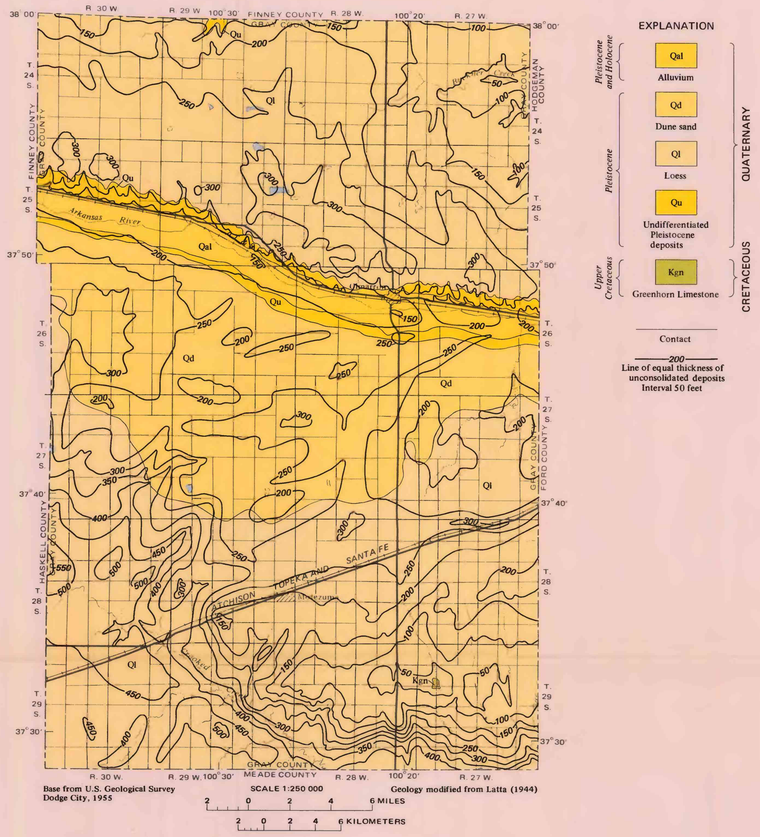
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
STATE GEOLOGICAL SURVEY OF KANSAS
KANSAS STATE DEPARTMENT OF HEALTH
KANSAS STATE BOARD OF AGRICULTURE

HYDROLOGIC INVESTIGATIONS
ATLAS HA-517 (SHEET 1 OF 2)

GENERAL GEOLOGY AND HYDROLOGY



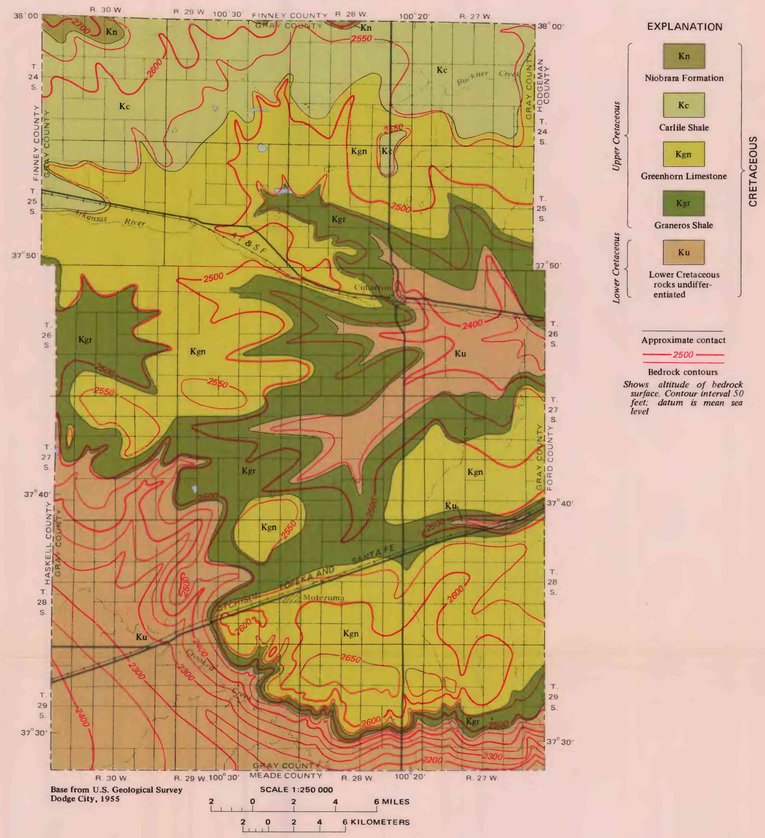
MAP SHOWING SURFICIAL GEOLOGY AND THICKNESS OF UNCONSOLIDATED DEPOSITS

EXPLANATION

Pleistocene and Holocene	Qal — Alluvium	QUATERNARY
Pleistocene	Qd — Dune sand	
Pleistocene	Ql — Loess	
Pleistocene	Qu — Undifferentiated Pleistocene deposits	
Upper Cretaceous	Kgn — Greenhorn Limestone	CRETACEOUS

