SURFICIAL GEOLOGY OF HODGEMAN COUNTY, KANSAS

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2012

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MAP M-107

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KANSAS GEOLOGICAL SURVEY
The University of Kansas

GENERAL GEOLOGY

Hodgeman County, in southwest Kansas, is bounded by Ness County on the north, Pawnee and Edwards counties on the east, Ford County on the south, and Finney and Gray counties on the west. The county has a total area of 864 mi^2 (2,238 km^2). Cretaceous (145–65 million years ago) and Neogene (23–2.6 million years ago) sedimentary rocks—sandstones, limestones, shales, cherts, and conglomerates—crop out in the county and range in age from Lower Cretaceous (Dakota Formation) to the Miocene and early Pliocene (Ogallala Formation) (Ludvigson et al., 2009). Pleistocene and Holocene loess (wind-deposited silt) mantles most of the southern and eastern portion of the upland regions of the county.

GEOMORPHOLOGY

Hodgeman County lies within the High Plains and Smoky Hills physiographic regions (Schoewe, 1949). In this county, the High Plains are characterized by relatively flat topography and consist of the loess- and Ogallala-capped uplands (Moss, 1932; Schoewe, 1949). In contrast, the Smoky Hills consist primarily of Carlile Shale and Greenhorn Limestone uplands and intermediate slopes (Moss, 1932; Schoewe, 1949). Topographic relief in the county is 594 ft (181 m), with the highest area (2,677 ft, 816 m) in the northwest corner of the county near the Fort Hays limestone exposure, and the lowest point (2,083 feet, 635 m) where the Pawnee River leaves Hodgeman County in the northeast corner. The primary drainage, the Pawnee River, flows from west to east along the northern boundary of the county with its principal tributary, Buckner Creek, flowing sub-parallel to it through the southwest and central portion of the county. The south and south-central sections of the county are drained by Saw Log Creek, a tributary to Buckner Creek. These major drainages have become entrenched, creating broad terraces with narrow floodplains. Three lakes are located in the central part of the county—HorseThief Reservoir, created on Buckner Creek west of Jetmore; Jetmore City Lake, on Spring Creek southwest of Jetmore; and Hodgeman County State Lake, on Rock Creek southeast of Jetmore.

MINERAL RESOURCES

Mineral resources in Hodgeman County include sand, gravel, and caliche from the Ogallala Formation, sand and gravel from alluvial deposits, building stone quarried from the Greenhorn Limestone, and oil and gas. Sand and gravel deposits are used chiefly for road surfacing. Utilization of the Fence-post limestone bed of the Greenhorn was much greater in the past when it was exploited for structural work such as buildings and bridges, but most frequently for fence posts (Moss, 1932).

Oil and gas production is concentrated in subsurface Paleozoic rock formations located in all but the southwestern third of Hodgeman County. Over 45 million barrels of oil and 3 million mcf (1000 cubic ft) of gas have been produced in Hodgeman County. Oil production was in steady decline (491,640 barrels from 280 wells in 1995 to 303,644 barrels from 216 wells in 2007) until production started to increase in 2008. In 2011, 477,077 barrels of oil from 257 wells were reported. Gas production in the county has been intermittent; the best year since 1995 was 2007 when 588,905 mcf were produced from 19 wells. Since 2010, gas production has not been recorded in Hodgeman County (Kansas Geological Survey, 2012a).

WATER RESOURCES

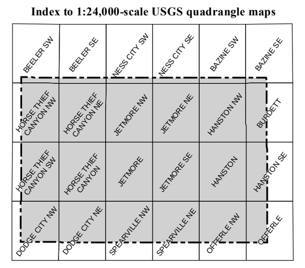
Surface streamflow of the major drainages in Hodgeman County is characterized by very low to no baseflow, except during significant precipitation events, and by high variability in yearly averages, ranging from years of no flow to years of high flow (Whittemore and Macfarlane, 2001; U.S. Geological Survey, 2012). Water for residential and agricultural uses come from wells tapping ground water in the alluvium of the Pawnee River, Buckner Creek, and Saw Log Creek, in the Ogallala Formation, and from sandstones in the Dakota Formation (Moss, 1932; Fishel, 1952; Kume and Spinazola, 1985). The primary sources of water for agricultural irrigation are the Dakota and High Plains (Ogallala) aquifers; however, only about 9% of the total acres in the county are permitted for irrigation (Kansas Geological Survey, 2012b). The rest of the county has low potential for irrigation. Playas are important for ground-water recharge and wetland habitat, and have functioned as perennial or ephemeral water sources for thousands of years (Bowen et al., 2009).

