KU KANSAS GEOLOGICAL SURVEY
The University of Kansas

PRELIMINARY SURFICIAL GEOLOGY OF MIAMI COUNTY, KANSAS

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2017

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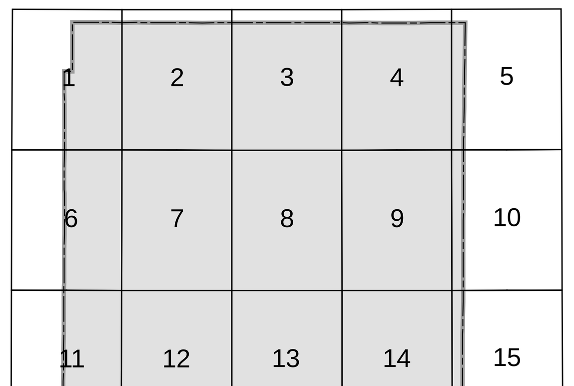
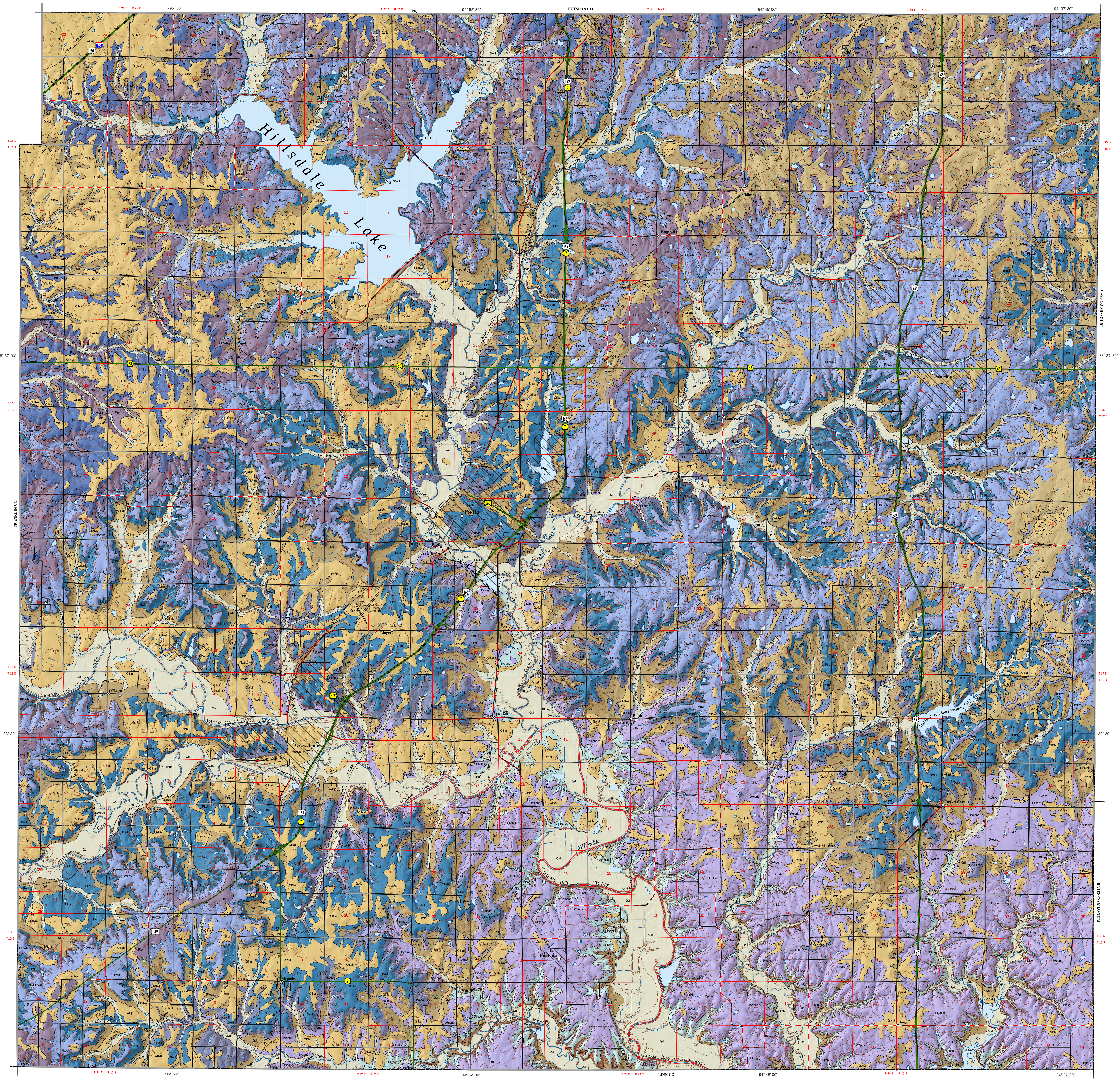
Open-File Report 2017-20

