SURFICIAL GEOLOGY OF BOURBON COUNTY, KANSAS

MAP M-97 (Revised)

Original geology by Ronald R. West and Robert S. Sawin (2002)

Coal and mined-land updates by Lawrence L. Brady

2020

Computer compilation and cartography by Jorgina A. Ross, Mieko Ono, and David Means (2002)

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KANSAS GEOLOGICAL SURVEY
The University of Kansas

GENERAL GEOLOGY

Bourbon County, near the southeastern corner of Kansas, is bounded on the north by Linn County, on the south by Crawford County, on the west by Neosho and Allen counties, and on the east by the state of Missouri. The county has a total area of 638 mi^2 (1,652 km^2) (Bell and Fortner, 1981), of which 9.7 mi^2 (25 km^2), or 1.5%, is water. Pennsylvanian sedimentary rocks—limestones, mudrocks, sandstones, and coals—crop out within the county and range in age from the lower Desmoinesian (Cherokee Group) to the lower Missourian (Kansas City Group). The general orientation of these rocks is diagonal (northeast–southwest) across the county from the oldest (Cherokee Group), exposed in the southeastern corner and eastern edge of the county, to rocks of the Marmaton and Pleasanton Groups across the middle, to the youngest (Kansas City Group) rocks along the western edge.

Rocks of the Cherokee Group are mostly siliciclastics (mudrocks and sandstones), with an occasional thin limestone. It is within this interval that most of the economically important coal beds occur. The lower Marmaton Group is siliciclastics and thick limestones; the upper Marmaton and Pleasanton Groups are mostly siliciclastics with thin limestones; and the Kansas City Group is mudrocks and thick limestones.

The stratigraphic sequence in Bourbon County extends from below the Mineral coal bed in the Cabaniss Formation (Cherokee Group) to the lower part of the Cherryvale Shale (Kansas City Group). Overlying these Pennsylvanian rocks in stream valleys are Quaternary alluvium and stream terraces. Although a number of changes have been proposed for the names of lithostratigraphic units in this interval, especially those associated with the Desmoinesian-Missourian boundary, such suggestions are, at this time, informal. The terminology used here is that given by Zeller (1968) with two exceptions: The Holdenville Shale has been divided into the Memorial Shale below and the Lost Branch Formation above (Heckel, 1991), and the Ladore Shale has been changed to the Elm Branch Shale (Heckel and Watney, 2002).

The bedrock geology of Bourbon County was mapped on U.S. Geological Survey topographic quadrangle maps at a scale of 1:24,000. Data points used in mapping the bedrock geology are available in Open-File Report 2002-02 (West and Sawin, 2002) at the Kansas Geological Survey (KGS). Some measured stratigraphic sections and descriptions of cores in Bourbon County are contained in KGS Open-File Report 94-37 (West and Sawin, 1994). Alluvial deposits, quarries, and strip pits were mapped using the Soil Survey of Bourbon County, Kansas (Bell and Fortner, 1981). Alluvium and stream terraces 5 ft (1.5 m) or greater in thickness were mapped. These deposits include sand, gravel, silt, and clay that were deposited on floodplains by streams, creeks, and rivers. These soil maps, along with data from the Kansas Department of Transportation, were also used to help locate and identify bedrock units. The groupings that have been mapped are what the authors considered mappable lithostratigraphic units.

GEOMORPHOLOGY

Physiographically, most of Bourbon County lies within the Osage Cuestas region; only the southeast corner is considered part of the Cherokee Lowlands. Rocks found in the Osage Cuestas are composed of alternating layers of sandstone, limestone, and mudrock. The cuestas, with generally steeper east-facing slopes and flatter west-dipping flanks, are subtle, large-scale features that are difficult to detect from the ground. Areas with long, narrow, water-filled pits bordered by hummocky, vegetated topography now characterize much of the Cherokee Lowlands in Bourbon County. These features are the result of extensive strip mining for coal before reclamation of the mines was required in 1969. These unreclaimed areas are now private property or public hunting, fishing, and wildlife areas.

