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GEOLOGY OF EASTERN FRANKLIN COUNTY, KANSAS

By

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by

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For the Department

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ABSTRACT

The bedrock cropping out in eastern Franklin County, is of Pennsylvanian age. Younger rock of Tertiary (?) and Quaternary age composes the valley-fill material along the major drainage. The rocks are all of sedimentary origin and their areal distribution is shown (Pl. 1).

The limestones are both evenly and irregularly bedded, making prominent east-facing escarpments. The shales are, in most cases, thicker than subjacent and superjacent formations and record both marine and non-marine deposition. The sandstone units are in part much younger than subjacent sediments and in part were deposited conformably. These sandstone units are interpreted as representing both marine and fresh-water deposition. Two thin coal seams are exposed. The valleys of the area are filled with alluvium, some of which is chert gravel, ranging from granule to cobble in size.

The discontinuous nature of the Frisbie limestone, the absence of the Quindaro shale, the discontinuous nature of the Island Creek shale, and the lenticular nature of the Farley limestone make recognition and correlation of parts of the Wyandotte formation in eastern Franklin County difficult. Sinkholes have developed near the town of Lane due to subsurface solution of the Argentine limestone.

The limestone formations of the area, with the exception of the Stanton formation appear to be genetically related units. The Stanton formation is divided by a disconformity between the Stoner limestone and the Rock Lake shale members. This indicates that the two upper members of the Stanton formation should not be included in the same megacyclic

sequence as the lower three members, since the word megacyclothem implies a genetic relationship. The shale formations show greater variation and their genetic relationships are not as readily discernable as those of the limestone formations.

The shale formations of the area exhibit radical thickness changes in short lateral distances. These shale formations are practically barren of fossils.

The lowermost member of the Plattsburg formation, the Merriam limestone, is an atypical "middle" type limestone in three-fourths of the available outcrops of eastern Franklin County.

A detailed regional study of the possibility of a disconformity at the top of the Spring Hill limestone should be conducted.

The geomorphology of the area is discussed with evidence for late Kansan terracing along the Marais des Cygne River valley stressed.

The natural resources of the area include soils, limestone and gravel, oil, ground water, and shale.

INTRODUCTION

Location

The location of the area considered in this report is shown on the index map (Fig. 1). The area is bounded on the north by the Douglas-Franklin County line, on the east by the Franklin-Miami County line, on the south by the Anderson-Franklin County line, and on the west by combined U.S. Highways 50 and 59.

Geography

Franklin County was established in 1855, organized in 1857, and as a result of the Wyandotte Constitutional Convention in 1859 became by law a political subdivision of Kansas. Franklin County has an area of 577 square miles (Schoewe, 1948, p. 273) of which the geology of 259 square miles is considered in this report.

The largest city in the area is Ottawa, with a population in 1955 of 10,570. Wellsville, with a population of 888, Lane, with a population of 251, and Rantoul, with a population of 189, are other towns in the area.

With rare exception, well-rocked county roads traverse the area making it easily accessible.

Purpose

It is planned that the results of this study will be combined with those of others to form a geologic report on Franklin County, for

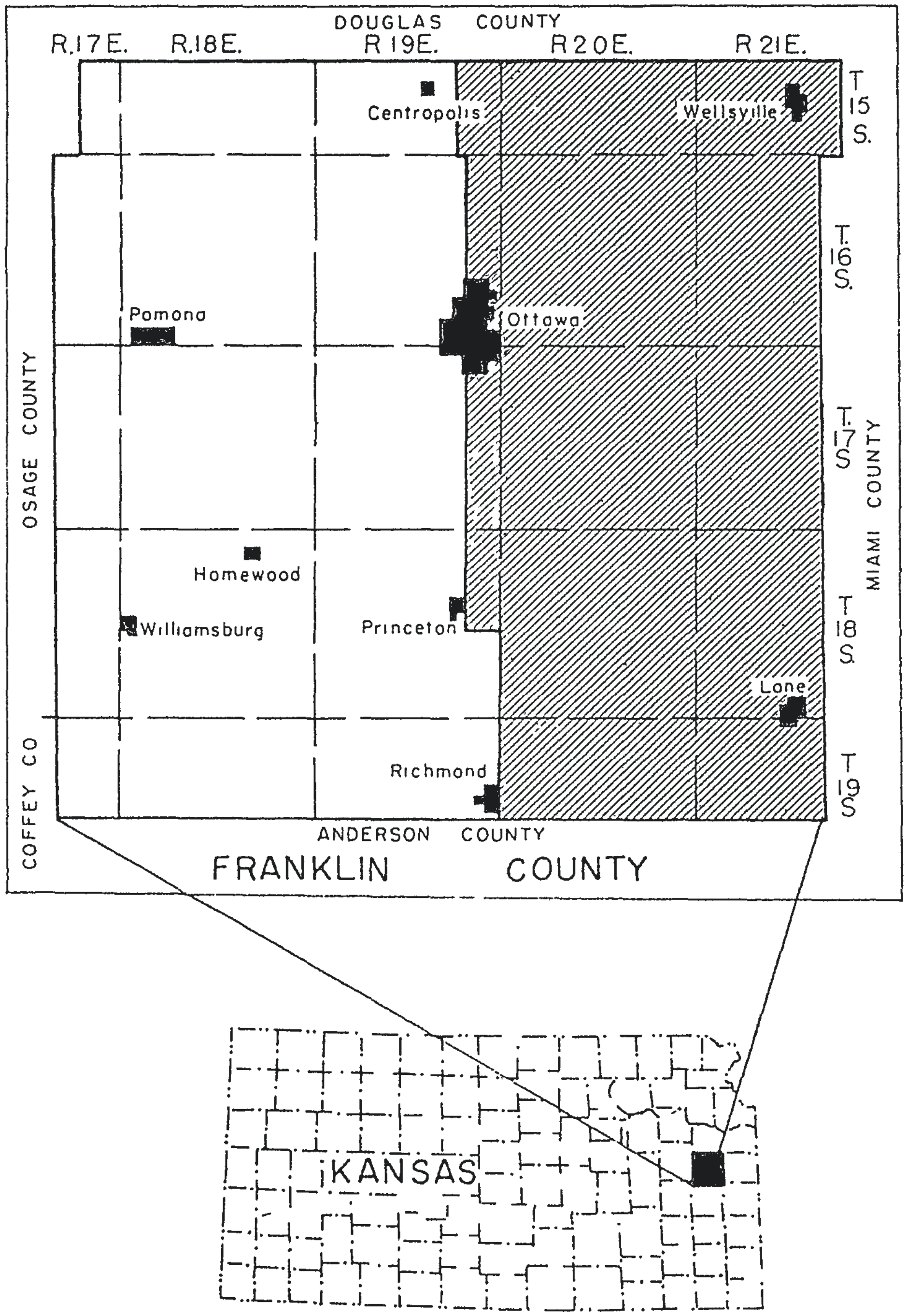


FIG. 1. Index map of Franklin County. Enlargement shows the location of the area covered by the report.

publication by the State Geological Survey. This report will be included in a long range project of the State Geological Survey of Kansas for similar reports on various counties in Kansas.

Methods

Field investigations were conducted from July, 1956 to June, 1957. Mapping was done on U.S. Geological Survey Wellsville NE, Wellsville NW, and Ottawa NE, Kansas quadrangle maps (scale 1:24000); and on U.S. Department of Agriculture aerial photographs (scale 1:21, 120). A base map which was made by the U.S. Soil Conservation Service, was used. Geology was transferred to the base map by use of a focalmatic projector. No corrections for distortion due to parallax or tilt were made.

Consideration of positioning in sequence proved the most feasible means of correlating units within the area. The use of lithology for correlative purposes was exercised with care. Detailed columnar sections were measured using a Locke level and 6-foot steel tape. Where intervals could not be measured in this manner; an alidade, plane table, and stadia rod were used. Rock samples were taken, the limestones were etched, and peels were prepared. Photomicrographs of the peels, field pictures, and pictures taken in the laboratory were used as an aid to detailed study. Laboratory and library investigations supplemented field investigations.

Previous Work

A number of articles were written before 1920 that were highly generalized and have no detailed application to this study. However, reading these articles supplied an insight as to the stratigraphic problems to be expected. Haworth and Kirk (1895) and Adams (1898) conducted regional geologic studies on the Pennsylvanian rocks of Kansas. Haworth (1900 and 1902) conducted more detailed studies on particular phases of Kansas geology.

Detailed studies of rocks belonging to the Pennsylvanian System in eastern Kansas were made by Moore (1932, 1936, 1941, 1949), Jewett (1949, 1951, 1954), and Newell (1935, 1942). These works are significant among those studies completed since 1920 and proved of great value to this study. Other works which were particularly useful were by Moore, Frye, and Jewett (1944) and by Moore, Frye, Jewett, Lee, and O'Connor (1951).

Unpublished manuscripts of Master's theses by J. Laughlin (1957) and M.M. Ball (1957) and a reconaissance geologic map of Franklin County in unpublished form by Newell (1931) were useful guides.

Acknowledgments

Dr. H.A. Ireland of the Department of Geology supervised the graduate work involved in this study. Special thanks are due him. I wish to thank especially Dr. J.M. Jewett of the Kansas State Geological Survey who gave willingly of his time by accompanying me into the field and through personal communication gave me an insight as to the regional relationships of the strata studied.

Mr. Mahlon M. Ball, my brother, is thanked for invaluable field assistance. I wish to thank also Mr. Robert Kulstad, Mr. Howard O'Connor, and Mr. Dwight Laughlin for their field assistance; Mr. Gary Lane for suggestions concerning the preparation of acetate peels; the Kansas State Geological Survey for monetary assistance, the use of survey equipment, access to unpublished files, and the use of other survey materials. Mr. A.C. Carpenter kindly loaned me a vertebrate fossil taken from an excavation in Ottawa. Mr. Halsey Miller gave of his time in identifying this vertebrate fossil.

Thanks are due Mrs. Sally Asbury, Mrs. Joan Marsh Smith, and Mrs. Margaret Buie for the drafting; and Mrs. Artis Ball, my wife, for typing the manuscript.

GEOMORPHOLOGY

General Statement

The area makes up a small part of the Osage Cuesta physiographic unit of Kansas (Fig. 2). With an average annual precipitation of 36 inches and an annual mean temperature of 56 degrees (Bidwell, 1956, pp. 4-5), the area falls into the Moderate Morphogenetic Regime.

Drainage

The principal stream draining the area is the Marais des Cygnes River and its principal tributaries are Ottawa Creek, Middle Creek, Hickory Creek, Turkey Creek, and Pottawatomie Creek. The last named becomes tributary to the Marais des Cygnes River east of the area near Osawatomie in Miami County. Marais des Cygnes River flows in a well-defined valley which ranges in width from one-eighth to $3\frac{1}{2}$ miles. The river gradient is approximately 1.6 feet per mile (Kansas State Board of Agriculture, 1945, p. 24). A dendritic drainage pattern has developed on nearly horizontal sedimentary strata. This dendritic drainage pattern is seemingly superposed upon the regional westward and northwestward dipping homoclinal structure. The tributaries to the Marais des Cygnes River are intermittent in their headwater portions.

Land Forms

The character of the land surface is due to the long-continued action of processes still in operation. The topography is gently rolling. The western and north-central portions of the area owe their low relief to the resistance of the Stoner limestone member of the Stanton formation

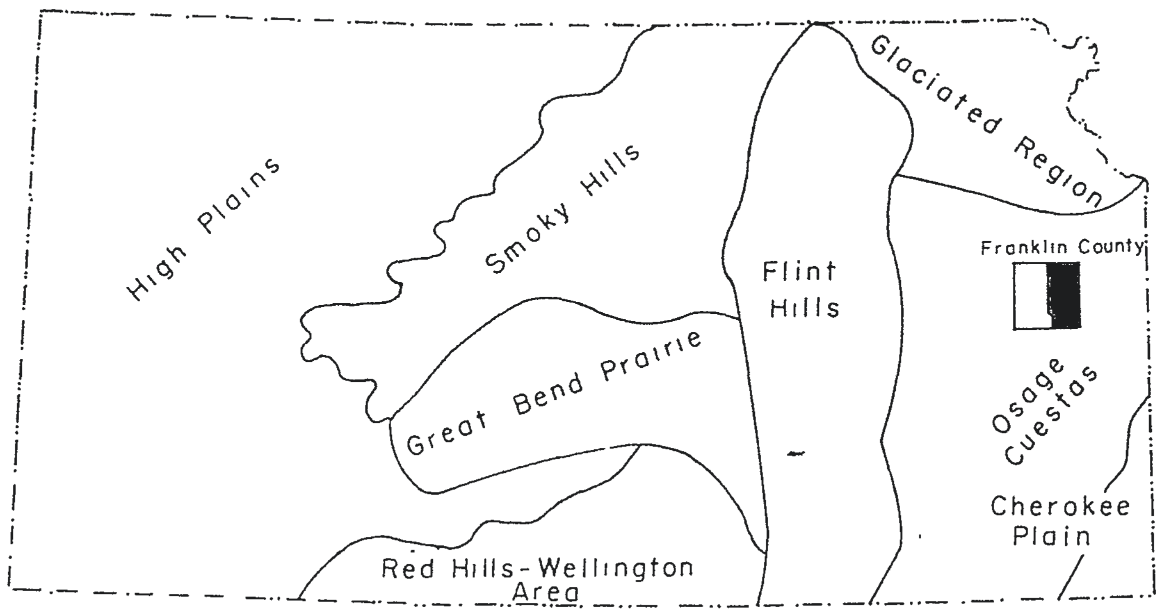


FIG. 2. Map showing the physiographic units of Kansas and the position of the area within the Osage Cuesta physiographic unit.

(see Plate 1 for stratigraphic column). The area of maximum relief is to the southeast where geologic processes have been able to attack thick shale formations. The major valley in the area is the well-defined Marais des Cygnes River valley, which trends southeast. Marais des Cygnes River follows a broadly meandering course throughout this portion of its valley. Four major tributary valleys enter the Marais des Cygnes River valley between Ottawa, Kansas and the Franklin-Miami County line. These tributary valleys are cut by Ottawa Creek, Middle Creek, Hickory Creek, and Turkey Creek. The valley carved by Pottawatomie Creek cuts the southeast corner of the area. Meanders and meander scars are characteristic.

Terrace development has occurred at three levels along this segment of the Marais des Cygnes River valley. These terraces are interpreted as of late Wisconsinan (?) age; late Kansan age; and pre-glacial, late Tertiary(?) or Nebraskan(?) age, respectively. The interpreted age of the late Kansan terrace is based on its corresponding altitude to the Menoken terrace along the Kansas River near Lawrence (Davis and Carlson, 1952, pp. 211-213) and the age of a Pleistocene horse tooth (Fig. 3) taken from the fill that composes this terrace. The terrace of late Wisconsinan(?) age, although fairly well developed in portions of the valley, is part of the floodplain complex in this segment of the valley. Only sparse scatterings of the pre-glacial(?) or Nebraskan(?) gravels are found in the area, but gravel pits in this terrace are found in western Franklin County (Laughlin, 1957, p. 35).

Isolated outliers of Pennsylvanian bedrock occur at various points along the valley. Natural levees can be seen in three places as

FIG. 3. Denture pattern of tooth of Equus (Plesippus) simplicidens Cope. (X 3.0)

shown on Figure 4. Stream-cut cliffs occur on the outsides of meander bends.

The Wyandotte formation is characterized by many solution cavities that have resulted in the formation of sinkholes. These sinkholes are well expressed topographically in the NEc sec. 9, T. 19 S., R. 21 E.

Erosional and Depositional History

The annual rainfall in the area has been sufficient to maintain a dense drainage texture, but insufficient to support a thick vegetal cover. This has resulted in well-developed dissection of the outcropping rock. The Iola, Argentine, Merriam, Spring Hill, Captain Creek, and Stoner limestones (Plate 1) have formed prominent escarpments. This can be attributed to the resistance, thickness, and the sequential position of these units. The Haskell limestone which might be expected to form a prominent scarp does not. This is due to sandstone bodies which overly and underly the Haskell, and are nearly as resistant and much thicker than the limestone causing a rolling hill topography to develop which masks the Haskell outcrop. This combination of conditions eliminates any possible chance for a prominent Haskell scarp.

