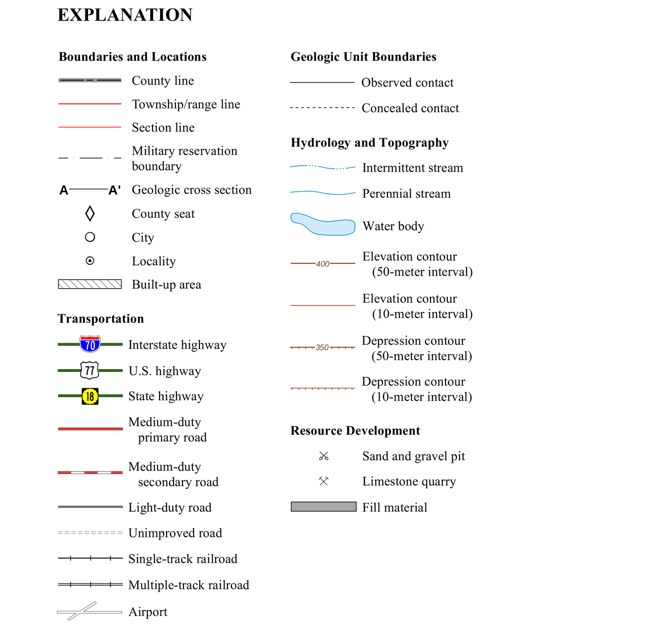
MAP M-122

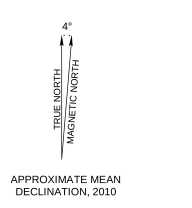
SURFICIAL GEOLOGY OF GEARY COUNTY, KANSAS

Geology by Robert S. Sawin and Ronald R. West

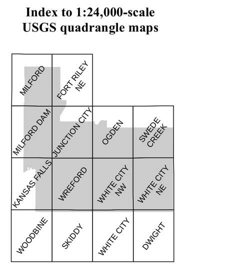
2010

Computer compilation and cartography by John W. Dunham, Scott T. Klopfenstein, R. Zane Price, and Ian J. Ramirez





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



Index shows the names and locations of the 14 USGS 7.5-min 1:24,000-scale quadrangles used in the digital compilation of the Geary County map. The geology was mapped in the field using these topographic maps.

Elevation contours are presented for general reference. They are generated from U.S. Geological Survey National Elevation Dataset (NED) digital elevation models (DEM) with 1/3 arc-second resolution, which are in turn generated from high-resolution elevation data and other USGS DEMs. In some places the contours may be more generalized than the base maps 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.

2006 U.S. Department of Agriculture – Farm Services Agency (USDA-FSA) National Agriculture Imagery Program (NAIP) digital imagery and 2002 USDA-FSA digital black and white orthophotos were used as reference in the digital mapping. USGS 7.5-min 1:24,000-scale topographic maps and USDA Natural Resources Conservation Service (NRCS) soil surveys were used to supplement the mapping.

Land within the Fort Riley Military Reservation, and a small area along the south and west boundaries of the fort, was not included in the original U.S. Public Land Survey. These areas were later surveyed randomly, without regard to existing section numbers or lines. As a consequence, within Townships 11 and 12 South, and Ranges 5 and 6 East, there are not only sections or partial sections 1 to 13, but also partial "special sections" (designated "SS") 1 to 13 (Suchy, 2002).

Roads and highways shown on the base map as represented by data from the Kansas Department of Transportation (KDOT) and Geary County. USDA-FSA 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.

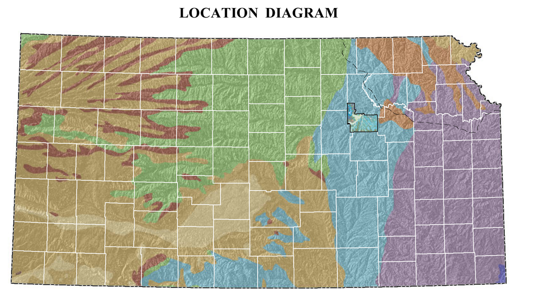
Map partially funded by the National Cooperative Geologic Mapping STATEMAP Program.

