KU KANSAS GEOLOGICAL SURVEY
The University of Kansas

MAP M-123

SURFICIAL GEOLOGY OF SALINE COUNTY, KANSAS

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2011

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GENERAL GEOLOGY

Saline County covers an area of approximately 721 mi² (1,868 km²) (Palmer et al., 1992) of which about 1.67 mi² (4 km²), or 0.23%, is surface water. The surficial sedimentary rocks are Permian (Leonardian) to Cretaceous (Lower Cretaceous) in age and are dominated by shales, siltstones, and sandstones (Zeller, [1968] 2009). The dip of the strata is generally to the west. The oldest rocks (Wellington Formation) crop out in the eastern portion of the county, generally east of Interstate 135. The youngest rocks (Dakota Formation) are most commonly found capping the hilltops in the western part of the county. Sandstones in the Kiowa Formation cap many of the hills bordering the Smoky Hill and Saline River valleys.

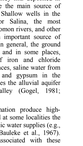
During the Pleistocene Epoch, erosion and deposition of sediments were driven by streams fed by glacial meltwater. Terraces (unconsolidated silt, sand, and gravel) preserved in the uplands in the extreme northeast corner of Saline County represent the level of older (Pleistocene) fluvial floodplains of the Smoky Hill River (Latta, 1949). Prior to glaciation in Kansas, the Smoky Hill River flowed south across western McPherson County to the Arkansas River. Glacial isostatic adjustments caused the Smoky Hill River to flow northward and intersect the Saline River (Frye and Leonard, 1952). Holocene sediments (clay, silt, sand, and gravel) occur as terrace and alluvial valley fill along today's streams and rivers. Some alluvium was later remobilized, creating the dune deposits that occur south of Gypsum.

In addition to the unconformity between Quaternary deposits and the underlying Cretaceous and Permian bedrock, a major unconformity separates Permian and Cretaceous rocks. In the subsurface in western Saline County, the Ninnescah Shale lies conformably on the Wellington Formation (Williams and Lohman, 1949), and the Kiowa Formation sits unconformably on the Ninnescah. Eastward, the Ninnescah thins and is exposed at the surface before it pinches out in the vicinity of the Smoky Hill River valley. East of the valley, the Ninnescah is missing and the Kiowa sits unconformably on the Wellington. The Wellington–Ninnescah contact is generally described as the change from gray shale (Wellington) to red shale (Ninnescah). In south-central Kansas the top of the Wellington Formation is defined by the Milan Limestone Member (Zeller, [1968] 2009), but the extent of the Milan north of that area is unknown. In the central part of Saline County west of Interstate 135, Bauleke et al. (1967, p. 30) reported "a few wells [that] have produced water from a dolomitic limestone bed that occupies the stratigraphic position of the Milan limestone, at the contact of the Ninnescah and Wellington." Whether this dolomitic limestone correlates to the Milan limestone in south-central Kansas is unknown.

GEOMORPHOLOGY

The majority of Saline County lies within the Smoky Hills physiographic region, which is composed of mostly Cretaceous rocks (Schoewe, 1949). The name Smoky Hills comes from the haze that covers the valleys in the early morning (Kansas Geological Survey, 2011a).

The topographic relief of Saline County is about 515 ft (157 m), with the lowest area (approximately 1,145 ft, 349 m) located in the northeast portion of the county near the confluence of the Solomon and Smoky Hill rivers, and the highest point (approximately 1,660 ft, 506 m) located about 3 miles (4.8 km) northwest of Brookville near the western edge of the county. Three major rivers – the Smoky Hill, the Saline, and the Solomon - flow through the county. Fluvial activity has resulted in large, relatively flat valleys that collectively cover approximately 37% of the county. These valleys are surrounded by rolling hills that are dissected by numerous small streams. The hills in the southwest and western parts of the county, especially those capped by sandstones in the Dakota Formation, have noticeably more relief. The Smoky Hill River flows northward through south-central Saline County before turning east at Salina. The Saline and Solomon rivers drain the northeast part of the county. The Saline River is the primary tributary to the Smoky Hill River; Gypsum Creek is another major tributary. Other major streams are Mulberry Creek, a tributary of the Saline River, and Spring Creek, a tributary of Mulberry Creek (Palmer et al., 1992).