Contact

200 — Line of equal thickness of unconsolidated deposits Interval 50 feet



MAP SHOWING BEDROCK GEOLOGY AND CONFIGURATION OF THE BEDROCK SURFACE

EXPLANATION

Upper Cretaceous	Kn — Niobrara Formation	CRETACEOUS
Upper Cretaceous	Kc — Carlile Shale	
Upper Cretaceous	Kgn — Greenhorn Limestone	
Upper Cretaceous	Kgr — Graneros Shale	
Lower Cretaceous	Ku — Lower Cretaceous rocks undifferentiated	

Approximate contact

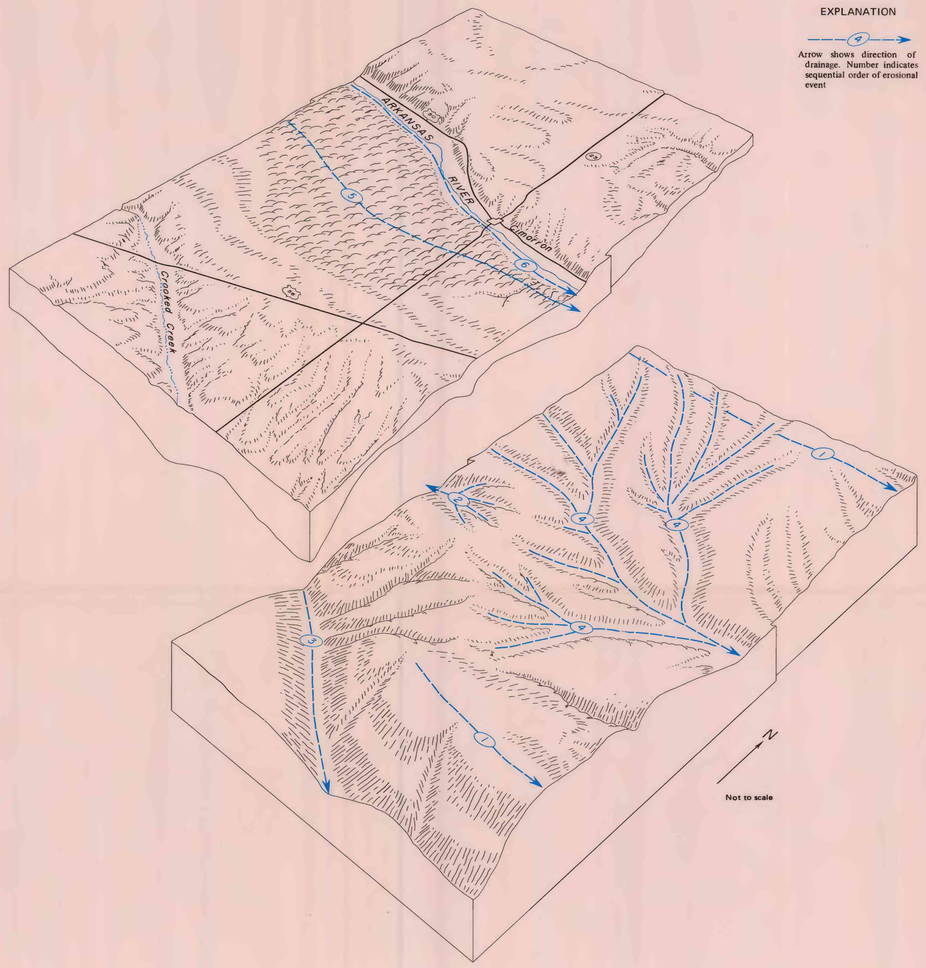
2500 — Bedrock contours

Shows altitude of bedrock surface. Contour interval 50 feet; datum is mean sea level

Generalized section of geologic units and water-yielding characteristics

NOTE.—The classification and nomenclature of the stratigraphic units used in this report are those of the U.S. Geological Survey and differ somewhat from those of the State Geological Survey of Kansas.