EXPLANATION

Boundaries and Locations

County line
Township/range line
Section line
A——A′ Geologic cross section
County seat

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



Map shows the locations of the 24 quadrangles used in the digital compilation of the Hodgeman County map. The index shows the name of each individual 7.5-minute quadrangle map.

6°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2012

Elevation contours are presented for general reference. They are taken from USGS Digital Line Graph (DLG) files compiled from 1:100,000-scale base maps. In some places the contours from the DLG's 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.

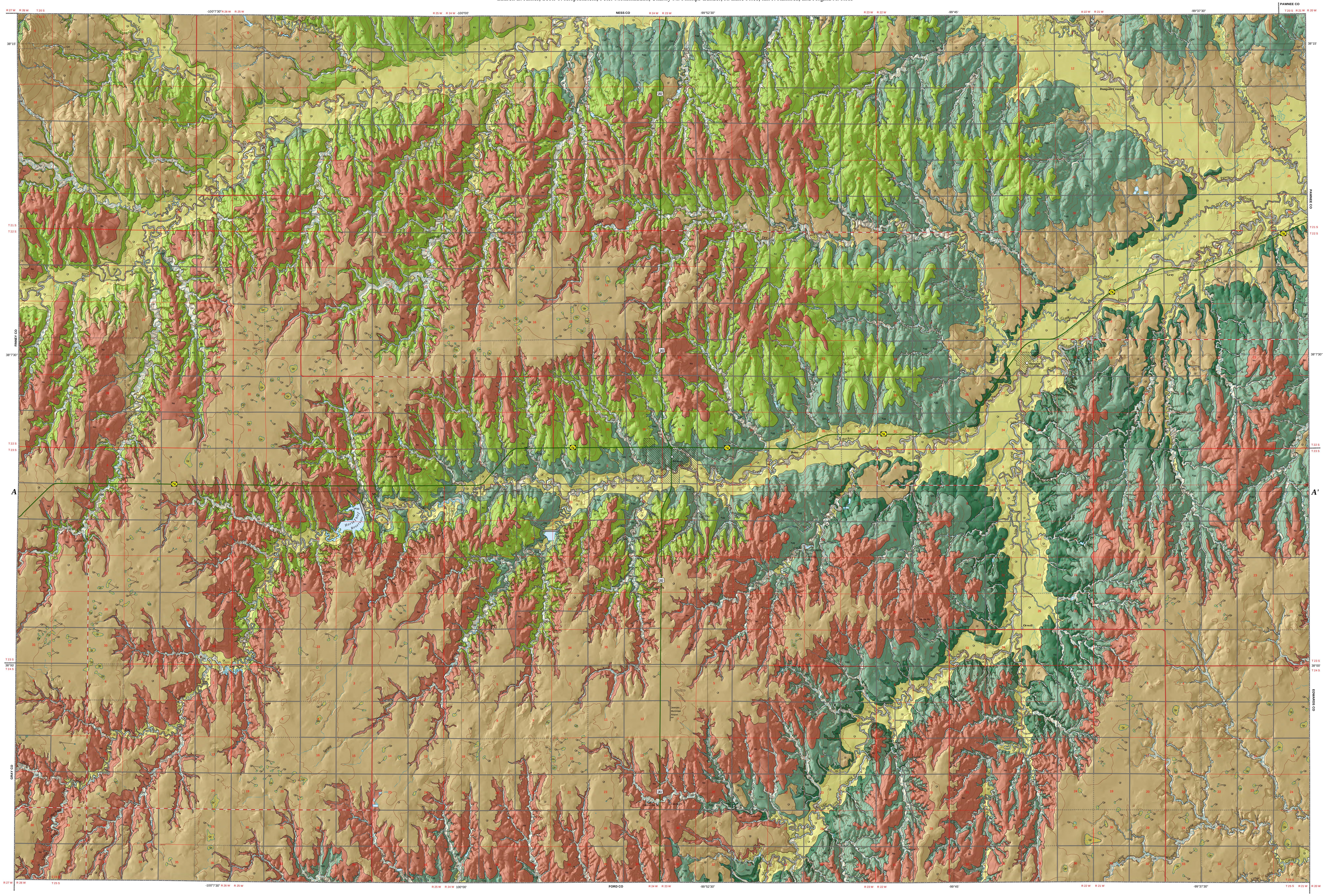
Geology was mapped in the field using USGS 7.5-minute 1:24,000-scale topographic maps.