Funded in part by the USGS National Cooperative Geologic Mapping Program



MIAMI COUNTY QUADRANGLES

1 Wellsville
2 Antioch
3 Spring Hill
4 Bucyrus
5 West Line MO-KS
6 Rantoul
7 Paola West
8 Paola East
9 Louisburg
10 Freeman MO-KS
11 Lane
12 Osawatomie
13 Fontana
14 New Lancaster
15 Drexel MO-KS



Explanation

Boundaries and Locations

- State boundary
- County boundary
- Township/range line*
- Section line
- Paola — County seat
- Louisburg — Other incorporated city
- Henson — Unincorporated city or locality
- Built-up area (incorporated cities only)

Transportation

- 35 50 — Interstate and U.S. highway
- 69 — U.S. highway
- 69 7 — U.S. and state highway (divided)
- 68 — State highway
- Medium-duty secondary road
- Light-duty road
- Unimproved road
- Railroad
- Unpaved landing strip
- Airport

Hydrology and Topography

- Perennial stream
- Intermittent stream
- Water body
- Water body - manmade shoreline
- 1000 — Elevation contour (100-foot interval)
- Elevation contour (20-foot interval)
- 1000 — Depression contour (100-foot interval)
- Depression contour (20-foot interval)

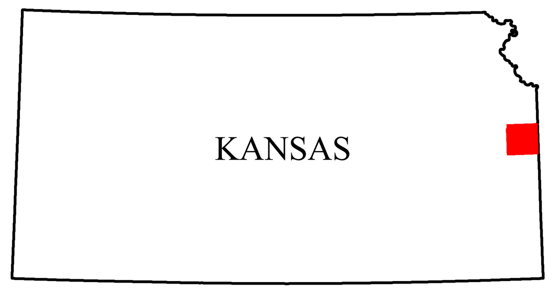
Geologic Unit Boundaries

- Observed contact

Resource Development

- Disturbed area or fill material

*Some areas of the Marais des Cygnes River, as navigable streams, were excluded from the U.S. Public Land Survey, resulting in partial sections in parts of the river's course through the county.



MAP LOCATION

Geology was mapped in the field using USGS 7.5-minute 1:24,000-scale topographic maps. Contacts were then converted to GIS format, edited, and attributes added. This data was then used to generate the mapped-unit GIS data, to which necessary attribution was also added.

Elevation contours are presented for general reference. Used in the U.S. Geological Survey's current US Topo 1:24,000-scale topographic map series, they were generated from hydrographically improved 1/3 arc-second National Elevation Dataset (NED) data and smoothed during processing for use at 1:24,000 scale. In some places, the contours may be more generalized than the base data used for compilation of geologic outcrop patterns. Outcrop patterns on the map will typically reflect topographic variation more accurately than the associated contour lines. Repeated fluctuation of an outcrop line across a contour line should be interpreted as an indication that the mapped rock unit is maintaining a relatively constant elevation along a generalized contour.