System	Series	Stratigraphic unit	Thickness (feet)	Physical character	Water supply
Quaternary	Holocene and Pleistocene	Alluvium	0–80	Clay, silt, and sand of Holocene age overlying medium to very coarse sand and gravel of late Pleistocene age.	Yields from 500 to 2,500 gpm (gallons per minute) to irrigation wells.
Quaternary	Pleistocene	Dune sand	0–70	Fine to medium sand; contains some silt and clay.	Generally lies above the water table and does not yield water to wells.
Quaternary	Pleistocene	Loess	0–20	Yellowish-tan windblown silt.	
Quaternary	Pleistocene	Undifferentiated deposits	0–550	Fine to medium sand and pink, tan, or gray silt and clay alternating with layers of loose to well-cemented medium to very coarse sand and gravel. Caliche and "mortar beds" are common.	Yields to wells range from 500 to 1,000 gpm in the fine- to medium-grained deposits, and from 500 to more than 2,000 in the medium- to coarse-grained deposits.
Tertiary	Pliocene	Ogallala Formation	0–200	Pink to tan sandy clay and silt alternating with poorly sorted, loose to well-cemented sand and gravel. Caliche and "mortar beds" are common.	Yields to wells range from a few gallons per minute to as much as 700 gpm.
Cretaceous	Upper Cretaceous	Niobrara Formation	50	White, tan, and light-gray limestone and interbedded white thin chalky shale.	Generally does not yield water to wells. May yield a few gallons per minute to domestic or stock wells from the upper weathered or fractured zone.
Cretaceous	Upper Cretaceous	Carlile Shale	100–200	Dark-gray to black silty sandstone and shale in the upper part. Dark-gray calcareous shale with a few thin gray limestone beds in the lower part.	
Cretaceous	Upper Cretaceous	Greenhorn Limestone	100–120	Light-gray to gray chalky and crystalline limestone and shale in the upper part. Thick beds of gray to dark-gray calcareous shale and thin beds of bentonite in the lower part with thin beds of gray crystalline limestone near the base.	
Cretaceous	Upper Cretaceous	Graneros Shale	40–60	Dark-gray to black shale with few very thin beds of sandstone, limestone, and bentonite.	
Cretaceous	Lower Cretaceous	Undifferentiated rocks	300–400	Upper unit (Dakota Formation)—gray to brown, red, and yellow shale and sandy shale; contains thick beds of fine- to medium-grained, loosely to well-cemented sandstone. Middle unit (Kiowa Shale)—dark-gray to black shale and a few thin beds of sandstone. Lower unit (Cheyenne Sandstone)—fine- to medium-grained, loosely to well-cemented sandstone and a few thin beds of light-gray shale.	Inadequately tested in county. Some domestic wells in Gray County obtain water from the upper sandstones. Wells in adjoining counties yield as much as 1,000 gpm from loosely cemented sandstones in these units.
Jurassic	Upper Jurassic	Undifferentiated rocks	100–200	Mostly gray shale interbedded with varicolored shale and a silty sandstone near the base.	Untested in county. May yield some water to wells from sandstone.
Permian	Upper Permian	Undifferentiated rocks	500	Red shale, sandy shale, silty sandstone, and anhydrite.	Yields no potable water to wells.



BLOCK DIAGRAMS OF BEDROCK AND LAND SURFACES SHOWING SEQUENCE OF TERTIARY AND QUATERNARY EROSION

UNCONSOLIDATED DEPOSITS

Tertiary and Quaternary deposits underlying most of Gray County range in thickness from a few feet to about 550 feet, as shown on the surficial geologic map.

The Ogallala Formation of Pliocene age does not crop out in the county, but is present in the northern and southern parts where it overlies consolidated rocks. This formation consists of interbedded fine- to coarse-grained alluvial sediments. Percolating ground water has deposited an abundance of calcium carbonate, which forms caliche in the silt and clay beds and cements some sand and gravel into "mortar beds."

Undifferentiated Pleistocene deposits crop out on the bluff north of the Arkansas River and on a low terrace along the south side. These deposits may overlie the Ogallala Formation or be in direct contact with consolidated rocks. In some areas, stratified layers of admixed clay, silt, and sand indicate deposition by laterally migrating, low-gradient streams. In other areas, very coarse sand and gravel indicate deposition in channels by high-velocity streams. Because the undifferentiated Pleistocene deposits also contain an abundance of caliche and "mortar beds," they commonly are indistinguishable from the Ogallala Formation in the subsurface.

Loess of late Pleistocene age underlies much of the upland area of the county. The land surface is level to gently rolling, and the silty soil formed on the loess is ideally suited for irrigation farming. Dune sand of late Pleistocene age forms hummocky ridges in a broad area south of the river valley. The sandy soil is ideally suited for rangeland and may be irrigated in some areas by sprinkler systems. Alluvium, which underlies the flood plain of the Arkansas River, consists of coarse-grained deposits of late Pleistocene age overlain by fine-grained deposits of Holocene age.