The segment of the Marais des Cygnes River valley here considered has been filled and reexcavated several times. The valley-fill material consists of clay, silt, and sand with lesser amounts of gravel, principally chert, and some rock fragments ranging from granule to pebble, and rarely cobble in size. Removal of the alluvial, or fill-material, at the various times of reexcavation has been incomplete leaving

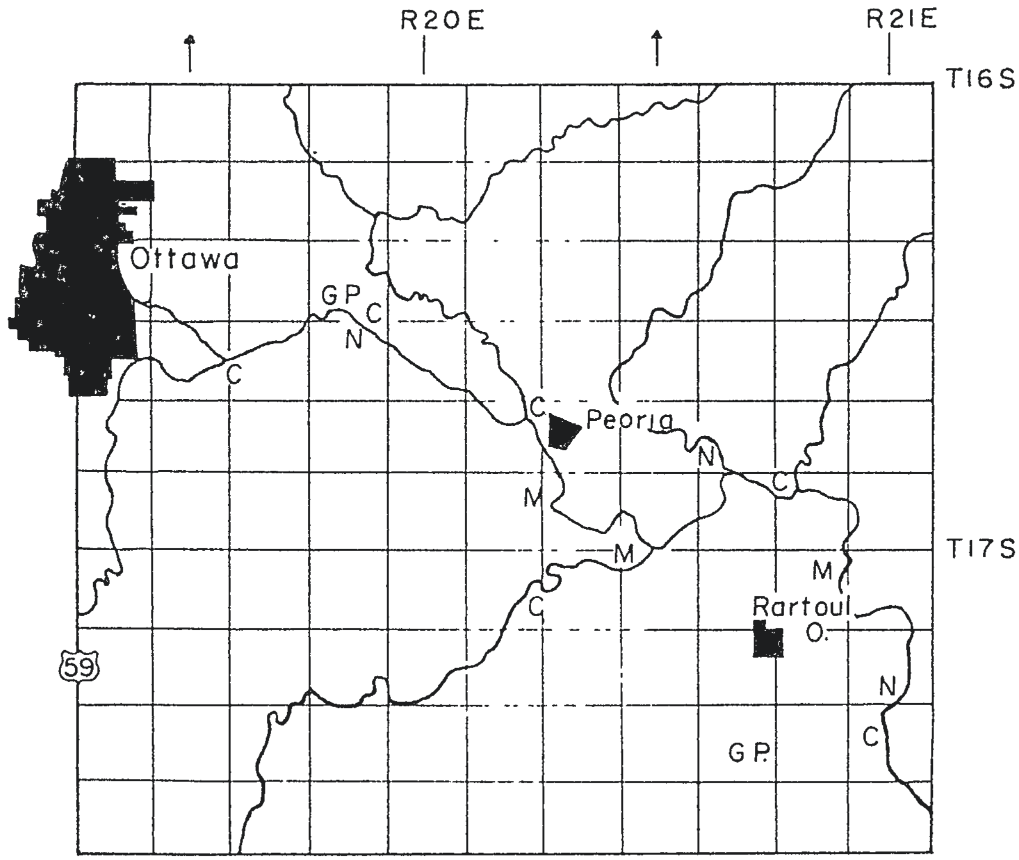


FIG. 4. Locations of Land Forms within the area.
C-cliffs.
G.P.-gravel pits.
M-meander scars.
N-natural levees.
O-outliers of bedrock.

remnants that are now terraces along the walls of the valley. The most recent deposition of alluvial material in the valley has built the land surface up to a level ranging from about 840 feet to 870 feet above sea level forming the present floodplain. The remnants of the high terrace lie at an elevation ranging from about 900 to 940 feet above sea level. This high terrace is interpreted as late Kansan in age. The Stanton formation holds up this terrace in the western part of the area. The Plattsburg formation supports the terrace in the eastern part of the area. The Flint Hills are believed to be the source of the chert on the basis of the fact that the head-waters of the Marais des Cygne River are located southeast of Eskridge, Kansas in Waubaunsee County. Also, the angularity of the chert particles and their relatively large size preclude a more distant origin. A portion of the chert included in the late Kansan terrace was probably furnished by the reworking of the pre-glacial, late Tertiary(?) or Nebraskan(?) terrace. This is suggested by the lithologic similarity between these two cherts. Remnants of the terrace interpreted as of late Kansan age are shown on Plate 1.

Marais des Cygnes River cuts the present floodplain in a broadly meandering path. On the inside of each of the meanders successively younger material is being deposited as the river carves a cliff into successively older rock on the outsides of the meander bends. This results in an asymmetric valley cross-section. At the present time, the Marais des Cygnes River is slowly entrenching itself into the mature topography of the area and its course is becoming increasingly more sinuous.

STRUCTURAL GEOLOGY

The dominant structural element in the area is the northwestward dipping homocline which results in generally east-facing cuestas along the strike of the rocks. Superimposed upon this structure are numerous small folds and broad flexures which are believed to be the result of differential compaction associated with silty shale formations. The uneven stratification caused by these folds and flexures is well displayed in quarry floors of the Argentine limestone in the vicinity of Lane, Kansas. Subsurface solution and resultant slumping of overlying material have produced a number of sinks or sinkholes in the vicinity of Lane. The best example is in the NEc sec. 9, T. 19 S., R. 21 E. The regional dip of the area is from 10 to 30 feet per mile. Anomolous dips in some of the shale formations are the result of differential compaction phenomena or deltaic deposition.

STRATIGRAPHY

General Statement.--Only beds of Pennsylvanian and Quaternary age crop out in eastern Franklin County. All of the approximately 450 feet of bedrock exposed is of Pennsylvanian age. Disconformities exist locally at the top of the Spring Hill limestone, at the top of the Stoner limestone, at the base of the Stranger formation, and at the base of the Lawrence formation. Many of the sharp contacts between the different lithologies in the column could conceivably be interpreted as representing hiatuses. However, most of these contacts can be interpreted as recording changes in the chemical and depositional conditions within the basin.

The following portion of this report concerns the detailed description of the lithology of the strata exposed. The classification of Moore et al is used. All descriptions pertain to the area of study.

Missourian Series

Kansas City Group

Iola formation.--

Iola formation consists of two limestones and one shale. In ascending order these units are the Paola limestone, the Muncie Creek shale, and the Raytown limestone. Only the youngest member of the formation, the Raytown limestone, crops out in eastern Franklin County.

Raytown limestone member.--The Raytown limestone (Hinds and Greene, 1915, p. 27) is the oldest unit cropping out in the area. This limestone ranges from gray to brown on the fresh surface and weathers buff. The bedding is thin and wavy. The texture is fine-grained and compact with abundant veinlet fillings of crystalline calcite. Punctospirifer and Lophophyllidium were identified. Fenestrate bryozoans, echinoid spines, crinoid columnals, and fragments of brachiopods occur. Foundations of many of the buildings in the town of Lane rest on the Raytown limestone. The average thickness is approximately 9 feet.

Lane formation.—

The Lane formation (Haworth and Kirk, 1895, p. 277) is predominantly shale with sparse limestone concretions in the lower 20 feet and siltstone in the upper 15 feet. The formation is varicolored. The lower 25 feet is composed of green, flaky shale. The superjacent 20 feet is a gray to blue upward, silty, flaky to blocky shale. Tan shale grading upward into siltstone with recognizable plant remains comprise the upper 25 feet. Best exposures are near the town of Lane, which is the type locality, in the southeast corner of the area. The average thickness of the formation is approximately 70 feet.

Wyandotte formation.--

The Wyandotte formation consists of three limestones and two shales. In ascending order these members are the Frisbie limestone, the Quindaro shale, the Argentine limestone, the Island Creek shale, and the Farley limestone. In eastern Franklin County, the Quindaro shale is absent and the Island Creek shale and the Farley limestone are erratic occurring only at random.

Frisbie limestone member.—The Frisbie limestone (Newell, in Moore, 1932, p. 92) where exposed in eastern Franklin County, is chocolate brown on both the fresh and weathered surfaces. It is a single, thick, well delineated bed. The surface texture is characterized by abundant crystalline calcite scattered in a fine-grained matrix (Fig. 5). The fauna includes the brachiopod genera, Enteletes and Linoproductus; the coral, Lophophyllidium; and robust Triticites. The flora is represented by Osagia. The average thickness is approximately 3 feet.

Quindaro shale member.--This member is missing in eastern Franklin County. At the only locality (cen. W line sec. 10, T. 19 S., R. 21 E.) where the Frisbie limestone can be positively identified it is in contact with the overlying Argentine limestone. This is only one of the anomalies exhibited by the extremely erratic Wyandotte formation in the area. The Argentine limestone is the only unit of the Wyandotte formation which is well-developed through-out the area. The Island Creek shale and the Farley limestone are discontinuous.

Argentine limestone member.--The Argentine limestone (Newell, in Moore, 1932, p. 92) is brown to gray to white upward on the fresh surface and weathers buff. This unit is thin to thick and irregularly bedded. The compact matrix of the rock is interrupted by abundant veinlet fillings of crystalline calcite and sparse limonite cavity filling. Profuse linear algae and Enteletes dominate the flora and fauna respectively. Dictyoclostus, Derbyia, Echinoconchus, Linoproductus, Marginifera, Neospirifer, Rhipodomella, sparse Triticites, fenestrate bryozoan, and crinoid remains are represented. The above description makes the Argentine limestone a typical "upper" type limestone in eastern Franklin County. Elliptical chert nodules 2 inches to 1 foot in long dimension and 2 to 8 inches in short dimension occur at some localities (Fig. 6). This unit has been extensively quarried in the vicinity of Lane. Sinkholes at the surface attest to the cavernous character

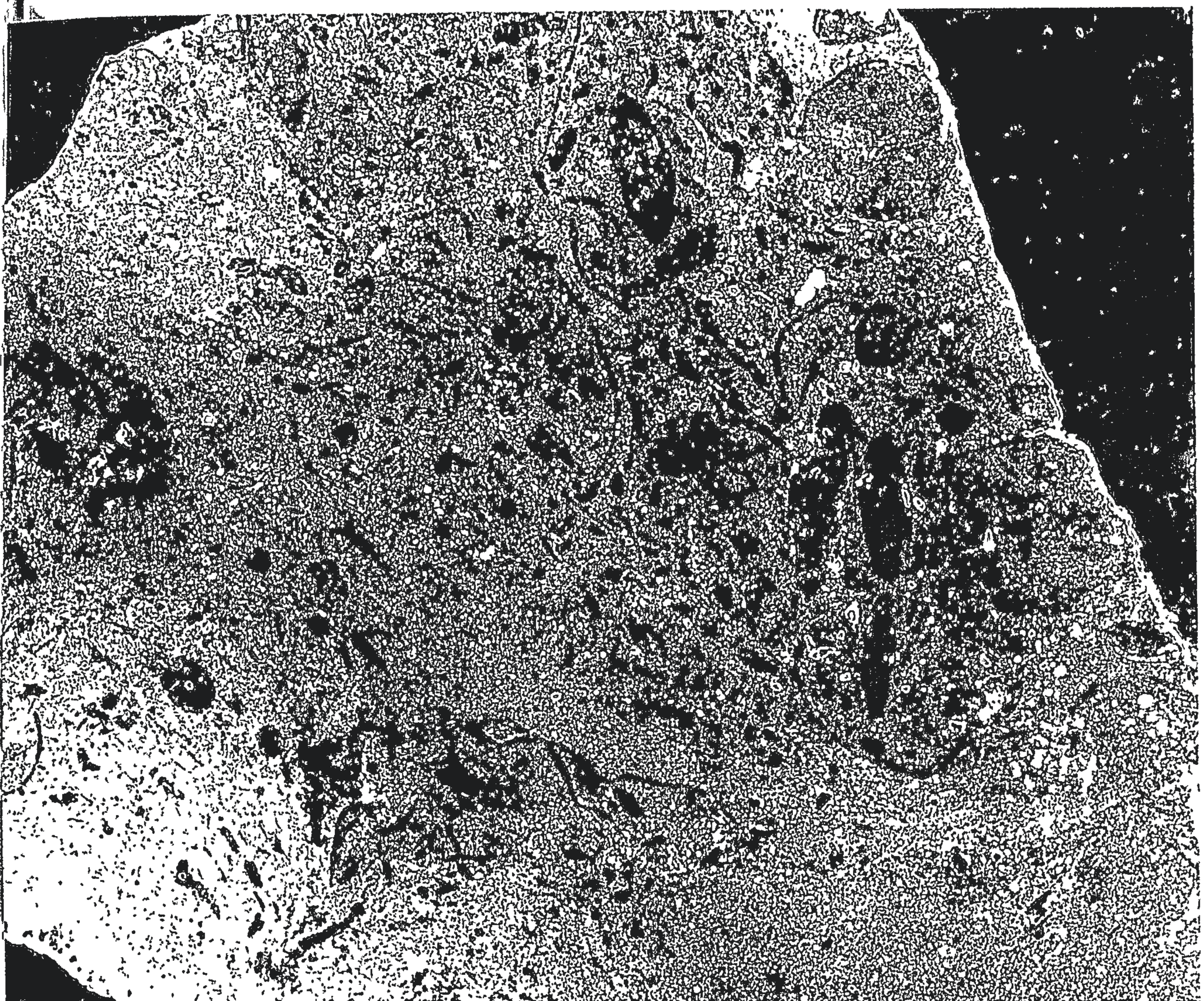


FIG. 5. Peel print of the Frisbie limestone (X4.0). Note extremely fine texture and scattered fusulinids in this compact limestone. Sample taken near the cen. W line sec. 10, T. 19 S., R. 21 E.

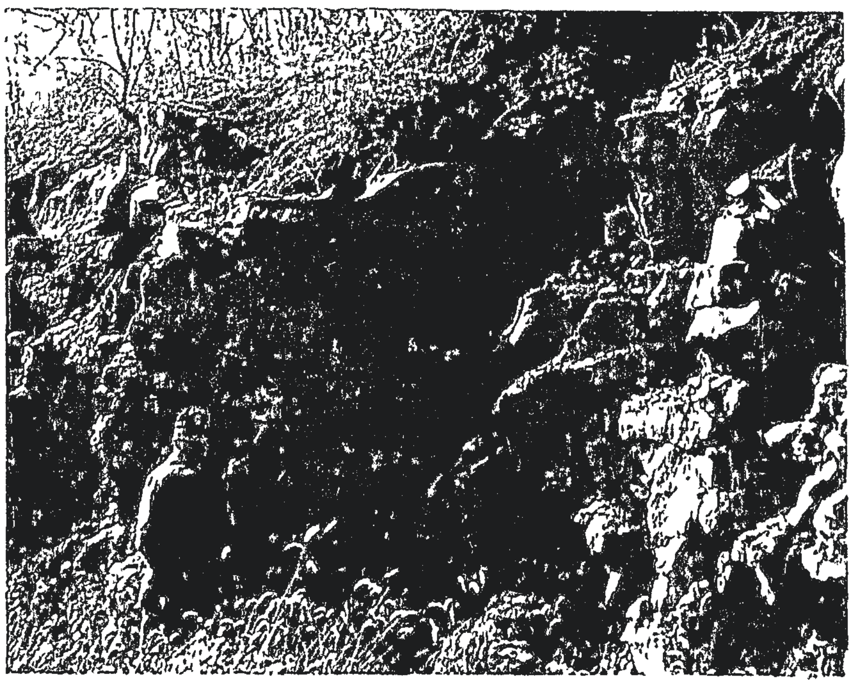


FIG. 6. Argentine limestone member showing its thin, wavy bedding with chert nodules. Picture looking east in the SEc sec. 8, T. 17 S., R. 21 E.

of the limestone and its susceptibility to solution by ground water. The average thickness is approximately 27 feet.