Topographic relief in the county is 350 ft (107 m), with the highest area (1,110 ft [338 m]) in the southwestern corner and the lowest (760 ft [232 m]) where the Marmaton River and Little Osage River exit the state along the eastern edge of Bourbon County. Major drainages include the Marmaton River that drains the central and southern parts of the county and the Little Osage River along the northern part. The West Fork of Dry Wood Creek cuts the southeastern corner of the county. Bourbon County State Lake and Lake Fort Scott are the largest lakes in Bourbon County.

STRUCTURAL GEOLOGY

The general direction of strike in Bourbon County is northeast–southwest with regional dip to the northwest at 15 to 20 ft (5 to 6 m) per mile. Locally, strike and dip directions can vary significantly. An inferred fault was mapped in the Hammond Quadrangle based on field data.

MINERAL RESOURCES

Bourbon County is known for its coal-mining heritage, and many different ethnic groups settled here to work in the coal fields. Coal was mined from the upper Cherokee and Marmaton Groups where they occur near the surface in the eastern part of the county. Most of the mines were surface mines, but some underground mining was conducted. Oil and gas is produced from about 30 active fields in Bourbon County, almost exclusively from Cherokee Group sandstones and coals. A few small fields have produced some oil from the Mississippian. Production for the county in 2019 was 56,442 barrels of oil from 607 wells and no gas (Kansas Geological Survey, 2020). Total cumulative production for the county, through February 2020, is 5,885,518 barrels of oil and 1,996,704 million cubic feet of gas. Limestone is quarried for aggregate from several Pennsylvanian formations throughout the county. The Bandera Sandstone Member of the Bandera Shale is quarried near Redfield for flagstone and building stone.

Explanation

Boundaries and Locations

- County line
- Township/range line
- Section line
- A — A′ Geologic cross section
- Fort Scott — County seat
- Bronson — Other incorporated city
- Devon — Unincorporated city or locality
- Built-up area (incorporated cities only)

Transportation

- U.S. highway
- State highway
- Medium-duty primary road
- Medium-duty secondary road
- Light-duty road
- Unimproved road
- Railroad
- Unpaved landing strip
- Airport

Resource Development

- Fill material

Geologic Unit Boundaries

- Observed contact
- Concealed contact

Geologic Structure

- Fault — inferred
- U/D — Fault block — "U" = upthrown, "D" = downthrown

Hydrology and Topography

- Perennial stream
- Intermittent stream
- Perennial water body
- Perennial water body, manmade shoreline
- Elevation contour (100-foot interval)
- Elevation contour (20-foot interval)
- Depression contour (100-foot interval)
- Depression contour (20-foot interval)

Pits and Quarries

- Pcs — Coal strip pit
- Pls — Limestone quarry
- Pss — Sandstone quarry

Index to 1:24,000-scale USGS quadrangle maps

Index shows the names and locations of the 20 USGS 7.5-min 1:24,000-scale quadrangles used in the digital compilation of the Bourbon County map. The geology was mapped in the field using these topographic maps.

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Bell, E. L., and Fortner, J. R., 1981, Soil survey of Bourbon County, Kansas: U.S. Department of Agriculture, Soil Conservation Service and Kansas Agricultural Experiment Station, 89 p., 50 maps.

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SUGGESTED REFERENCE TO THIS MAP

West, R. R., and Sawin, R. S., [2002] 2020, Surficial Geology of Bourbon County, Kansas: Kansas Geological Survey, Map M-97 (revised), scale 1:50,000.

Elevation contours, from the USGS US Topo dataset, are presented for general reference. They were generated from 1/3 arc-second National Elevation Dataset (NED) digital elevation models (DEMs), filtered to smooth the arcs. The NED data were modified by the National Hydrography Dataset (NHD) features for better integration between hypsography and hydrography. In some places the contours may be more generalized than the base maps used for compilation of geologic contacts. Contacts on the map will typically reflect topographic variation more accurately than the associated contour lines. Repeated fluctuation of a contact across a contour line indicates that the mapped rock unit is maintaining a relatively constant elevation along a generalized contour.