APPROXIMATE MEAN DECLINATION, 2011

Dissolution of gypsum beds in the Wellington Formation has created a localized area of subsidence in the floodplain near the confluence of the Solomon and Smoky Hill rivers (Bauleke et al., 1967). Subsidence at the surface occurs when alluvial materials fill voids created by the dissolution of the underlying gypsum beds. The subsidence tends to occur as broader areas rather than localized sink holes (Bauleke et al., 1967).

STRUCTURAL GEOLOGY

Saline County lies within the Salina Basin, a northward-plunging syncline that encompasses an area of approximately 12,700 mi² (32,893 km²; Merriam, 1963). The general strike of the Permian units is north-south, with a slight dip to the west. The younger Cretaceous units strike northeast-southwest and dip gently to the northwest (Bauleke et al., 1967).

MINERAL RESOURCES

High-quality clay deposits (mostly kaolinite) have been reported in the Terra Cotta Clay Member of the Dakota Formation in the west-central part of the county (Plummer and Romary, 1947; Bauleke et al., 1967).

Gypsum in the Wellington Formation crops out east of the Smoky Hill River. An underground mine and mill operated in the late 1890's southwest of Solomon, and as early as 1887 gypsum was quarried just east of Salina (Kulstad et al., 1956). A mill and mine operated near Gypsum (then called Gypsum City) in the 1890's that processed gypsum earth (gypsite) (Jewett, 1942). Gypsite is a granular or earthy material that forms at the surface where calcium-sulfate-charged ground water accumulates (usually in low, swampy areas) and evaporates (Kulstad et al., 1956). The Hutchinson Salt Member of the Wellington Formation occurs in the subsurface in western Saline County, but it has never been commercially mined here.

Sand and gravel, sourced from alluvium deposits along the Smoky Hill, Saline, and Solomon rivers, is readily available throughout the county and is used mainly for aggregate (Kansas Geological Survey, 2011b). Calcite-cemented sandstone in the Kiowa Formation, locally called "quartzite," was quarried 2 miles (3.2 km) east of Bavaria (Swineford, 1947). These quarries are now abandoned. This hard sandstone is commonly used for aggregate and rip rap.

Oil, first discovered in Saline County in 1929, is the most important geological asset in the county (Bauleke et al., 1967). In the southeast corner of the county, oil is produced from the Mississippian at about 2,700 ft (824 m); south and east of Salina, oil production is mostly from the Viola Limestone and Maquoketa Shale (Ordovician) from about 3,200-3,400 ft (976-1,037 m). Many of these wells were drilled in the 1940's and 1950's. In 2010, 101 wells produced 65,720 barrels of oil and no gas; cumulatively, nearly 22.8 million barrels of oil have been produced in Saline County (Kansas Geological Survey, 2011c).

WATER RESOURCES

Holocene terraces and alluvial valley fills deposited in the Smoky Hill River valley are the main source of ground water in Saline County. Shallow wells in the alluvium provide freshwater for Salina, the most populous city. The Saline and Solomon rivers, and other tributaries in the county, are an important source of ground water for smaller wells. In general, the ground water in Saline County is hard, and in some places, contains high concentrations of iron and chloride (Bauleke et al., 1967). In some places, saline water from the natural dissolution of salt and gypsum in the Wellington Formation contaminates the alluvial aquifer of the Smoky Hill River valley (Gogel, 1981; Whittemore et al., 1981).

Sandstones in the Kiowa Formation produce high-quality water in limited areas, and at some localities the yields have been adequate for public water supplies (e.g., Gypsum, Kansas) (Latta, 1949; Bauleke et al., 1967). Springs and seeps are often associated with these sandstones.

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 Saline County map. The geology was mapped in the field using these topographic maps.

EXPLANATION

Boundaries and Locations
- County line
- Township/range line
- Section line
- A—A′ Geologic cross section
- Military reservation boundary
- Salina County seat
- Gypsum Other incorporated city
- Falun Unincorporated city or locality
- Built-up area (incorporated cities only)

Index Reference Features
- 1:24,000 quadrangle boundary

Transportation
- Interstate highway
- U.S. highway, divided
- State highway
- Primary road
- Medium-duty secondary road
- Light-duty road
- Unimproved road
- Railroad
- Airport

Geologic Unit Boundaries
- Observed contact
- Concealed 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 sand or gravel pit

CITED REFERENCES

Bauleke, M. P., Hardy, R. G., Franks, P., Plummer, N., and Stewart, G., 1967, Evaluating mineral resources, Saline County (a pilot project): Kansas Department of Economic Development, Planning for Development, Report No. 158, 52 p.

