SURFICIAL GEOLOGY OF FORD COUNTY, KANSAS

MAP M-108

Geology by William C. Johnson and Terri L. Woodburn

2009

Computer compilation and cartography by John W. Dunham, Daniel S. Gertsema II, Darren J. Haag, Scott T. Klopfenstein, Matthew D. Krieger, David L. Means, Ian J. Ramirez, Jorgina A. Ross, and Gerald W. Wright III

KANSAS GEOLOGICAL SURVEY
The University of Kansas

GENERAL GEOLOGY

Ford County, in southwestern Kansas, is bounded by Hodgeman County on the north, Edwards and Kiowa counties on the east, Clark and Meade counties on the south, and Gray County to the west. The county has a total area of 1,082 mi^2 (2,802 km^2), of which approximately 75% is upland plains; the remainder is stream floodplains and intermediate slopes. Cretaceous (145 – 65 MYA) and Neogene (23 – 2.6 MYA) sedimentary rocks – sandstones, limestones, shales, cherts, and conglomerates – crop out in the county and range in age from Early Cretaceous (Dakota Formation) to the Miocene and possibly early Pliocene (Ogallala Formation). Pleistocene and Holocene silt and sand cover much of the county as eolian loess and sand-dune deposits.

GEOMORPHOLOGY

Ford County can be divided into two physiographic regions: the High Plains and the Arkansas River Lowlands. Sand dunes, sand sheets, and Pleistocene and Holocene alluvium comprise the Arkansas River Lowlands region, which generally occupies central Ford County from west to east. The High Plains consist of bounding uplands to the north and south of the river. The principal tributary of the Arkansas River in Ford County, and flowing sub-parallel to it on the southern uplands, is Mulberry Creek. Saw Log Creek, in north-central Ford County, is a major tributary of Buckner Creek in Hodgeman County.

Topographic relief in the county is 450 ft (137 m), with the highest area (2,750 ft, 838 m) along the western border, and the lowest point (2,240 feet, 683 m) along the eastern border where Cow Creek exits the county. The relatively low relief of the county is due to the upland region's broad, gentle slopes and the low dip angle of the bedrock.

MINERAL RESOURCES

Mineral resources in Ford County include sand and gravel from alluvial terrace deposits, which are used for road surfacing and concrete construction, and building stone quarried from the Greenhorn Limestone and Dakota Formation (Waite, 1942). Historically, this stone was exploited for structural work such as buildings and bridges (Waite, 1942); today, however, they are used mainly for road material.

Oil and gas production is concentrated in subsurface Paleozoic rock formations located in the eastern three-quarters of Ford County. Between 1998 and 2008, an average of 38 oil wells and 24 gas wells were in production, producing approximately 78,500 barrels of oil and 388,500 mcf (1000 cubic feet) of gas per year. Oil production began to increase in 2006 and continued to a production high of 185,000 barrels in 2008. Gas production, however, has slowly decreased from 800,000 mcf in the mid-1990s to 200,000 mcf in the mid-2000s (Kansas Geological Survey, 2009).

WATER RESOURCES

Water flow in the Arkansas River through eastern Colorado and western Kansas is recharged primarily from ground-water seepage from the High Plains aquifer. In Ford County, the Arkansas River has been mostly dry for the last three decades due to decreasing ground-water levels caused by irrigation. Reduced water flow has increased salinity and contaminated the adjoining alluvial aquifer (Young et al., 1999).

Almost all of Ford County's water supply comes from the High Plains aquifer. Continual ground-water mining for consumptive uses (mostly irrigation) and decreased recharge from the Arkansas River is resulting in a decline in the water level of the High Plains aquifer in Ford County and other western Kansas counties (Young et al., 1999).

A large, but lesser used water source, the Dakota aquifer, occurs at depths greater than the High Plains aquifer. Deeper wells result in higher drilling, well construction, and pumping costs, and the water quality is questionable in many regions of the aquifer (Macfarlane et al., 1989).

Explanation

Boundaries and Locations
- County line
- Township/range line
- Section line
- A—A' Geologic cross section
- County seat
- City
- Locality
- Built-up area

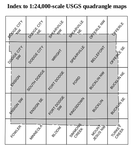
Transportation
- U.S. highway
- State highway
- Medium-duty primary road
- Medium-duty secondary road
- Light-duty road
- Unimproved road
- Railroad
- Unpaved landing strip
- Airport

Geologic Unit Boundaries
- Observed contact
- Inferred contact

Hydrology and Topography
- Perennial stream
- Intermittent stream
- Perennial water body
- Intermittent water body
- Elevation contour (50-meter interval)
- Elevation contour (10-meter interval)
- Depression contour (50-meter interval)
- Depression contour (10-meter interval)

Resource Development
- Open gravel pit

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



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

APPROXIMATE MEAN DECLINATION, 2009

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

The geology was mapped in the field using USGS 7.5-min 1:24,000-scale topographic maps.

