

# PRELIMINARY SURFICIAL GEOLOGY OF THE SILVERDALE QUADRANGLE, COWLEY COUNTY, KANSAS

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## GEOLOGIC UNITS

### CENOZOIC

#### Quaternary System

##### Pleistocene-Holocene

Qal<sub>1</sub>

Qt

Qal<sub>2</sub>

Qds

Pwe

Pno

Po

Pwi

Pd

Pb

Pm

**Undifferentiated floodplain alluvium** — Relatively recent alluvial deposits make up the modern floodplain associated with the Arkansas River and numerous smaller streams and tributaries. Most channel systems, especially those with perennial flow, experienced entrenchment during the latest Holocene, with the Arkansas River and its two main tributaries actively undergoing floodplain redevelopment. Floodplain alluvium consists of silt, sand, and gravel, with only minute amounts of clay, exhibited primarily as slack water deposits. The alluvial deposits are relatively thin, probably not exceeding 20 ft (6 m) in thickness.

**Alluvial terrace deposits** — Terrace deposits are generally found adjacent to and slightly above modern floodplains of the Arkansas River and smaller streams and tributaries. The Arkansas River valley in Cowley County has a well-expressed broad terrace, primarily on the east side of the channel, and is traceable into upstream counties, where it has been radiocarbon and luminescence dated to a maximum age of 35,000 years ago, with younger ages from the late Holocene being derived in relatively close proximity to the modern channel. Terrace deposits of the Arkansas River consist primarily of silt, sand, and gravel and are exposed in multiple cut-bank exposures along the east side. Terrace deposits of the Walnut River, Grouse Creek, and their tributaries are finer grained (clay, silt, fine sand) as a result of originating in the Permian and Pennsylvanian shales. The thickest deposits of up to 70 ft (21 m) occur in the Arkansas River valley, but thicknesses range down to only a few feet in tributaries.

**Upland alluvium** — Upland alluvial deposits are extensive in Cowley County and often occur well above and often distant from stream floodplains. The alluvium is composed chiefly of Pleistocene reddish-brown silt, arkosic sand, and locally derived chert gravel. Unit thickness ranges from 0 to perhaps 50 ft (15 m).

**Dune sand** — Aeolian sand deposits are few within the county but they do occur on the floodplain (Qal) and low terrace (Qt) of the Arkansas River. Dune sand is sourced from the active channel, probably during low-water periods of strong or gusty winds. Dunes are generally less than 8 ft (2.4 m) in height and vegetated, and the age of dune formation or most recent activation is most certainly within the last few hundred years (Halfen et al., 2012).

### PALEOZOIC

#### Permian System

##### Leonardian Series

**Wellington Formation** — The Wellington Formation is the only formation of the Permian Sumner Group exposed in Cowley County. The Wellington Formation is about 80 ft (24 m) thick in Cowley County but is upwards of 650 ft (198 m) thick elsewhere in Kansas. It is composed primarily of gray to greenish-gray shales with some thin-bedded and argillaceous limestone, dolomite, siltstone, gypsum, and anhydrite. Members of the Wellington include, in ascending order, the Hollenberg Limestone Member, Carlton Limestone Member, Hutchinson Salt Member, and Milan Limestone Member as well as two unnamed members (Sawin et al., 2008). The Wellington weathers easily and tends to form gentle slopes rather than vertical outcrops. With a lack of exposures revealing the contact between the uppermost Milan Limestone Member and the overlying distinctive reddish-gray Ninnescah Shale, it is difficult to ascertain stratigraphic situation within the Wellington. The Wellington is locally overlain by loess, but the two have similar soil profiles and topography, making them difficult to distinguish.