Island Creek shale member.--The Island Creek shale (Newell, in Moore, 1932, p. 92) is represented at only one outcrop (D, Pl. 3). Here it is 14 feet of tan, silty shale and siltstone. No fossils were observed.

Farley limestone member.--The Farley limestone (Newell, in Moore, 1932, p. 92) is equally as discontinuous as the underlying Island Creek shale. It is seen at only two localities where it exhibits strikingly different facies. At locality B, (Pl. 3), the upper part of the Farley is lithologically similar to the Argentine limestone but the lower part is 2.2 feet of fossiliferous conglomerate (Fig. 7). The Island Creek shale is absent at this locality. At locality D, (Pl. 3), the Farley limestone is gray to brown on the fresh surface and weathers yellow to brown. The bedding is thin with poorly developed cross-bedding. The surface texture exhibits the detrital nature of the rock. Crinoid and bryozoan remains dominate the fauna. Sparse Triticites were observed (Fig. 8) along with sparse foraminifers and sparse ooliths. Composita and Neospirifer are representative brachiopods. The average thickness is approximately 5 feet.

Bonner Springs formation.--

The Bonner Springs formation (Newell, in Moore, 1932, p. 93) ranges radically in thickness within short distances. Where thickest this formation consists of a basal arenaceous zone of silty shale and siltstone to fine sandstone beds. Overlying this is a clay shale and tan silty shale zone capped at some localities by a zone of maroon shale, overlain by an arenaceous, nodular, "boxwork", limestone. This in turn is overlain by a sparsely fossiliferous limy yellow shale near the Merriam limestone

FIG. 7. Peel print of the lower part of the Farley limestone (X3.0). The white portions of this conglomerate are limonite and the gray portions are limestone. Sample taken near the cen. W line sec. 10, T. 19 S., R. 21 E.

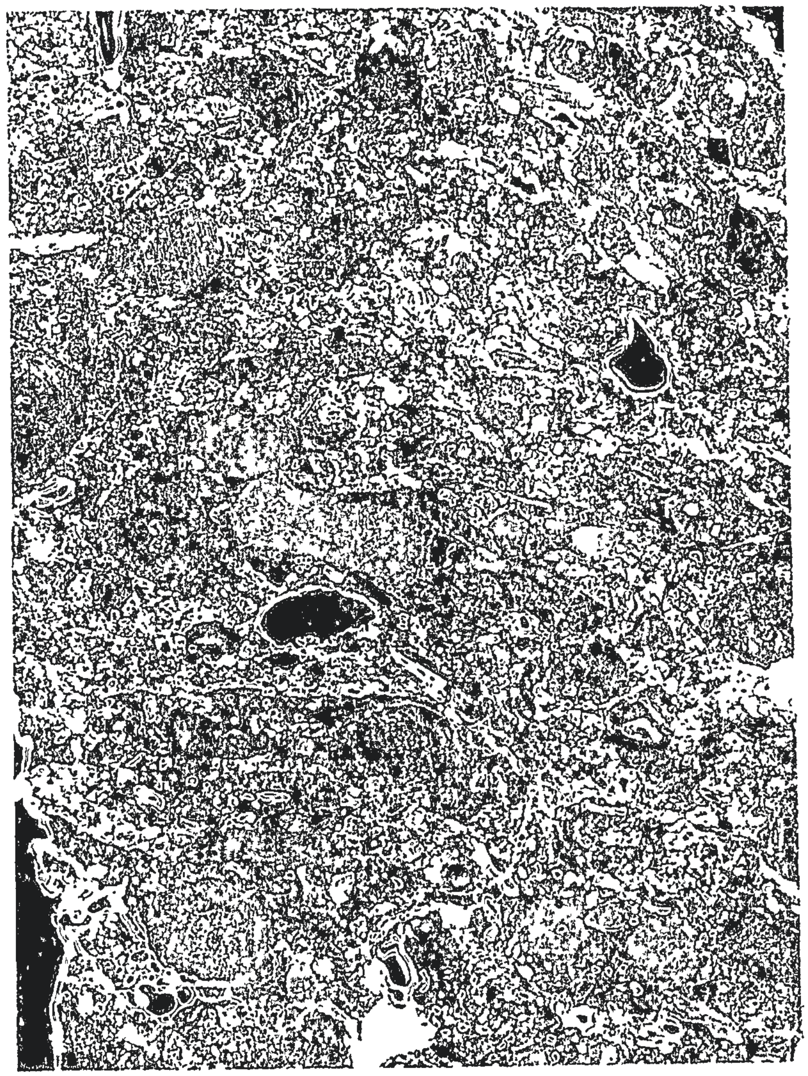


FIG. 8. Peel print of the Farley limestone (X5.0). Note the predominance of crinoid remains. Sample taken near the SWc sec. 36, T. 18 S., R. 20 E.

contact. Pelecypod, crinoid, and brachiopod remains were found at this horizon. The thickness ranges from 2.5 to 54 feet.

Lansing Group

Plattsburg formation.--

The Plattsburg formation contains two limestone members and one shale member. In ascending order these members are the Merriam limestone, the Hickory Creek shale, and the Spring Hill limestone.

Merriam limestone member.--The oldest member of the Plattsburg formation was designated Merriam by Newell (in Moore, 1932, p. 93). This rock exhibits two facies. One facies is gray on the fresh surface and weathers brown. Two or three well defined beds are characteristic. This fine-grained compact rock contains crystalline calcite, sparse ooliths, sparse foraminifers, and sparse *Triticites*. Fragments of planispiral gastropods, fenestrate bryozoan, *Lophophyllidium*, and crinoid remains are common. The characteristic faunal feature of this facies is a prominent *Composita* and *Myalina* zone in the lower part. This is a typical "middle" type limestone of Moore (1936, p. 129) in its upper part.

The facies more common to eastern Franklin County is gray to brown on both fresh and weathered surfaces. The bedding is thin and well-developed cross-bedding is common (Fig. 9). This facies is a microcoquina or spergenite of foraminifers, fusulinids, and sparse ooliths cemented by clear calcite (Fig. 10). *Osagia*, *Lophophyllidium*, coiled gastropods, and echinoid spines occur. The *Composita* and *Myalina* zone persists. Where the subjacent Bonner Springs formation is

FIG. 10. Peel print of the Merriam limestone (X3.0). Note foraminifers, Osagia, Triticites, and cross-section through large Myalina shell. Sample taken in the SEc sec. 35, T. 18 S., R. 20 E.

extremely thin, the lower portion of the Merriam limestone is composed of a shaly shell and limestone breccia with fragments of clams, brachiopods, crinoids, fenestrate bryozoan, and the gastropod, Bellerophon occurring. This breccia averages 2.0 to 3.0 feet in thickness. This facies is strikingly atypical and more closely resembles Moore's "super" type limestone (1936, p. 27). The average thickness is 5.5 feet.

Hickory Creek shale member.--The Hickory Creek shale (Newell, in Moore, 1932, p. 93) is the middle member of the Plattsburg formation. This shale is yellowish and extremely limy. Slender ellipsoidal pieces of limestone arranged parallel to the bedding are common. The shale is fossiliferous, containing poorly preserved remains of bryozoans, crinoids, and brachiopods. The type locality for the trilobite, Ditomopyge lansingensis, Newell (1931, p. 268) is located near the cen. S line sec. 27, T. 16 S., R. 21 E., where Ditomopyge remains are found in the Hickory Creek. The average thickness is 1.1 feet.

Spring Hill limestone member.—The Spring Hill limestone (Newell, in Moore, 1932, p. 93) is the uppermost division of the Plattsburg formation. Three distinct units were noted in the Spring Hill limestone. The lower unit is blue-gray in the lower part to gray in the upper part on the fresh surface and weathers buff. The bedding ranges from thin to thick and is irregular or wavy. The texture is extremely fine-grained and compact with limited crystalline calcite. The fauna is dominated by brachiopods with Composita, Echinoconchus, Enteletes, Derbyia, Dictyoclostus, Dielasma, Juresania, Marginifera, and

Linoproductus represented. The cephalopod, Mooroceras; the trilobite, Ameura; and crinoid remains occur. To the northeast abundant echinoid spines and locally Triticites occur near the top of this unit. The average thickness of this unit is 9.5 feet.

The middle unit of the Spring Hill is gray to brown on the fresh surface and weathers buff. The bedding is thin to thick and irregular. The texture is that of a spergenite cemented by clear carbonate. This unit is arenaceous in its lower part. Foraminifers are dominant although bryozoan, brachiopods, and crinoid fragments are plentiful. Near the top of the unit shell pavement composed of robust Composita occurs (Fig. 11). The average thickness of the unit is 2.5 feet.

The upper unit is gray-blue on both the fresh and weathered surfaces. The bedding is thin to thick and only slightly irregular. The texture is that of a mortar cementing shell fragments (Fig. 12). Allorisma, Aviculopinna, Orthomyalina, and Pseudomonotis are common pelecypods. Fistolipora and Septopora are abundant bryozoan. Flattened Composita are also abundant. A ferruginous weathering rind from a fraction of an inch to as much as 0.5 foot caps this unit, at least locally. Ameura and Ditomopyge trilobites and sparse ostracodes occur in this weathering rind. The average thickness of this unit is approximately 2 feet.

The middle unit of the Spring Hill limestone in eastern Franklin County is foraminiferal with Osagia (Fig. 13), and seemingly it is equivalent to the rock that commonly elsewhere is the uppermost part of the ledge (Moore, 1936, p. 130). The upper unit of the area has

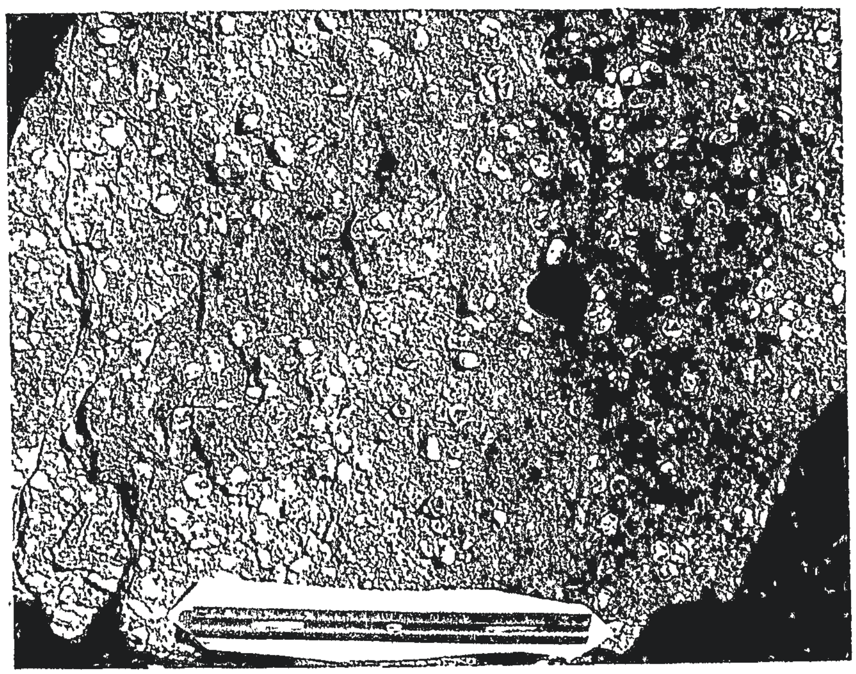


FIG. 11. Shell pavement of robust Composita occuring in the middle unit of the Spring Hill limestone. Picture taken of a slab in a quarry in SW$\frac{1}{4}$ sec. 27, T. 16 S., R. 20 E.

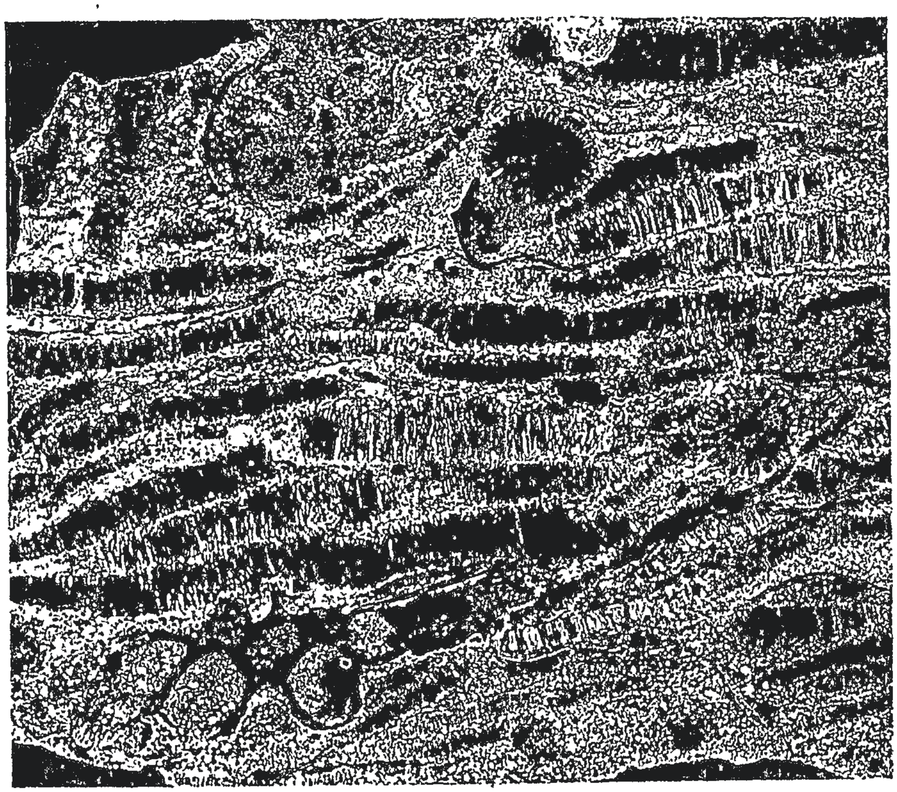


FIG. 12. Peel print of the pelecypod and bryozoan mortar which caps the Spring Hill limestone in the SEc sec. 6, T. 18 S., R. 20 E.

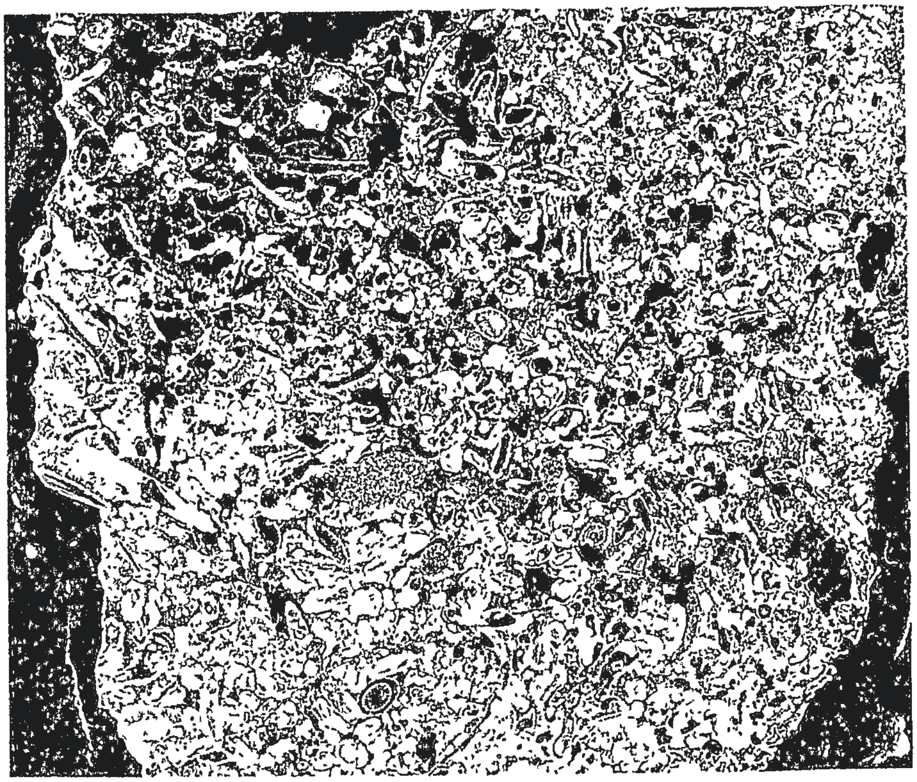


FIG. 13. Peel print of the middle unit of the Spring Hill limestone (X3.0). Note foraminifers, *Osagia*, and sparse ooliths. Sample taken in SEc sec. 6, T. 18 S., R. 20 E.

a prolific clam and bryozoan fauna and seems to be, at least locally, a vertical development in the Spring Hill. The weathering rind capping this unit is regarded as evidence of disconformity. The average thickness of the Spring Hill limestone is approximately 14 feet.