Roads and highways 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 a USGS digital elevation model (DEM) with 1/3 arc-second resolution. The 1/3 arc-second data, in ESRI GRID format, were smoothed using a focal mean algorithm to minimize unwanted artifacts. 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.).

References

Kansas Geological Survey, 2009, Ford County – oil and gas production: Kansas Geological Survey, http://www.kgs.ku.edu/PRS/County/def/ford.html. Last accessed on 16 July 2009.

Macfarlane, P. A., Whittemore, D. O., Townsend, M. A., Doveton, J. H., Hamilton, V. J., Coyle, W. G., III, Wade, A., Macpherson, G. L., and Black, R. D., 1989, The Dakota Aquifer Program Annual Report, FY89: Kansas Geological Survey, Open-file Report 90-27, 301 p.

Young, D. P., Whitmer, J. M., and Whittemore, D. O., 1999, Upper Arkansas River Corridor Study: Lithologic characterization of unconsolidated deposits in Gray and Ford counties: A Kansas Water Plan Project: Kansas Geological Survey, Open-file Report 1999-23, 22 p.

Waite, H. A., 1942, Geology and ground-water resources of Ford County, Kansas: Kansas Geological Survey, Bulletin 43, 250 p.

Supplemental references

Dodge, D. A., Tomasu, B. I., Haberman, R. L., Roth, W. E., and Baumann, J. B., 1965, Soil survey of Ford County, Kansas: U.S. Department of Agriculture, Soil Conservation Service, in cooperation with the Kansas Agricultural Experiment Station, 84 p., 60 maps.

Frye, J. C., and Leonard, A. B., 1952, Pleistocene geology of Kansas: Kansas Geological Survey, Bulletin 99, 230 p.

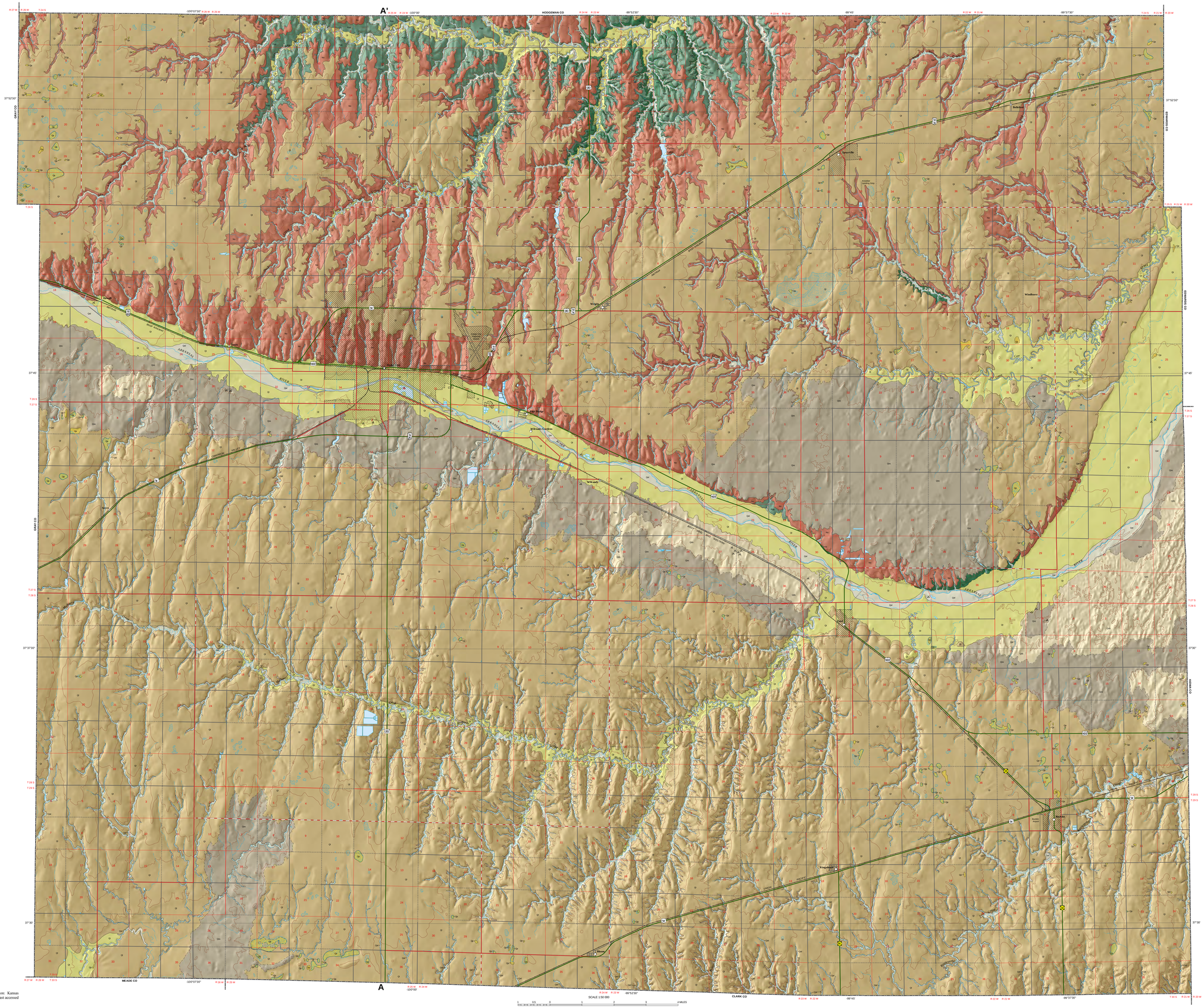
Frye, J. C., Leonard, A. B. and Swineford, A., 1956, Stratigraphy of the Ogallala Formation (Neogene) of northern Kansas: Kansas Geological Survey, Bulletin 118, 92 p.