Roads and highways are shown on the base map as represented by data from the Kansas Department of Transportation (KDOT), U.S. Census Bureau, and other sources. U.S. Department of Agriculture – Farm Services Agency (USDA-FSA) National Agriculture Imagery Program (NAIP) imagery also was used to check road locations.

Shaded relief is based on 1-meter hydroflattened bare-earth DEMs from the State of Kansas LiDAR Database. The DEM images, in ERDAS IMAGINE format, were mosaicked into a single output DEM, downsampled to 5-meter resolution, and reprojected to decimal degrees. The output DEM was then converted to a hillshade, a multidirectional shaded-relief image using angles of illumination from 0°, 225°, 270°, and 315° azimuths, each 45° above the horizon, with a 4x vertical exaggeration.

This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program, award number G16AC00195 (FY2016).

The Miami County map was produced using the ArcGIS system developed by Esri (Environmental Systems Research Institute, Inc.).

SUGGESTED REFERENCE TO THE MAP

Layzell, A. N., Mandel, R. S., Newell, K. D., and Dunham, J. W., 2017, Preliminary surficial geology of Miami County, Kansas: Kansas Geological Survey, Open-File Report 2017-20, scale 1:50,000, unpublished.

SCALE 1:50 000

1 0.5 0 1 2 3 4 MILES

1 0.5 0 1 2 3 4 5 KILOMETERS

LAMBERT CONFORMAL CONIC PROJECTION
WITH STANDARD PARALLELS AT 33° AND 45°
NORTH AMERICAN DATUM OF 1983

1°56'
TRUE NORTH
MAGNETIC NORTH

APPROXIMATE MEAN DECLINATION, 2017

GEOLOGIC UNITS

CENOZOIC

Quaternary System

Qal

Undifferentiated alluvium — Undifferentiated alluvium comprises valley fills beneath an extensive alluvial terrace (T-1) of the Marais des Cygnes River and its tributaries. This alluvium consists of clay, silt, sand, and gravel, with the coarsest sediments comprising the lower 3–6 ft (0.9–1.8 m) of the alluvial fills. The fine-grained alluvium is mostly brown, dark yellowish-brown, and yellowish-brown silty clay loam. These deposits can reach thicknesses greater than 70 ft (21 m) in the Marais des Cygnes River valley and typically are 4,000 to 11,000 years old. Younger alluvial deposits comprise the valley fills beneath the modern floodplain of the Marais des Cygnes River and its tributaries. The fine-grained floodplain facies are mostly dark-gray, gray, dark grayish-brown, and grayish-brown silty clay and silty clay loam.

QtNal

Quaternary and Neogene alluvium — Clayey alluvium often interbedded with cherty gravel is common beneath high terraces and on hilltops in Miami County. The numerical age of these alluvial deposits is unknown. However, based on their position in the landscape, the deposits on the hilltops probably aggraded during the Neogene (Aber, 1998), and it is likely that the high-terrace fills date at least to the middle Pleistocene. The lower 3–6 ft (0.9–1.8 m) of the terrace fills and hilltop deposits consist of cherty gravel. The overlying fine-grained alluvium mostly consists of dark-gray, gray, dark grayish-brown, and pale brown silty clay. The distribution of fine-grained alluvium interbedded with cherty alluvial gravels is indicated by the Kenoma soil series, as shown on the Soil Survey of Linn and Miami Counties, Kansas (Penner, 1981). Redoximorphic features, including strong brown and reddish-brown mottles and iron and manganese oxide concretions, are common in the upper 3–10 ft (0.9–3 m) of the fine-grained alluvium. Alluvial deposits comprising the fills of high terraces are typically 20–30 ft (6–9 m) thick, but the alluvial deposits on hilltops generally are less than 15 ft (4.6 m) thick. A veneer of loess that is less than 3 ft (0.9 m) thick often caps the high terrace and hilltop alluvial deposits.