Vilas formation.--

The Vilas formation (Adams, 1898, p. 96) is the middle unit of the Lansing Group. This formation consists of blocky to flaky shale grading upward from blue to green to gray brown. Where the formation is thickest, marine, fresh-water(?), or nodular, impure, "boxwork" limestone facies are associated. The fresh-water(?) limestone C, (Pl. 2) is thin-bedded and contains fossil plant materials near the top. The "boxwork" or punky limestone of locality C, (Pl. 2) is in the same relative position in the Vilas formation as the "boxwork" limestone of the upper part of the Bonner Springs formation especially in places where the Bonner Springs is thickest. The shale is silty and extremely micaceous. The thickness of the Vilas ranges considerably. In places, such as in the Bert Ross Quarry (SWc sec. 6, T. 17 S., R. 20 E.) the Vilas formation consists of 0.9 foot of green clay shale and is much thinner than the Eudora shale member of the Stanton formation. This is an anomolous situation as the Vilas formation is commonly much thicker than the Eudora shale. The average thickness of the Vilas is approximately 19 feet.

Stanton formation.--The Stanton formation contains three limestones and two shales. These members are described in ascending order below.

Captain Creek limestone member.—The lowermost member of the Stanton formation is the Captain Creek limestone (Newell, 1932, p. 76). This member consists of two distinct units. The lower unit is blue gray to brown on fresh surfaces but it weathers yellow brown. The bedding is extremely even (Fig. 14). The texture is fine-grained and compact, causing the rock to be hard and brittle. The fauna consists of sparse foraminifers, crinoid remains, fenestrate bryozoan fragments, Lophophyllidium, Enteletes, and Triticites. The average thickness of this unit is 2.7 feet.

The upper unit of Captain Creek limestone exhibits a characteristic mottling in shades of blue, gray, and brown on the fresh surface (Fig. 15) and weathers gray to buff. The unit is compact, brittle, hard, slightly irregularly bedded, and sparingly fossiliferous. Echinoid and brachiopod remains with abundant algae in the form of Ottonosia near the top make up the fauna and flora. The average thickness of this unit is 4.8 feet.

Eudora shale member.—Between the Captain Creek limestone below and the Stoner limestone above, the Eudora shale (Condra, 1930, p. 12) is extremely persistent. The lower part of this member is black, fissile to platy shale. The upper part is green to gray, flaky, and clayey. The black lower portion contains a conodont fauna with the genera Hindeodella, Idionathodus, Lonchodina, Ozarkodina, and Streptognathodus observed. The inarticulate brachiopods, Lingula and Orbiculoidea also were identified. The upper portion of the shale is seemingly barren of fossils. Carbonate-phosphate nodules are locally abundant in the lower portion. Many

FIG. 14. Captain Creek limestone member showing its unusually well developed even-bedded character. Picture taken looking east in the SW$\frac{1}{4}$ sec. 27, T. 16 S., R. 20 E.

FIG. 15. Peel print of the Captain Creek limestone (X4.0) showing the characteristic mottling of the upper portion. Sample taken in the SW$\frac{1}{4}$ sec. 27, T. 16 S., R. 20 E.

of the nodules which have a high carbonate content and a low phosphate content (personal communication, Russ Runnels, Chemist for the State Geol. Survey) formed around a nucleus of pyrite. The average thickness of this member is 7.2 feet.

Stoner limestone member.--Stoner limestone (Condra, 1930, p. 11) has the widest surface distribution of any unit in the area. Stoner limestone is light blue to gray to white on the fresh surface and weathers buff. The bedding is thin and wavy. In quarry walls, portions of the unit appear plastered, obscuring the true bedding (Fig. 16). The texture is fine-grained with abundant crystalline calcite scattered through the matrix (Fig. 17). The member is sparingly fossiliferous. At some localities Enteletes, and Triticites flourish. Composita, Derbyia, Punctospirifer, fenestrate bryozoan, trilobite pygidia, foraminifers, planispiral gastropods, crinoid remains, and echinoid spines occur sparsely. A disconformity overlies this member. The hummocky top surface of the Stoner limestone and the overlying fine limestone breccia of localities A and H (Pl. 2) indicate disconformity. Post-Iatan erosion, which resulted in the Missourian-Virgilian disconformity, and recent erosion have served to obliterate this disconformity between the Stoner limestone and the Rock Lake shale. Although the Missourian-Virgilian disconformity is not seen in outcrop at a horizon as low as the Stoner limestone, good evidence for it exists in the area. Broad areas of Stoner limestone crop out with little or no evidence of Rock Lake shale and South Bend limestone, pointing to coalescense of the

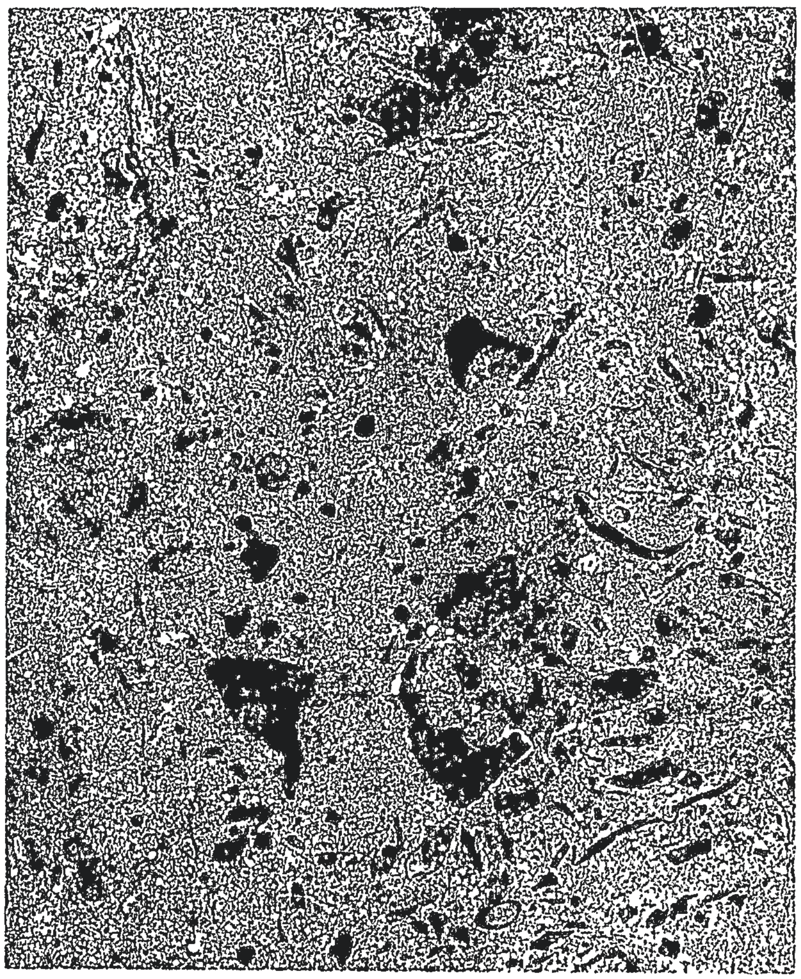


FIG. 16. Peel print of the Stoner limestone (X2.5). Note the extremely compact texture of this limestone and the tiny spired gastropod at the lower center. Sample taken near cen. W line sec. 28, T. 17 S., R. 20 E.

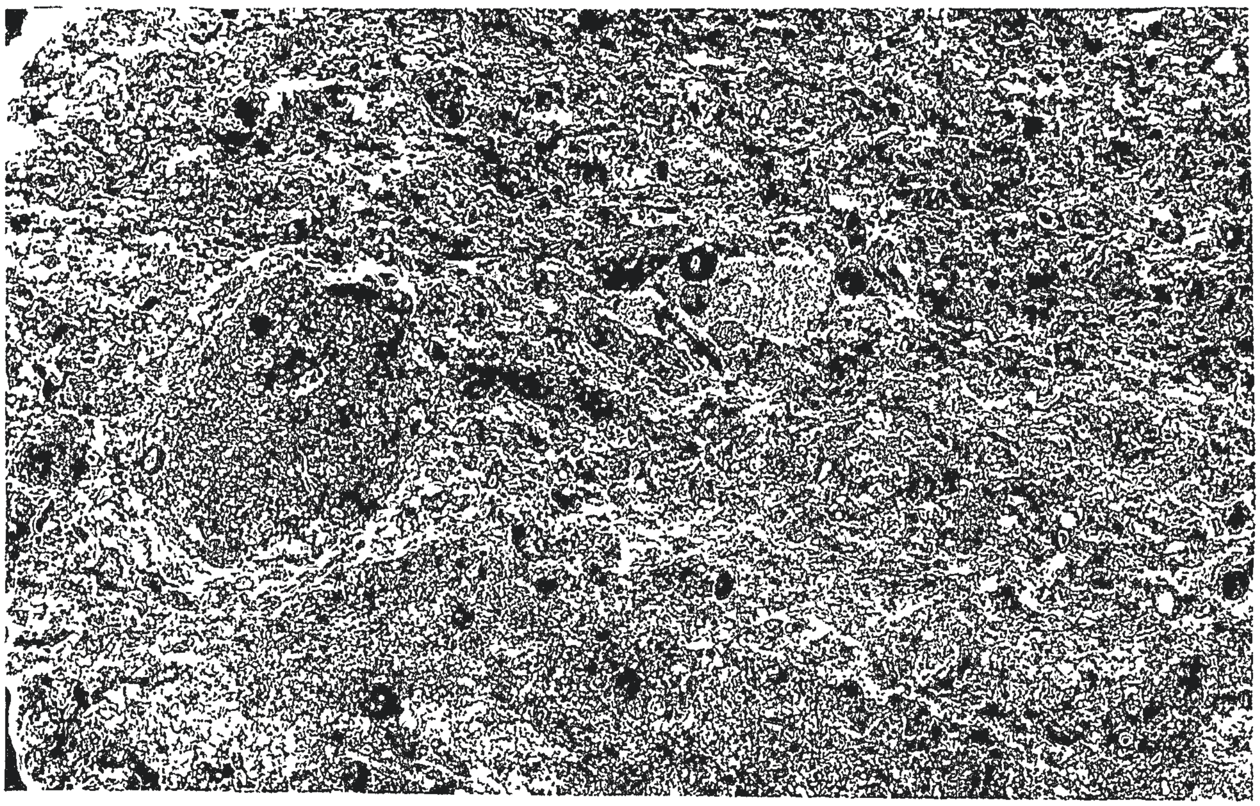


FIG. 17. Peel print of the upper portion of the fine, limestone breccia overlying the disconformable surface at the top of the Stoner limestone. The several large, irregular, gray patches are limestone fragments in a finer matrix. Sample taken near the cen. E line sec. 23, T. 18 S., R. 19 E.

Missourian-Virgilian and Stoner-Rock Lake disconformities. This Stoner-Rock Lake disconformity is easily traceable in several northeast Kansas counties. The results of a regional study of this disconformity will appear in a future State Geological Survey publication. The average thickness is approximately 18 feet.

Rock Lake shale member.--For descriptive purposes the Rock Lake shale (Condra, 1927, p. 59) contains three persistent units and locally a coal seam in eastern Franklin County. The lower unit is an unbedded mortar-like breccia with the texture of cement. In the lower 0.5 foot angular limestone fragments one-eighth to one inch across occur (Fig. 18). Above this breccia of limestone and shell fragments the bed is a mortar cementing foraminifers and abundant shell fragments. *Aviculopinna*, *Bellerophon*, *Worthenia*, *Neospirifer*, and *Composita* are locally abundant. The bottom of the bed is hummocky and overlies a disconformity. The average thickness is approximately 1.6 feet.

The middle unit is a nodular, impure facies in some places and a good limestone in others. It is gray to brown on the fresh surface and weathers buff. Where it is highly nodular and impure, it is seemingly unfossiliferous. Where it is a good limestone facies, it is wavy-bedded and contains a good fauna. *Aviculopinna*, *Dictyoclostus*, *Linoproductus*, *Neospirifer*, crinoid remains, and trilobite pygidia are found. The average thickness is approximately 2 feet.

The upper unit of Rock Lake shale grades upward from green to brown to gray, blocky, clay shale which locally contains a 1 inch

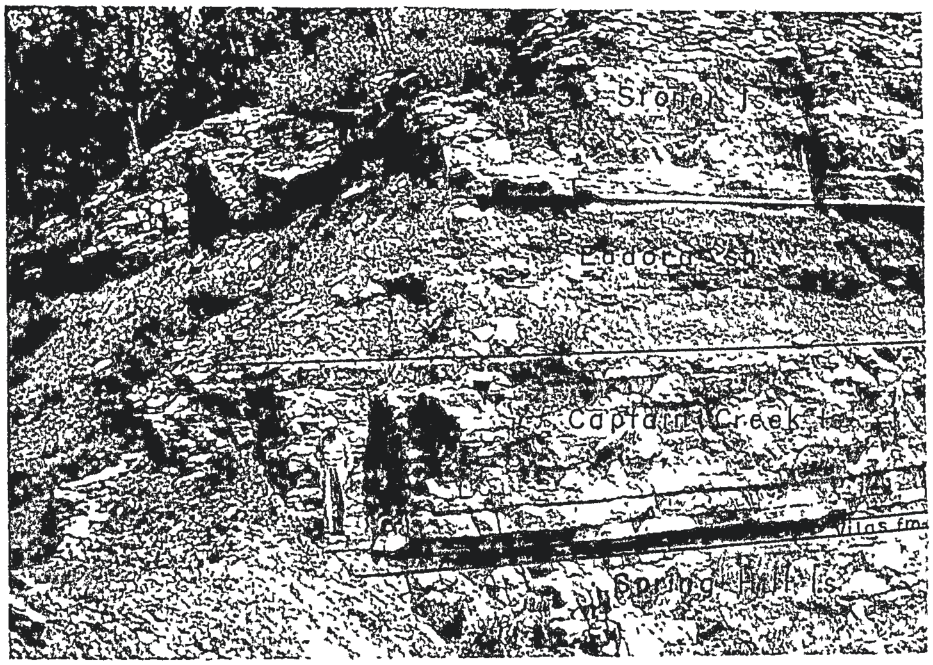
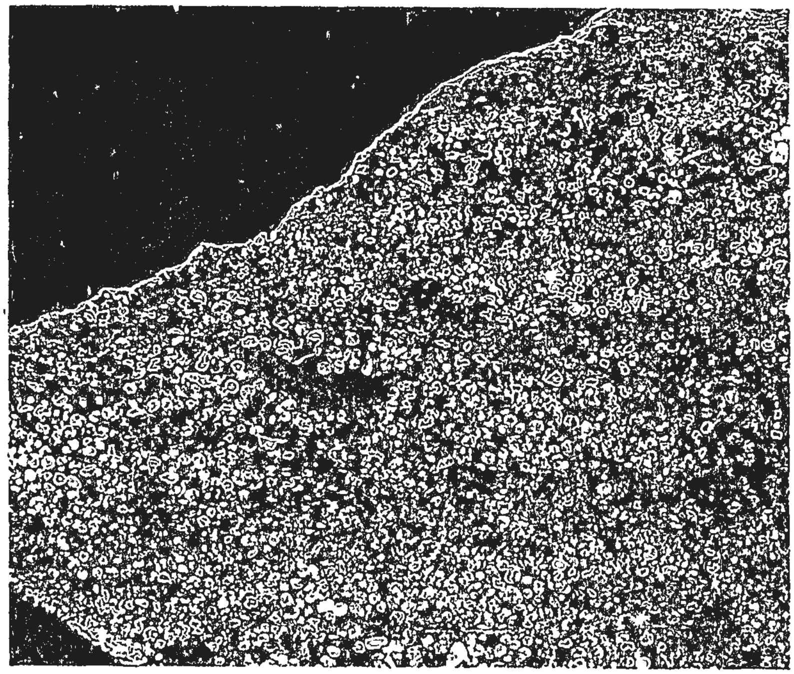


FIG. 18. East face of the Bert Ross Quarry in the SWc sec. 6, T. 17 S., R. 20 E. Note the plastered character of the lower part of the Stoner limestone and the thin, wavy character of the bedding in the upper part.

coal stringer and/or plant remains. The average thickness is about 1 foot. The lower unit discussed above is persistent over a wide area. The upper two units are discontinuous and although identifiable in spots at every locality, can be seen to lense out in quarry walls. Small lenticular sand facies are interrelated with these upper units. The average overall thickness of this member is approximately 5 feet.