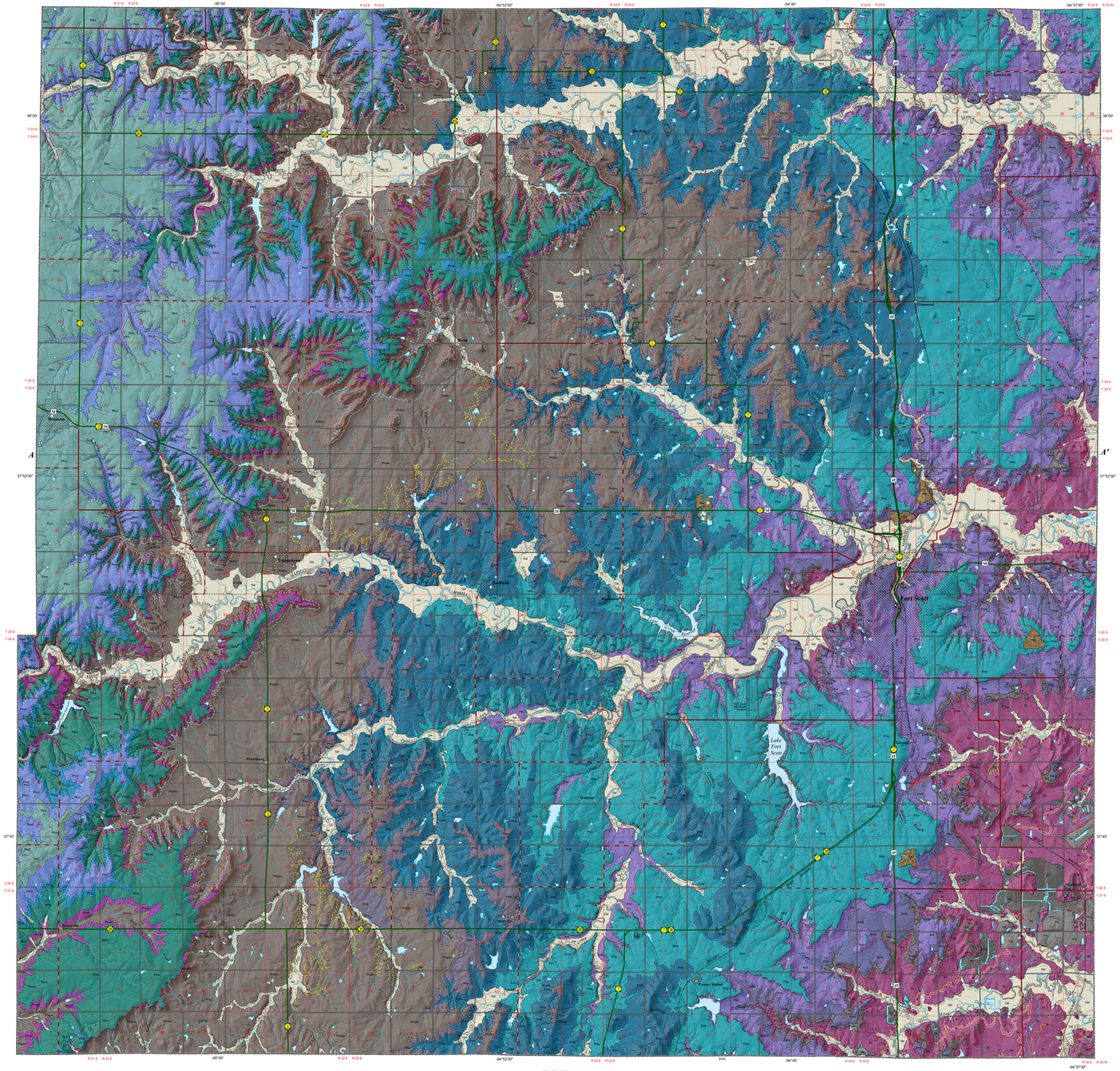
Roads and highways are shown on the base map as represented by data from the Kansas Department of Transportation (KDOT) and other sources. U.S. Department of Agriculture–Farm Services Agency (USDA-FSA) National Agriculture Imagery Program (NAIP) imagery also was used to check road locations.