#### Wolfcampian Series

**Nolans Limestone** — The Nolans Limestone is the uppermost formation of the Chase Group and has a total thickness in Cowley County of approximately 30 ft (9 m). In ascending order, the formation is composed of the Kridler Limestone Member, Paddock Shale Member, and Herington Limestone Member. The Kridler Limestone Member, commonly less than 10 ft (3 m) thick, consists of two limestone beds separated by a 1 ft (0.3 m) yellow-brown shale. The Paddock Shale Member is a 10 ft (3 m) bed of gray calcareous shale. The Herington Limestone Member averages 15 ft (4.6 m) in thickness and is a yellow-tan, dolomitic limestone. In northern Cowley, the upper portion of the Herington is granular in texture and the lower is blocky and ledge forming, marking the boundary with the overlying Wellington Formation. The Herington is more massive to the south with abundant chert nodules in the upper part and calcic geodes in the lower.

**Odell Shale** — The Odell Shale is approximately 35 ft (11 m) thick and is composed of calcareous shale that is predominantly gray with dark blue-gray streaks. The Odell commonly underlies vegetation-covered slopes between the scarp-forming Winfield Limestone and the Herington Limestone Member of the Nolans Limestone.

**Winfield Limestone** — The Winfield Limestone ranges up to 30 ft (9 m) in thickness and is composed of massive beds of light-blue to gray limestone with thin shale partings. The Winfield weathers white to light gray and forms steep outcrops. Though composed of three members elsewhere, only the uppermost Crosswell Limestone Member is recognized in Cowley County and the upper contact with the Odell Shale is nearly always covered.

**Doyle Shale** — The Doyle Shale is about 90 ft (27 m) at its thickest and is composed of, in ascending order, the Holmesville Shale Member, Towanda Limestone Member, and the Gage Shale Member. The Holmesville Shale is a 30 ft (9 m) thick greenish gray to red, unfossiliferous shale. The Towanda Limestone Member, averaging 10 ft (3 m) in thickness, is a resistant gray to yellow, brecciated limestone that often forms a bench between the lower Barneston and overlying Winfield formations. The Gage Shale Member is a red, green, and brown calcareous shale 45 ft (14 m) thick and characterized by a concretion zone and forming steep slopes below the overlying Winfield Limestone.

**Barneston Limestone** — The Barneston Limestone is about 80 ft (24 m) thick, thinning to the south in Cowley County, and buff to gray in color, with blue-gray chert occurring in the lower Florence Limestone Member. Edinoid and other fossils occur throughout, with fusulines near the base. The middle Oketo Shale Member is generally absent in southeastern Kansas. The upper Fort Riley Limestone Member gradually transitions to the overlying Doyle Shale.