Qsl

Colluvial apron and alluvial fan deposits — Deposits of clay, silt, sand, and gravel occur on footslopes and toeslopes in valley landscapes. These deposits mostly accumulated during the early and middle Holocene, although some may date back to the terminal Pleistocene, and they comprise both colluvial aprons and alluvial fans. The colluvial aprons consist of massive deposits of poorly sorted sediments that include many angular, bedrock-derived pebbles and cobbles. The alluvial fans formed where small, intermittent streams enter the Marais des Cygnes River valley and the valleys of its major tributaries. The fan deposits are stratified and consist of well-sorted alluvium dominated by brown, dark yellowish-brown, and yellowish-brown silty clay, silty clay loam, and silt loam. Thin lenses of gravel are common, and buried soils often occur at the top of upward-fining sequences.

Ql

Loess — Deposits of grayish-brown and reddish-brown loess cover hilltops and high alluvial terraces in portions of Miami County. The Peoria loess, which dates between 20,000 and 12,000 B.P., comprises deposits of grayish-brown silt loam. The distribution of the Peoria loess is indicated by the Grundy soil series. In some areas, erosion has stripped off the Peoria loess and exposed reddish-brown silty sediment comprising the Loveland loess. The distribution of the Loveland loess is indicated by the Welda soil series. The Loveland loess accumulated between 160,000 and 130,000 B.P. Deposits of loess greater than 10 ft (3 m) thick were mapped.

PALEOZOIC

Carboniferous System – Pennsylvanian Subsystem
(descriptions from Miller, 1966)

Lansing Group

Pls

Stanton Limestone — The Stanton Limestone (~35 ft [10.7 m]) is the uppermost formation in the Lansing Group. It is composed of three limestones separated by two shales. In ascending order, these members are the Captain Creek limestone, Eudora shale, Stoner limestone, Rock Lake shale, and South Bend limestone. The **Captain Creek Limestone Member** (5–11 ft [1.5–3.4 m]) is commonly a mottled pale yellowish-brown to light-gray, medium-grained, thick-bedded, cherty limestone that is locally sandy in its upper part. This upper part weathers into large, angular blocks. A thin (0.2 ft [0.1 m]) fossiliferous limestone containing brachiopods, crinoids, and bryozoans occurs at the base of the unit. The **Eudora Shale Member** (5.5–11 ft [1.7–3.4 m]) is olive-gray to light yellowish-brown, clayey, and blocky with a black, fissile shale near the middle that locally makes up 40 to 50 percent of the member. The Eudora shale is relatively unfossiliferous except for sparse inarticulate brachiopods, conodonts, and rare conularids, which occur in the black shale. The **Stoner Limestone Member** (19 ft [5.8 m]) is poorly exposed. It comprises the following sequence of units, in ascending order: (1) 13.3 ft (4.1 m) of yellowish-gray, medium-grained, uneven- and medium-bedded limestone that contains fusulinids, crinoids, and algae; (2) 0.5 ft (0.2 m) of yellowish-brown, arenaceous shale; (3) 2.4 ft (0.7 m) of grayish-orange, sucrosic, uneven- and medium-bedded limestone; (4) 1.1 ft (0.3 m) of yellowish-gray, coarse-grained, wavy- and thin-bedded limestone that contains gastropods, pelecypods, and brachiopods; (5) 0.3 ft (0.1 m) of dusky-yellow, banded shale; and (6) 0.5 ft (0.2 m) of light-gray sandy limestone containing pelecypods, brachiopods, and small sponges. Approximately 4 ft (1.2 m) of the weathered gray **Rock Lake Shale Member** is poorly exposed in the northwestern part of the county; similarly, 3–5 ft (0.9–1.5 m) of the **South Bend Limestone Member** is likely present in this part of the county, but it is not exposed.