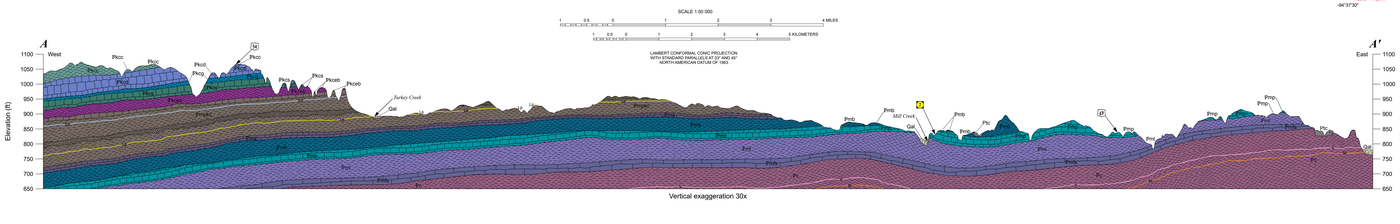
Shaded relief is based on 1-meter hydroflattened bare-earth DEMs from the State of Kansas LiDAR Database. The DEM images, in Erdas Imagine (.img) format, were mosaicked into a single output DEM in Esri file geodatabase raster format. That DEM was then downsampled to 2-meter resolution and subsequently converted to geographic coordinates. 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.

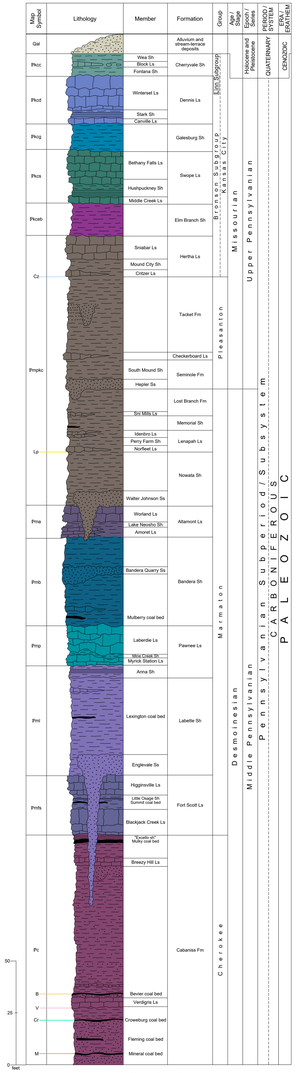
This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program.

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

Last updated 6/28/2024

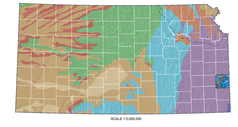






Lithologic Explanation

- Unconsolidated silt, sand, and gravel
- Limestone
- Black shale
- Sandstone
- Sandy mudrock
- Mudrock
- Coal



GENERALIZED GEOLOGY OF KANSAS

QUATERNARY SYSTEM — Holocene–Pleistocene Series
- Loess and river-valley deposits
- Sand dunes
- Glacial-drift deposits
- Limit of glaciation in Kansas

NEOGENE SYSTEM — Miocene Series
- Ogallala Fm

CRETACEOUS SYSTEM

PERMIAN SYSTEM

CARBONIFEROUS SYSTEM
- Pennsylvanian Subsystem
- Mississippian Subsystem

Computer compilation and cartography by the Kansas Geological Survey's Cartographic Services unit. For purchase information, or for information about other KGS maps or publications, please call

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(785) 864-3965

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GEOLOGIC UNITS

CENOZOIC ROCKS

Holocene

Alluvium and stream terraces—Alluvium and stream terraces include sand, gravel, silt, and clay that were deposited on floodplains by streams, creeks, and rivers. Deposits estimated to be 5 ft (1.5 m) or more in thickness, based on Bell and Fortner (1981), are included in this unit. Qal

PALEOZOIC

Cherryvale Shale—The Cherryvale Shale occurs only in the northwestern part of Bourbon County and like the other mudrock units in the county, it is mostly covered. A thin, hard, dense limestone bed, probably the **Block Limestone Member**, is occasionally exposed. Pkcc

Dennis Limestone—The lowest member of the Dennis Limestone, the **Canville Limestone Member**, is a thin, slabby, hard, slightly fossiliferous limestone 1 ft (0.3 m) or less in thickness. Above the Canville Limestone Member, the **Stark Shale Member** is lithologically similar (black shale and gray mudrock) to, but thinner than, the Hushpuckney Shale Member of the Swope Limestone. Overlying the Stark Shale Member is the **Winterset Limestone Member**, a medium to thick-bedded, light-gray to whitish, fossiliferous, often algal limestone that is 3 to 20 ft (1 to 6 m) thick. A crossbedded, oolitic limestone occurs in the upper part of the Winterset. Chert may also occur in the middle and upper parts. The Dennis Limestone is well exposed in the northwestern part of the county and is 25 to 50 ft (8 to 15 m) thick. Pkcd

