location 24. NE¼, Sec. 18, T. 22 S., R. 24 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

8. Limestone, brown, massive, soft6.7

Pleasanton Group (Exposed 82.0 feet)

7. Shale, gray to brown, blocky, slightly calcareous,
contains chonetid brachiopods2.5

“Knobtown” Sandstone

6. Sandstone, gray to brown, thin bedded, silty, micaceous4.5

5. Sandstone and siltstone interbedded, micaceous,
containing concretions12.0

4. Covered interval7.0

3. Sandstone, brown, massive, slightly calcareous11.0

- 2. Siltstone, brown, thin bedded, micaceous52.0
- 1. Sandstone, gray, hard, calcareous, only top exposed.....

Location 25. NW Line, Sec. 25, T. 22 S., R. 24 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 5. Limestone, light gray, massive, hard3.1
- 4. Covered interval4.0

Pleasanton Group

- 3. Limestone, dark gray, dense, shale partings.....16.0
- 2. Sandstone, dark gray, thin bedded, soft, asphaltic1.5

Marmaton Group

Lenapah Limestone

- 1. Limestone, gray, hard, sandy1.0

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

Pleasanton Group

Helper Sandstone

- 3. Sandstone, reddish-brown, thin bedded, cross-bedded
in upper part, ripple marks8.7
- 2. Sandstone, brown, thin bedded, cross-bedded.....3.8
- 1. Sandstone, buff, thin bedded, grades downward into sand
siltstone.....15.0

Location 31. Sec. 16, T. 22 S., R. 25 E.

Pleasanton Group (Exposed 37.2 feet)

- 2. Limestone, dark gray, medium bedded, thin shale partings, conchoidal fracture6.2
- 1. Shale, gray, blocky, soft31.0

Location 32. SW $\frac{1}{4}$, SE $\frac{1}{4}$, Sec. 15, T. 23 S., R. 23 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 3. Limestone, gray, massive, contains Myalina4.6

Pleasanton Group (Exposed 34.0 feet)

- 2. Limestone, dark gray, medium bedded, interbedded with gray, calcareous shale15.0
- 1. Shale, gray to brown, thin bedded, slightly calcareous9.0

Location 33. NW $\frac{1}{4}$, Sec. 16, T. 23 S., R. 23 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 2. Limestone, brown, thin bedded, sparsely fossiliferous3.1

Pleasanton Group (Exposed 25.0 feet)

- 1. Siltstone, brown to gray, thin bedded, contains crinoid fragments25.0

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

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 3. Limestone, dark gray, thin bedded, numerous fossil fragments3.7
- 2. Covered interval5.0

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, calcareous, beds range from 0.2 to 1.0 foot in thickness30.0

Location 35. Sec. 27, T. 23 S., R. 22 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 3. Limestone, gray, massive, numerous fossil fragments3.7

Pleasanton Group (Exposed 35.0 feet)

- 2. Limestone and shale interbedded, Limestone is dark gray, hard, dense, medium bedded. Shale is brown to gray, calcareous, thin bedded25.0
- 1. Shale, brown to gray, thin bedded, silty.....10.0

Location 36. Sec. 27, T. 23 S., R. 22 E.

Pleasanton Group (Exposed 19.9 feet)

- 4. Shale, brown, thin bedded, calcareous5.2
- 3. Shale, dark brown to brown platy, hard, weather brown.....0.7
- 2. Shale, brown, thin bedded, calcareous, poorly preserved brachiopods and pelecypods in upper part2.0
- 1. Limestone and shale interbedded, limestone is dark gray, dense, hard, with a few small brachiopods, weathers brown. Shale is brown to gray, thin bedded, calcareous.....12.0

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

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 3. Limestone, gray to buff, thin wavy bedded, numerous fossil fragments.....2.1
- 2. Covered interval4.0

Pleasanton Group

- 1. Limestone and shale interbedded, limestone is 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 0.1 to 1.5 feet in thickness54.0

