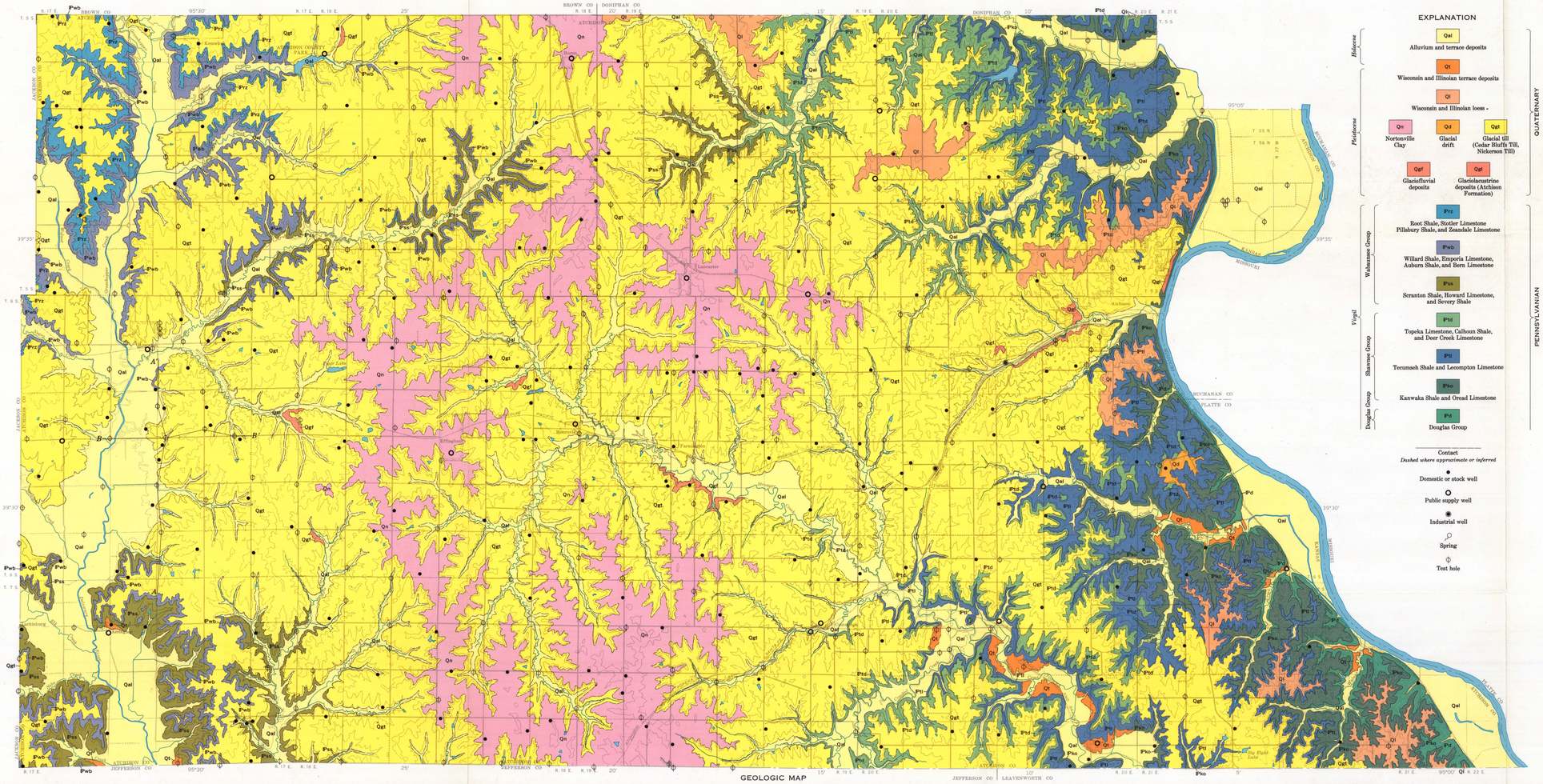
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
STATE GEOLOGICAL SURVEY OF KANSAS
KANSAS STATE DEPARTMENT OF HEALTH
KANSAS STATE BOARD OF AGRICULTURE

HYDROLOGIC INVESTIGATIONS
ATLAS HA-467 (SHEET 1 OF 2)

GEOLOGY AND GENERAL HYDROLOGY



GEOLOGIC MAP

Base from U.S. Geological Survey, 1:24,000
Denton, Effingham, Everest, Horton, Lancaster, Oak Mills, Weston, and Whiting, 1961; Arrington, Atchison East, Nortonville, and Potter, 1960; Atchison NE, Atchison West, Bendena, and Half Mound, 1959