Bayne, C. K., Franks, P. C., and Ives, W., 1971, Geology and ground-water resources of Ellsworth County, central Kansas: Kansas Geological Survey, Bulletin 201: http://www.kgs.ku.edu/General/Geology/Ellsworth/index.html.

Byrne, F. E., Walters, C. P., Hill, J. L., and Riseman, L., 1959, Geology and construction-material resources of Marion County, Kansas: U.S. Geological Survey, Bulletin 1060B, 95 p.

Franks, P. C., 1966, Petrology and stratigraphy of the Kiowa and Dakota Formations (basal Cretaceous), north-central Kansas: Unpublished Ph.D. thesis, University of Kansas, 2 vols., 312 p.

Franks, P. C., 1979, Paralic to fluvial record of an early Cretaceous marine transgression - Longford member, Kiowa Formation, north-central, Kansas: Kansas Geological Survey, Bulletin 219, 55 p.: http://www.kgs.ku.edu/Publications/Bulletins/219/index.html.

Frye, J. C., and Leonard, A. B., 1952, Pleistocene geology of Kansas: Kansas Geological Survey, Bulletin 99, 230 p., http://www.kgs.ku.edu/Publications/Bulletins/99/index.html.

Gogel, T., 1981, Discharge of saltwater from Permian rocks to major stream-aquifer systems in central Kansas: Kansas Geological Survey, Chemical Quality Series 9, 60 p. http://www.kgs.ku.edu/Publications/Bulletins/CQS09/index.html.

Jewett, J. M., 1942, Gypsum; in, Kansas Mineral Resources for Wartime Industries, J. M. Jewett and W. H. Schoewe, eds.: Kansas Geological Survey, Bulletin 41, pt 3, p. 138-144.

Kansas Geological Survey, 2011a, Smoky Hills; in, GeoKansas: Kansas Geological Survey; http://www.kgs.ku.edu/Extension/smoky/smoky.html.

Kansas Geological Survey, 2011b, Saline County; in, KGS Directory of Kansas Industrial Mineral Producers; http://www.kgs.ku.edu/Magellan/Minerals/index.html.

Kansas Geological Survey, 2011c, Saline County - Oil and gas production: Kansas Geological Survey; http://www.kgs.ku.edu/PRS/County/ry/saline.html.

Kulstad, R. O., Fairchild, P., and McGregor, D., 1956, Gypsum in Kansas: Kansas Geological Survey, Bulletin 113, 110 p.

Latta, B. F., 1949, Ground-water conditions in the Smoky Hill valley in Saline, Dickinson, and Geary counties, Kansas: Kansas Geological Survey, Bulletin 84, 152 p.

Merriam, D. F., 1963, The geologic history of Kansas: Kansas Geological Survey, Bulletin 162, 317 p.; http://www.kgs.ku.edu/Publications/Bulletins/162/06_pres. html.

Palmer, C. D., Hamilton, V. L., Hoffman, B. R., Fahnestock, P. B., and Barker, W. L., 1992, Soil survey of Saline County, Kansas: U. S. Department of Agriculture, Natural Resources Conservation Service, in cooperation with Kansas Agricultural Experimental Station, 133 p.: http://soildatamart.nrcs.usda.gov/Manuscripts/KS169/0/saline.pdf.

Plummer, N., and Romary, J. R., 1947, Kansas clay, Dakota Formation: Kansas Geological Survey, Bulletin 67, 241 p.

Schoewe, W. H., 1949, The geography of Kansas, pt. 2, Physical geography: Kansas Academy of Science Transactions, v. 52, no. 3, p. 261-333.

Swineford, A., 1947, Cemented sandstones of the Dakota and Kiowa formations in Kansas: Kansas Geological Survey, Bulletin 70, 104 p.

Whittemore, D. O., Basel, C. L., Gaffe, O. K., and Waugh, T. C., 1981, Geochemical identification of saltwater sources in the Smoky Hill River valley, McPherson, Saline, and Dickinson counties, Kansas: Kansas Geological Survey, Open-file Report 81-6, 78 p.: http://www.kgs.ku.edu/Hydro/Publications/1981/OFR81_6/index.html.

Williams, C. C., and Lohman, S. W., 1949, Geology and ground-water resources of a part of south-central Kansas with special reference to the to the Wichita municipal water supply: Kansas Geological Survey, Bulletin 79: http://www.kgs.ku.edu/Publications/Bulletins/79/06_geonret.html.