Location 38. SE¼, Sec. 13, T. 24 S., R. 22 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

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

Pleasanton Group

- 6. Shale, brown, blocky, thin bedded1.0
- 5. Covered interval12.0
- 4. Shale, brown, blocky, grades to black shale below7.2
- 3. Shale, black, platy, hard, carbonaceous1.2
- 2. Limestone, dark gray, nodular, discontinuous, contains a few brachiopod fossils.....0.6
- 1. Shale, brown, thin bedded, calcareous5.0

Location 39. SE¼, NE¼, Sec. 35, T. 24 S., R. 22 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 7. Limestone, gray to brown, massive, contains fossil fragments.....4.0

Pleasanton Group (Exposed 11.9 feet)

- 6. Shale, brown, thin bedded, silty5.8
- 5. Covered interval9.6
- 4. Shale, brown, blocky, contains orbiculoid brachiopods and pelecypods.....3.1
- 3. Shale, black, hard, platy0.8

- 2. Limestone, dark gray, nodular, discontinuous.....0.7
- 1. Shale, brown. blocky, calcareous, silty.....1.5

Location 40. NW¼, Sec. 6, T. 24 S., R. 23 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 6. Limestone, gray to brown, massive, contains fossil fragments.....4.0

Pleasanton Group (Exposed 9.1 feet)

- 5. Shale, brown to yellow, soft, silty, contains brachiopods.....4.5
- 4. Shale, brown, thin bedded, calcareous, some fossils0.4
- 3. Shale, black, platy, hard.....2.2
- 2. Limestone, dark gray, hard, dense, discontinuous.....0.5
- 1. Shale, brown. blocky, calcareous, silty.....1.5

Location 43. SE¼, NW¼, Sec. 34, T. 25 S., R. 22 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

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

Pleasanton 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 outcropping.....46.0
- 3. Shale, gray to brown, thin bedded, silty.....5.0

- 2. Limestone, dark gray, impure, thin bedded, contains a few fossil fragments2.5
- 1. Shale, dark gray to brown, thin bedded, silty, calcareous in part.....45.5

Location 44. NW¼, Sec. 12, T. 26 S., R. 21 E.

Bronson Subgroup

Hertha Limestone

Critzer Limestone member

- 2. Limestone, gray to brown, hard, massive, abundant fossils....8.5

Pleasanton Group

- 1. Shale, medium gray, blocky, partly calcareous, a few scattered limy nodules27.0

APPENDIX B

Percent Chart of the Insoluble Residue of the Pleasanton Group

“Flaggy” Limestone Facies

Sample Location	Total Fraction		Coarse Fraction		Fine Fraction	
	Grams	Percent	Grams	Percent	Grams	Percent
32-1	2.79	6.9	1.02	2.6	1.77	4.3
32-2	2.74	6.8	0.50	1.3	2.24	5.5
32-3	3.90	9.7	0.63	1.6	3.27	8.1
34-1	2.33	6.6	0.72	1.8	1.61	4.8
34-2	1.80	4.5	0.56	1.4	1.24	3.1
34-3	3.01	7.7	0.76	1.8	2.25	5.9
36-1	2.22	5.5	0.85	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	0.60	1.5	2.61	6.6
37-2	3.70	9.3	0.65	1.6	3.05	7.7
37-3	3.73	9.3	0.78	1.9	2.95	7.4

Gray Shale Facies

Sample Location	Total Fraction		Coarse Fraction		Fine Fraction	
	Grams	Percent	Grams	Percent	Grams	Percent
38-1	4.57	11.4	0.85	2.1	3.72	9.3
38-2	4.67	11.7	0.66	1.6	4.01	10.1
40-2	4.76	11.9	0.87	2.1	3.89	9.8
41-1	2.91	7.3	0.15	0.4	2.76	6.9

Note: All examples 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 is the sample number where 1 is the upper part, 2 the middle part and 3 the lower part.