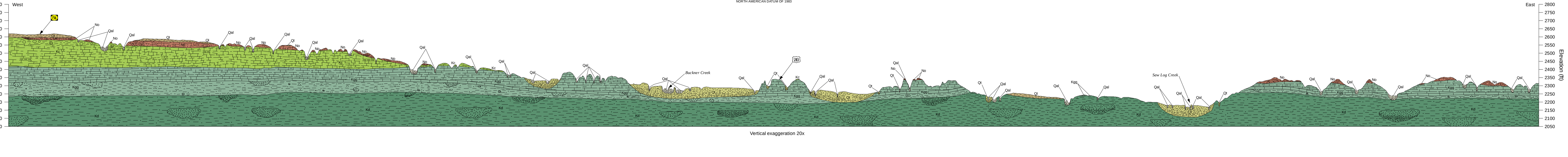
Roads and highways are shown on the base map as represented by data from the Kansas Department of Transportation (KDOT), TeleAtlas, and other sources. U.S. Department of Agriculture – Farm Services Agency (USDA-FSA) National Agriculture Imagery Program (NAIP) imagery also was used to check road locations.

Shaded relief is based on U.S. Geological Survey digital elevation model (DEM) with 1/3 arc-second resolution. The 1/3 arc-second data, in ESRI GRID format, were 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 numbers 00HQAG0055 (FY2000) and 01HQAG0050 (FY2001).

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





CITED REFERENCES

Bowen, M. W., Johnson, W. C., Klopfenstein, S. T., and Dunham, J. W., 2009, Developing a geospatial database of playas within the High Plains of Kansas: Current Research in the Pleistocene, v. 26, p. 191-193.

Fishel, V. C., 1952, Ground-water resources of Pawnee Valley, Kansas: Kansas Geological Survey, Bulletin 94, 144 p.

Hattin, D. E., 1962, Stratigraphy of the Carlile Shale (Upper Cretaceous) in Kansas: Kansas Geological Survey, Bulletin 156, 155 p.; http://www.kgs.ku.edu/Publications/Bulletins/156/index.html

Hattin, D. E., 1965, Stratigraphy of the Graneros Shale (Upper Cretaceous) in central Kansas: Kansas Geological Survey, Bulletin 178, 83 p.

Hattin, D. E., 1975, Stratigraphy and depositional environment of the Greenhorn Limestone (Upper Cretaceous) of Kansas: Kansas Geological Survey, Bulletin 209, 128 p.

Kansas Geological Survey, 2012a, Hodgeman County–Oil and gas production: Kansas Geological Survey; http://www.kgs.ku.edu/PRS/County/ghj/hodgeman.html.

Kansas Geological Survey, 2012b, Kansas High Plains aquifer atlas: Kansas Geological Survey; http://www.kgs.ku.edu/HighPlains/HPA_Atlas/Land%20Cover%20and%20Irrigation/index.html#Water%2520Rights%2520-%2520Percent%2520of%2520Irrigated %2520 Acres.jpg.

Kume, J., and Spinazola, J. M., 1985, Geohydrology of sandstone aquifers in southwestern Kansas: Kansas Geological Survey, Irrigation Series 8, 49 p.