SCALE 1:62 500
1 0 1 2 3 4 MILES
1 .5 0 1 2 3 4 KILOMETERS
CONTOUR INTERVAL 50 FEET
DATUM IS MEAN SEA LEVEL

Geology mapped in 1966–68

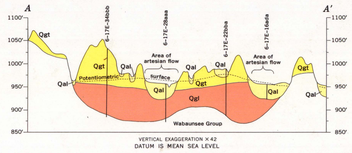
EXPLANATION

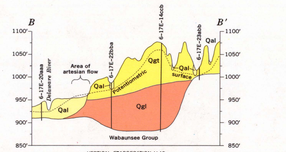
- Qal — Alluvium and terrace deposits
- Qt — Wisconsin and Illinoian terrace deposits
- Ql — Wisconsin and Illinoian loess
- Qn — Nortonville Clay
- Qd — Glacial drift
- Qgt — Glacial till (Cedar Bluffs Till, Nickerson Till)
- Qgf — Glaciofluvial deposits
- Qgl — Glaciolacustrine deposits (Atchison Formation)
- Pwz — Root Shale, Stotler Limestone, Pillsbury Shale, and Zeandale Limestone
- Pwb — Willard Shale, Emporia Limestone, Auburn Shale, and Bern Limestone
- Pss — Scranton Shale, Howard Limestone, and Severy Shale
- Ptd — Topeka Limestone, Calhoun Shale, and Deer Creek Limestone
- Pd — Tecumseh Shale and Lecompton Limestone
- Pko — Kanwaka Shale and Oread Limestone
- Pd — Douglas Group

Contact
Dashed where approximate or inferred

- Domestic or stock well
- Public supply well
- Industrial well
- Spring
- Test hole

Holocene / Pleistocene — QUATERNARY
Virgil / Douglas Group — PENNSYLVANIAN

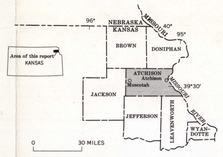




GEOLOGIC SECTIONS

INTRODUCTION

This study is part of an investigation of the geology and availability of ground water in northeastern Kansas (see index map).



INDEX MAP SHOWING LOCATION OF STUDY AREA

GEOLOGY

Bedrock of Late Pennsylvanian age is exposed throughout the county (see geologic map). The Stranger Formation of the Douglas Group (see generalized columnar section), the oldest exposed formation, occurs at the base of bluffs along the Missouri River in the southeastern part of the county. The Root Shale of the Wabaunsee Group, the youngest exposed formation, is found in the northwestern corner of the county. Pennsylvanian rocks are exposed only along stream valley walls, except near the Missouri River where erosion has removed much of the glacial cover from the uplands. Bedrock exposures are often discontinuous along valley walls as a result of bedrock lows, caused by buried stream valleys, which extend across or along present stream valleys (see geologic sections).

The overall dip of the Pennsylvanian beds is northwestward at about 15 feet per mile. North of Atchison a slight southwestward dip is apparent on the base of the Oread Limestone. The bedrock-configuration map indicates that the bedrock surface has a slight northeastward slope and that several bedrock highs are separated from one another by both buried and present stream valleys.

A major buried stream valley extends from south of Muscotah eastward to Atchison. This valley and its tributaries began developing at least as early as Nebraskan time, and evidence indicates that it extends northwestward from Muscotah for about 90 miles and northeastward from Atchison into Missouri. The width of the buried valley ranges from ½ to 1½ miles, and the valley walls are as much as 200 feet high. The thickness of the unconsolidated deposits reaches a maximum of 250 feet. Some buried tributaries to the major valley are at the same base level, whereas others, which are younger, are hanging relative to the major valley. The younger tributaries are eroded into both bedrock and glacial deposits. The trends and gradients of both the buried and present stream valleys indicate that pre- and early Pleistocene drainage was eastward, whereas late Pleistocene and Holocene drainage is southward and southeastward.

Unconsolidated glacial drift, loess, deposits beneath terraces, and alluvium overlie the bedrock surface (see map showing thickness of unconsolidated deposits). These deposits range in total thickness from 0 to 250 feet. Although Nebraskan(?) till has not been identified in exposures, deep test holes reveal till-like clay deposits below deposits of Kansan age. Nebraskan(?) deposits are composed largely of lacustrine sand and clay, and chert and limestone gravels. Most of the gravel deposits are related to glacial activity, because erratic igneous pebbles have been identified within them. Other pebbles probably were derived largely from rocks of Permian and Cretaceous age west of this area and were transported to their present locations by periglacial streams flowing in the now-buried channels.