Zeller, D. E., ed., [1968] 2009, Classification of rocks in Kansas, revised by Kansas Geological Survey Stratigraphic Nomenclature Committee; in, The Stratigraphic Succession in Kansas: Kansas Geological Survey, Bulletin 189, 81 p., 1 plate: http://www.kgs.ku.edu/General/Strat/index.html.

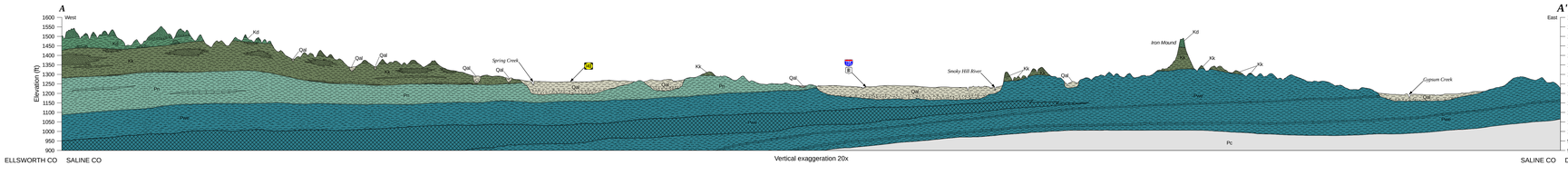
ADDITIONAL SOURCES

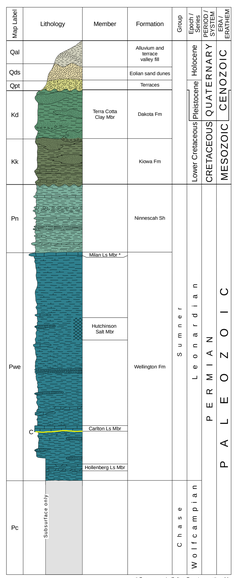
Franks, P. C., 1975, The transgressive-regressive sequence of the Cretaceous Cheyenne, Kiowa, and Dakota formations of Kansas; in, The Cretaceous System in the Western Interior of North America, W. G. E. Caldwell, ed.: Geological Association of Canada, Special Paper 13, p. 469-521.

Lee, W., Leatherock, C., and Botinelly, T., 1948, The stratigraphy and structural development of the Salina basin of Kansas: Kansas Geological Survey, Bulletin 74: http://www.kgs.ku.edu/Publications/Bulletins/74/02_intro.html.

SUGGESTED REFERENCE TO THIS MAP

McCauley, J. R., 2011, Surficial geology of Saline County, Kansas; text and geologic-unit descriptions by C. M. Phillips-Lander and R. S. Sawin; cross section geology by R. S. Sawin: Kansas Geological Survey, Map M-123, scale 1:50,000.





GEOLOGIC UNITS

CENOZOIC

Holocene

Alluvium and Terrace Valley Fill – Alluvium and terrace valley fill are found along major rivers and smaller streams. Floodplain deposits associated with the major rivers (Smoky Hill, Saline, and Solomon) contain mostly clay, silt, sand, and gravel (Latta, 1949). The smaller streams draining the uplands contain floodplain sediments primarily derived from weathered shales and sandstones. As a result, clay and silt dominate these deposits, although sand and gravel are present in varying amounts (Latta, 1949). The thickness of the alluvium ranges up to approximately 60 ft (18 m).

Eolian Sand Dunes – Fine-grained Holocene sand dunes are found in small areas south of Gypsum. These eolian sands were derived from the floodplain of Gypsum Creek and re-deposited by prevailing winds along the west side of the creek.

Pleistocene

Terraces – Unconsolidated, poorly sorted sand, gravel, and silt were probably deposited by the Smoky Hill River when it flowed at a higher level during the Pleistocene (Latta, 1949). These terraces have subsequently been dissected as the Solomon and Smoky Hill rivers downcut through the deposit. The average thickness of this unit is about 15-20 ft (4.5-6 m).

MESOZOIC

Dakota Formation – The Dakota Formation consists of two members: in descending order, the Jansson Clay Member and the Terra Cotta Clay Member (Plummer and Romary, 1947). Probably only the basal **Terra Cotta Clay Member** is present in Saline County. The Terra Cotta is composed primarily of red-mottled, light-gray to greenish-gray clay and siltstone, and coarse-grained and conglomeratic sandstone (Bayne et al., 1971). Lenticular, crossbedded sandstone layers in the Terra Cotta can be locally prominent – the iron-oxide cemented sandstones are resistant to erosion and cap many of the hills and benches – but generally this member is mostly clay and siltstone (Bayne et al., 1971). The maximum exposed thickness of the Dakota Formation is approximately 200 ft (61 m) near the western edge of the county.