BEDROCK FORMATIONS

Consolidated rocks of Permian to Cretaceous age (referred to as bedrock) underlie the unconsolidated deposits. Because data for bedrock formations in Gray County are meager, descriptions are based on a few deep well logs and on data from adjacent counties. The configuration of the bedrock surface and the geologic units that subcrop at this surface are shown on the bedrock geologic map. The stratigraphic relation, thickness, physical character, and water-yielding capability of geologic units are given in the generalized section.

Upper Permian rocks (red beds), which underlie all of the county, consist of fine-grained rocks interbedded with numerous layers of gypsum. Because the water occurring in these rocks is highly mineralized, the top of the red beds represents the maximum depth of drilling for water wells.

Upper Jurassic rocks, which overlie the red beds, consist mostly of shale with a silty sandstone near the base. Correlation of logs in counties to the west indicates that some water may be obtained from the sandstone. Logs of wells in counties to the east and south show the Jurassic unit to be thin or absent from the geologic section. The areal extent of Jurassic rocks in Gray County is not known.

Undifferentiated Lower Cretaceous rocks include the Cheyenne Sandstone, Kiowa Shale, and Dakota Formation. In adjacent counties, wells in loosely cemented sandstones of the Cheyenne and Dakota units commonly yield water for domestic and stock use and, in some areas, yield ample water for irrigation. The Kiowa unit yields little or no water to wells. Test drilling of the entire section of Lower Cretaceous rocks in Gray County has been too meager to permit an adequate forecast of the potential yield to irrigation wells.

Upper Cretaceous rocks (Graneros Shale, Greenhorn Limestone, Carlile Shale, and Niobrara Formation) underlie unconsolidated deposits, except where the rocks have been removed by erosion, as shown on the bedrock geologic map. The formations consist of limestone and shale that yield no water to wells, except where the upper part in the subsurface has been altered by weathering and fracturing.

HISTORY OF TERTIARY AND QUATERNARY GEOLOGY

The probable sequence of geologic events that occurred in Gray County during Tertiary and Quaternary time is illustrated on the block diagrams showing the bedrock and land surfaces.

During Pliocene time, streams flowed eastward through the region eroding channels in the bedrock and depositing mostly granitic sediments derived from the Rocky Mountains. Dissected remnants of a Pliocene erosion surface on the bedrock (1) occur along the northern part of the county and on the ridge in the southern part.

During late Pliocene and early Pleistocene time, solution and removal of thick Permian salt deposits in southwestern Kansas caused regional subsidence of overlying beds. As a result, the principal streams flowed southeastward and southward through the area of subsidence (McGovern, 1970). In Gray County, tributary channels (2) downcut westward toward a major channel trending southward from Finney County through Haskell County. These tributary channels subsequently were filled with sediments derived locally from Cretaceous and Pliocene formations.

Renewed subsidence, especially in the deep basin in north-central Meade County (Frye, 1942), caused headward erosion of a deep channel (3) across southwestern Gray County. This channel, which is incised into an older southward-trending channel in Haskell County (Gutentag and Stullken, 1973) probably was formed in early Pleistocene time. Deposits in southwestern Gray County consist of tan to dark-gray sandy clays interbedded with limestone and sandstone gravels in the lower part and granitic sand and gravel interbedded with pink to tan sandy clay in the upper part. The contrast in sediments of this area may indicate several stages of subsidence and deposition.

In late Pleistocene time, the drainage system apparently shifted to flow eastward across Gray County (4). Erosion removed much of the Pliocene deposits and eroded deep channels into the bedrock. Sediments in the lower part of the channels commonly contain limestone and sandstone gravels derived from Cretaceous formations. These channels were filled and overtopped by thick beds of stratified fine- to medium-grained alluvial sediments. Subsequently, another major stream flowed eastward across the county in an area south of the present river (5); it eroded a broad channel into the stratified sediments and deposited very coarse sand and gravel of Rocky Mountain origin.

During late Pleistocene and Holocene time, strong winds deposited a mantle of silt and sand over the area. The major drainage shifted northward during this time and eroded a shallow channel (6) that coincides with the boundary of the Arkansas River flood plain. Then the channel was partly refilled with very coarse sand and gravel of very late Pleistocene age and fine-grained sediments of Holocene age.

GROUND WATER IN GRAY COUNTY, SOUTHWESTERN KANSAS

By
H. E. McGovern and W. A. Long

1974

Interior—Geological Survey, Reston, Va.—1974

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