Galesburg Shale—The Galesburg Shale is a medium- to dark-gray to yellowish-brown, platy to blocky mudrock that may be silty and/or sandy. The Galesburg is commonly covered and ranges from 2 to 15 ft (0.6 to 5 m) thick. Pkcg

Swope Limestone—At the base of the Swope Limestone, the **Middle Creek Limestone Member** is a hard, dense, bluish-gray, sparsely fossiliferous limestone between 1 and 2 ft (0.3 to 0.6 m) thick. It is easily identified because of its position just below the dark-gray to black, platy to fissile shale of the **Hushpuckney Shale Member**. The lower part of the Hushpuckney is black shale and the upper part is a yellowish-gray mudrock. In northeastern Bourbon County, the Hushpuckney is up to 8 ft (2.4 m) thick, but commonly it is thinner. Overlying the Hushpuckney Shale Member is the **Bethany Falls Limestone Member**, consisting of 15 to 35 ft (5 to 11 m) of thin, wavy-bedded, light-gray, fossiliferous limestone. The upper 10 to 12 ft (3 to 4 m) of the Bethany Falls is more thickly bedded and is whitish-gray with darker gray mottling. Oolitic beds may also be present. Pkcs

Elm Branch Shale—The Elm Branch Shale ranges from 5 to 15 ft (1.5 to 5 m) thick. Most often this unit is covered, its position and thickness determined by the top of the underlying Sniabar Limestone Member of the Hertha Limestone and the base of the overlying Middle Creek Limestone Member of the Swope Limestone. Where seen, the Elm Branch is a medium- to dark-gray to yellowish-brown, platy to blocky mudrock. In places it may be slightly silty and sandy. Pkceb

Hertha Limestone, Tacket Formation, Checkerboard Limestone, Seminole Formation, Lost Branch Formation, Memorial Shale, Lenapah Limestone, and Nowata Shale—The interval between the base of the Sniabar Limestone Member of the Hertha Limestone and the top of the Altamont Limestone is predominantly siliciclastic and contains several thin, discontinuous limestones. The thickness of this interval ranges from 100 ft (30 m) to more than 180 ft (55 m). The Norfleet Limestone Member of the Lenapah Limestone and the Critzer Limestone Member of the Hertha Limestone are locally mappable but are not continuous throughout the county. The boundary between the Desmoinesian and Missourian series occurs within this interval, but lithostratigraphic evidence for separating them was not found. Pmpkc

Hertha Limestone—The Hertha Limestone is composed of three members that are, in ascending order, the **Critzer Limestone Member**, the **Mound City Shale Member**, and the **Sniabar Limestone Member**. The Critzer Limestone Member is thin or absent in Bourbon County, and the Mound City Shale Member is a gray, medium- to thick-bedded, fossiliferous limestone that ranges from 5 to 10 ft (1.5 to 3 m). The Sniabar is commonly an algal limestone with numerous vugs and ranges from 5 to 10 ft (1.5 to 3 m) thick. Abundant iron oxide gives it a dark-reddish-brown weathered color.

Tacket Formation—The Tacket Formation is a gray, thin-bedded micaceous siltstone (Seevers, 1969). Because the Checkerboard Limestone is thin or absent, it is difficult to separate the Tacket from the underlying Seminole Formation. Sequences of interbedded, thin, hard, dense, dark-gray, unfossiliferous limestones and medium-gray mudrocks, referred to in the literature as the Bourbon flags, occur in the upper part of the Tacket. The stratigraphic position of the Bourbon flags is unclear and may be, in part, equivalent to the Critzer Limestone Member of the Hertha Limestone. The occurrence of the Bourbon flags is not consistent.

Checkerboard Limestone—The Checkerboard Limestone (or its equivalent) is thin or absent in Bourbon County.

