KU KANSAS GEOLOGICAL SURVEY
The University of Kansas

# SURFICIAL GEOLOGY OF JEWELL COUNTY, KANSAS

**Geology by Terri L. Woodburn and William C. Johnson**
**2025**

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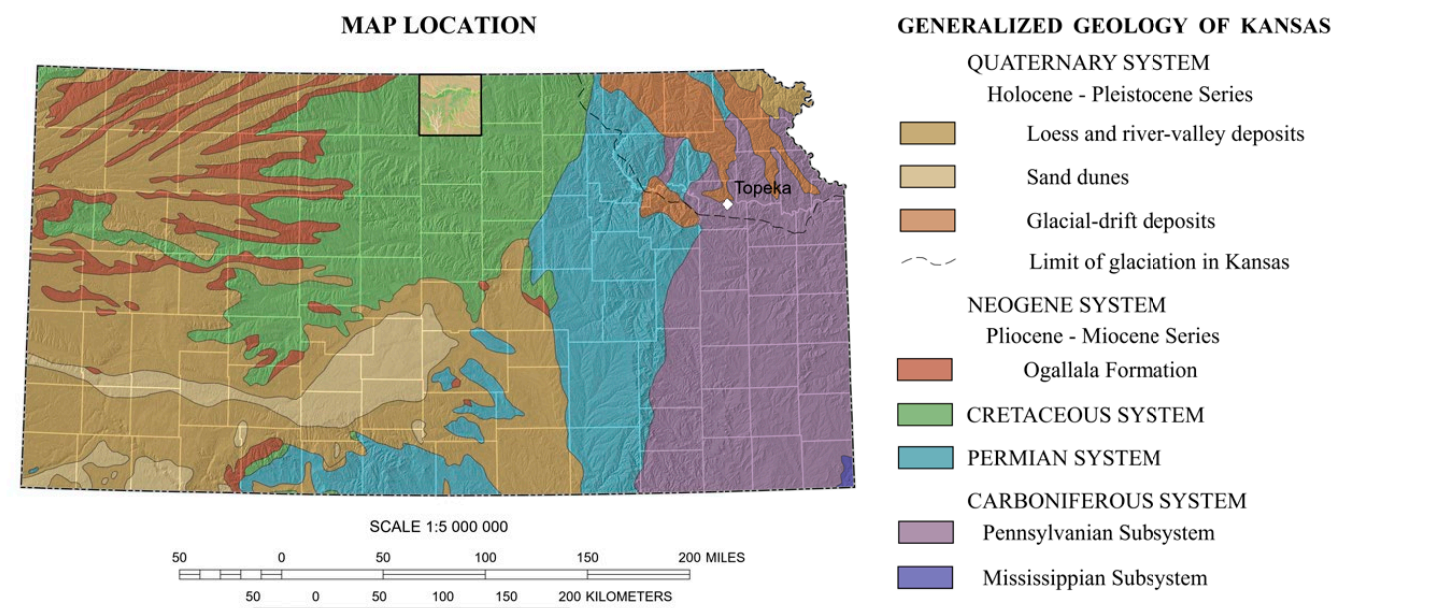
**MAP M-128**

**Funded in part by the USGS National Cooperative Geologic Mapping Program**



## GEOGRAPHY

Jewell County lies within the Smoky Hills physiographic province. The name refers to the haze that sometimes covers the valleys in the early morning (Kansas Geological Survey, 2021c). The topographic relief of Jewell County is 1,001 ft (305 m). The lowest point lies at 984 ft (300 m) along Plum Creek in the southeast part of the county, and the highest elevation is at 1,985 ft (605 m) within the northwest part of the county.

Jewell County covers an area of approximately 914 mi$^2$ (2,367 km$^2$) in north-central Kansas, sharing its northern border with the state of Nebraska. Of this area, approximately 4.4 mi$^2$ (11.4 km$^2$) is water (U.S. Census Bureau, 2021). The largest impoundment of water in the county, Lovewell Reservoir, occupies about 3.2 mi$^2$ (8.3 km$^2$) at peak (U.S. Department of the Interior, Bureau of Reclamation, 2021a).