Plpv

Plattsburg Limestone/Vilas Shale — The lower part of the Lansing group is composed of the Plattsburg Limestone and overlying Vilas Shale (~35 ft [10.7 m] thick). The **Plattsburg Limestone** (~16 ft [4.9 m]) is composed of two limestone members and an intervening shale member. In ascending order, these units are the Merriam limestone, Hickory Creek shale, and Spring Hill limestone. The **Merriam Limestone Member**, averaging 3.5 ft (1.1 m) but ranging from 1 to 9.5 ft (0.3 to 2.9 m), is commonly a single, massive bed of bluish-gray to light-gray, fine-grained, dense limestone. The lower part (3.6 ft [1.1 m]) of the Merriam limestone is a massive, bluish-gray to light-gray, cross-bedded, oolitic limestone, locally with black, fossiliferous chert. It is commonly a resistant unit, forming scarps and outcrops. Coated grains and *Osagia*-like forms are usually present and in some places these constitute a large part of the limestone. Myalinid pelecypods and productid brachiopods can be common. The upper part of the Merriam limestone is a light- to medium-gray, fine-grained, massive, locally cherty limestone but usually is not fossiliferous. "Worm tubes" are present in some localities on the upper surface. The **Hickory Creek Shale Member** (locally absent to 2 ft [0.6 m]) is yellowish-gray to orangish-gray, clayey, nodular, and calcareous. A thin, nodular limestone bed locally occurs near the middle of the unit. The shale is fossiliferous, commonly with crinoid remains and bryozoans. The **Spring Hill Limestone Member** (4–17 ft [1.2–5.2 m]) is light olive-gray to yellowish-gray, fine- to coarse-grained, thin- to medium-bedded, and sandy. It contains chert locally and may be oolitic in places at its top or conglomeratic with limonite pebbles, shale and ironstone fragments, and small abraded calcite crystals. Shale partings and thin, wavy carbonaceous streaks may be present within this member. *Triticites* sp. and *Osagia*-like forms and echinoid spines are locally abundant. A zone of large *Composita* sp. is commonly found near the base of the unit. The **Vilas Shale** (5 ft [1.5 m], thickening westward to 30 ft [9 m]) is grayish-olive to light gray, sandy, and blocky. In the western part of the county, it contains a considerable amount of moderate yellowish-brown siltstone and orangish-gray cross-bedded sandstone, which may be up to 4 ft (1.2 m) thick. Plant remains are common in the sandy layers, but otherwise it is relatively unfossiliferous.

Kansas City Group

Pkcwb

Wyandotte Limestone/Bonner Springs Shale — The uppermost part of the Kansas City Group is composed of the Wyandotte Limestone and the overlying Bonner Springs Shale. The **Wyandotte Limestone** is composed of five alternating shale and limestone members. From the base upward, these five units are the Frisbie limestone, Quindaro shale, Argentine limestone, Island Creek shale, and Farley limestone. The Wyandotte is a cuesta-forming formation, ranging in thickness from 10 to 80 ft (3 to 24 m). The shale members are present only locally in Miami County. The absence of the shale members and the similarity in the lithology of the two upper limestone members make identification of the units difficult. The **Frisbie Limestone Member** (2.5–3.6 ft [0.8–1.1 m]) is a light olive-gray to light brownish-gray, fine-grained, massive limestone. Locally, thin shales (<0.5 ft [0.15 m]) can be present. Crinoid stems and small productid brachiopods are the most common fossils and locally *Osagia*-like forms (coated grains) may be present. The **Quindaro Shale Member** (locally absent to 3.3 ft [1 m]) is a dusky-yellow to dark yellowish-orange, sandy shale. In places, the lower part of this unit is composed of very dark-gray shale. The Quindaro is very fossiliferous, with *Heterocoelia* sp., *Dielasma* sp., and *Phricodothyris* sp. being the most common forms. Crinoid fragments and bryozoans are also abundant. The **Argentine Limestone Member** (~35 ft [10.7 m]) is probably the most persistent member of the Wyandotte. It is lithologically similar to the Farley limestone, which is normally the uppermost limestone member of the Wyandotte. Locally, the Farley limestone can be missing and the Argentine limestone is the uppermost member. The Argentine is a light olive-gray to grayish-orange, medium-grained, thin-bedded, locally cherty limestone that weathers into thin fragments. The Argentine has a varied fauna, with the brachiopods *Composita* sp., *Echinaria* sp., *Antiquatonia* sp., and *Phricodothyris* sp. being most common. *Enteletes* sp. is abundant west and south of Paola. The fusulinid *Triticites* sp. is common locally. The **Island Creek Shale Member** (~1.5 ft [0.5 m]) is not well exposed. It is a grayish-orange clayey shale containing abundant gastropods. The **Farley Limestone Member** (locally absent to ~15 ft [4.6 m]), where present, is the uppermost member of the Wyandotte Limestone. It is a light olive-gray to pinkish-gray coarse-grained, wavy, thin- to thick-bedded limestone. Locally, the lower part of this unit can be oolitic. The Farley limestone contains much the same fauna as the Argentine limestone. The **Bonner Springs Shale** (0.9–31.5 ft [0.3–9.6 m]) is the uppermost formation of the Kansas City Group. The lower part is composed of pale olive-gray to light-gray sandy shale, which in places is a thin-bedded micaceous siltstone. The upper part is an olive-gray to yellowish-brown clayey shale in the upper part. Varying lithologies can be present near the middle of the unit—unfossiliferous grayish-red clayey shale or medium-gray clayey shale containing carbonaceous streaks, plant rootlets, and leaf impressions or medium-grained, medium-bedded, calcareous sandstone is found in this interval. In areas where the Bonner Springs is primarily clayey shale, scattered limestone nodules are present, and a thin, argillaceous limestone bed (~1 ft [0.3 m]) is present 2.0 ft (0.6 m) below the top of the formation. The limestone bed is very fossiliferous and contains abundant pelecypods, algae, brachiopods, gastropods, and bryozoan fragments.