South Bend limestone member.--The South Bend limestone (Condra and Bengston, 1915, p. 23) is extremely uniform, both lithologically and faunally, as seen by me in several northeast Kansas counties. The fresh surface is blue gray and brown-banded and the weathered surface is brown. The bedding is thin to thick and slightly wavy. The texture is fine-grained and dense with ooliths concentrated in bands throughout. The ooliths are extremely abundant, but minute and diminish upward (Fig. 19). Two or three beds are common. Brachiopods are dominant with the genera, Chonetina, Composita, Derbyia, Dictyoclostus, Dielasma, Juresania, Marginifera, Meekella, Neospirifer, and Punctospirifer represented. The genera Triticites is locally abundant. Crinoid remains, echinoid spines and plates, and both ramose and fenestrate bryozoan are common. Sparse trilobite pygidia occur. The smoothly concave, solution carved surface and in places the Missourian-Virgilian disconformity atop this member are distinguishing characteristics. The average thickness of South Bend limestone is approximately 3.2 feet.



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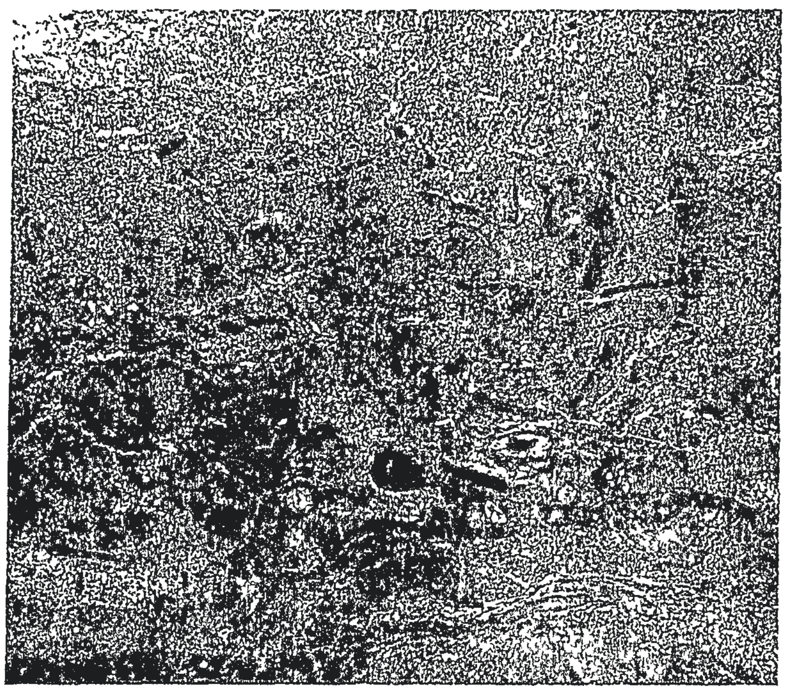

B

FIG. 19. A--Peel print of the lower portion of the South Bend limestone (X4.0). Note the abundant minute ooliths.
B--Peel print of the upper portion of the South Bend limestone (X3.0). Note the compact texture, Triticites, and sparse ooliths. Samples taken in the NWc sec. 22, T. 16 S., R. 20 E.

Pedee Group

Weston formation.—

Weston formation (Keyes, 1889, p. 300) occupies the interval between Stanton and Iatan formations. The formation is predominantly shale with some siltstone. The color ranges from blue gray to brown, to yellow upward and the bedding grades from blocky to flaky. The formation east of Highway 59 in Franklin County is seemingly unfossiliferous. Limonite concretions are common in the lower and middle portions. The thickness of the formation varies considerably from outcrop to outcrop. These changes in thickness are related to erosion prior to deposition of Virgilian strata. The thickness ranges from approximately zero to 110 feet.

Iatan formation.—

Iatan formation (Keyes, 1899, p. 300) was largely removed from eastern Franklin County by post-Iatan, pre-Douglas erosion. Removal by erosion rather than non-deposition is indicated by an arenaceous comglomerate occurring at the approximate stratigraphic horizon to be expected for Iatan. This conglomerate at the base of the Douglas strata is composed of limonite fragments, sparse brachiopod and crinoid remains, and silt in a lime matrix. Jewett (1954, p. 209) refers to a thin limestone near Wellsville which seemingly correlates with Iatan. Due to the most profuse vegetation in recent years and recent road changes this exposure was not located. However, this does attest to the probably scant existence of Iatan formation in the area.

Virgilian Series

Douglas Group

Stranger formation.—This formation consists of a variety of lithologies including coals, sandstones, shales, and limestones. The members of the formation cropping out in eastern Franklin County are described below.

Tonganoxie sandstone member.—Tonganoxie sandstone (Moore, Elias, and Newell, 1934) contains massive cross-bedded and thin to thick evenly defined beds. The sandstone is yellow to brown and 90 percent of the angular quartz grains are of fine, very fine, and smaller size. The disconformity at Tonganoxie sandstone base is widespread and in many places where limestones have been eroded, conglomerates remain as evidence. In places the sandstone body is of channel form and in other places is a thin, even-bedded sandstone which does not have the appearance of a channel sandstone. Extremely sparse fossils in the form of brachiopod and clam fragments occur. The Missourian-Virgilian disconformity reaches at least to the lower part of the Weston formation in eastern Franklin County. The thickness of this member ranges from a few feet to more than 30 feet.

Westphalia(?) limestone member.—The Westphalia limestone (Moore and Newell, 1936, p. 150) is not definitely recognized in the area. A thin limestone found in the NEc sec. 2, T. 15 S., R. 20 E. fits the description of a Westphalia equivalent (Moore, 1936, p. 150-151). This limestone is composed of thin laminations containing plant material (Fig. 20) is approximately 0.5 foot

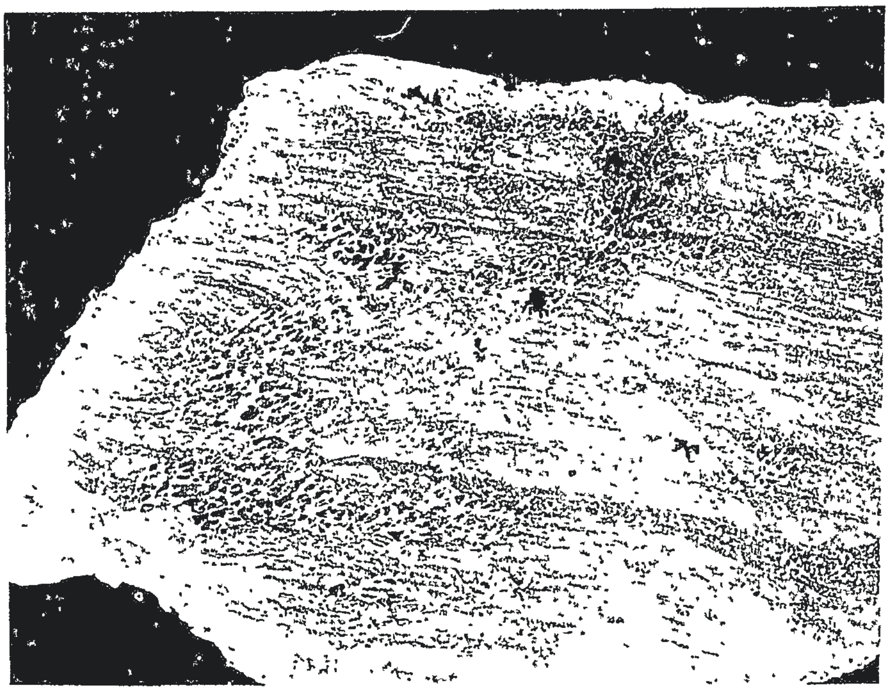

FIG. 20. Peel print of the Westphalia limestone (X3.0). Note thin laminations of plant material. Sample taken in NW$\frac{1}{4}$ sec. 22, T. 15 S., R. 20 E.

thick, crops out at an horizon equivalent to Westphalia, and is lenticular.

Vinland shale member.--Vinland shale (Patterson and Addison, 1934) is composed of silty, gray to green shale and interbedded sandstone beds in the lower part, and silty, fossiliferous, gray shale in the upper part. In places the lower part of flaky shale is red on the bedding planes. The associated sandstones are predominantly fine-and very fine-grained, gray on the fresh surface and brown on the weathered surface, extremely compact, and even-bedded. These sandstones are seemingly unfossiliferous. The upper part of the shale contains Orthomyalina and Aviculopecten in the few good exposures of the area. Elsewhere in Franklin County, this zone just beneath the Haskell limestone is abundantly fossiliferous. The average thickness is approximately 32 feet.

Haskell limestone member.--Haskell limestone (Moore, 1932, p. 93) is blue gray on the fresh surface and weathers brown. One or two well-delineated beds are common. The texture is extremely fine-grained and compact and the rock breaks with a conchoidal fracture. Brachiopods, crinoid remains, and sparse foraminifers make up the fauna. Sparse ooliths occur. A solution-carved upper surface and in some places a goethite zone overlying this surface are characteristic. The average thickness is approximately 1.5 feet.

Lawrence formation.--Only the lowermost member of the Lawrence formation is exposed in the area of study.

Ireland sandstone member.--Ireland sandstone (Moore, 1932, p. 93) is composed of massive sandstone and sandy shale in eastern Franklin County. This member is brown, fine-and very fine-grained, and is commonly unfossiliferous. Locally where it cuts through limestone as in the SWc sec. 19, T. 15 S., R. 20 E. the sandstone is fossiliferous. The thickness ranges from several feet to more than 25 feet.

Post-Pennsylvanian beds

Tertiary and younger rocks are surficial and are composed of limestone and chert gravels and other alluvial material. Their lithologic description and stratigraphic relationships are discussed in the geomorphologic section of the report.

NATURAL RESOURCES

Soils

Chronologically, soil was the earliest resource to be exploited in the area. Much of the arable soil is residual, being derived largely from the bedrock upon which it has developed and where it is now found. The residual soils occupy the uplands and the upland slopes. A part of the area is covered with soil that was not derived from rocks that underly the surface where the soil is now found. These transported soils are either alluvial or colluvial materials. With the exception of flat upland areas and the lower portions of the steeper slopes, the transported materials occupy the bottomlands and are mapped as Recent alluvium (Pl. 1). On the basis of work done by Norman Plummer of the Kansas State Geological Survey, field observations, soil publications, and discussion with Dr. J.M. Jewett; it is my belief that the flat upland areas are covered with a soil mantle which consists of a complex of Pleistocene materials, Recent colluvial materials, and residual soils.

The soils of the area are divided into classes of land according to use capability (U.S. Department of Agriculture, Soil Conservation Service, and the Kansas Agriculture Experiment Station Report of April, 1946). The transported soils of the area fall into two land classes. These land classes are those which are best suited to cultivation and require either no special practices or only simple practices to curtail erosion and maintain fertility. The residual soils range from those upon which intensive practices are employed to render them cultivable to those upon which severe restrictions, pertaining to use as a crop support, are placed. The gravelly soils, associated with the terracing along the major drainage, are not usable for cultivation. A large part of the residual soil supports grass and timber. The grass is of economic importance because of the feed-crop livestock system of farming. Timber is used both for building purposes and as firewood.

Limestone and Gravel

Near the turn of the century and for some 30 years following, many tons of rock were delivered by wagon and team to Ottawa and other sites for use as building stone. In the early years of the business, many loads were given away free to inspire trade. Due to the combination of the use of trucks, the availability of stone, and an increasing demand, the quarry business flourished. At the present time, five quarries operating and 14 abandoned quarries can be observed. Strata quarried extensively for building purposes are Argentine, Spring Hill, Captain Creek, and Stoner limestones. Limestone from the area is also utilized as agriculture limestone, crushed rock and riprap, raw material for the manufacture of cement, roads, and other products having a variety of uses. Pits in the terrace chert gravels have supplied material for many of the all-weather county roads of the area.

Ground Water

In many parts of eastern Kansas fresh ground water is hard to find. Periods of extended dry weather do not alleviate the problem. Water supplies for domestic and livestock use are obtained from wells and ponds. The wells are fed from porous surficial deposits and fissured near-surface limestones. The ponds, if properly constructed, catch the surface drainage. Larger quantities, generally sufficient for city supplies, are obtained from wells in the alluvium of the larger streams and from artificial lakes as is the case at Richmond, Kansas.

Oil

Franklin County has produced oil for some 50 years. The fields are located in the eastern part of the area with production concentrated in T. 16 S. and T. 17 S., R. 21 E. All production has been from Pennsylvanian rocks with the "Squirrel sand", upper Cherokee, the most prolific reservoir in the area (Jewett, 1954, p. 211). The "Squirrel sand" is topped at an average depth of 650 feet, has a thickness of from 16 to 30 feet, and is part of the Wellsville Shoestring. At the present time, virtually all production is accomplished through repressurization by water injection. Water flooding was initiated in the area approximately 30 years ago (Jewett, 1954, p. 27). Geobel et al, (1956, p. 67) have given the 1955 production: Oil produced from 12 areas in 3 fields totaled 376, 674 barrels. Of this figure 310, 525 barrels were produced by secondary recovery projects. The Eudora shale which crops out in the area is a potential oil shale (Runnels et al, 1952, pp. 176-177).

Shale

The black, fissile portion of the Eudora shale in crushed form is used as a carbonate-phosphate fertilizer by farmers of the area. Weston shale crops out on Fowler's Hill (cen. E line sec. 34, T. 15 S., R. 20 E.) and on Coffman's Hill (cen. E line sec. 30, T. 15 S., R. 21 E.). These outcrops are seemingly lithologically similar to the Weston shale quarried by Buildex Incorporated in the NEc sec. 23, T. 17 S., R. 19 E., where the Weston shale is used in the preparation of light-weight aggregate.

CONCLUSIONS

1. The Wyandotte formation is characterized by missing and discontinuous beds in eastern Franklin County.

2. The sinkholes in the Argentine limestone near Lane, Kansas are a special feature of the area.

3. The Merriam limestone of eastern Franklin County more commonly resembles a "super" type than a "middle" type limestone.

4. There is the possibility of a disconformity at the top of the Spring Hill limestone and a detailed study should be conducted.

5. A disconformity at the top of the Stoner limestone is well developed in the area of study and in several northeast Kansas counties.

6. The upper two members of the Stanton formation should not be included in the same megacyclic sequence as the lower three members because of the disconformity at the top of the Stoner limestone.

7. The Marais des Cygne River valley in eastern Franklin County has been partially filled and reexcavated at least three times with the terrace interpreted to be of late Kansan age being the best developed.

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APPENDIX

Detailed Descriptions of Columnar Sections Shown on Plate II

A-Cen. E. line of sec. 23, T. 18 S., R. 19 E.