## GENERAL GEOLOGY

The surficial sedimentary rocks are northwest dipping and Cretaceous in age. Dominant lithologies include shales and limestones, with some siltstones, sandstones, and chalk (Schoewe, 1949; Zeller, [1968] 2022). The oldest rocks—shales, siltstones, and sandstones of the upper Dakota Formation—are located on the south side of the Buffalo Creek valley in the southeast corner of Jewell County. Dakota Formation deposits represent a swampy deltaic environment (Muilenburg and Swineford, 1975). Locally, the Dakota contains a fossiliferous sandstone bed known as the “shark-tooth conglomerate,” which contains teeth from several species of shark (Swineford, 1947). Above the Dakota, the Graneros Shale, Greenhorn Limestone, and Carlile Shale (comprising the Fairport Chalk, Blue Hill Shale, and Codell Sandstone [not mappable at scale] Members) record deposition during the Greenhorn cyclothem of Western Interior Seaway transgression and regression (Hattin, 1964). The Fence-post limestone bed of the Greenhorn Limestone is the high-water mark of that cycle (Everhart, 2007). The Graneros crops out near the Dakota in the southeast corner, the Greenhorn is mostly found in the southeastern part of the county, and the Carlile crops out along streams from the southwestern part of the county to north of Lovewell Reservoir. The youngest rocks, representing offshore marine deposition during the Niobrara cyclothem (Hattin, 1964), include the Fort Hays Limestone and Smoky Hill Chalk Members of the Niobrara Chalk, which crop out in creek valleys throughout the center of the county. Peak transgression of the sea during the Niobrara cyclothem is recorded in the Fort Hays Limestone Member (Everhart, 2007). Bentonite seams observed throughout the Cretaceous rocks (Fishel and Leonard, 1955) indicate deposition of volcanic ash from the western United States in marine environments (Muilenburg and Swineford, 1975). A significant unconformity separates the deeply eroded Cretaceous bedrock geology from younger Quaternary sediments.

Quaternary sediments represent the youngest stratigraphic units in Jewell County. Thick accumulations of wind-blown silt (loess) were deposited over most of the county during Pleistocene to Holocene times and mantle the topography. Dune sand occurs in localized areas along the Republican River. Colluvial limestone gravels containing material from the Niobrara Chalk (Smoky Hill Chalk and Fort Hays Limestone Members) and Carlile Shale were developed in the middle to early Pleistocene and are exposed in the southwest part of the county. Deposits of undifferentiated upland alluvium, formerly known as the “Meade formation” (an abandoned informal stratigraphic unit), crop out in the north and central parts of Jewell County and appear to have been deposited along active streams during the mid-Pleistocene, coincident with preceding loess deposition (Fishel and Leonard, 1955). Holocene sediments include recent floodplain alluvium and stream terraces that border the courses of current streams and indicate the location of older floodplains, before these streams cut down through them.

## GEOMORPHOLOGY

The topography of Jewell County is the product of ongoing deposition and erosion beginning in the Pleistocene and of the character of the underlying bedrock (Fishel and Leonard, 1955). The Niobrara escarpment (fig. 1), formed by early Pleistocene erosion of the Fort Hays Limestone Member of the Niobrara Chalk, is one of the most prominent features in Jewell County. It extends in a sinuous wall from near the southwest boundary of the county near Little Oak Creek to the alluvial deposits in the White Rock Creek valley near Lovewell dam in the northeast. North of the escarpment, chalk pediments, composed of the Smoky Hill Chalk Member of the Niobrara Chalk, crop out along a 12-mile-long (19.3 km) section of White Rock Creek (Fishel and Leonard, 1955).

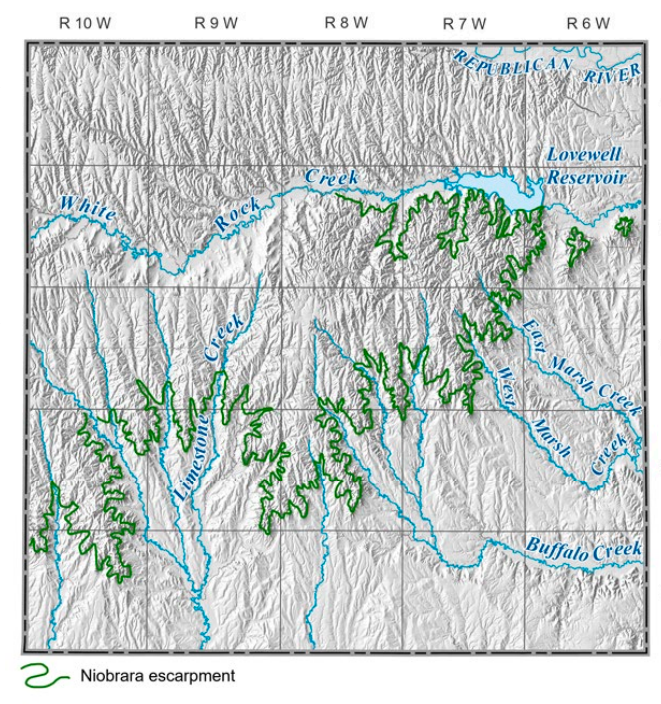


Figure 1. Trace of the Niobrara escarpment in Jewell County. Prominent fluvial features affected by the escarpment are included. Map adapted from Fishel and Leonard (1955), figure 3.