Pkcil

Iola Limestone/Lane Shale — The **Iola Limestone** (10–12 ft [3–3.7 m]) is composed of two limestone members and an intervening shale member. The lower limestone is the Paola limestone, the middle shale is the Muncie Creek shale, and the upper limestone is the Raytown limestone. The **Paola Limestone Member** (absent to ~2.5 ft [0.8 m]) is composed of a massive bed of dark-gray to brownish-gray, fine-grained, dense limestone. The contact with the underlying shale is fairly smooth, but the upper surface of the unit is very irregular. Locally, iron-stained "worm tubes" extend downward 1 to 3 in (2.5 to 7.6 cm) from the upper surface of the Paola. Crinoid stems and small productid brachiopods are the most abundant fossils. Coated grains and bryozoans are common. The **Muncie Creek Shale Member** (0.5 ft [0.2 m]) is a bluish-gray to dusky-yellow sandy shale that locally has a dark-gray, carbonaceous, fissile facies that contains small (0.4–1.2 in [1–2 cm]) phosphatic nodules. The **Raytown Limestone Member** (5–24 ft [1.5–7.3 m]) is a light olive-gray to light-gray medium- to coarse-grained limestone with numerous silty shale partings and abundant vugs lined with crystalline calcite. The Raytown is medium bedded in the northern part of Miami County but becomes progressively thin bedded toward the southern part. Abundant large productid brachiopods occur in the Raytown, with *Echinaria* sp. and *Linoproductus* sp. being the most common. The **Lane Shale** (25 ft [8 m], increasing in thickness westward to 80 ft [24.4 m]), is lithologically variable. In the western half of the county is an olive-gray to dusky-yellow silty to sandy shale and thin-bedded siltstone. In the eastern half, it is an olive-gray to light-gray clayey shale. Thin carbonaceous streaks 1/16 to 1/4 in (1.6 to 6.4 mm) thick are found locally in the Lane. In east-central Miami County, a thin light-gray, clayey shale containing laminae of reddish-brown calcareous silt occurs just below the overlying Wyandotte Limestone. The Lane is unfossiliferous except for sparse plant remains and, locally, small brachiopods and crinoids in the upper few feet of the formation.