APPENDIX C

Constituents of the coarse fraction of the insoluble residue of the Pleasanton Group

“Flaggy” Limestone Facies

32-1:	96% Silt and Clay	3% Pyrite	Trace Muscovite Trace sponge spicules
32-2:	97% Silt and Clay	3% Pyrite	
32-3:	99% Silt and Clay	Trace Pyrite	
34-1:	99% Silt and Clay	Trace Pyrite	
34-2:	97% Silt and Clay	2% Pyrite arenaceous foram fragments	Trace Muscovite
34-3:	100% Silt and Clay		
36-1:	98% Silt and Clay	2% Pyrite	
36-2:	99% Silt and Clay	Trace Pyrite	Trace Quartz grains
36-3:	99% Silt and Clay	Trace Pyrite	Trace Muscovite
37-1:	95% Silt and Clay	4% Pyrite arenaceous foram fragments	Trace Muscovite
37-2:	99% Silt and Clay	1% Pyrite	
37-3:	98% Silt and Clay	2% Pyrite	

Gray Shale Facies

38-1:	97% Silt and Clay	3% Pyrite	
39-2:	98% Silt and Clay	2% Pyrite	
40-2:	97% Silt and Clay	3% Pyrite	
41-1:	100% Silt and Clay		

APPENDIX D

Percent Chart of Size Analysis

Samples by Weight Retained per fraction: "Knobtown" Sandstone

Sample No.	½ to ¼ mm	¼ to 1/8 mm	1/8 to 1/16 mm	< 1/16 mm
1-2	2.0	32.1	35.0	30.0
8-4		8.9	50.8	40.3
11-1	4.0	47.9	28.0	20.1
11-2	2.1	50.0	26.0	21.9
15-1	3.1	31.0	40.1	25.8
15-2		30.6	30.0	39.4
18-1		16.6	54.6	28.8
18-2		19.5	43.0	37.5
18-5	2.0	15.5	44.0	38.5
19-1	2.6	18.9	29.8	48.7
21-3		30.3	30.1	37.6
21-4	1.0	18.5	37.0	43.5

Samples by Accumulate Retained: "Knobtown" Sandstone

Sample No.	½ to ¼ mm	¼ to 1/8 mm	1/8 to 1/16 mm	< 1/16 mm
1-2	2.0	34.1	69.1	100
8-4		8.9	59.7	100
11-1	4.0	51.9	79.9	100
11-2	2.1	52.1	78.1	100
15-1	3.1	34.1	74.2	100
15-2		30.6	60.6	100
18-1		16.6	71.2	100
18-2		19.5	62.5	100
18-5	2.0	17.5	56.5	100
19-1	2.6	21.5	51.3	100
21-3		30.3	60.4	100
21-4	1.0	19.5	56.5	100

Samples by Weight Retained per fraction: Helper Sandstone

Sample No.	½ to ¼ mm	¼ to 1/8 mm	1/8 to 1/16 mm	< 1/16 mm
14-1	2.6	71.4	14.9	11.1
14-2	1.6	75.0	12.2	11.2
17-1	2.1	73.4	15.4	9.1
17-2	2.0	63.5	21.2	13.3
19-1	2.2	50.7	39.1	8.0
19-2		42.1	42.4	15.5
30-1	2.5	35.5	48.8	13.2
30-2	2.0	46.2	42.1	9.7
42-1	2.0	42.0	40.4	15.6

Samples by Accumulate Retained: Helper Sandstone

Sample No.	½ to ¼ mm	¼ to 1/8 mm	1/8 to 1/16 mm	< 1/16 mm
14-1	2.6	76.0	88.9	100
14-2	1.6	76.6	88.8	100
17-1	2.1	75.5	90.9	100
17-2	2.0	65.5	86.7	100
19-1	2.2	52.9	92.0	100
19-2		42.1	84.5	100
30-1	2.5	38.0	86.8	100
30-2	2.0	48.2	90.3	100
42-1	2.0	44.0	84.4	100