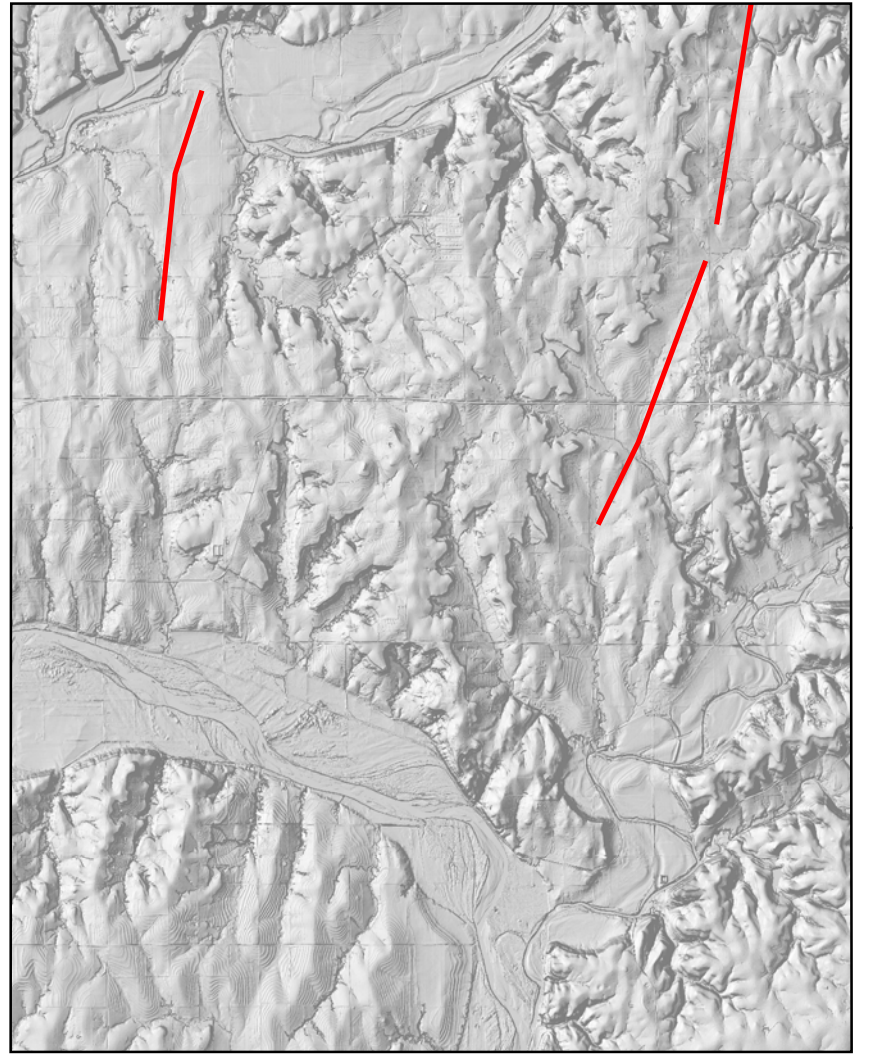
**Matfield Shale** — The Matfield Shale averages 60 ft (18 m) thick and is composed of, in ascending order, the Wynmore Shale Member, Kinney Limestone Member, and the Blue Springs Shale Member. The Wynmore Shale is composed of approximately 15 ft (4.6 m) of generally poorly exposed maroon and gray shale. The Kinney Limestone Member is composed of interbedded gray to buff limestone and gray shale with a total thickness of 18 ft (5.5 m). The Blue Springs Shale is up to 30 ft (9 m) thick and composed of red shale (restricted to the upper part), a persistent limestone bed approximately 6 ft (2 m) below the top of the member, and gray limy shale.

### CITED REFERENCES

- Halfen, A. F., Johnson, W. C., Hanson, P. R., Woodburn, T. L., Ludvigson, G. A., and Young, A. R., 2012, Activation history of the Hutchinson dunes in east-central Kansas, USA during the past 2200 years: *Aeolian Research* 5, p. 9–20.
- Sawin, R. S., Franseen, E. K., West, R. R., Ludvigson, G. A., and Watney, W. L., 2008, Clarification and changes in Permian stratigraphic nomenclature in Kansas: *in*, Current Research in Earth Sciences: Kansas Geological Survey, Bulletin 254, part 2, <http://www.kgs.ku.edu/Current/2008/Sawin/index.html>.