Five important fluvial features drain the county—the Republican River, White Rock Creek, Buffalo Creek, Marsh Creek, and Limestone Creek. The Niobrara escarpment serves as an important drainage divide between the Republican River and White Rock Creek to the north and Buffalo, Marsh, and Limestone creeks to the south. Many small creeks serve as tributaries to these major systems. Every major creek in Jewell County contains a preserved stream terrace located 10–20 ft (3–6.1 m) higher than the present floodplain (Fishel and Leonard, 1955).

The Republican River has a wide floodplain with only localized terrace remnants exposed at the surface. Ancestral Republican River terrace remnants are preserved beneath the loess deposits between the Republican River and White Rock Creek in the east. The ancestral Republican River was diverted from the White Rock Creek valley to its present course as a result of a buildup of Pleistocene outwash sediments (Joeckel et al., 2007; Fishel and Leonard, 1955; Fishel, 1948).

## MINERAL RESOURCES

Limestone, chalk, sand and gravel, and volcanic ash are important mineral resources in Jewell County. Because of a lack of timber in the area, settlers of the central Smoky Hills used the Fence-post limestone bed, the upper bed of the Greenhorn Limestone, for fenceposts and as a decorative building stone starting in the 1870s (Fishel and Leonard, 1955; Muilenburg and Swineford, 1975; fig. 2). The Fort Hays Limestone Member of the Niobrara Chalk also has been used as a structural material for buildings in Jewell County (Fishel and Leonard, 1955) and is currently quarried in several locations for road metal (Kansas Geological Survey, 2021a; Byrne et al., 1950). Sand and gravel also have been mined in the Republican River valley and are currently mined in the White Rock Creek valley for use as concrete aggregate and road metal (Kansas Geological Survey, 2021a; Byrne et al., 1950). Volcanic ash deposits among the upland alluvium (“Meade formation”) are identified as the Lava Creek B ash bed (formerly the Pearlette family ash beds) whose source is the last major eruption of the Yellowstone Caldera 620,000 years ago (Izett and Wilcox, 1982). This ash bed was locally quarried for use as an abrasive, concrete aggregate, and additive to ceramics and enamels (Byrne et al., 1950; Carey et al., 1952; Schoewe, 1942). All ash quarries in Jewell County are now abandoned (G. Ludvigson, personal communication, 2022). There are no oil or gas resources in Jewell County (Kansas Geological Survey, 2021b).

Figure 2. Ruins of an ornate Fence-post limestone house in Jewell County. Photo credit: William C. Johnson, University of Kansas.

## WATER RESOURCES

Active water management is an important issue in the county. To address concerns from local residents after a devastating regional flood in 1935 and increased agricultural need for water, the Kansas-Bostwick Irrigation District was authorized in 1944 and construction was completed in 1968 (U.S. Department of the Interior, Bureau of Reclamation, 2021b; Spruill, 1985). In Jewell County, the district draws water from the Republican River and Lovewell Reservoir on White Rock Creek (fig. 3) and uses the Courtland Canal to supplement irrigation needs (U.S. Department of the Interior, Bureau of Reclamation, 2021b; Spruill, 1985). Additional water for irrigation is drawn from groundwater sources, primarily Quaternary alluvium (Spruill, 1985). Domestic, stock, and public water supplies are obtained primarily from groundwater sources (Fishel and Leonard, 1955; Spruill, 1985). Some wells in southeastern Jewell County use the Dakota Formation (Fishel and Leonard, 1955). Aquifers in Jewell County are classified as alluvial and Dakota (Kansas Geological Survey, 2023).

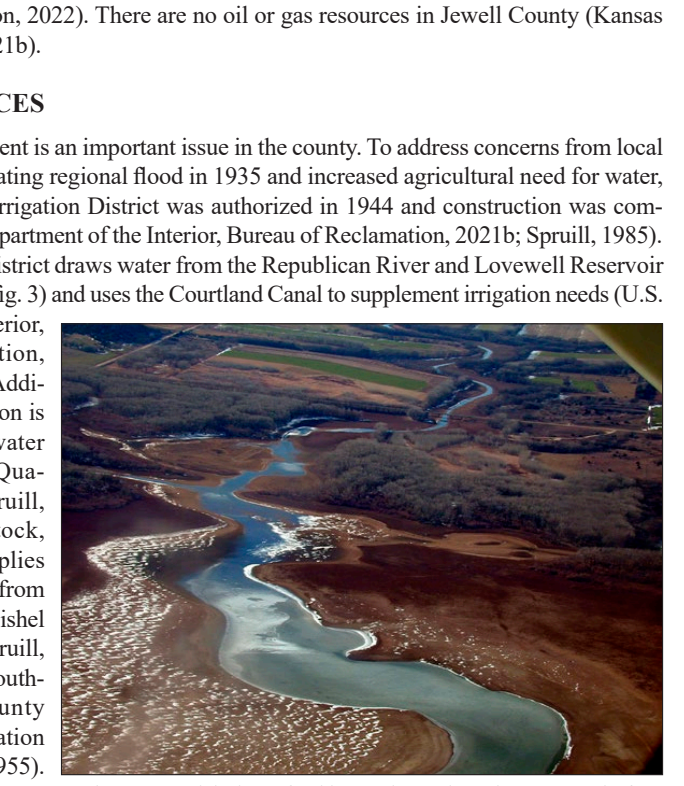


Figure 3. Aerial view of White Rock Creek at the upper end of Lovewell Reservoir in Jewell County. Photo credit: Brad Logan, Kansas State University.