Ludvigson, G. A., Sawin, R. S., Franseen, E. K., Watney, W. L., West, R. R., and Smith J. J., 2009, A review of the stratigraphy of the Ogallala Formation and revision of Neogene ("Tertiary") nomenclature in Kansas: Kansas Geological Survey, Current Research in Earth Sciences, Bulletin 256, part 2, 9 p.; http://www.kgs.ku.edu/Current/2009/Ludvigson/index .html.

Moss, R. G., 1932, The geology of Ness and Hodgeman counties, Kansas: Kansas Geological Survey, Bulletin 19, 48 p.

Schoewe, W. H., 1949, The geography of Kansas, pt. 2, Physical geography: Kansas Academy of Science Transactions, v. 52, no. 3, p. 261-233.

U. S. Geological Survey, 2012, Surface water data from USA: USGS Surface-Water Monthly Statistics: U.S. Geological Survey; http://waterdata.usgs.gov/nwis/monthly.

Wallace, K. C., and Nelson, M. E., 1988, Depositional history of the Codell Sandstone Member, Carlile Shale (Upper Cretaceous), Kansas: Fort Hays State University, Fort Hays Studies, Science, Third Series, no. 10, p 102-116.

Whittemore, D. O., and Macfarlane, P. A., 2001, Identification of salinity sources affecting ground waters in the alluvial aquifer of Buckner Creek, Hodgeman County: Kansas Geological Survey, Open-file Report 2001-61, 26 p.; http://www.kgs.ku.edu/Hydro/ Publications/2001/OFR01_61/index.html.

ADDITIONAL SOURCES

Evans, C. S., 2010, Playas in Kansas and the High Plains: Kansas Geological Survey, Public Information Circular 30, 6 p.; http://www.kgs.ku.edu/Publications/PIC/pic30.html.

Johnson, W. C., and Arbogast, A. F., [1993] 2008, Geologic map of Finney County, Kansas; Playa deposits and Arkansas River terrace deposits by W. C. Johnson and T. L. Woodburn: Kansas Geological Survey, Map M-28 (Revised), scale 1:50,000; http://www.kgs.ku.edu/General/Geology/County/def/finney.html.

Johnson, W. C., and Woodburn, T. L., 2009, Surficial geology of Ford County, Kansas: Kansas Geological Survey, Map M-108, scale 1:50,000; http://www.kgs.ku.edu/General/Geology/County/def/ford.html.

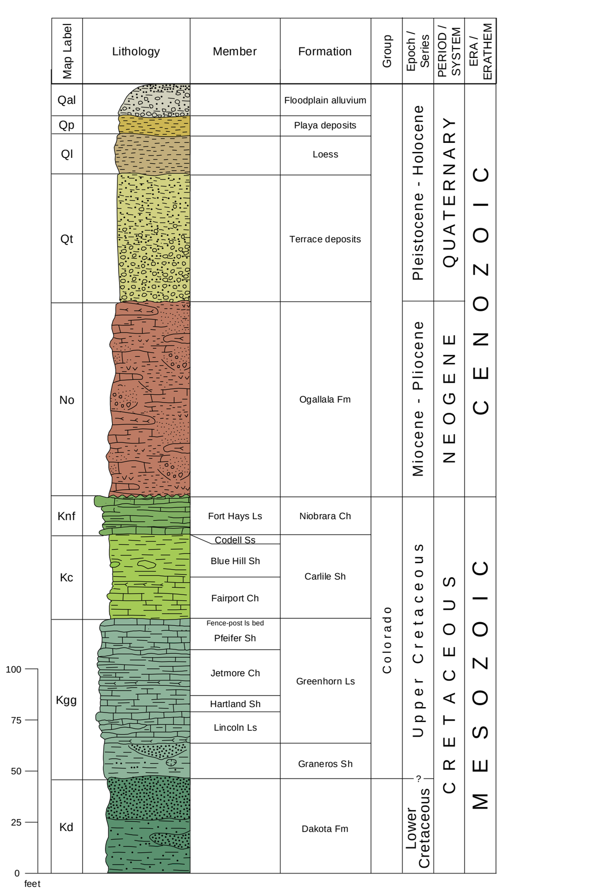
Mandel, R. D., 1994, Holocene landscape evolution in the Pawnee River valley, southwestern Kansas: Kansas Geological Survey, Bulletin 236, 117 p.