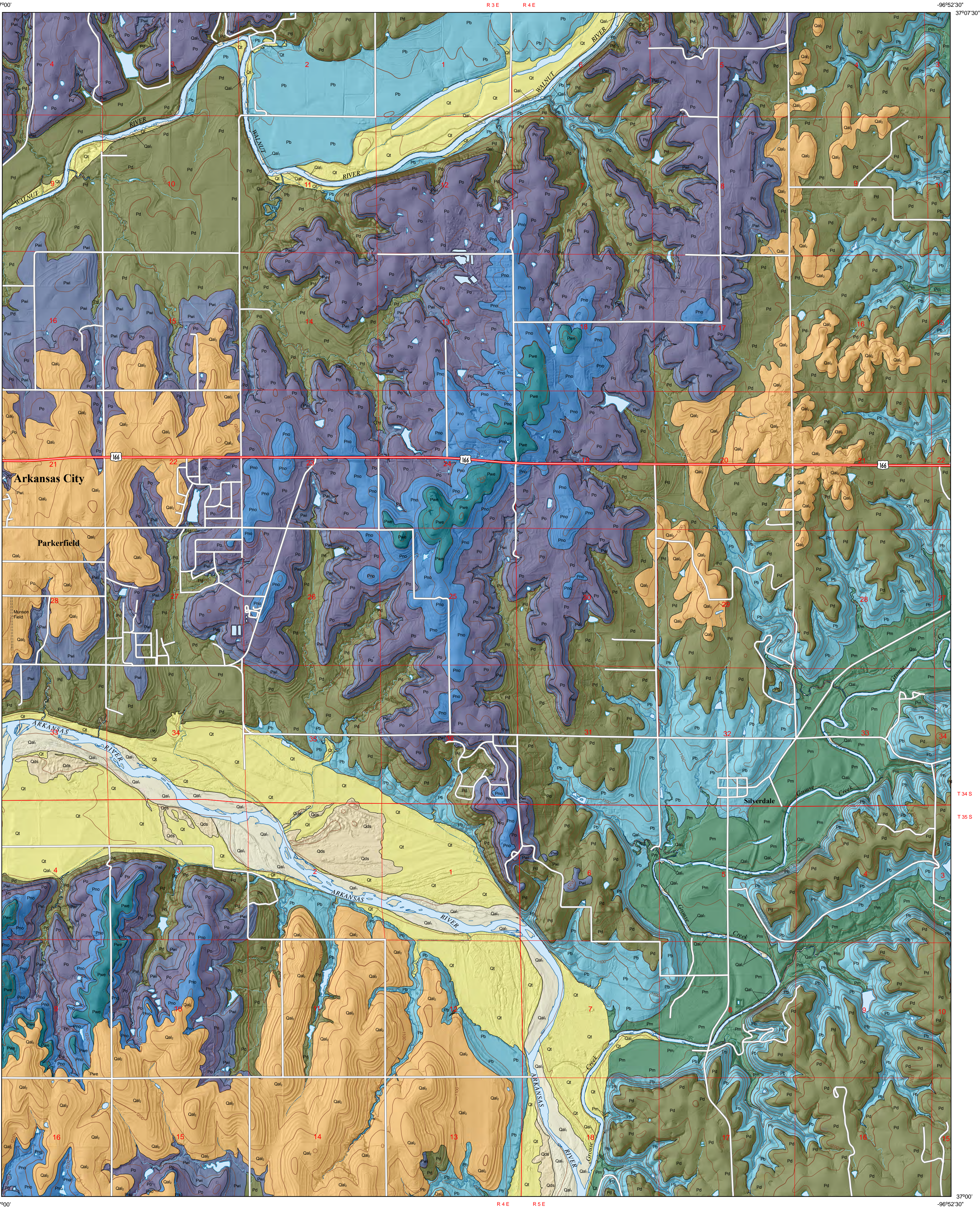
### ADDITIONAL SOURCES

- Bass, N. W., 1929, The geology of Cowley County, Kansas: Kansas Geological Survey, Bulletin 12, 203 p.
- Bayne, C. K., 1960, Geology and ground-water resources of Harper County, Kansas: Kansas Geological Survey, Bulletin 143, 183 p.
- Bayne, C. K., 1962, Geology and ground-water resources of Cowley County, Kansas: Kansas Geological Survey, Bulletin 158, 219 p.
- Walters, K. L., 1961, Geology and ground-water resources of Sumner County, Kansas: Kansas Geological Survey, Bulletin 151, 198 p.



**Inset showing mapped lineaments as potential surface expressions of structural features (e.g., faults, folds, joints, ridges).** South-central Kansas, like other parts of the central and eastern United States, resides in a region of relatively low historical and instrumentally recorded seismicity. Despite this, the state has experienced approximately 3,500 earthquakes since 2013, with more than 130 of the events recorded as magnitude 3.0 or greater. This recent spate of seismicity raises concerns about the potential risk that structural features (faults, folds, joints, and ridges) may pose for moderate to large earthquakes. Investigations into the size or extent of these faults include mapping previously unrecognized surface features, such as lineaments, that may reflect more deeply seated structural features.