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

CITED REFERENCE

Suchy, D. R., 2002, The Public Land Survey System in Kansas: Kansas Geological Survey, Public Information Circular 20, 4 p.

LOCATION DIAGRAM



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
Pliocene - Miocene Series
- Ogallala Fm
- CRETACEOUS SYSTEM
- JURASSIC SYSTEM
- PERMIAN SYSTEM

CARBONIFEROUS SYSTEM
- Pennsylvanian Subsystem
- Mississippian Subsystem

ADDITIONAL SOURCES

Chaplin, J. R., 1988, Lithostratigraphy of Lower Permian rocks in Kay County, north-central Oklahoma, and their stratigraphic relationships to lithic correlatives in Kansas and Nebraska, p. 79-111; *in*, Permian Rocks of the Midcontinent, W. A.. Morgan and J. A. Babcock, eds.: Society of Economic Paleontologists and Mineralogists, Midcontinent Section, Special Publication, no. 1, 224 p.

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U.S. Army Corps of Engineers, undated, Geologic map and column of the Milford Lake construction area.

Voran, R. L., 1977, Fossil assemblages, stratigraphy, and depositional environments of the Crouse Limestone (Lower Permian) in north central Kansas: Unpublished master's thesis, Kansas State University, 208 p.

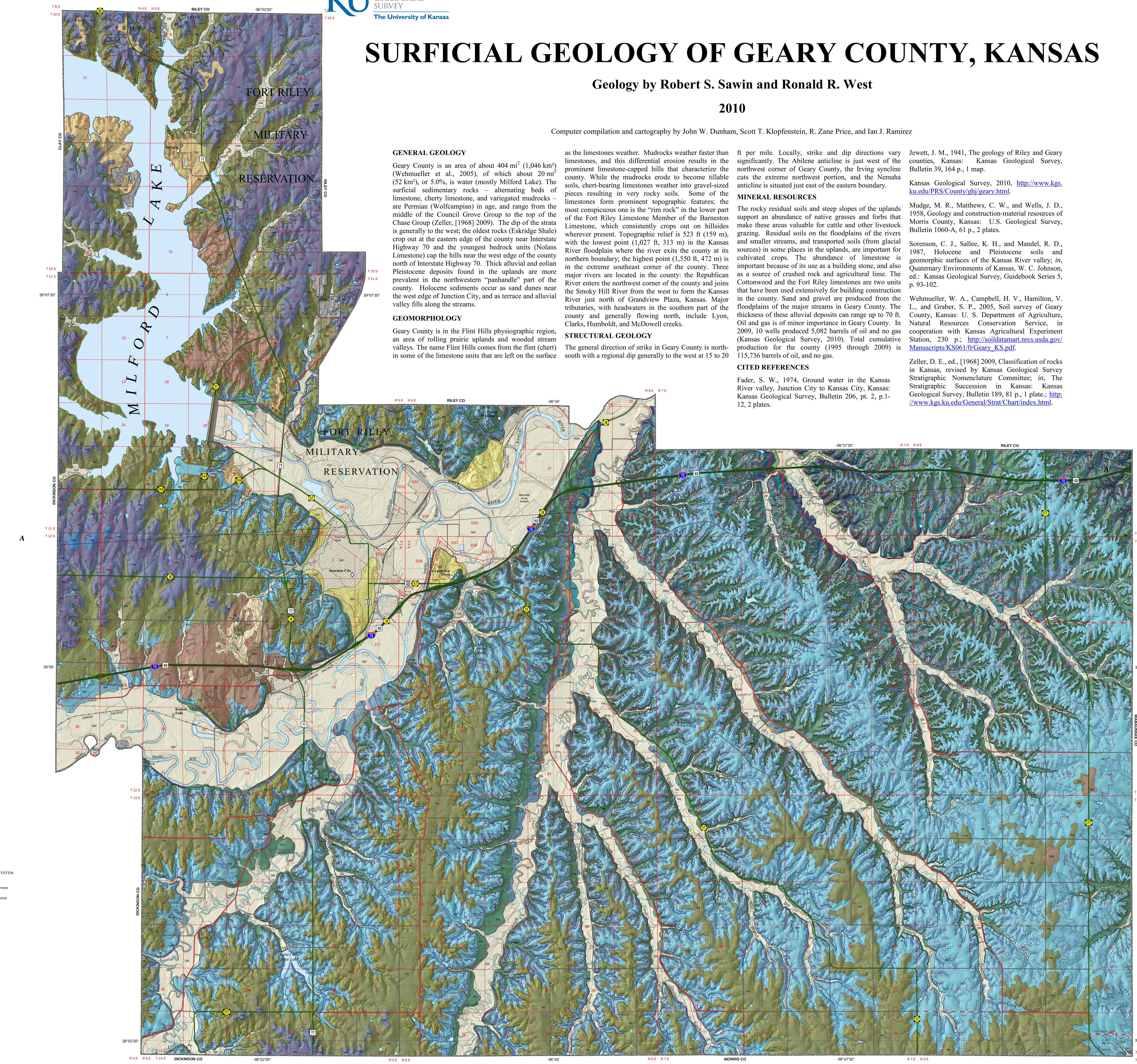
West, R. R., ed., 1972, Stratigraphy and depositional environments of the Crouse Limestone (Permian) in north-central Kansas: Geological Society of America, Field Trip Guidebook for 6th Annual Meeting, South Central Section, 109 p.