Merriam, D. F., 1963, The geologic history of Kansas: Kansas Geological Survey, Bulletin 162, 317 p.; http://www.kgs.ku.edu/Publications/Bulletins/162/index.html.

Neuhauser, K. R., Wilcox, T. M., and Schumacher, B. A., 1996, Geologic map of Ness County, Kansas: Kansas Geological Survey, Map M-47, scale 1:50,000; http://www.kgs.ku.edu/General/Geology/County/nop/ness.html.

SUGGESTED REFERENCE TO THIS MAP

Johnson, W. C., and Woodburn, T. L., 2012, Surficial geology of Hodgeman County, Kansas: Kansas Geological Survey, Map M-107, scale 1:50,000.



Lithologic Explanation

Unconsolidated silt, sand, and gravel
Sandstone or sand
Unconsolidated silt and clay
Shale
Undifferentiated sandstone or siltstone
Limestone
Chalk
Bentonite
Volcanic ash

CENOZOIC ROCKS

Qal — **Undifferentiated floodplain alluvium –** Alluvial floodplain deposits are composed primarily of gravel and silty clay that were derived mostly from the surrounding Ogallala and Cretaceous bedrock. The average thickness of these deposits is about 14 ft.

Qp — **Upland intermittent lake (playa) deposits –** Shallow basins, also known as playas or buffalo wallows, have developed in the upland loess deposits, mainly south of the Pawnee River. The origin of these features is usually attributed to wind deflation, animal activity, dissolution, or some combination of these processes. The age of the playas probably ranges from late Pleistocene to Holocene. The basins range in size from less than an acre to tens of acres. The basin fill consists of re-deposited silt and fine sand from the loess. In the larger basins, a caliche layer typically develops a few feet below the basin floor. The average thickness of the fill is approximately 6 ft.

Ql — **Loess –** Uplands in the county are mantled by loess composed of wind-deposited silt and minor amounts of clay and fine sand. The loess is calcareous and buff in color. The age of the loess ranges from late Pleistocene to Holocene, and the thickness is up to 18 ft.

Qt — **Alluvial terraces –** Terraces occur along the Pawnee River and its major tributaries: Hackberry Creek, Buckner Creek, and Saw Log Creek. Silt and clay dominate the fill, but the deposits also contain sand and gravel likely derived from the Ogallala Formation. The age of the terrace fill ranges from late Pleistocene to at least middle Holocene. The average thickness of the terrace fill is about 60 ft.

No — **Ogallala Formation –** The Ogallala Formation is primarily Miocene and earliest Pliocene in age (Ludvigson et al., 2009) and is composed of gravel, sand, silt, and clay deposited by streams that transported sediments eastward from the Rocky Mountains. These sediments are variously cemented (ranging from unconsolidated to caliche-type deposits) with calcium carbonate. Throughout the Ogallala, thick caliche beds, referred to regionally as "mortar beds," irregularly and discontinuously crop out (Moss, 1932). Silt dominates the Ogallala and commonly occurs in poorly sorted lenticular bodies. In Hodgeman County, the Ogallala Formation caps the uplands, is exposed along rivers and streams, and has a relatively uniform eastward dip of about 10 ft per mile (Moss, 1932). The maximum thickness of the Ogallala in the county is about 100 ft.