Stanton formation
7. Soil
South Bend limestone
6. Limestone; blue-gray to brown on the fresh surface, weathers brown; thin to thick and slightly wavy bedded; fine-grained and compact; Chonetina, Composita, Derbyia, Dielasma, Marginifera, Meekella, Punctospirifer, Triticites, crinoid, fenestrate bryozoan, and trilobite pygidia; characteristic concave upper surface . . . . 5.1 feet

Rock Lake shale
5. Shale; gray-green; blocky . . . . 0.7 foot
4. Limestone; gray on the fresh surface, weathers buff; wavy bedded; impure; Aviculopinna, Dictyoclostus, Linoproductus, Neospirifer, crinoids, and trilobite pygidia . . . 2.7 feet
3. Limestone; gray-white on both fresh and weathered surfaces; a single bed; breccia of limestone and shell fragments in a fine limestone matrix, more of a breccia in the lower 0.5 foot; Aviculopinna, Composita, Neospirifer, crinoids . . 1.8 feet

Stoner limestone
2. Limestone; gray-white on the fresh surface, weathers gray; thin, wavy beds; fine-grained and compact; Composita, Dictyoclostus, Enteletes, Linoproductus, Neospirifer, crinoids, and trilobite pygidia; portions of upper part appear plastered in quarry walls; stylolithic; hummocky top probably an erosion surface . . . . .10.9 feet

Eudora shale
1. Shale; black; platy to fissile; conodonts; lower contact covered . . . . 1.0 foot

B-Cen. S. line of sec. 7, T. 18 S., R. 20 E.

7. Soil

Stanton formation
Stoner limestone
6. Limestone; gray-white on both fresh and weathered surfaces; wavy, thin beds; fine-grained; Enteletes, slender Triticites, and crinoids; stylolithic; abundant crystalline calcite; total thickness not represented due to surface erosion accompanied by soil formation . . . . 6.5 feet

Eudora shale
5. Shale; brown to green downward; flaky; . . . . 2.0 feet
4. Shale; black; platy to fissile; conodonts; . . . . 1.5 feet
Captain Creek limestone
3. Limestone; yellow-brown on fresh surface, weathers buff; even bedded; compact; Enteletes and fenestrate bryozoan; mottling on the fresh surface in the upper part . . . . 8.4 feet
Vilas formation
2. Shale; gray-green; clay shale in upper 2.0 feet; mostly covered by a thick brush entanglement. . . . . 19.7 feet
Plattsburg formation
Spring Hill limestone
1. Limestone; gray-white on the fresh surface, weathers buff; thin, wavy beds; fine-grained and compact; Composita shell pavement approximately 3.0 feet below top, echinoid spines; lower contact covered. . . . . 11.0 feet

C-SE$\frac{1}{4}$ sec. 6, T. 18 S., R. 20 E.

15. Soil
Stanton formation
Stoner limestone
14. Limestone; gray-white on both the fresh and weathered surfaces; thin, wavy beds; compact; brachiopod, crinoid, and echinoid remains; crystalline calcite; stylolithic . . . . 5.0 feet
Eudora shale
13. Shale; brown; flaky . . . . 4.0 feet
12. Shale; black; platy to fissile. . . . . 1.5 feet
Captain Creek limestone
11. Limestone; white on the fresh surface, weathers gray; thin to thick and even bedded; compact; Triticites and fragmentary brachiopod, crinoid, coral, and bryozoan remains; abundant crystalline calcite . . . . 11.4 feet
Vilas formation
10. Shale; gray-brown to yellow on the fresh surface, weathers gray-brown; clay shale; limy in upper 2.0 feet. . 6.5 feet
9. Limestone; yellow; impure "boxwork" . . . . 1.0 foot
8. Shale; gray-brown; flaky to blocky. . . . . 4.0 feet
7. Limestone; gray-blue on fresh surface, weathers tan; thin even beds; contains plant remains; may be a fresh water limestone (?) . . . . 1.5 feet
6. Shale; gray-blue on the fresh surface, green to brown to blue upward on the weathered surface; flaky to platy; clay shale . . . . 6.1 feet
5. Limestone; gray-blue to black on the fresh surface, gray to brown on the weathered surface; single bed; fossiliferous with fragments unidentifiable . . . . 0.6 foot
4. Shale; gray-blue; limy clay shale . . . . 0.7 foot

Plattsburg formation

Spring Hill limestone

3. Limestone; gray to white on the fresh surface, weathers blue-gray; thin to thick, wavy beds; fine-grained and compact; Aviculopinna, Allorisma, Ameura, Composita, Enteletes, Echinoconchus, Dictyoclostus, Ditomopyge, Fistolipora, Juresania, Linoproductus, Mooroceras, Orthomyalina, Septopora, and crinoid remains; ferruginous weathering rind caps bed . . . . 14.8 feet

Hickory Creek shale

2. Shale; gray; limy . . . . 0.4 foot

Merriam limestone

1. Limestone; gray on fresh surface, gray-blue on weathered surface; thin, wavy beds; extremely compact and brittle with abundant crystalline calcite; abundant crinoid remains; lower contact covered . . . . 3.0 feet

D-Composite of NE$\frac{1}{4}$ sec. 32, T. 17 S., R. 20 E. (Captain Creek to Spring Hill) and SE$\frac{1}{4}$ sec. 29, T. 17 S., R. 20 E. (Spring Hill to Merriam).

Stanton formation

Captain Creek limestone

5. Limestone; gray to yellow-brown on fresh surface, weathers buff; even bedded; compact; contains Enteletes, Triticites, Lophophyllidium, and crinoid remains. . . . . 2.2 feet

Vilas formation

4. Covered interval . . . . .13.2 feet

Plattsburg formation

Spring Hill limestone

3. Limestone; gray to white on both fresh and weathered surfaces; thin, wavy beds; compact with abundant crystalline calcite; Composita, Juresania, Lophophyllidium, echinoid spines, fenestrate bryozoan, and crinoids; nodular chert in upper 3.5 feet . . . . .10.6 feet

Hickory Creek shale

2. Shale; yellow; calcareous with yellow limestone stringers; highly weathered . . . . 2.6 feet

Merriam limestone

1. Limestone; gray on the fresh surface, weathers gray-brown; even bedded; compact; prominent Composita-Myalina assemblage about 1.0 foot above the base of the unit, contains Marginifera and crinoids . . . . 3.1 feet

E-SW$\frac{1}{4}$ sec. 24, T. 17 S., R. 20 E.

Stanton formation

Captain Creek limestone

8. Limestone; gray to blue on fresh surface, weathers buff; even to slightly wavy and thin bedded; fine-grained and compact with abundant crystalline calcite; Triticites and fragmentary remains of brachiopods, crinoids, and corals; upper contact covered . . . . 2.0 feet

Vilas formation

7. Shale; gray-green; flaky throughout; limy clay shale in upper part, silty shale in lower part . . . . 15.0 feet

6. Siltstone; yellow-brown . . . . 1.0 foot

5. Shale; gray-green to brown; clay shale . . . . . . 6.7 feet

Plattsburg formation

Spring Hill limestone

4. Limestone; gray-white on both fresh and weathered surfaces; thin, wavy beds; compact; Osagia with sparse ooliths and a pavement of robust Composita in the upper 1.5 feet, abundant crinoid remains . . . . 8.2 feet

Hickory Creek shale

3. Shale; yellow-green; impure calcareous shale and shaly limestone . . . . 2.1 feet

Merriam limestone

2. Limestone; gray-blue on fresh surface, weathers tan; even bedded; extremely compact; contains Composita-Myalina zone in lower part. . . . . 3.0 feet

Bonner Springs formation

1. Shale; gray-green; silty; lower contact covered. . 1.0 foot

F-SW$\frac{1}{4}$ sec. 6, T. 17 S., R. 20 E. (Bert Ross Quarry)

7. Terrace gravels of Kansan age.

Stanton formation

Stoner limestone

6. Limestone; white on the fresh surface, gray-white in the lower part and brown in the upper part on the weathered surface; thin and wavy bedded; fine-grained; Enteletes, Dictyoclostus, Triticites, crinoids, and fenestrate bryozoan; upper part appears plastered in quarry walls . . . . 18.2 feet

Eudora shale

5. Shale; green to brown; flaky . . . . 3.4 feet

4. Shale; black; platy to fissile; phosphatic nodules with pyrite nuclei; abundant conodonts, Orbiculoidea and Lingula 5.0 feet

Captain Creek limestone

3. Limestone; blue-gray on the fresh surface, yellow-brown on the weathered surface; thin to thick and fairly even bedded; compact; contains brachiopod, bryozoan, echinoid, and Triticites remains; stylolithic; manganese (?) stains in dendrite patterns on the fresh surface . . . . 9.1 feet

Vilas formation

2. Shale; gray to brown; flaky . . . . 0.9 foot

Plattsburg formation

Spring Hill limestone

1. Limestone; blue-gray on the fresh surface, weathers gray to brown; thin, wavy beds; fine-grained; Composita zone 2.7 feet below top of unit, Osagia and oolite bed associated with Composita shell pavement, crinoids, and fenestrate bryozoan; stylolites; abundant crystalline calcite . . . . . . 8.9 feet

G-SE$\frac{1}{4}$ sec. 27, T. 16 S., R. 20 E. Abandoned quarry 5 miles E. of Ottawa on Kansas Highway 68-33.

8. Soil

Stanton formation

Stoner limestone

7. Limestone; gray-white on both fresh and weathered surfaces; wavy, thin beds; fine-grained; crinoid and brachiopod remains; not an original thickness . . . . 5.0 feet

Eudora shale

6. Shale; tan; fissile or papery bedding . . . . 4.5 feet

5. Shale; black; platy to fissile; conodonts . . . . 4.3 feet

4. Shale; drab; platy; clay shale. . . . . 1.5 feet

Captain Creek limestone

3. Limestone; gray-white to blue on the fresh surface, weathers buff; upper 3.0 feet largely algal with Ottonosia and irregularly bedded, lower 4.2 feet extremely even bedded; compact throughout; Enteletes, crinoid, and echinoid remains . . . . 7.2 feet

Vilas formation
2. Shale; lower portion blue, upper part green to brown; flaky clay shale . . . . 3.2 feet
Plattsburg formation
Spring Hill limestone
1. Limestone; gray-white on the fresh surface, weathers gray-brown; thin to thick, wavy beds; fine-grained; Aviculopinna, Composita, Derbyia, Dictyoclostus, crinoids, and fenestrate bryozoan; abundant crystalline calcite . . . . .10.4 feet

H-NWc sec. 22, T. 16 S., R. 20 E. Abandoned quarry near schoolhouse.

10. Soil; limonitic gravel; black carbonaceous band at the base in places.
Stanton formation
South Bend limestone
9. Limestone; blue-brown on the fresh surface, weathers buff; thin to thick regular bedding; fine-grained and brittle; Composita elongata or Dielasma (?), Derbyia, Marginifera, Meekella, Neospirifer, Triticites, Chonetina crust caps lower bed of this unit, crinoids, echinoids, and both ramose and fenestrate bryozoan remains . . . . 3.2 feet
Rock Lake shale
8. Shale; green-brown; blocky clay shale . . . . 0.3 foot
7. Coal; 0.1 foot stringer
6. Shale; gray-green; blocky clay shale . . . . 1.0 foot
5. Limestone; gray on fresh surface, weathers buff; nodular; impure . . . . 1.0 foot
4. Limestone; gray-blue on both fresh and weathered surfaces; single bed; mortar breccia with coarse to fine pieces of limestone in a finer limestone matrix; Worthenia and Bellerophon; probably overlies a surface of disconformity . . . . 1.8 feet
Stoner limestone
3. Limestone; gray on both fresh and weathered surfaces; thin to thick and slightly wavy bedded; fine-grained; Composita, Derbyia, Punctospirifer, crinoids, fenestrate bryozoan, planispiral gastropods, and echinoid spines; portions appear plastered in quarry walls; top of unit hummocky . . . . .19.0 feet
Eudora shale
2. Shale; tan; flaky . . . . 1.2 feet
1. Shale; black; platy to fissile; conodonts; exposed in creek bank east of quarry . . . . 2.0 feet

I-SE¼ sec. 27, T. 15 S., R. 21 E. Abandoned quarry.

Stanton formation
Stoner limestone
3. Limestone; gray to white on the fresh surface, weathers

yellow-brown; thin to thick and irregular bedded; sparsely fossiliferous, contains brachiopod and crinoid remains and sparse slender Triticites . . . . 18.0 feet

Eudora shale

2. Shale; green in upper part to brown in lower part; flaky clay shale . . . . 3.1 feet
1. Shale; black; fissile; lower contact covered . . 2.1 feet

Detailed Descriptions of Columnar Sections Shown on Plate III

A-Cen. E. line of sec. 16, T. 19 S., R. 21 E. Roadcut.

Plattsburg formation

4. Limestone; gray-white on the fresh surface, weathers tan; very thin wavy beds; Osagite-oolite texture with abundant Osagia and ooliths; near coquinoid with profuse crinoid columnals and calyx plates and abundant echinoid spines and plates; beds have a tendency to spall in roadcut . . . . 10.0 feet.
3. Limestone; gray-white on the fresh surface, weathers buff; wavy, thin beds; fine-grained; robust Composita shell pavement 3.0 feet above base of this unit, Dictyoclostus, Marginifera, Punctospirifer, crinoids, and planispiral gastropods; typical "upper" limestone lithology of Moore's megacycle . . .17.0 feet.
2. Shale; gray-green where exposed; mostly covered. . . .28.0 feet.

Wyandotte formation

Argentine limestone

1. Limestone; gray-white on both fresh and weathered surfaces; wavy, thin beds; compact; brachiopod and crinoid remains; neither upper or lower contact well exposed. . . . . .3.0 feet plus

B-Cen. of E. line of sec. 9, T. 19 S., R. 21 E.

Plattsburg formation

9. Limestone; gray on fresh surface, weathers buff; slightly wavy and thin bedded; compact; brachiopods, crinoids, linear algae, and echinoid spines; nodular chert float covers top of this unit and forms a mantle over the uplands of the area. . . .19.0 feet.

Bonner Springs formation

8. Limestone; yellow-brown; impure "boxwork", ... 0.7 feet.
7. Shale; green; blocky clay shale. . . . . 0.8 feet.
6. Limestone; yellow-brown; impure "boxwork", ... 1.0 feet.

Wyandotte formation

Farley limestone

5. Limestone; gray on the fresh surface weathers gray-white; irregular bedding; fine-grained; Composita, Enteletes, Neospirifer, fenestrate bryozoan, and linear algae; fossils replaced by brown calcite; differs lithologically from unit 9 only in increased number of brachiopods. 6.5 feet.
4. Conglomerate; limestone-limonite conglomerate with crinoids, brachiopods, and bryozoan. . . . . 2.2 feet.

Argentine limestone

3. Limestone; brown to gray to white upward on the fresh surface, weathers buff; wavy, thin beds; fine-grained; profuse Enteletes, also Marginifera, crinoids and bryozoan; abundant crystalline calcite. . . . . .33.0 feet.

Frisbie limestone

2. Limestone; chocolate brown on both the fresh and weathered surfaces; one thin and one thick, even beds; compact; Enteletes, Linoproductus,

Lophophyllidium, robust Triticites and sparse crinoids; voids abundant, probably due to solution by ground water . . 3.4 feet.

Lane formation

1. Shale; tan; silty; contains plant remains. . . . .3.0 feet plus

C-SW$\frac{1}{4}$ of sec. 4, T. 19 S., R. 21 E. Abandoned quarry SW of Lane.

Plattsburg formation

Merriam limestone

4. Limestone; gray to brown to white upward on the fresh surface, weathers gray-brown; thin, crossed bedding; detrital; molluscan fauna with Allorisma, Aviculopinna, Bellerphon, and Myalina, also abundant crinoids, echinoid spines and plates, ooliths and fusulinids in the central portion, and Aviculopinna, Composita, and Myalina in the upper part. . . . . .8.2 feet.