SUPPLEMENTAL REFERENCE

Sawin, R. S., and West, R. R., 2010, Data control points used to construct the surficial geology map (M-122) of Geary County, Kansas: Kansas Geological Survey, Open-file Report 2010-13, 218 p.

SUGGESTED REFERENCE TO THIS MAP

Sawin, R. S., and West, R. R., 2010, Surficial geology of Geary County, Kansas: Kansas Geological Survey, Map M-122, scale 1:50,000.



GENERAL GEOLOGY

Geary County is an area of about 404 mi^2 (1,046 km^2) (Wehmueller et al., 2005), of which about 20 mi^2 (52 km^2), or 5.0%, is water (mostly Milford Lake). The surficial sedimentary rocks – alternating beds of limestone, cherty limestone, and variegated mudrocks – are Permian (Wolfcampian) in age, and range from the middle of the Council Grove Group to the top of the Chase Group (Zeller, [1968] 2009). The dip of the strata is generally to the west; the oldest rocks (Eskridge Shale) crop out at the eastern edge of the county near Interstate Highway 70 and the youngest bedrock units (Nolans Limestone) cap the hills near the west edge of the county north of Interstate Highway 70. Thick alluvial and eolian Pleistocene deposits found in the uplands are more prevalent in the northwestern "panhandle" part of the county. Holocene sediments occur as sand dunes near the west edge of Junction City, and as terrace and alluvial valley fills along the streams.

GEOMORPHOLOGY

Geary County is in the Flint Hills physiographic region, an area of rolling prairie uplands and wooded stream valleys. The name Flint Hills comes from the flint (chert) in some of the limestone units that are left on the surface as the limestones weather. Mudrocks weather faster than limestones, and this differential erosion results in the prominent limestone-capped hills that characterize the county. While the mudrocks erode to become tillable soils, chert-bearing limestones weather into gravel-sized pieces resulting in very rocky soils. Some of the limestones form prominent topographic features; the most conspicuous one is the "rim rock" in the lower part of the Fort Riley Limestone Member of the Barneston Limestone, which consistently crops out on hillsides wherever present. Topographic relief is 523 ft (159 m), with the lowest point (1,027 ft, 313 m) in the Kansas River floodplain where the river exits the county at its northern boundary; the highest point (1,550 ft, 472 m) is in the extreme southeast corner of the county. Three major rivers are located in the county: the Republican River enters the northwest corner of the county and joins the Smoky Hill River from the west to form the Kansas River just north of Grandview Plaza, Kansas. Major tributaries, with headwaters in the southern part of the county and generally flowing north, include Lyon, Clarks, Humboldt, and McDowell creeks.