MESOZOIC ROCKS

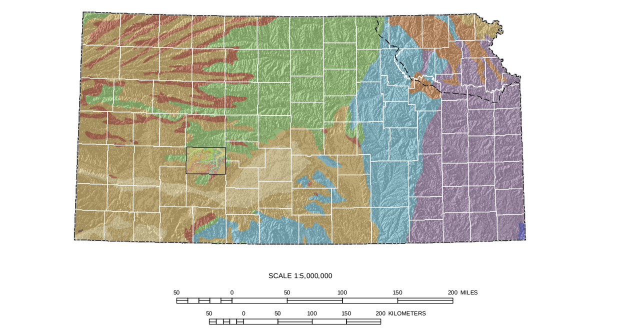
Knf — **Niobrara Chalk –** The Upper Cretaceous Niobrara Chalk is composed of two members, the Smoky Hill Chalk Member and the underlying Fort Hays Limestone Member. As a result of pre-Ogallala erosion, the Smoky Hill Chalk Member has been completely eroded and only the Fort Hays Limestone Member is exposed in Hodgeman County (Moss, 1932). The **Fort Hays Limestone Member** is composed of thick beds of light-to-dark-gray chalk separated by thin beds of chalky shale. Weathered outcrops are cream-to-tan colored. The only occurrence of Fort Hays limestone is in the extreme northwest corner of the county in an area less than half of a square mile (Moss, 1932). Only about 20 ft of Fort Hays limestone is exposed in Hodgeman County.

Kc — **Carlile Shale –** The Cretaceous Carlile Shale is composed of three members, in ascending order: the Fairport Chalk Member, the Blue Hill Shale Member, and the Codell Sandstone Member. The **Fairport Chalk Member** is an olive-gray to dark-gray, blocky, fossiliferous, chalky shale intercalated with chalk and chalky limestone beds and a few thin bentonite beds. Thin beds of chalky limestone are more common near the base of the Fairport Chalk and form small benches when weathered (Moss, 1932; Hattin, 1962). The upper part of the Carlile Shale is represented by the **Blue Hill Shale Member**, which is a bluish-black, blocky to fissile, slightly silty shale containing pyrite nodules, selenite crystals, and septarian concretions (Moss, 1932; Hattin, 1962). The contact between the Blue Hill shale and Fairport chalk is not exposed in Hodgeman County (Moss, 1932). The **Codell Sandstone Member** has not been observed in the county (Wallace and Nelson, 1988; Hattin, 1962; McKellar, 1962). Outcrops of the Carlile Shale occur in the northwestern parts of the county, including areas along Buckner Creek, the upper tributaries of Dry Creek, the Pawnee River, and Hackberry Creek. The total thickness of the Carlile Shale in the county is about 250–300 ft; however, only 40–50-ft intervals are exposed.

Kgg — **Graneros Shale and Greenhorn Limestone –** In Hodgeman County, the Graneros Shale and Greenhorn Limestone are poorly exposed and therefore have not been differentiated. The **Graneros Shale** is a medium–dark–gray shale with numerous thin sandstone and siltstone layers and lenses (Moss, 1932; Hattin, 1965). Selenite crystals may litter weathered outcrops (Moss, 1932). The overlying **Greenhorn Limestone** has four members, which are from bottom to top: the **Lincoln Limestone Member**, the **Hartland Shale Member**, the **Jetmore Chalk Member**, and the **Pfeifer Shale Member**. Because the Greenhorn Limestone is so poorly exposed, it was not possible to differentiate the members. Generally, the Greenhorn Limestone is composed of numerous thin beds of chalk and chalky limestone separated by thicker beds of chalky shale. These beds are light gray to dark gray but weather light gray to tan. Thin beds of bentonite are common in the chalky shales. Thin skeletal limestone layers and lenses occur in the lower part and chalky limestone concretions are found in the upper part (Moss, 1932; Hattin, 1975). Several different species of the characteristic fossil clam *Inoceramus* occur in the limestones (Hattin, 1975). The Greenhorn Limestone is capped by the Fence-post limestone bed. In Hodgeman County, the thickness of the Graneros Shale averages about 30 ft and the Greenhorn Limestone is about 125 ft (Moss, 1932; Hattin, 1965).

Kd — **Dakota Formation –** The Lower Cretaceous Dakota Formation is the oldest unit that crops out in the county. Probably only the upper 50–60 ft of the Dakota are exposed (Moss, 1932). These deposits consist of light-gray to brown lenticular sandstones and gray to variegated shales. The sandstones are typically crossbedded and are cemented with either calcite or iron oxide (Moss, 1932; Hattin, 1965). The Dakota Formation is exposed in the eastern part of the county along Buckner Creek and Saw Log Creek.

LOCATION DIAGRAM



SCALE 1:5,000,000

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

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