Bonner Springs formation

3. Limestone; yellow-brown; highly impure, "rotten", highly fossilferous with clams, brachiopods, gastropods, crinoids, and fenestrate bryozoan . . . . 3.0 feet.
2. Shale; blue to brown upward; platy and hard; varicolored laminations of blue, brown, and gray; micaceous; limy; almost a slate in central part. 4.0 feet.

Wyandotte formation

Argentine limestone

1. Limestone; gray-white on both surfaces; wavy, thin beds; fine-grained; brachiopod, bryozoan, coral, and crinoid remains; abundant crystalline calcite; cave in quarry wall; lower contact covered. . . . . .31.0 feet.

D-W. $\frac{1}{2}$ of S. boundary of sec. 36 and E. end of S. boundary of sec. 35, T. 18 S., R. 20 E. From E. to W. along road.

Plattsburg formation

Merriam limestone

5. Limestone; gray-blue on the fresh surface, weathers tan; thin, even beds which break in cleavage blocks; abundant Myalina and other clams, abundant Composita and other brachiopods, Lophophyllidium, planispiral gastropods; bottom surface of unit a cast of the top of the underlying shale. . . . . 4.0 feet.

Bonner Springs formation

4. Shale and sandstone; brown; silty throughout, with prominant sandstone beds in central portion. . . . . .24.5 feet.

Wyandotte formation

Farley limestone

3. Limestone; gray-white on the fresh surface, weathers yellow-brown; extremely thin and poorly cross-bedded; detrital; oolite-osagite bed, Composita and crinoid columnals dominate the fauna.7.0 feet.

Island Creek shale

2. Shale and sandstone; brown; flaky; silty shale with a prominant sandstone bed approximately 5.0 feet below top of unit; seemingly sterile. . . . . .14.0 feet.

Argentine limestone

1. Limestone; gray-white on the fresh surface, weathers yellow-brown; thin to thick and slightly wavy bedded; fine-grained with abundant crystalline calcite; Chonetes, Composita, Enteletes, crinoid stems and calices; upper portions appear plastered in parts of the quarry. . . . . .18.2 feet.

E-Near Cen. of sec. 34, T. 17 S., R. 20 E.

Plattsburg formation

Merriam limestone

3. Limestone; yellow-tan on both fresh and weathered surfaces; well-developed cross-bedding; compact; Composita-Myalina zone 1.1 feet above base of unit . . . . 8.2 feet.

Bonner Springs formation

2. Silty shale and "boxwork" limestone; silty shale green to gray downward, "boxwork" limestone 2.7 feet below top of unit, is yellow-brown; shale flaky throughout . . . . .39.7 feet.

Wyandotte formation

Argentine limestone

1. Limestone; gray-white on both fresh and weathered surfaces; thin, wavy beds; fine-grained; corals, crinoids, brachiopods, and fenestrate bryozoan; abundant crystalline calcite; crops out in creek bed at bottom of hill; lower contact covered . .16.0 feet.

F-NE cor. of sec. 26, T. 17 S., R. 21 E. Roadcut.

Plattsburg formation

Merriam limestone

3. Limestone; gray to yellow on the fresh surface, weathers yellow-brown; even bedded; compact; Osagia, Composita, Myalina, and crinoids; upper contact not shown on Plate III . . . . 2.3 feet.

Bonner Springs formation

2. Shale; green to gray to tan downward with a 1.5 feet impure "boxwork" limestone 8.7 feet below top of unit and sandstone beds in middle and lower portions; flaky and silty throughout.37.2 feet.

Wyandotte formation

Argentine limestone

1. Limestone; brown on the fresh surface, weathers gray; thin to thick and irregular bedded; fine-grained with crystalline calcite; Osagia, slender Triticites, and Neospirifer; chert nodules in upper part; lower contact covered . . . . .20.0 feet.

G-Cen. of E. line of sec. 7, T. 17 S., R. 21 E. Roadcut.

Plattsburg formation

Merriam limestone

4. Limestone; gray on the fresh surface, weathers brown; thin, even beds; Composita, Myalina, crinoids, and lophophyllid corals; upper contact not shown in Plate III . . . . 6.0 feet

Bonner Springs formation

3. Shale; yellow to brown; silty; micaceous . . . . 24.5 feet

Wyandotte formation

Argentine limestone

2. Limestone; gray on the fresh surface, weathers brown; thin, irregular beds; fine-grained with crystalline calcite; Enteletes, Dictyoclostus, Marginifera, Lophophyllidium, Osagia, and crinoids; sparse chert fragments . . . . 5.0 feet

Lane formation

1. Shale and sandstone; yellow to brown to red; alternating beds of silty shale and sandstone; almost a loam in part; sparse brachiopod fragments in the lowest portion . . . . 40.5 feet

H-Composite of SEc of sec. 8 (Lane and Argentine) and N¼ of boundary between sections 8 and 9 (Bonner Springs and Merriam) T. 17 S., R. 21 E.

Plattsburg formation

Merriam limestone

4. Limestone; light brown on the fresh surface, weathers yellow-brown; even, thin beds; compact; Myalina, Osagia, and crinoids; upper contact not shown on Plate III . . . . 2.8 feet

Bonner Springs formation

3. Shale; yellow to brown; flaky clay shale; silty throughout; seemingly sterile . . . . 26.0 feet

Wyandotte formation

Argentine limestone

2. Limestone; gray-brown on the fresh surface, weathers brown; thin, wavy beds; compact and brittle; Derbyia, Dictyoclostus, Echinoconchus, and crinoids; crystalline calcite has replaced shells; roughly elliptical chert nodules, 2 inches to 1 foot in long dimension and 2 to 8 inches in short dimension occur in the upper 6.0 feet . . . . 23.1 feet

Lane formation

1. Shale; yellow to brown in lower part, gray in upper part; flaky clay shale; silty in lower part; lower contact covered24.0 feet

I-Composite of cen. of sec. 34, T. 16 S., R. 21 E. (Argentine and lower Bonner Springs) and N. cen. of sec. 34, T. 16 S., R. 21 E. (Upper Bonner Springs and Merriam)

Plattsburg formation

Merriam limestone

3. Limestone; gray-brown on both fresh and weathered surfaces; cross-bedded; compact; Composita-Myalina zone in lower part, michaelnoceroid cephalopods, crinoids, echinoids, and fenestrate bryozoan 9.0 feet

Bonner Springs formation

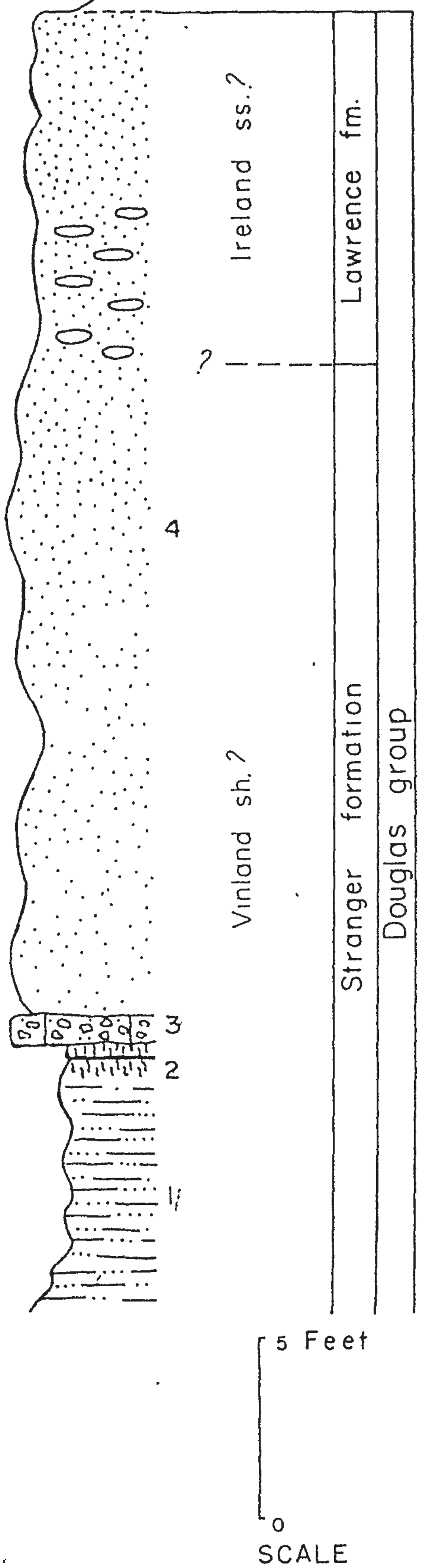
2. Shale; green to tan to gray downward; flaky and silty throughout; unfossiliferous . . . . 40.0 feet

Wyandotte formation

Argentine limestone

1. Limestone; gray-white on both fresh and weathered surfaces; thin, wavy beds; fine-grained; brachiopods; lower contact covered; associated chert nodules . . . . 2.5 feet

Cen. N. ½ of W. line sec. 12, T. 16 S., R. 19 E.



Lawrence formation (?)

Ireland sandstone(?)

4. Sandstone; brown at the base to red upward; massive; fine-grained; micaceous; ironstone concretions in upper part; upper contact covered . . . . 28.0 fee

3. Conglomerate; gray to brown; arenaceous; brachiopod and crinoid remains. . . . 0.9 foot

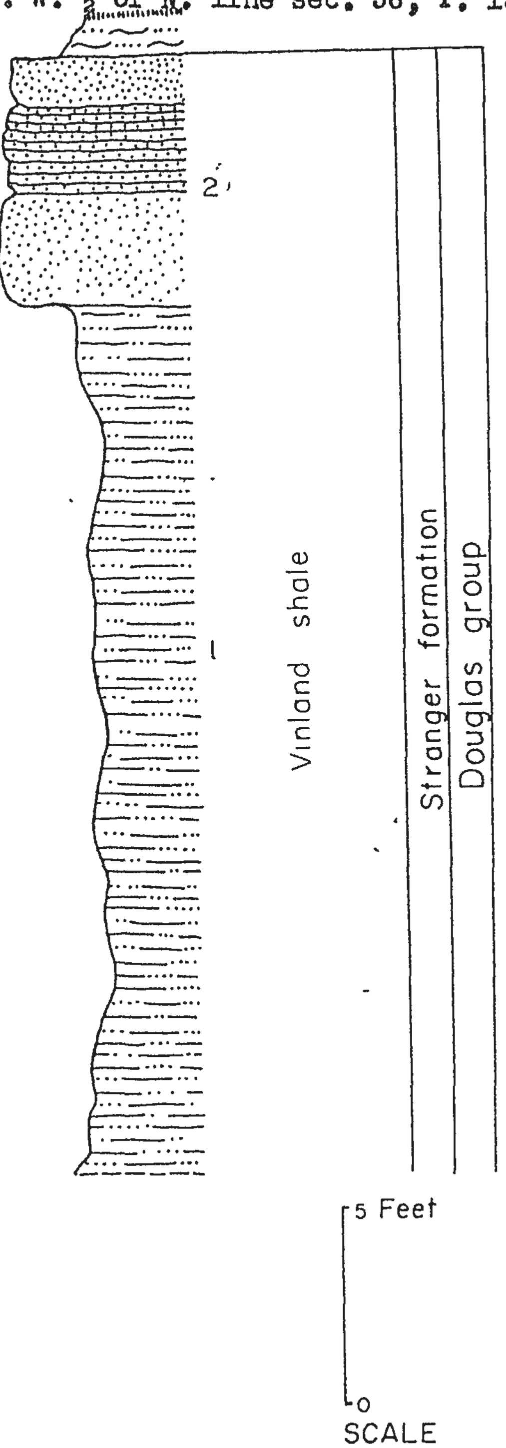
Stranger formation

Vinland shale

2. Clay; yellow to brown with a three-fourths inch coal stringer three inches below the top . . . . . 1.0 foot

1. Shale; yellow to brown; lower contact covered; exposed portion quite silty . . . . 6.0 feet

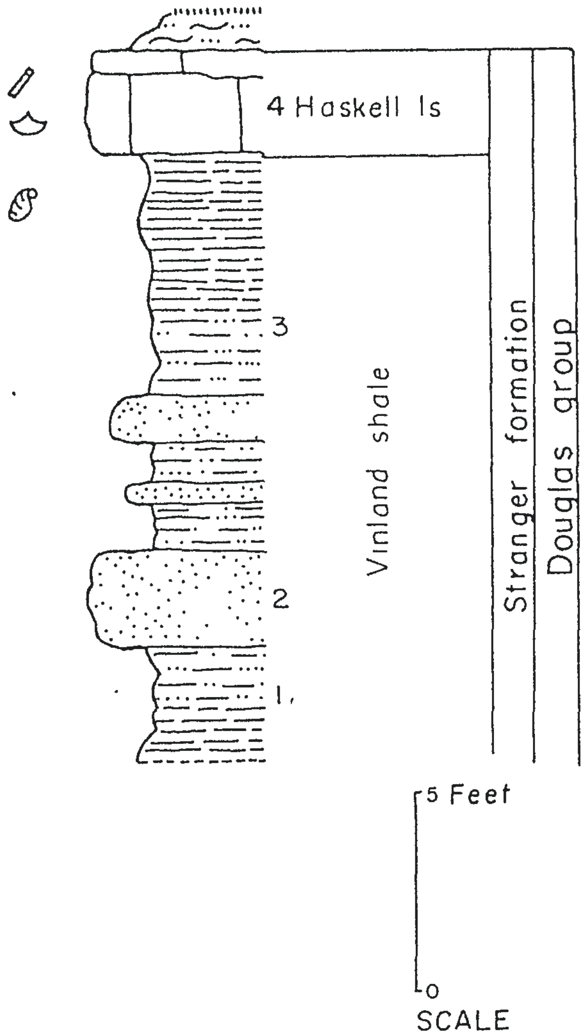
Cen. W. ½ of N. line sec. 36, T. 15 S., R. 19 E.



Stranger formation
Vinland shale

2. Sandstone; gray on fresh surface, weathers brown; even bedded; fine-grained and compact; shaly in the lower part . . . . 6.4 feet
1. Shale; yellow to brown; red on bedding planes in upper part; profuse Orthomyalina zone near the top; lower contact covered. .28.0 feet

On the Douglas-Franklin County line. Cen. of W. ½ of N. line sec. 19, T. 15 S., R. 20 E.



Stranger formation

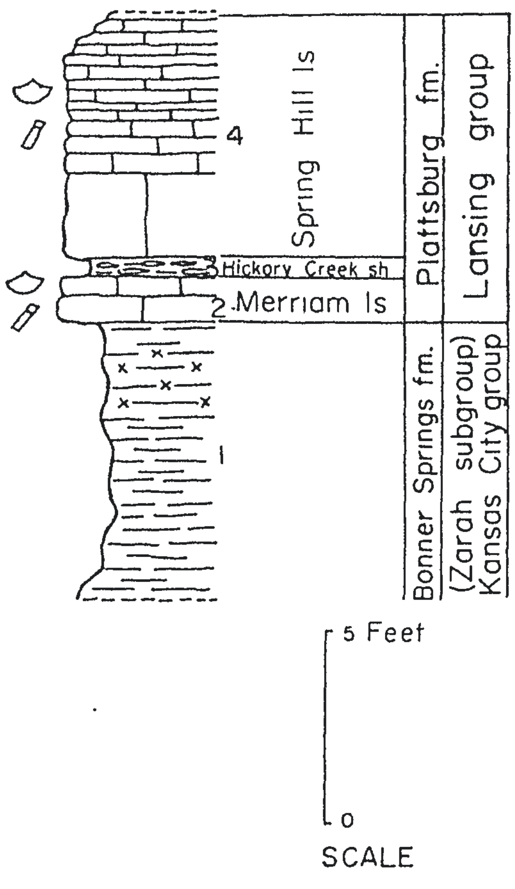
Haskell limestone

4. Limestone; blue to gray on fresh surface, weathers brown; even bedded; fine-grained, compact; brachiopod and crinoid remains; characteristic solution carved upper surface; Ireland sandstone can be observed cutting into the Haskell limestone at this outcrop; in ditch north of road 2.1 feet

Vinland shale

3. Shale and sandstone; yellow to brown to gray downward; sandstone fine and very fine-grained; prolific clam fauna in upper 0.5 foot with Aviculopecten and Orthomyalina in great numbers. . 10.2 feet
2. Sandstone; yellow to brown; even bedded; fine-grained; micaceous . . . . . 2.4 feet
1. Shale; yellow to brown; arenaceous; micaceous; lower contact covered . . 3.0 feet

On Kansas Highway 68-33, 8½ miles E. of Ottawa; near the cen. S. line sec. 29, T. 16 S., R. 21 E.