STRUCTURAL GEOLOGY

The general direction of strike in Geary County is north-south with a regional dip generally to the west at 15 to 20 ft per mile. Locally, strike and dip directions vary significantly. The Abilene anticline is just west of the northwest corner of Geary County, the Irving syncline cuts the extreme northwest portion, and the Nemaha anticline is situated just east of the eastern boundary.

MINERAL RESOURCES

The rocky residual soils and steep slopes of the uplands support an abundance of native grasses and forbs that make these areas valuable for cattle and other livestock grazing. Residual soils on the floodplains of the rivers and smaller streams, and transported soils (from glacial sources) in some places in the uplands, are important for cultivated crops. The abundance of limestone is important because of its use as a building stone, and also as a source of crushed rock and agricultural lime. The Cottonwood and the Fort Riley limestones are two units that have been used extensively for building construction in the county. Sand and gravel are produced from the floodplains of the major streams in Geary County. The thickness of these alluvial deposits can range up to 70 ft. Oil and gas is of minor importance in Geary County. In 2009, 10 wells produced 5,082 barrels of oil and no gas (Kansas Geological Survey, 2010). Total cumulative production for the county (1995 through 2009) is 115,736 barrels of oil, and no gas.

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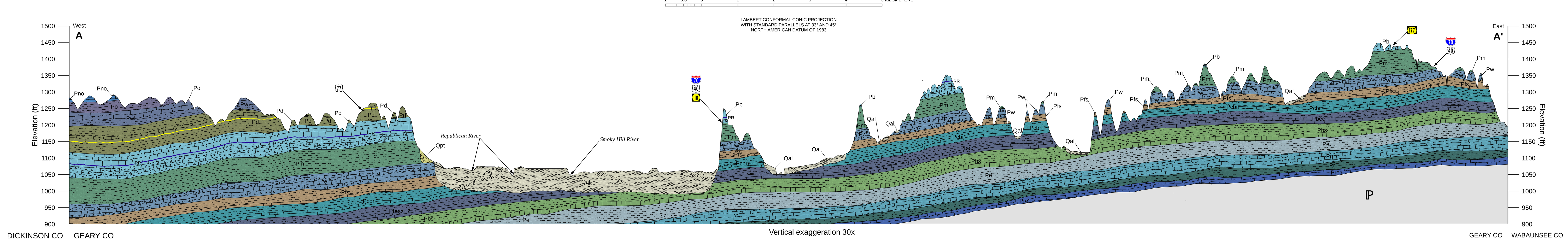
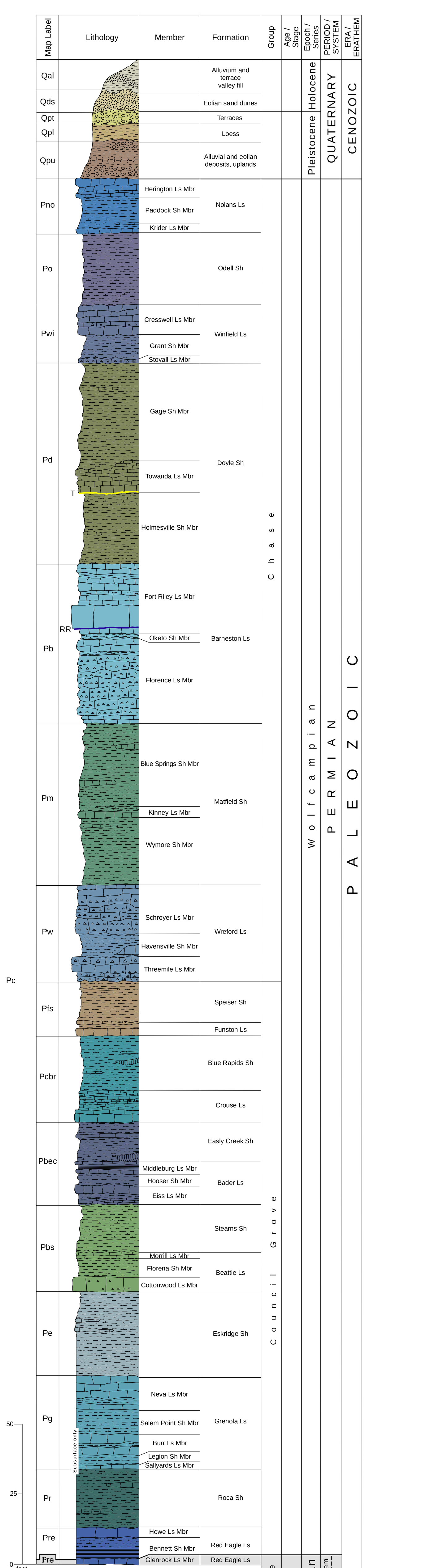
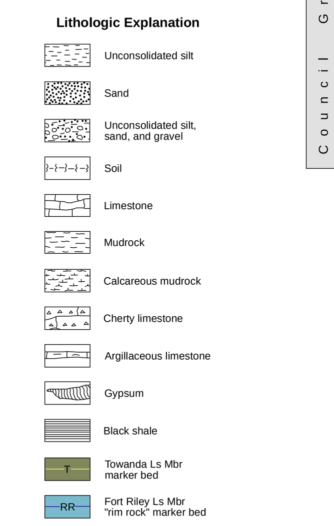