## PALEONTOLOGY

A variety of Cretaceous marine fossils have been found in Jewell County. In 1874, Benjamin F. Mudge discovered a plesiosaur in the Fort Hays (Everhart, 2005). As the Western Interior Seaway shoreline regressed to the west, the Codell recorded a shallow marine environment leaving many notable fossils in Jewell County. Bice and Shimada (2016) analyzed a collection including sharks (*Squalicorax* cf. *S. falcatus* and *Scapanorhynchus raphiodon* teeth were most abundant), turtles, plesiosaurs, mosasaurs, rays (*Rhinobatos* sp. teeth), and bony fish (*Enchodus* cf. *E. petrosus* were most abundant). They also noted reports of invertebrate fossils (several *Inoceramus* bivalves and a variety of ammonites) and annelid worm burrows within the Codell (Bice and Shimada, 2016).

Pleistocene fossils also have been uncovered in Jewell County. Fossils found below the Hartford Ash (dated 0.706 million years ago) include mollusks (Miller and Eshelman, 1985) and frogs, snakes, turtles, and salamanders (Rogers, 1982). Erosion around Lovewell Reservoir has contributed to the discovery of seven mammoths and other fossils categorized as the Lovewell Local Fauna, which include camels, dire wolves, horses, llamas, sloths, small mammals (mice, voles, gophers, squirrels, and prairie dogs), toads, snakes, fish, and birds. Radiocarbon dating has shown the mammoths lived between 18,000 and 21,000 $^{14}$C yrs BP. Some mammoth finds displayed evidence of human processing via breakage and flaking on the bones (Holen, 2006).

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Base map compiled by the Kansas Geological Survey Cartographic Services unit from digital data provided by U.S. Geological Survey (USGS), Kansas Department of Transportation, State of Kansas Data Access and Support Center (DASC), and Kansas Next Generation 911. U.S. Department of Agriculture–Farm Services Agency National Agriculture Imagery Program (NAIP) imagery was used to verify feature locations.

Geology based on fieldwork and data analysis by T. L. Woodburn and W. C. Johnson, 2005–2006. Digital compilation of geologic data and cartography by Cartographic Services. Contacts were compiled in GIS format and edited, and attributes were added. These data were then used to generate the mapped-unit GIS data, to which attribution was added.

Contours and multi-angle hillshade (0°, 225°, 270°, and 315° azimuths, 45° altitude, 4x vertical exaggeration, 5-meter resolution) were derived from lidar data provided by DASC. 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.

This map was produced using the ArcGIS system developed by Esri and the Adobe Creative Cloud Suite (InDesign and Illustrator). Geologic Map Schema (GeMS) GIS data were produced for this map. GeMS is a standard format for the digital publication of geologic maps published in USGS Techniques and Methods 11-B10, DOI: 10.3133/tm11B10. GeMS data can be downloaded from the USGS National Geologic Map Database.