Pkcdc

Drum Limestone/Chanute Shale — The **Drum Limestone** (1.7–8 ft [0.5–2.4 m]) consists of a single massive bed of yellowish-gray to reddish-brown fine- to medium-grained cross-bedded limestone that is uniform in lithology and weathers into thin slabs. The most characteristic feature of this unit is abundant, small, white crinoid segments scattered throughout the limestone. Other fossils are *Neospirifer* sp., *Marginifera* sp., *Composita* sp., and, locally, the small sponge *Heliospongia* sp. The **Chanute Shale** (8–38 ft [2.4–11.6 m]) varies greatly in thickness and lithology over short lateral distances. It is yellowish-brown to greenish-gray sandy to clayey shale, which locally contains sandstone in the lower and middle parts and commonly in the upper part. The Chanute Shale is a relatively unfossiliferous unit except for plant impressions found locally in the sandy layers. The Chanute Shale contains the Thayer coal bed (0–0.5 ft [0–0.2 m]) 11–15 feet (3.4–4.6 m) above the base of the formation. The Thayer occurs at differing stratigraphic positions in respect to the upper formational boundary but is absent where the Chanute is thinner than 11 ft (3.4 m).

Pkcdnc

Dennis Limestone/Cherryvale Shale — The **Dennis Limestone** (~32 ft [10 m]) is resistant, forming prominent scarps. It is composed of three members, which, in ascending order, are the Canville limestone, Stark shale, and Winterset limestone. The **Canville Limestone Member** is absent in Miami County but may be represented locally by a thin, impure, nodular limestone. The **Stark Shale Member** (0.9–6 ft [0.3–1.8 m]) is represented by a black, fissile to very thin bedded, carbonaceous shale in the lower part. The upper part is medium-olive to greenish-gray sandy shale and is about twice the thickness of the underlying black shale. The Stark is fossiliferous in the upper, sandy part, with chonetid brachiopods being the most common fossil. The lower part is unfossiliferous except for rare inarticulate brachiopods. The **Winterset Limestone Member** (~29 ft [8.8 m]), the uppermost member of the Dennis Limestone, is light gray to olive gray, medium grained, medium bedded, and dense in the lower part and more fine grained in the middle part. The lower and middle parts of the member characteristically contain shaly partings and abundant chert. The upper part is usually separated from the lower beds by a thin bed of calcareous gray shale (~1.5 ft [0.5 m]). The upper part of the Winterset is dense, fine-grained, massive limestone. It contains an abundance of dark-gray chert. Locally, 1 to 3 ft (0.3–0.9 m) of oolitic limestone can be present near the top. The upper part of the Winterset is very fossiliferous and is characterized by numerous large productid brachiopods and locally by abundant gastropods. *Triticites* sp. is also very abundant in the upper part and is usually found in chert. The **Cherryvale Shale** (~60 ft [18 m]) comprises a shale-dominated unit between the top of the Dennis Limestone and the base of the Drum Limestone. It includes five members, in ascending order: the Fontana shale, the Block limestone, the Wea shale, the Westerville limestone, and the Quivira shale. The **Fontana Shale Member** (~15 ft [4.6 m]) is greenish-gray to olive-gray sandy shale. Locally, a thin, nodular limestone occurs in the lower part. It is relatively unfossiliferous except for sparse chonetid brachiopods in the lower part. The **Block Limestone Member** (~4 ft [1.2 m]), the lowermost limestone bed in the Cherryvale Shale, is a bluish-gray to olive-gray medium-grained, thin-bedded fossiliferous limestone with numerous thin, fossiliferous shale partings. *Triticites* sp. is the most characteristic fossil, but *Marginifera* sp. and *Syringopora* sp. also are abundant. The **Wea Shale Member** (~18 ft [5.5 m]) is characteristically olive-gray sandy shale that contains sandstone beds locally near the base. A thin bed of maroon shale may occur near the top. Locally, pyritiferous nodules and limonite concretions occur in the Wea, but plant impressions and carbonaceous partings can be found at its top. In places, a very thin coal occurs near the top of the member. The **Westerville Limestone Member** (absent to ~2 ft [0.6 m]) is poorly exposed but where present is composed of conglomeratic limestone containing abundant limonite nodules and quartz sand. It can lithologically transition to yellowish-gray marly limestone. The **Quivira Shale Member** (~4 ft [1.2 m]) is the uppermost member of the Cherryvale Shale. Its lower part (0.5–1 ft [0.2–0.3 m]) is composed of black, carbonaceous, fissile shale or maroon clayey shale. The upper part consists of olive-gray sandy shale. The Quivira is unfossiliferous except for sparse inarticulate brachiopods and conodonts in the black fissile shale.