Lineaments were mapped using aerial photography and bare-earth LiDAR Digital Elevation Models (DEMs), based on one or more of the following criteria: (1) Visible offset in marker beds; (2) relatively low- to high-relief linear ridges that are not obvious geomorphic features due to erosion, slumping, subsidence, or dune formation; (3) linear ridges that cross drainage divides; (4) ridges that display curvilinear or backstepping (en echelon) configurations; (5) rectilinear or parallel drainage patterns; and (6) linear drainage patterns that align across drainage divides.



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.

1-meter LiDAR hillshades (2010 imagery), 1-meter U.S. Department of Agriculture – Farm Services Agency (USDA-FSA) National Agriculture Imagery Program (NAIP) digital imagery (2015 imagery), and 1-foot Kansas NG911 digital imagery were used as references in the digital mapping. USDA Natural Resources Conservation Service (NRCS) SSURGO data and other geologic maps and bulletins were used to supplement the mapping. Field mapping was undertaken from October 2018 to May 2019. Roads and highways are shown on the base map as represented by data from the U.S. Census Bureau. 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 2-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.

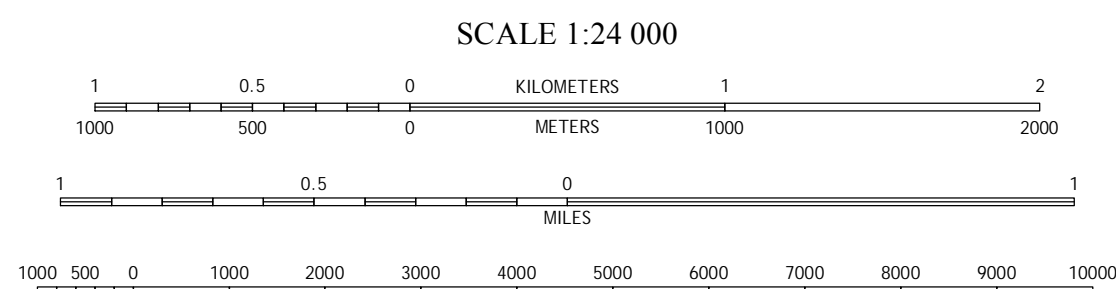
This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program, award number G18AC00197 (FY2018).

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

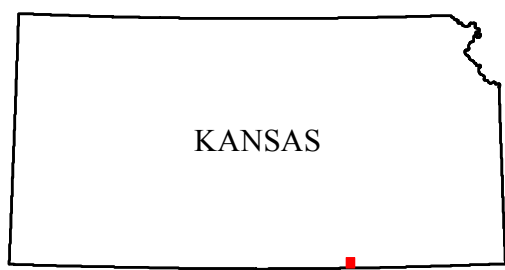
This map is a preliminary product and has had less scientific and cartographic review than the Kansas Geological Survey's M-series geologic maps. KGS does not guarantee this map to be free from errors or inaccuracies and disclaims any responsibility or liability for interpretations made from the map or decisions based thereon.

### SUGGESTED REFERENCE TO THE MAP

Smith, J. J., and Dunham, J. W., 2019, Preliminary surficial geology of the Silverdale quadrangle, Cowley County, Kansas: Kansas Geological Survey, Open-File Report 2019-15, scale 1:24,000, unpublished.



QUADRANGLE LOCATION



### EXPLANATION

- Boundaries and Locations**
- Township/range line
  - Section line
- Transportation**
- U.S. highway
  - Local road
  - Airstrip
- Geologic Unit Boundaries**
- Observed contact
- Hydrology**
- Perennial stream
  - Intermittent stream
  - Water body
  - Water body – manmade shoreline
- Topography**
- Elevation contour (100-foot interval)
  - Elevation contour (10-foot interval)