Seminole Formation—The Seminole Formation contains two members, the **Hepler Sandstone Member** and the **South Mound Shale Member**. The Hepler sandstone is a relatively thin, fine-grained, brown to gray sandstone that can be calcareous; it is sometimes seen in outcrop. The South Mound shale is a gray, argillaceous mudrock and may contain minor amounts of coal and limestone (Jewett et al., 1965); it is usually covered in Bourbon County. The Seminole Formation is 10 to 20 ft (3 to 6 m) thick.

Lost Branch Formation and Memorial Shale—The Lost Branch Formation and Memorial Shale (in descending order) are not well exposed in Bourbon County. Jewett (1945) suggested the combined thickness of these gray, bedded, slightly blocky clay mudrock units is generally less than 30 ft (9 m). Formerly the Holdenville Shale (Zeller, 1968), Heckel (1991) has proposed the names Lost Branch Formation and Memorial Shale.

Lenapah Limestone—The Lenapah Limestone consists of two limestones and an intervening mudrock. They are, in ascending order, the **Norfleet Limestone Member**, the **Perry Farm Shale Member**, and the **Idenbro Limestone Member**. In Bourbon County, both limestones vary in lithology and are thin (less than 2 ft [0.6 m]) or absent. The Perry Farm shale is a gray mudrock that may contain thin beds of limestone or irregular limestone nodules. Its thickness may range from 10 to 15 ft (3 to 5 m) (Jewett, 1945).

Nowata Shale—The poorly exposed Nowata Shale is composed of light-gray, yellow, and limonitic mudrocks, sandy mudrocks, and sandstone. It varies in thickness from a few feet to nearly 50 ft (15 m) (Jewett, 1945). The Nowata Shale is lithologically similar to the Labette Shale and Bandera Shale. An incised valley-fill sandstone, the **Walter Johnson Sandstone Member**, occurs in the lower part of the Nowata and in places appears to cut out part, or all, of the Altamont Limestone but also can be locally absent. Pmnd

Altamont Limestone—In general, the Altamont Limestone in Bourbon County ranges from 10 to 15 ft (3 to 4.5 m) thick (Jewett, 1945). In ascending order, the Altamont Limestone is composed of the **Amoret Limestone Member**, the **Lake Neosho Shale Member**, and the **Worland Limestone Member**. The Amoret Limestone Member is absent or represented by a poorly developed nodular limestone. In the northwestern part of the county, it is a thin conglomerate to brecciated carbonate; in southeast Bourbon County, the Amoret is better developed and the three members of the Altamont are recognizable. The prominent Worland Limestone Member is a hard, medium-gray, slightly fossiliferous, medium-bedded limestone. Between the Worland and Amoret, the Lake Neosho Shale Member is a yellow-brown to light-gray mudrock that contains dark phosphatic nodules. Pmna

Bandera Shale—The Bandera Shale overlies the Pawnee Limestone and ranges from 40 ft (12 m) to more than 60 ft (18 m) thick. Mostly a siliciclastic sequence, the lower part of the Bandera Shale contains a thin coal, the **Mulberry**, and in the southern part of the county, a thin, dark-brown, fossiliferous limestone that occurs just above the Mulberry. This limestone may be what has been informally called the Edna limestone in adjacent counties. A thick sandstone, the **Bandera Quarry Sandstone Member**, is a conspicuous component of this formation, though its occurrence is restricted. West of Redfield, Kansas, it is quarried for building stone. Pmpb

Pawnee Limestone—Units mapped as the Pawnee Limestone are, in ascending order, the **Myrick Station Limestone Member**, **Mine Creek Shale Member**, and **Labette Limestone Member**. The combined thickness of these three members in Bourbon County ranges from 20 to 30 ft (6 to 9 m). Although the **Anna Shale Member** is formally recognized (Zeller, 1968) as the basal member of the Pawnee Limestone, this study does not support the mappability of the base of the Anna Shale Member. The thickness of the Anna is variable (usually 2 to 6 ft [0.6 to 2 m]) and sometimes it is absent. The top of the underlying Labette Shale is often a black to very dark-gray mudrock or shale, making it difficult to distinguish from the overlying Anna. The Myrick Station Limestone Member (1 to 8 ft [0.3 to 2.4 m]) is a thin-bedded, gray, fossiliferous limestone that weathers into reddish-orange-brown blocks. The Mine Creek Shale Member, a dark-gray fossiliferous mudstone, is usually thin (less than 2 ft [0.6 m]) or absent. The Labette Limestone Member is responsible for most of the thickness (up to 20 ft [6 m]) of the Pawnee Limestone in Bourbon County. The Pawnee thickens where concentrations of algal debris occur in the light- to medium-gray, hard, thin- to medium- and thick-bedded fossiliferous Labette. Pmpa