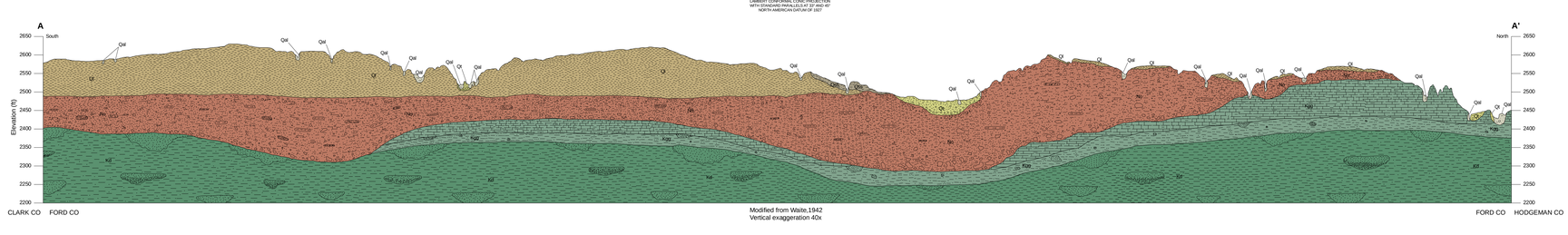
Merriam, D. F., 1963, The geologic history of Kansas: Kansas Geological Survey, Bulletin 162, 317 p.

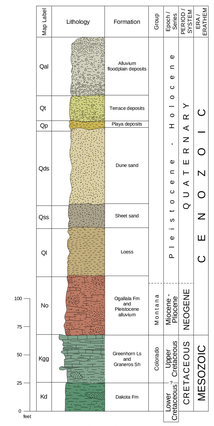
Sherow, J. E., 1990, Watering the valley: Development along the High Plains Arkansas River, 1870-1950: University Press of Kansas, 222 p.

Suggested reference to this map

Johnson, W. C., and Woodburn, T. L., 2009, Surficial geology of Ford County, Kansas: Kansas Geological Survey, Map M-108, scale 1:50,000.







Lithologic Explanation

- Unconsolidated silt, sand, and gravel
- Sand and gravel, conglomerate, or "mortar beds"
- Unconsolidated silt
- Bentonite
- Sand
- Volcanic ash
- Sandstone with shale or siltstone
- Undifferentiated sandstone or siltstone
- Limestone

CENOZOIC ROCKS

Undifferentiated floodplain alluvium - Alluvium is found in the Arkansas River, Saw Log Creek, Mulberry Creek, and other small stream valleys in Ford County. Alluvial sediment, consisting of primarily sand, gravel, and silt, reaches a thickness of 15 feet or less in the smaller tributaries and the eastern part of the Arkansas River valley and a thickness of about 50 feet in the central and western part of the Arkansas River valley.