Pkcsg

Swope Limestone/Galesburg Shale — The **Swope Limestone** (34 ft [10.4 m]), the lower part of this map unit, is composed of two limestone members and an intervening shale member. In ascending order, these members are the Middle Creek limestone, Hushpuckney shale, and Bethany Falls limestone. The **Middle Creek Limestone Member** (1.8–2 ft [0.5–0.6 m]) is a medium-gray to bluish-gray, fine-grained, dense limestone that is commonly expressed in outcrop as a single massive unit. A thin shale parting can be present approximately in the middle of this unit. The **Hushpuckney Shale Member** (4–7.5 ft [1.2–2.3 m]) is composed of black fissile shale overlain by grayish to yellow sandy shale. Locally, a thin bed of light olive-gray shale can overlie the black shale. The upper part of the Hushpuckney is fossiliferous, with chonetid and productid brachiopods. The **Bethany Falls Limestone Member** (13–28 ft [4–8.5 m]) is a light-gray to light brownish-gray, medium-grained, medium- to thick-bedded sandy limestone containing numerous thin shale partings. In most areas, the member can be divided into two distinct parts. The lower part (12–16 ft [3.7–4.9 m]) contains fusulinids and the upper part (0–14 ft [0–4.3 m]) is cherty and locally cross-bedded. Pelletal limestone or oolites, or both, may be present at the very top of the Bethany Falls. Where the pelletal or oolitic limestone is present, the upper part locally contains vertical, tubular cavities 3–4 ft (0.9–1.2 m) in length and 1–2 in (2.5–10.2 cm) in diameter containing iron-stained crystalline calcite. The Bethany Falls is a fossiliferous unit in which *Meekella* sp., *Derbyia* sp., *Antiquatonia* sp., and chonetid brachiopods are most common. *Triticites* sp. is found locally in the lower part of the unit. Algae are locally abundant. The **Galesburg Shale** (4–12 ft [1.2–3.7 m]), which overlies the Swope Limestone, consists of greenish-gray to dusky-yellow, sandy to calcareous, blocky shale. It is characteristically sparsely fossiliferous and poorly exposed.

Pkchl

Hertha Limestone/Ladore Shale — The **Hertha Limestone** (~8 ft [2.4 m]), the lower part of this map unit, is composed, in ascending order, of the Critzer limestone, Mound City shale, and Sniabar limestone. The Hertha is commonly poorly exposed. The **Critzer Limestone Member** (~1 ft [0.3 m]) is composed of light olive-gray, medium-grained, cherty limestone with abundant crinoid fragments and some bryozoans. The **Mound City Shale Member** (~0.4 ft [0.1 m]), if exposed, is present only as a thin, dusky yellow, unfossiliferous sandy shale. The **Sniabar Limestone Member** (~6 ft [1.8 m]) is a medium- to coarse-grained, medium- to thick-bedded limestone. It is oolitic at the top and contains chert in the lower part. Hematite pebbles and limestone conglomerate are locally present at the base of this unit. Generally present over much of the county, the Sniabar Limestone Member is composed of two distinct limestone beds (both of which can be rich with gastropods) separated by a thin bed of shale. The **Ladore Shale** (1.2–11.4 ft [0.4–3.5 m]), which overlies the Hertha Limestone, is light gray to olive-gray and weathers to a yellowish-gray. It is usually sandy and in some localities calcareous, with a thin limestone bed near the middle. It is unfossiliferous, except for plant impressions in the sandy layers.

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