Lithologic Explanation



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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University of Kansas
Lawrence, Kansas 66047

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GEOLOGIC UNITS

These descriptions are a compilation of several sources including field notes and measured sections, Kansas Department of Transportation geological reports and profiles, and lithologic descriptions in Jewett (1941), Mudge et al. (1958), and others.

CENOZOIC

Holocene

Qal

Alluvium and Terrace Valley Fill – Alluvium and terrace valley fill of major rivers and smaller streams. The smaller streams that drain the uplands have floodplain sediment derived primarily from weathered shale and loess, so clay and silt dominate these deposits. Floodplain deposits of the major rivers (Smoky Hill, Republican, and Kansas) contain mostly silt, sand, and gravel (the coarsest sediments are near the bedrock surface). These deposits can reach thicknesses greater than 70 ft in the Kansas River valley. Terraces in the present-day floodplain are called Newman (oldest) and Holliday (youngest) by Sorenson et al. (1987).

Qds

Sand Dunes – Holocene sand dunes are found in an area north of the Kansas River and west of Junction City. These eolian sands were derived from the Kansas River floodplain and deposited by prevailing southerly winds on the slopes north of the river.

Pleistocene

Qpt

Terraces – Pleistocene terraces are composed of alluvial sediments (clay, silt, sand, and gravel) that were deposited by present-day rivers when the stream bed was at a higher elevation. These former floodplain remnants are positioned on the sides of the valleys above the current floodplain. The Pleistocene terraces mapped in Geary County are after Fader (1973) and Sorenson et al. (1987) and are referred to as the Buck Creek terrace.

Qpl

Loess – Loess is windblown silt associated with glacial activity. Loess was originally deposited as outwash or floodplain sediments that were redeposited in the uplands by wind. A thin mantle of reddish-brown loess covers the high upland ridges, flats, and side slopes in much of Geary County, but the thickest deposits are associated with the Republican River valley, especially in the Milford, Kansas, area. Known deposits of loess greater than 10 ft thick were mapped.

Qpu

Alluvial and Eolian Deposits (Uplands) – Mixed alluvial and eolian deposits positioned on the uplands. Fluvial clay, silt, sand, and gravel sediments and windblown sand and silt characterize this unit. In Geary County, known accumulations greater than 10 ft thick were mapped; significant areas of these deposits are found north of the Kansas River just west of Junction City and north of Milford Dam on the east side of Milford Lake.

PALEOZOIC

Pno

Nolans Limestone – The **Krider Limestone Member** at the base of the Nolans Limestone is one or two beds of hard, gray to a yellowish-brown, locally nodular, limestone containing bivalves and some brachiopods; a thin mudrock bed less than 1 ft thick may separate the two thin limestone beds. The total thickness of the Krider is 1 to 2 ft. Above the Krider limestone, the **Paddock Shale Member** is typically about 11 ft of gray mudrock containing calcite stringers. The upper part of the Paddock is missing in Geary County. The uppermost member of the Nolans Limestone, the **Herington Limestone Member**, is not present in Geary County. The Nolans Limestone is found capping the hills north of Interstate Highway 70 near the western border with Dickinson County.