Labette Shale—The Labette Shale is a siliciclastic sequence that ranges from 30 to 75 ft (9 to 23 m) thick. Although it is mostly mudrock, a sandstone (the **Englevale Sandstone Member**) occurs in the lower part; a thin coal, the **Lexington coal bed**, occurs near the middle; and a thin limestone may be present in the upper part. This thin limestone may be what has informally been called the Winer School limestone in adjacent counties. The Englevale Sandstone Member appears to be an incised valley-fill deposit (formerly referred to in the literature as a channel sandstone) that, in places, cuts out the lower Labette Shale, the Fort Scott Limestone, and the Cabaniss Formation down to the top of the Verdigris Limestone Member (Schoewe, 1959). Pmnb

Fort Scott Limestone—The Fort Scott Limestone consists of two prominent limestone members and a dark-gray to black intervening mudrock and shale. The Fort Scott Limestone is stratigraphically the lowest conspicuous limestone in the county and ranges from 20 to 30 ft (6 to 9 m) thick. The lowest member, the **Blackjack Creek Limestone Member**, is thinly bedded in the upper part with the lower part more medium to thickly bedded. The Blackjack Creek Limestone Member (8 to 12 ft [2.4 to 4 m] thick), and the upper member, the **Higginsville Limestone Member** (8 to 15 ft [2.4 to 4.5 m] thick) are hard, dense, gray, fossiliferous limestones. Between these two limestones is the **Little Osage Shale Member** (about 5 ft [1.5 m] thick), a dark-gray to yellowish-brown mudrock in the upper part and a black, platy to fissile shale in the lower part. A thin coal, the **Summit coal bed**, sometimes occurs within this member. Pmnb

CHEROKEE GROUP—The Cherokee Group, a siliciclastic sequence, consists of marine and nonmarine sandstones, thin limestones, coal beds, and silty, sandy mudrocks. The Cherokee Group (including surface and subsurface rocks) is composed of the Cabaniss Formation above and the Krebs Formation below (Zeller, 1968) and in Bourbon County is up to 400 ft (122 m) thick (Ebanks et al., 1977). The Krebs Formation does not occur at the surface in Bourbon County.

Cabaniss Formation—Underlying the Blackjack Creek Limestone Member of the Fort Scott Limestone is the informally named **Excello shale**, a black, fissile to platy shale that overlies the **Mulky coal bed**. Beneath the Mulky coal is the **Breezy Hill Limestone Member**, a thin-bedded, often pedogenic limestone. The Breezy Hill Limestone Member averages less than 2 ft (0.6 m) but can range from a feather-edge to 8 ft (2.4 m) (Schoewe, 1959). The **Bevier coal bed** occurs below the Breezy Hill and 1 to 2 ft (0.3 to 0.6 m) above the **Verdigris Limestone Member**. The Cabaniss Formation above the Verdigris Limestone Member ranges in thickness from 80 to 100 ft (24 to 30 m). The Verdigris is up to 3 ft (1 m) thick and is easily recognized where it is exposed in the southeastern part of the county. According to Howe (1956), the Verdigris consists of one to three beds of hard, dark-gray to black, fossiliferous limestone that weather a dark orange-brown. This interval is sometimes informally subdivided; the thick limestone is regarded as the Verdigris and the one or two other thinner limestone beds and associated black shale are referred to as the V-shale, a unit widely recognized in the subsurface. Below the Verdigris, the Cabaniss consists of sandstones and mudrocks with three named coal beds. The coals are, in descending order, the **Croweburg**, **Fleming**, and **Mineral**. Calcareous, pyritic beds often overlie these coals and form caprocks. The Mineral and Crowburg coals have been extensively mined, but the Fleming is poorly developed in the county. Below the Verdigris, 10 to 45 ft (3 to 14 m) of Cabaniss is exposed in Bourbon County. The four coal beds—Mulky, Bevier, Croweburg, and Mineral—were mapped using data in the files of the Kansas Geological Survey. Pc