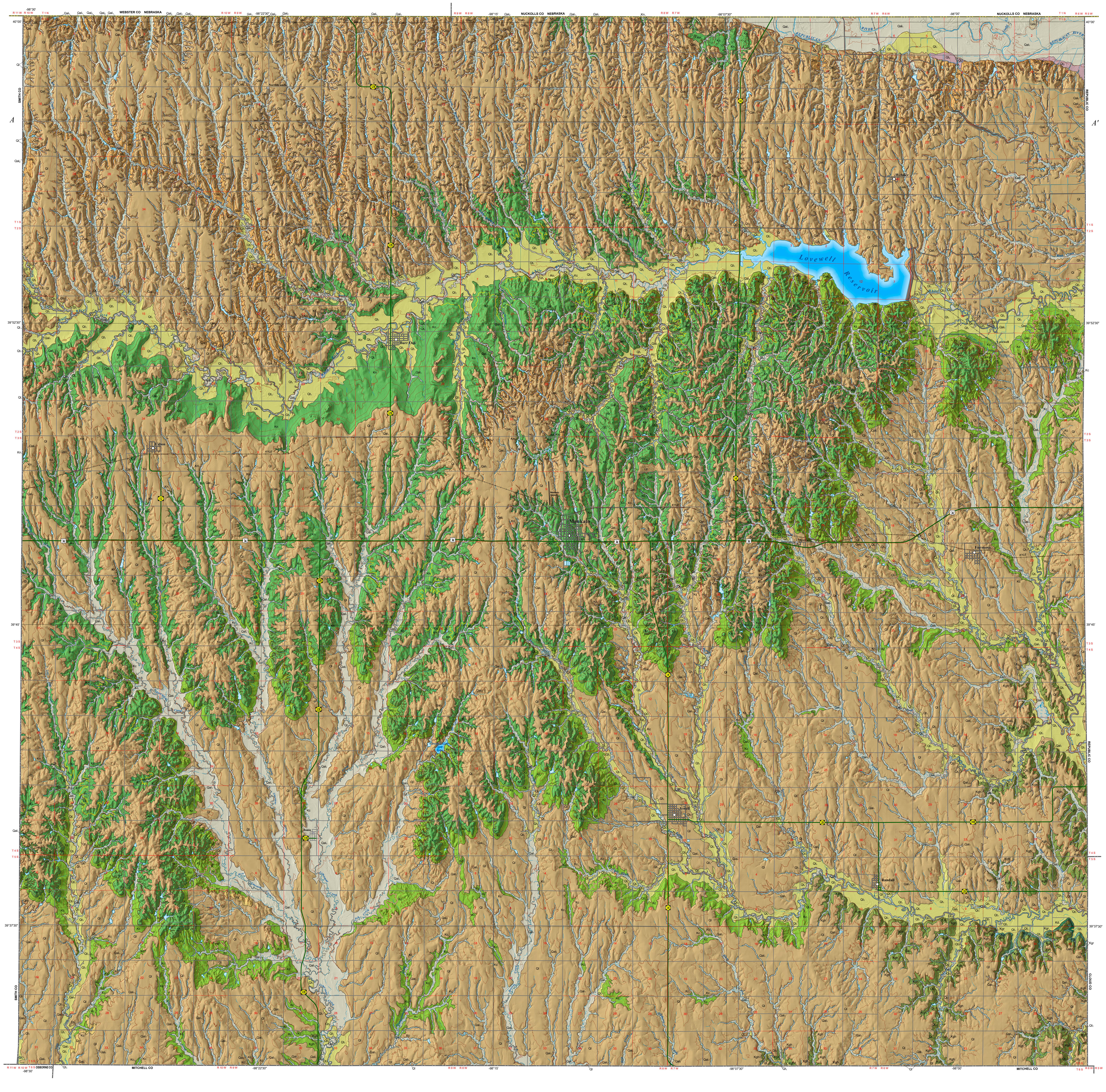
This geologic map was funded in part by USGS National Cooperative Geologic Mapping Program EDMAP grants. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. government.

The Kansas Geological Survey 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.

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

| | | | | | | |
|---|---|---|---|---|---|---|
| MCCRACKEN BRANCH | BURR OAK NW | NORTH BRANCH | MANKATO NW | WEBBER | SCANDIA NW | |
| LEBANON | ESBON | BURR OAK | MANKATO | MONTROSE | COURTLAND | |
| PORTIS NE | CAWKER CITY NW | IONIA | JEWELL | RANDALL | JAMESTOWN NW | |
| DOWNS NORTH | CAWKER CITY | GLEN ELDER NORTH | JEWELL SW | JEWELL SE | SCOTTSVILLE | |

USGS 7.5-minute quadrangles used in the digital compilation of the Jewell County map. The geology was mapped in the field using these topographic maps.



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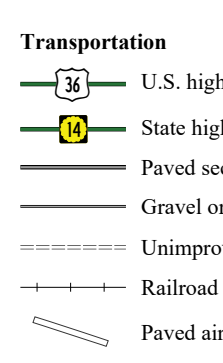


APPROXIMATE MEAN DECLINATION, 2025

**Transportation**
- U.S. highway
- State highway
- Paved secondary road
- Gravel or soil secondary road
- Unimproved road
- Railroad
- Paved airstrip

**Boundaries and Locations**
- State line
- County line
- Township/range line
- Section line
- A——A′ Geologic cross section
- ◊ **Mankato** County seat
- ○ **Webber** City
- ⊙ **Ionia** Locality

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

2025
Kansas Geological Survey
University of Kansas
Lawrence, Kansas 66047
ISBN# 978-1-58806-987-0

**Topography**
- Elevation contour (100-foot interval)
- Elevation contour (25-foot interval)
- Depression contour (100-foot interval)
- Depression contour (25-foot interval)