Plattsburg formation

Spring Hill limestone

4. Limestone; gray to brown on fresh surface, weathers yellow to brown; thin, wavy beds; fine-grained and compact; Composita and crinoid remains 6.2 feet

Hickory Creek shale

3. Shale; yellow to brown limestone in yellow shale . . . . . . 0.4 foot

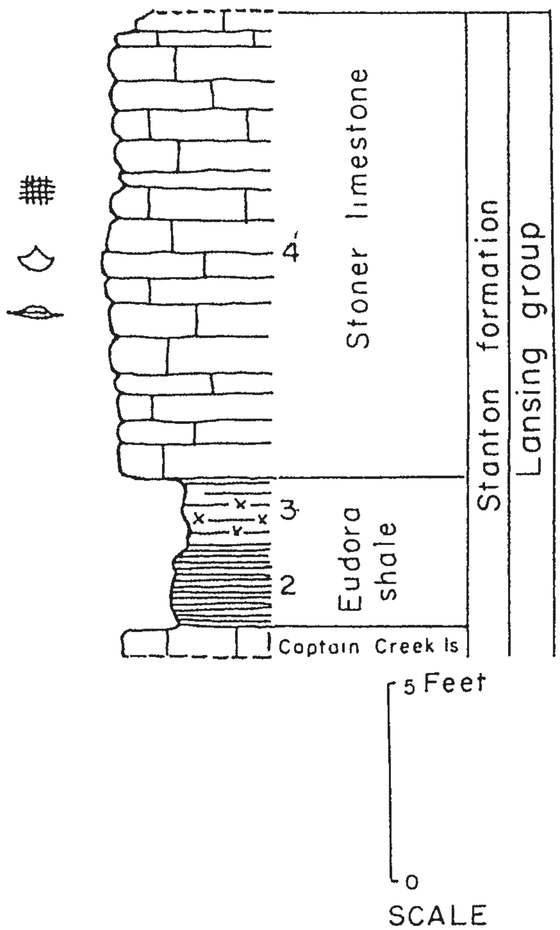
Merriam limestone

2. Limestone; gray on fresh surface, weathers yellow to brown; even bedded; compact brachiopod and crinoid remains . . . . . 1.2 feet

Bonner Springs formation

1. Shale; gray to brown; arenaceous; lower contact covered . . . . . 10.0 feet

Near cen. W. line sec. 20, T. 16 S., R. 21 E.



Stanton formation

Stoner limestone

4. Limestone; gray to white on fresh surface, weathers gray; thin and wavy bedded; compact; <u>Enteletes</u>, <u>Triticites</u> and bryozoan remains; crystalline calcite; upper contact covered . . 12.0 feet

Eudora shale

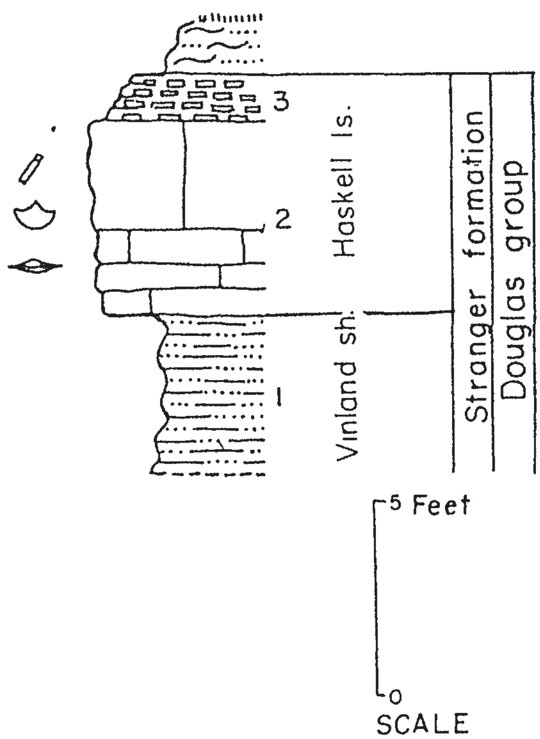
3. Shale; green to brown downward; clay shale . . . 2.3 feet

2. Shale; black; platy to fissile; conodont fauna. . . . 1.7 feet

Captain Creek limestone

1. Limestone; gray on both fresh and weathered surfaces; forms pavement in creek bed.

SWc sec. 26, T. 15 S., R. 19 E.



Stranger formation

Haskell limestone

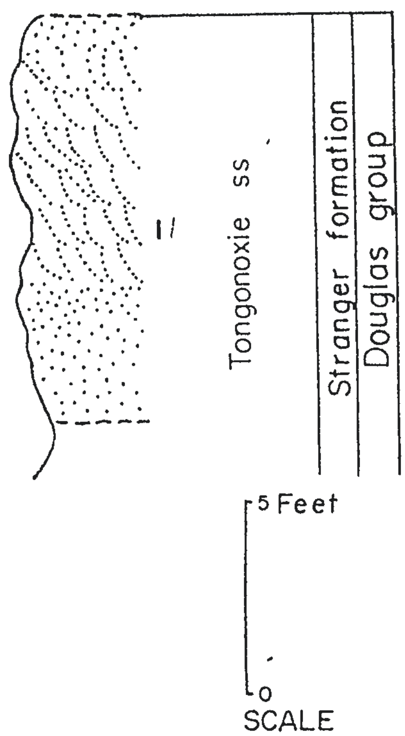
3. Goethite; brown; punky; sparse, minute ironstone concretions sometimes associated . . . 0.7 foot

2. Limestone; uniformly blue-gray on fresh surface, weathers yellow to brown; even bedded; fine-grained and compact, breaking with a conchoidal fracture; Derbyia, crinoid, and fusulinid remains; lower contact covered . 5.1 feet

Vinland shale

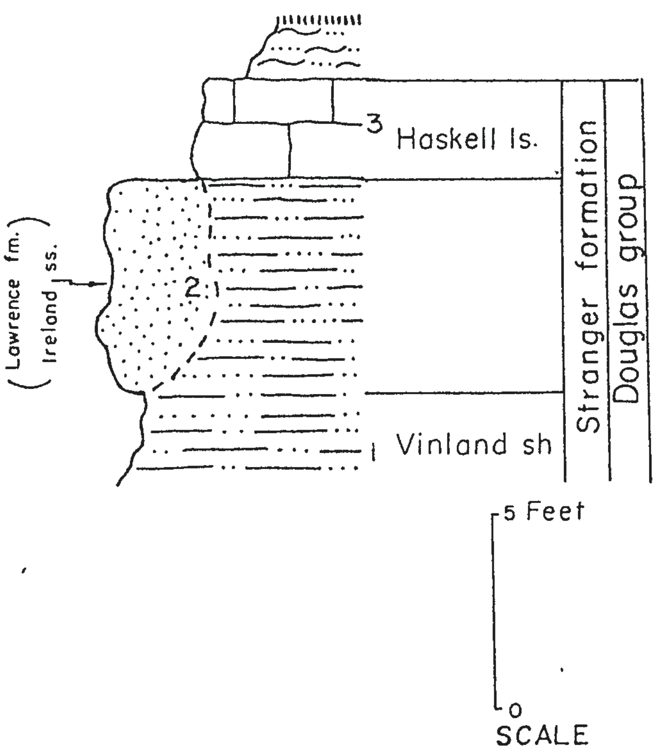
1. Shale; yellow to brown; clay; lower contact covered . . . . . 5.0 feet

SEc sec. 24, T. 15 S., R. 21 E.



Lawrence formation
Ireland sandstone
1. Sandstone; brown; cross-bedded; micaceous; lower contact covered 10.9 feet

At the S. end of the section boundary between sec. 24 and sec. 19, T. 15 S., R. 19 E.



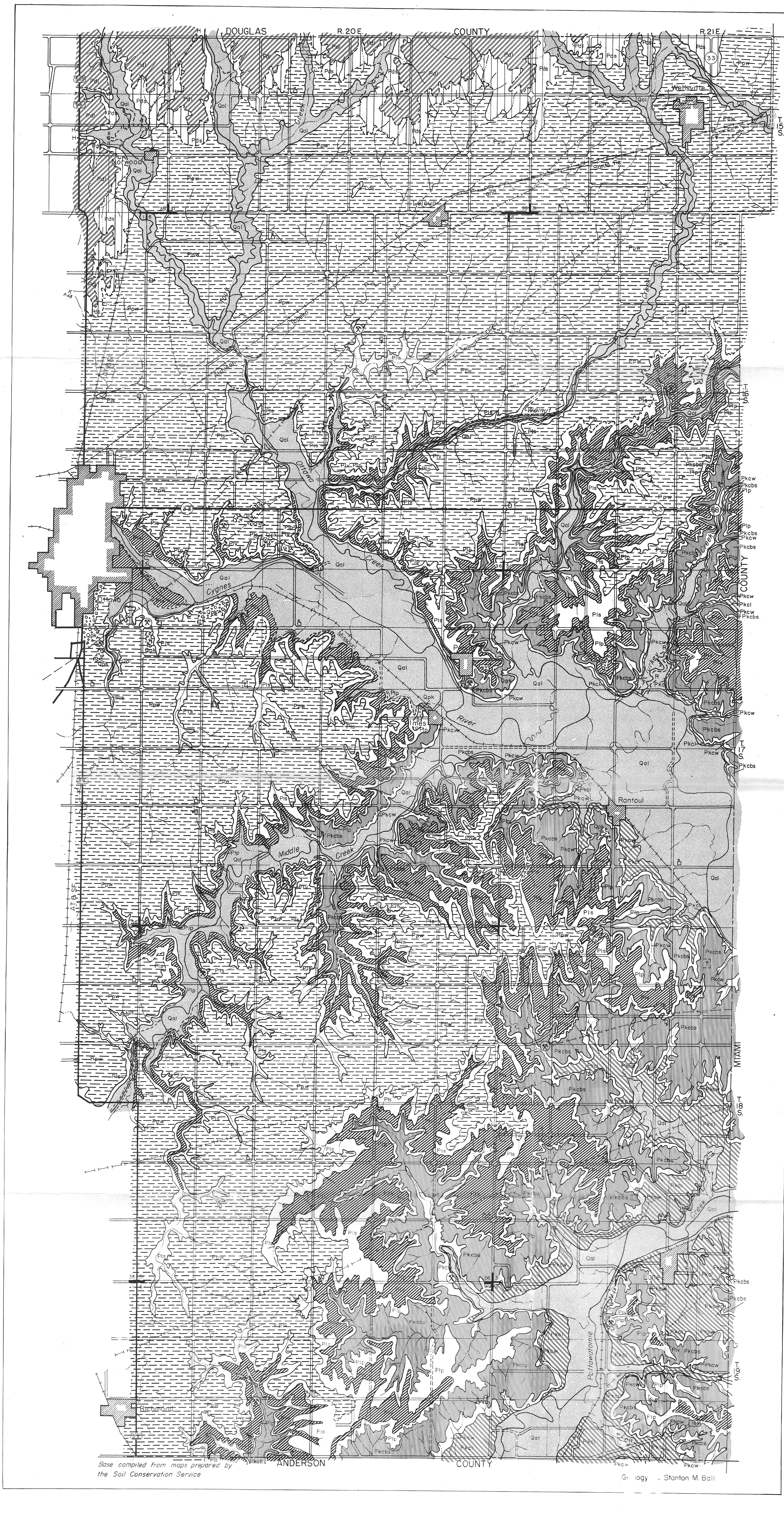
Stranger formation
Haskell limestone
3. Limestone; yellow to gray on fresh surface, weathers gray to brown; compact; brachiopod and crinoid remains 2.6 feet

Lawrence formation
Ireland sandstone
2. Sandstone; brown; limy in upper part; brachiopod, pelecypod, and gastropod remains . . . . 5.4 feet

Stranger formation
Vinland shale
1. Shale; yellow to brown; lower contact covered, remainder partially covered . . . . 2.0 feet

Kansas Geological Survey
Open-file Report 57-10
Plate I

57-10



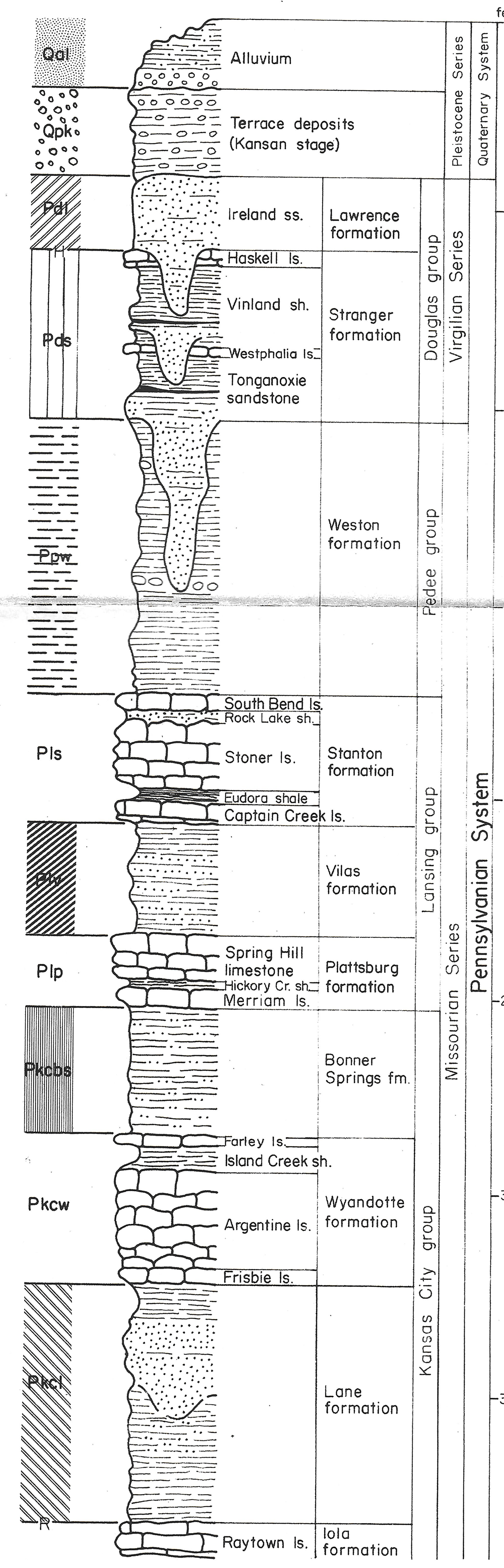
Base compiled from maps prepared by the Soil Conservation Service

Geology ... Stanton M. Ball

PLATE I

EXPLANATION

Generalized stratigraphic column of outcropping rock:



Paved Highway

Unimproved Road

Abandoned Road

Railroad

Perennial Stream

Intermittent Stream

Contact (Dashed where approximately located)

Pipe Line

Quarry

Abandoned Quarry

School House

Cemetery

Church

TRUE NORTH
MAGNETIC NORTH

Approximate mean declination 1956

1 1/2 0 1 2 3 miles
SCALE

GEOLOGIC MAP OF EASTERN FRANKLIN COUNTY, KANSAS

57-10

Correlation of Lansing Rocks in Eastern Franklin County, Kansas

Stanton M. Ball, 1957

PLATE II

Kansas Geological Survey
Open-file Report 57-10
Plate III

57-10

Correlation of Kansas City Rocks and Merriam Limestone in Eastern Franklin County, Kansas

Stanton M. Ball, 1957

PLATE III