Po

Odell Shale – Yellow to gray, calcareous mudrocks characterize the lower part of the Odell Shale; the middle and upper parts are variegated (mostly red, but also green, purple and bluish gray). The Odell ranges from 20 to 40 ft in thickness.

Pwi

Winfield Limestone – At the base of the Winfield is the **Stovall Limestone Member,** a thin (1.5 to 2.5 ft), light- to medium-gray, dense limestone containing one to two bands of bluish-gray chert and some fossils. Although thin, the Stovall is a reliable marker bed and is easily recognized by the presence of chert (its stratigraphic position is over 100 ft above the uppermost major chert-bearing limestone); at times, the only clue to its existence is a band of chert rubble. Above the Stovall, the **Grant Shale Member** ranges from 9 to 16 ft, but is commonly about 10 ft thick. It is a gray to yellowish-gray, crumbly, fossiliferous mudrock; *Derbyia* sp., productids, and the bivalve *Myalina* sp. are common. The Grant is exposed at several localities. The uppermost **Cresswell Limestone Member** is about 16 ft thick with thick to massive beds of yellowish-brown to medium-gray, fossiliferous (echinoid spines are characteristic), sometimes vuggy limestone in the lower 5 to 6 ft; the upper beds are a thin-bedded, platy, argillaceous, medium-gray to yellowish-brown limestone that weathers somewhat like a calcareous mudrock. Calcite geodes and concretions are common in the upper part. The lower contact with the Grant shale is sharp and often exposed; the upper contact is almost always covered. The Winfield outcrop is restricted to the "panhandle" region north of the Smoky Hill River and a small area along the southern border near U.S. Highway 77. The total thickness of the Winfield Limestone is about 25 to 30 ft.

Pd

Doyle Shale – The lower **Holmesville Shale Member** ranges from 6 to 22 ft in thickness, but more typically is about 15 ft thick. It is predominantly a gray, but also yellow, red, and green mudrock; the upper few feet are characteristically green. A 1- to 5-ft limestone or calcareous mudrock may occur near the middle, but one or more beds of limestone can occur elsewhere. Above the Holmesville is the **Towanda Limestone Member**, a thin- to medium-bedded, platy to blocky, unfossiliferous, characteristically yellow limestone that ranges from 10 to 15 ft thick. The Towanda thickens to form massive bluffs in the Milford, Kansas, area, and is best seen rimming the shore of Milford Lake. Elsewhere, this member forms a prominent bench and is traceable on the landscape. The base of the Towanda is often exposed along with the green mudrock of the underlying Holmesville shale. The upper contact is almost always covered. The Towanda crops out in the western half of the county and along the southern border with Morris County. The uppermost **Gage Shale Member** can be divided into three parts; the lower two-thirds is a variegated (red, green, purple, and dark brown) to dull grayish-yellow mudrock; nearer the top is a thin (less than 1 ft), calcareous mudrock or limestone; the upper part is a yellowish-gray, very fossiliferous mudrock (at some localities, coquinas composed largely of brachiopod shells, mostly *Derbyia* sp., occur). The Gage is rarely exposed in Geary County; its average thickness ranges from 20 to 40 ft. The total thickness of the Doyle Shale is about 60 ft.