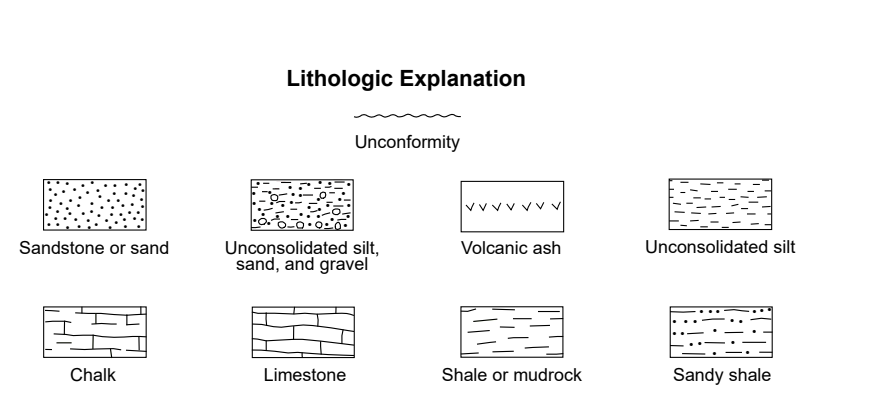
**Hydrology**
- Perennial stream
- Intermittent stream
- Perennial water body
- Marsh or swamp
- Dam

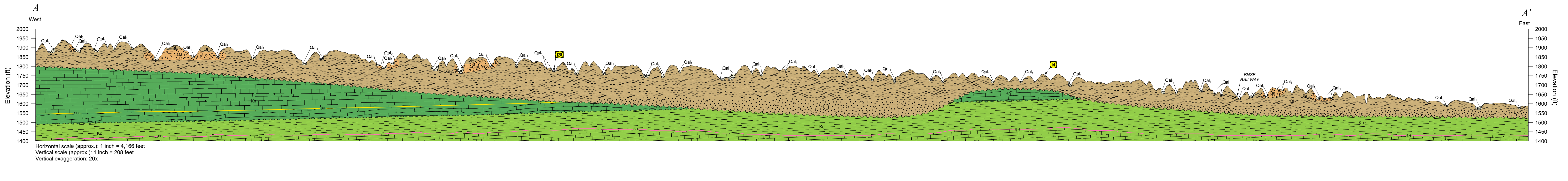
**Resource Development**
- Open sand or gravel pit
- Quarry

**Geologic Unit Boundaries**
- Observed contact

**SUGGESTED REFERENCE TO THIS MAP**

Woodburn, T. L., and Johnson, W. C., 2025, Surficial geology of Jewell County, Kansas: Kansas Geological Survey, Map M-128, scale 1:50,000.





Horizontal scale (approx.): 1 inch = 4,166 feet
Vertical scale (approx.): 1 inch = 208 feet
Vertical exaggeration: 20x

| SYSTEM | GEOLOGIC UNITS | SERIES |
|---|---|---|

**Quaternary** — **Holocene to Pleistocene**

**Qal$_1$**

**Undifferentiated floodplain alluvium**

Floodplain alluvium occurs in the Republican River valley, White Rock Creek, Buffalo Creek, Limestone Creek and their tributaries. Alluvial sediment is primarily sand and gravel along the Republican River and silt, sand, and gravel along creeks. Sediment age is late Holocene and most deposits date to the last 1,000 years. Sediment thickness is 15 ft (4.6 m) or less in the smaller tributaries and is about 65 ft (19.8 m) in the Republican River valley.

**Qt$_1$** **Qt$_2$**

**Alluvial terrace deposits**

Lower terrace deposits (Qt$_1$) within the county occur along the Republican River and the major tributaries, with upper terrace deposits (Qt$_2$) occurring primarily along the south side of the Republican River. Coarse gravel with some sand and silt, derived primarily from the Ogallala Formation, dominates the lower terrace deposits, whereas fine-grain sediments, derived primarily from upland loess, dominate upper terrace deposits. Age of the lower terrace deposits is Holocene, and that of the upper terrace is primarily late Pleistocene (contains megafaunal remains; Logan, 2011). Thickness of the terrace deposits ranges from 15–25 ft (4.6–7.6 m) in the small tributaries to about 75 ft (22.9 m) in the Republican River valley and the western end of White Rock Creek.

**Qal$_2$**

**Undifferentiated upland alluvium**

Outcrops of this alluvial unit, typically expressed as eroding slopes or road cuts, occur in upper tributary reaches on the uplands primarily between the White Rock Creek and Republican River valleys. The unit lithology is highly variable, ranging from gravels originating from local Cretaceous bedrock or the Rocky Mountains to silt and fine sand. Sand and gravel zones often display cross-bedding and other sedimentary structures and in many localities are highly oxidized or calcareous. The alluvium also contains bodies of redeposited volcanic ash classified as the Lava Creek B bed (formerly Pearlette family ash beds, see Layzell et al., 2017) (Izett and Wilcox, 1982). This unit was originally mapped in Jewell County by Fishel and Leonard (1955) as the “Meade formation” (Cragin, 1896; Frye and Hibbard, 1941), which is not formally recognized as a stratigraphic unit by the Kansas Geological Survey (Zeller, [1968] 2022; Layzell et al., 2017) and has been used colloquially to describe primarily alluvial mid-Pleistocene deposits.