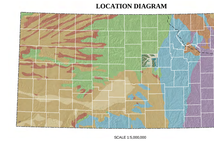
Kiowa Formation – The Kiowa Formation consists of medium- to dark-gray and black fissile shales with scattered thin beds of fine-grained sandstone and siltstone and thin beds of fossiliferous limestone (shell-beds). Pyrite, marcasite, gypsum crystals, cone-in-cone structures, siderite (iron-claystone concretions), and marine fossils occur within the shale. Thick (up to 100 ft, 30 m), lenticular and thinner (less than 10 ft, 3 m), sheet-like, fine- to medium-grained, crossbedded sandstones are more common in the upper part of the formation (Franks, 1979), but they are not laterally continuous over long distances (Swineford, 1947). These sandstones are typically very light-gray to pale grayish orange, but in places iron-oxide cement colors it reddish brown. Locally, calcite-cemented sandstones ("quartzite") are found in the Kiowa. The Kiowa Formation includes the locally mappable "Longford member" (Franks, 1966), which is present in the north-central part of the county (Franks, 1979). The Longford, where found, is the basal unit of the Kiowa and is composed of a white to grayish-orange capping siltstone underlain by red-mottled and gray clay rocks and siltstone, although the lithologies below the capping siltstone can be highly variable (Franks, 1979). The maximum exposed thickness of the Kiowa Formation in Saline County is about 140 ft (43 m).

PALEOZOIC

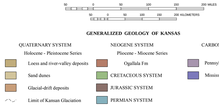
Ninnescah Shale – The Ninnescah Shale is mostly red shale but may contain some green shale beds and a few thin beds of argillaceous limestones. Thin, cross-cutting, secondary satin spar gypsum veins may be present (Williams and Lohman, 1949). Erosion has removed the upper part of the Ninnescah in Saline County where its maximum exposed thickness is about 100 ft (30 m) before it thins eastward and pinches out in the vicinity of the Smoky Hill River valley. Its contact with the Wellington is inferred along the I-135 corridor in the south-central part of the county. The Ninnescah is poorly exposed in Saline County.

Wellington Formation – The Wellington Formation in Saline County is predominantly gray and bluish-gray shale with beds of gypsum, anhydrite, and argillaceous limestone. Maroon, red, and green argillaceous shales can also occur (Williams and Lohman, 1949; Byrne et al., 1959). The uppermost **Milan Limestone Member** is not known to occur in central Kansas; however, Bauleke et al. (1967) reported a dolomitic limestone bed at the stratigraphic position of the Milan Limestone in Saline County. The **Hutchinson Salt Member** occurs only in the subsurface in the western part of the county. The **Carlton Limestone Member** is a light-gray to pale-yellow-tan, thin-bedded, platy, argillaceous limestone and interbedded tan-gray, calcareous shale (Byrne et al., 1959). Plant and insect fossils are found at some localities. The Carlton crops out east of Gypsum Creek near the eastern edge of the county. Below the Carlton in this area, several gypsum beds, ranging from 1 to 5 ft thick (0.3-1.6 m, Kulstad et al., 1956), crop out. Gypsum layers also occur elsewhere in the Wellington. The **Hollenberg Limestone Member** does not crop out in Saline County but should be present in the subsurface. Outcrops of the Wellington Formation are generally poor. Although the Wellington Formation can be up to 700 ft (214 m) thick, only about 100 ft (30 m) is exposed in Saline County.

LOCATION DIAGRAM



GENERALIZED GEOLOGY OF KANSAS



Elevation contours are presented for general reference. They were generated by the U.S. Geological Survey from USGS National Elevation Dataset (NED) digital-elevation models (DEM) with 1/3 arc-second resolution, which in turn contain resampled data from the 1/9 arc-second layer of NED. Secondary datums used in generation of the contours include the high-resolution flow lines, water bodies, and areas from the National Hydrography Dataset (NHD). 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. Expected fluctuations 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-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) and Saline County. U.S. Department of Agriculture – Farm Services Agency (USDA-FSA) National Agriculture Imagery Program (NAIP) imagery and Saline County imagery also were 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 were mosaicked into a single output DEM in Esri GRID format, converted to geographic coordinates. This DEM was downsampled to 1/3 arc-second resolution and 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.).

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.

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