Pb

Barneston Limestone – The bottom member of the Barneston, the **Florence Limestone Member**, is the uppermost and thickest of the three conspicuous chert-bearing limestones in Geary County. It is a thick-bedded (up to 1 ft), fossiliferous, yellowish-brown to gray limestone that contains numerous bluish-gray chert nodules or beds up to 0.5 ft thick; the lower 5 ft is alternating beds of mudrock and non-cherty limestone; in the upper part, mudrock partings (up to 2 ft) are common. Hills capped by the Florence limestone are characteristically rounded and covered with small fragments of chert. The Florence is about 30 to 35 ft thick. Overlying the Florence limestone is the **Oketo Shale Member** that is 5 to 6 ft thick; it is bluish gray to yellowish brown, fossiliferous, calcareous, and may contain a thin limestone bed. In the southeast corner of the county, the Oketo ranges from 14 to 21 ft where it occurs along U.S. Highway 177. The light-gray to yellowish-tan **Fort Riley Limestone Member**, the uppermost member of the Barneston Limestone, averages 35 to 40 ft in thickness. A 3- to 6-ft-thick massive limestone bed near the base of this member, the "Fort Riley rim rock," is the most conspicuous limestone in Geary County and is an excellent marker bed. It is easily identified by its light-gray color, thickness, vertical bivalve burrows, and prominent outcrop. Springs commonly occur at the base of the rimrock. Beds above and below the rimrock are medium-bedded, argillaceous limestones and calcareous mudrocks that are generally poorly exposed. The upper part of the Fort Riley limestone becomes more thin bedded and platy. The Barneston Limestone averages about 75 ft in thickness and is exposed nearly everywhere in the county except for the northwestern "panhandle" portion.

Pm

Matfield Shale – The lower **Wymore Shale Member** is 15 to 25 ft of variegated (shades of red, gray, green, purple, and dark brown) mudrock and is rarely exposed. The middle **Kinney Limestone Member** typically ranges from 3 to 8 ft in thickness and is a yellowish-brown limestone. It commonly occurs as two limestones separated by a fossiliferous, calcareous mudrock, but it can vary considerably; at times one of the limestones can be absent or poorly developed, or become a massive, 4-ft bed. The uppermost member of the Matfield Shale is the **Blue Spring Shale Member**; the lower part of this mudrock member is variegated (red, shades of green, dark brown, and purple) and the upper part is calcareous and yellow to gray. One to three limestone and/or calcareous mudrock beds up to 2.5 ft thick can occur within the member. The thickness of the Blue Springs Shale Member ranges from 35 to 40 ft. The total thickness of the Matfield Shale is about 60 ft.

Pw

Wreford Limestone – The **Threemile Limestone Member**, the lowermost member of the Wreford Limestone, is one of the three easily recognized chert-bearing limestones in the county; the lower 2 to 3 ft of the Threemile is a thin-bedded, light-gray limestone with numerous bedded chert nodules. The upper, gray to yellowish-brown, massive, cherty limestone is 7 to 8 ft thick and is the most conspicuous, ledge-forming part of the Threemile. In some areas, the upper limestone has intervals that are void of chert. The Threemile limestone is consistently about 10 to 12 ft thick. Above the Threemile limestone is 10 to 25 ft of gray, flaky to platy, fossiliferous mudrock, the **Havensville Shale Member**; thin limestone beds (up to 2 ft) are common in the upper part of the Havensville, and at some localities, it contains a prominent (5+ ft thick) bioclastic limestone near its base. The **Schroyer Limestone Member** is the uppermost member of the Wreford Limestone and is the second conspicuous chert-bearing limestone in the area; most of the 8 to 10 ft of this light-gray to nearly white limestone is cherty; however, the upper 1 ft is a non-cherty, coated grainstone that is easily recognized where exposed. The Wreford Limestone averages about 40 to 45 ft in thickness. Outcrops are found in the northeastern and central portion of the county.

Pfs

Funston Limestone and Speiser Shale – The thickness of the Funston Limestone is variable and may be from less than 4 to 8 ft thick with less obvious, thin, irregular limestone beds above and below a thick, massive, conspicuous, light-gray to bluish-gray limestone. In some places a gray to yellowish-gray, fossiliferous mudrock may occur either above or below the massive limestone bed. Variegated (gray, red, green, and purple) mudrocks characterize all but the upper portion of the Speiser Shale. Above this variegated interval is a thin, 1- to 2-ft bed of gray to grayish-brown limestone overlain by 2 to 3 ft of yellowish-brown to gray, flaky to platy, fossiliferous mudrock. Brachiopods (*Derbyia* sp., *Composita* sp., and productids), bryozoans, fish, and other vertebrate remains are common in this upper mudrock. The Speiser ranges in thickness from 10 to 18 ft, but probably averages about 14 ft.