**Qg**

**Limestone gravel deposits**

Limestone gravel deposits occur throughout the county, predominantly southeast of the Niobrara escarpment, but usually underlie loess deposits. Small exposures occur in the southwestern part of the county. This gravel consists primarily of subangular to subrounded water-worn limestone intermixed with fragments of shale from the Carlile Shale. Limestone gravels are derived from the Fort Hays Limestone Member, limestone beds of the Smoky Hill Chalk Member, or shale members of the Carlile Shale. Most of the deposits are colluvial in origin and have a thickness of up to 15 ft (4.6 m) (Fishel and Leonard, 1955). The age of the deposit is middle to early Pleistocene.

**Qds**

**Dune sand**

Sand dunes appear in a small, localized area on the floodplain of the Republican River in the northeastern part of the county. The sand is derived from Republican River valley alluvium and reaches a thickness of about 12 ft (3.7 m). The dune sand deposit likely dates to the late Holocene (Halfen and Johnson, 2013).

**Ql**

**Loess**

Loess, which mantles uplands in the county, comprises wind-deposited silt, with minor amounts of clay and fine sand. Locally, the loess contains intercalated paleosols, such as the Gilman Canyon Formation and the Brady Geosol (Layzell et al., 2017). Loess also may exhibit thin beds of Crete sand and gravels at its base. Deposits in the county range in age from the late Pleistocene to the late Holocene and have a total depth of up to 100 ft (30.5 m).

**Cretaceous** — **Upper Cretaceous**

**Kn** **SH**

**Niobrara Chalk**

The Niobrara Chalk comprises two members and both are identified in Jewell County. The ***Fort Hays Limestone Member***, the lower member of the Niobrara Chalk, is composed of thick beds of chalk separated by thin beds of chalky shale. Exposures up to 45 ft (13.7 m) cap the underlying Blue Hill Shale Member and create a southwest-to-northeast trending escarpment through the midsection of the county. The ***Smoky Hill Chalk Member***, the upper member of the Niobrara Chalk, is composed of thin-bedded shaly chalk or chalky shale, blue-gray to yellowish orange in color. Exposures are found in the central and west-central part of the county, mainly south of White Rock Creek and north of the Niobrara escarpment. This member has been eroded to rounded hills and pediments (primarily seen directly south of White Rock Creek). Outcrops have thicknesses of up to 30 ft (9.1 m). The lower half of the member, 300–350 ft (91–107 m) is present in the county (Fishel and Leonard, 1955). The base of the Smoky Hill (SH) is mapped.

**Kc** **BH**

**Carlile Shale**

The Carlile Shale comprises three members. The ***Fairport Chalk Member*** is the lowest member of the Carlile Shale and is composed of light gray to bright yellow calcareous shale over buff to pink chalky limestone, concretionary beds, and bentonite seams. Abundant *Ostrea* shells are found within the thin-bedded shale. Outcrops have been found along streams from the southwest corner of the county, diagonal to the east-central county boundary, and have a maximum thickness of 24 ft (7.3 m) (Fishel and Leonard, 1955). The ***Blue Hill Shale Member***, the middle member, is exposed along the Niobrara escarpment that runs diagonally from the southwest corner to the east-central part of the county. This member is a fissile, bluish-black, noncalcareous clay shale that is well-exposed with thicknesses up to 200 ft (61 m) (Fishel and Leonard, 1955). Septarian concretions and fossil-bearing concretions (ammonite, gastropod, and *Inoceramus* shells) are present in the upper and lower parts of the unit, respectively. The base of the Blue Hill (BH) is mapped. The upper member, the ***Codell Sandstone Member***, is locally very thin (6–15 in [15.2–38.1 cm] thick), a source of marine vertebrate fossils (Fishel and Leonard, 1955; Bice and Shimada, 2016), and not mapped.

**Kgh**

**Greenhorn Limestone**

The Greenhorn Limestone comprises four members: the ***Lincoln Limestone Member*** (lower), ***Hartland Shale Member***, ***Jetmore Chalk Member***, and ***Pfeifer Shale Member*** (upper) (Zeller, [1968] 2022). Exposures of the Greenhorn Limestone have been found throughout the southern part of the county along Buffalo Creek, Marsh Creek, Limestone Creek, and other small tributaries. Greenhorn Limestone consists of chalky shale with thin limestone beds and limestone concretions, and thin chalky limestone beds separated by chalky shale and occasional bentonite seams. A characteristic fossil, *Inoceramus labiatus*, is found throughout the formation. The Fence-post limestone bed, a moderately fine and chalky limestone that hardens upon exposure, marks the top of the Greenhorn Limestone and is reported to be 0.8 ft (0.2 m) thick in Jewell County. It was quarried in the county for building stone and fence posts. The basal limestone is petroliferous. Outcrops have a thickness of up to 32 ft (9.8 m) (Fishel and Leonard, 1955).