Alluvial terrace deposits - Terrace deposits within the county occur along the Arkansas River, Saw Log Creek, and Mulberry Creek. Coarse gravel dominates the fill, with some sand and silt; the Ogallala Formation is the primary source of this material. The terrace deposits date from the late Pleistocene to at least the middle Holocene. The thickness of terrace deposits ranges from a few feet in the smaller tributaries to about 21 feet in the Arkansas River valley.

Upland intermittent lake (playa) deposits - Shallow basins, also known as playas, lagoons, or buffalo wallows, have developed in the upland loess deposits north and south of the Arkansas River valley. The origin of these features is usually attributed to wind deflation, animal activity, dissolution, or some combination of these processes. Age of the features appears to range from at least the early Holocene to the historic period. The basins range in size from less than an acre to hundreds of acres. Fill within these basins has an average thickness of 6 feet and consists of redeposited silt and fine sand from the loess. In the larger basins, a carbonate layer (caliche) typically develops a few feet below the basin floor.

Dune sand - Sand dunes occur immediately south of the Arkansas River, mainly in the eastern half of the county and north of the river in the east-central part of the county. The sand is derived from the Pleistocene terraces of the Arkansas River valley. Dunes reach a height of about 70 feet.

Sheet sand - Sand occurring in sheets, or subdued undulating swells and swales, is expressed immediately south of the Arkansas River along its entire length in Ford County. A smaller region of sheet sand is found in the southwest corner of the county. The origin of the sand is the Pleistocene terraces of the Arkansas River valley. Sheet sand may reach a thickness of about 20 feet.

Loess - Wind-deposited silt, with minor amounts of clay and fine sand, comprises the loess, which mantles the uplands in the county, both north and south of the Arkansas River valley. The loess is calcareous and a buff color, and ranges in age from the late Pleistocene to the late Holocene. Loess thickness ranges up to 42 feet. This unit includes the alluvial Kingsdown silt, a unit described and mapped by Waite (1942) south of the Arkansas River; the unit cannot be reliably differentiated from overlying loess deposits.

Ogallala Formation - Ogallala sediments are believed to be primarily Miocene and earliest Pliocene in age and are composed of calcareous gravel, sand, silt, and clay deposited by streams transporting sediments eastward from the Rocky Mountains. Ogallala outcrops commonly contain thick calcrete beds, regionally referred to as "mortar beds." Within the county, the mortar beds occur as lentils and therefore crop out irregularly. The unit mapped as Ogallala in Ford County also includes early Pleistocene alluvial deposits of the same Rocky Mountain gravel and sand materials. Outcrops of the Ogallala occur along the north side of the Arkansas River valley, along both sides of Saw Log Creek valley, and adjacent to the smaller tributaries in the northern part of the county. Most of the county is underlain by the Ogallala, which ranges in thickness from a few feet to about 250 feet (well-log data) in the north-central part; surface exposures range up to 51 feet thick.

MESOZOIC ROCKS

Greenhorn Limestone and Graneros Shale - The Upper Cretaceous Greenhorn Limestone and Graneros Shale are not differentiated in this county due to the lack of consistently good exposures and thin outcrops. Exposures have been mapped only in the northern part of the county along Saw Log Creek and its tributaries, and at one location north of the Arkansas River near the town of Ford. Greenhorn deposits consist of chalky shale with thin limestone beds and limestone concretions, and of thin chalky limestone beds separated by chalky shale. A characteristic fossil clam *Inoceramus* sp. is found throughout the unit. The Graneros Shale occurs below the Greenhorn and is a bluish-gray clay and sandy shale with sandy lenses. Outcrops have a thickness of up to 42 feet.

Dakota Formation - Dakota Formation exposures occur along Saw Log Creek and some of its tributaries in the north-central part of the county, in small outcrops along Cow Creek, and on the north side of the Arkansas River near the town of Ford. The deposits consist of white to brown lenticular sandstone with gray and variegated sandy shale. This is the oldest formation that crops out in the county and is Late Cretaceous in age. The outcrop thickness ranges up to 25 feet.

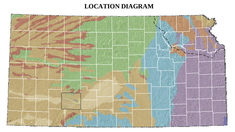
Computer compilation and cartography by the Kansas Geological Survey's Cartographic Services unit. For purchase information, or for information about other KGS maps or publications, please call

Publication Sales
(785) 864-2157

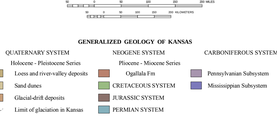
or visit the Kansas Geological Survey website at www.kgs.ku.edu

2009
Kansas Geological Survey
University of Kansas
Lawrence, Kansas 66047
ISBN #: 1-58806-948-6

LOCATION DIAGRAM



GENERALIZED GEOLOGY OF KANSAS



Last updated 12/24/2009