Pcbr

Crouse Limestone and Blue Rapids Shale – The Crouse Limestone is most easily recognized by the platy character of the upper 5 to 6 ft of limestone; the lower part consists of one to three beds of medium- to thick-bedded limestone that contains a molluscan fossil assemblage in many places. Between these two limestones is a very clayey, platy limestone that, when weathered, has the appearance of a mudrock. Overall the yellowish-brown to yellowish-gray Crouse Limestone ranges from 8 to 18 ft, but more commonly is about 13 ft thick. The Blue Rapids Shale is a variegated mudrock (gray, gray-green, red, and maroon) that may contain thin beds of limestone; it is 20 to 25 ft thick. A 1.5-ft-thick gypsum bed in the upper part of the Blue Rapids occurs in bridge borings where U.S. Highway 77 crosses Lyon Creek in the east-central part of the county.

Pbec

Bader Limestone and Easly Creek Shale – The **Eiss Limestone Member** of the Bader Limestone consists of three beds: 2.5 ft of thin-bedded, gray limestone, 1.5 ft of gray mudrock, and 2.5 ft of very resistant limestone (total Eiss thickness is about 6 ft). Weathered, vuggy blocks of the upper resistant limestone bed are noticeable on the surface below the outcrop line. Above the Eiss is the **Hooser Shale Member**, an 8-ft bed of gray to grayish-green and maroon mudrock. The **Middleburg Limestone Member** is composed of two yellowish to yellowish-brown limestones separated by a thin, dark-gray to black shale and/or yellowish-gray, mudrock layer. The lower limestone is about 3 ft thick, the middle shale/mudrock varies from 0.5 to over 3 ft, and the upper limestone is variable but usually less that 1 ft thick. The total thickness of the Middleburg is generally 3 to 7 ft. Exposures of the Bader Limestone are restricted to the northeast part of the county. The total thickness of the Bader Limestone is about 17 ft. The dominantly gray and green mudrock of the Easly Creek Shale contains intervals of dark-brown, yellow, and red mudrock with thin limestone beds. A persistent limestone about 2 to 3 ft thick occurs 6 to 8 ft below the top of the formation. The thickness of the Easly Creek ranges from 20 to 30 ft and is best seen in road cuts along Interstate Highway 70 in eastern Geary County. Lenticular layers of gypsum up to 7 ft thick occur at the base of the Easly Creek in bridge borings in the Grandview Plaza, Kansas, area.

Pbs

Beattie Limestone and Stearns Shale – The lower member of the Beattie Limestone, the **Cottonwood Limestone Member**, is a massive, light-gray to white, fossiliferous limestone that is commonly about 6 ft thick; the consistent thickness, abundant fusulinids, and scattered siliceous nodules make it easy to recognize. Immediately above the Cottonwood is the **Florena Shale Member**, a gray to brownish-gray, platy to blocky, calcareous mudrock that is about 7 ft thick; fossils are abundant in the lower 2 ft and the brachiopod *Neochonetes granulifera* is very abundant and aids in identifying this member. The upper member of the Beattie Limestone, the **Morrill Limestone Member** is a brownish-gray, vuggy (some with calcite crystals), poorly bedded limestone that is about 1.5 ft thick. The Beattie Limestone only occurs in the northeast part of the county near Interstate Highway 70 at McDowell Creek and at the eastern edge of the county. The mudrock and upper limestone occasionally contain small mollusks. The average thickness of the Beattie Limestone is about 14 ft. The Stearns Shale is a platy to blocky, gray to yellowish and greenish-gray mudrock that is about 19 ft thick; the Stearns only occurs in the northeast portion of the county near Interstate Highway 70 where it is mostly covered.

Pe

Eskridge Shale – Only the upper part of the Eskridge Shale is exposed in Geary County at the east boundary near Interstate Highway 70. This mudrock is gray and may be fossiliferous. The total thickness of the Eskridge is about 28 ft.