**Kgr**

**Graneros Shale**

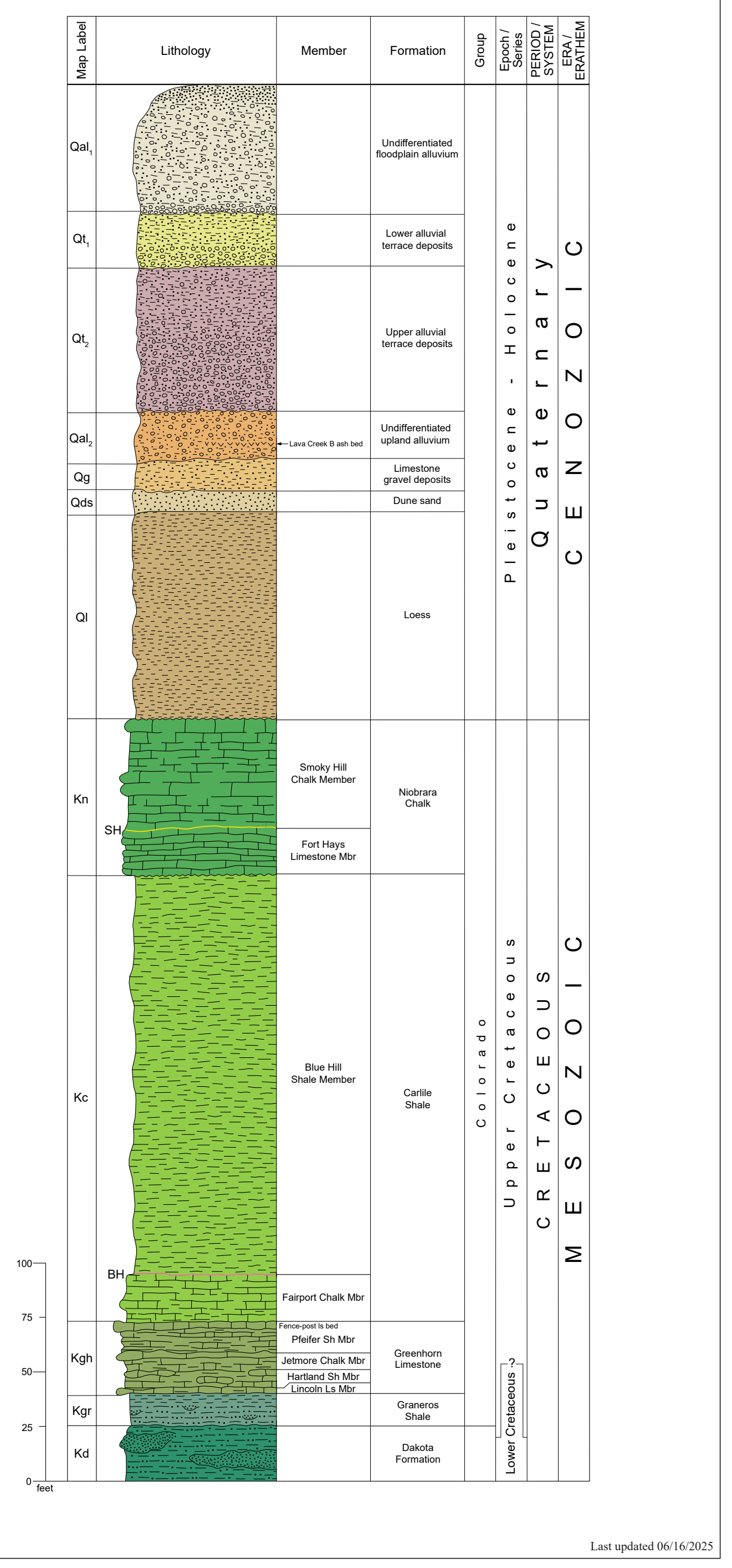
The Graneros Shale consists of fissile bluish-gray clay shale and sandy shale deposits with sand lenses. Exposed Graneros is found in the southeastern corner of the county along the south side of Buffalo Creek and has a maximum outcrop thickness of about 15 ft (4.6 m) (Fishel and Leonard, 1955). A bentonite bed observed by Fishel and Leonard (1955) is likely the “X-bentonite” of Hattin (1965), which is a significant marker bed used for correlating Cretaceous units. This bed was not investigated as part of this study.

**Lower Cretaceous**

**Kd**

**Dakota Formation**

The Dakota Formation is exposed only in one small location along the south side of Buffalo Creek in the southeastern part of the county. The deposit consists of white to brown lenticular sandstone that is loosely cemented with limonite or well cemented with calcite (“quartzite”-like) with gray and variegated sandy shale. Locally, lignite was mined from the upper 30 feet. This is the oldest formation cropping out in the county, with an outcrop thickness of up to 28 ft (8.5 m) (Fishel and Leonard, 1955). The boundary dividing the Lower and Upper Cretaceous is contained within the Dakota Formation (Zeller, [1968] 2022).



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