The Atchison Formation of Moore and others (1951), herein adopted, is an early Kansan glaciolacustrine sand deposit that overlies the Nebraskan(?) deposits and generally is confined to buried stream valleys. Deposition of the very fine silty sand in the Atchison Formation is believed to have preceded an early Kansan glacial advance that deposited the Nickerson Till of Reed and Dreeszen (1965), which is herein adopted. Although deposition of the Nickerson Till was not confined to old stream channels, this till either was not deposited on or has been eroded from the highest bedrock surfaces. The Nickerson Till is separated locally from the overlying medial Kansan Cedar Bluffs Till of Reed and Dreeszen (1965), herein adopted, by sandy and pebbly glaciofluvial deposits which were deposited in stream channels or lakes on the Nickerson Till surface by melt water from the glaciers. The lateral extent of unconsolidated deposits below the Cedar Bluffs Till is shown by the areal-distribution map. The Cedar Bluffs Till underlies the county everywhere except along stream valleys where it has been removed by erosion. The Nortonville Clay of Frye and Leonard (1952), herein adopted, is late Kansan in age and overlies the Cedar Bluffs Till at high topographic positions. The Nortonville Clay is believed to have been deposited in a large late Kansan lake marginal to glaciers to the north, which indicates that the Cedar Bluffs Till was thick and very extensive before dissection by streams.

Because the glaciers did not extend into the county during Illinoian Glaciation, depositional processes were minimal. Stream erosion was the primary geologic process, and deposits underlying terraces believed to be remnants of Illinoian stream activity are present in several stream valleys. These deposits are composed primarily of sandy clay, which is characteristic of reworked glacial deposits. Some terrace deposits along tributaries to the Missouri River are composed of loesslike silt. The present stream pattern began developing during Illinoian Glaciation, with some streams cutting new channels into the bedrock surface and others, after removing the glacial cover, resuming flow in the preglacial channels.

Stream activity increased greatly during Wisconsin time. Deposits of Wisconsin age underlie terraces in all major stream valleys. As are the Illinoian deposits, these deposits are composed of reworked glacial material. Loess, primarily of Wisconsin age, mantles the uplands and is less than 10 feet thick, except along the Missouri River bluffs where thicknesses are as much as 30 feet.

Alluvium of Holocene age is in all stream valleys in the county. It is composed primarily of reworked and redistributed clayey glacial deposits, except along the Missouri River where deposits of fine sand to coarse gravel are present.

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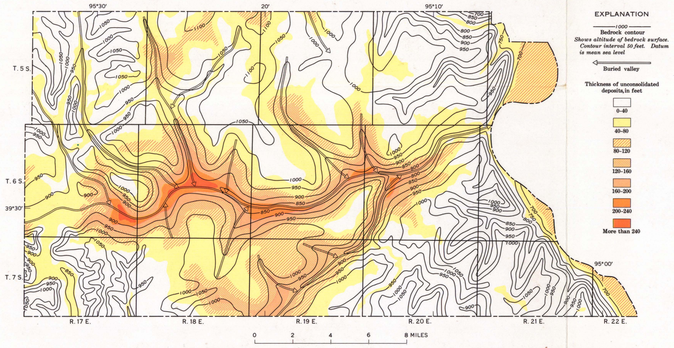
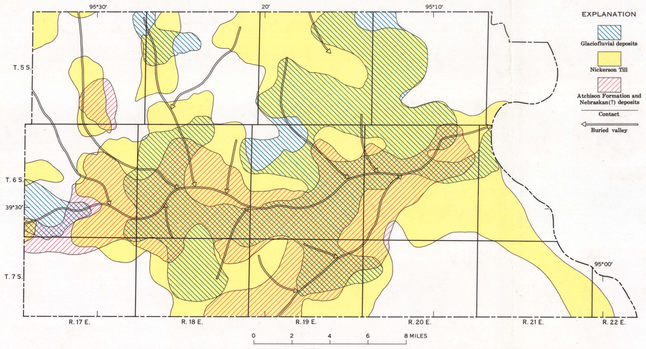
Note: Additional information on drillers' logs and well-inventory and water-analysis data is on file in the offices of the U.S. Geological Survey and State Geological Survey of Kansas, Lawrence, Kans. 66044.



MAP SHOWING CONFIGURATION OF BEDROCK SURFACE AND THICKNESS OF UNCONSOLIDATED DEPOSITS



MAP SHOWING AREAL DISTRIBUTION OF UNCONSOLIDATED DEPOSITS BELOW THE CEDAR BLUFFS TILL

GENERALIZED COLUMNAR SECTION AND WATER-BEARING CHARACTERISTICS

[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	Glaciation and alternating glacials	Group	Formation or rock unit	Member	Thickness[1] (feet)	Lithology	Hydrology[2]
Quaternary	Holocene	?	?	Alluvium		0–105	Deposits of brown to bluish-gray sandy pebbly clay. Thin beds of gravel may be interspersed throughout or rest directly on bedrock. Gravel composed of limestone, chert, and glacial material. Missouri River alluvium is predominately layers of medium to coarse sand and fine to coarse gravel.	Yields small to moderate quantities of water everywhere except in the alluvium of the Missouri River, where yields of 2,000 gpm (gallons per minute) are possible. The potential for development is excellent.
	Pleistocene	Illinoian Wisconsin		Terrace deposits		0–70	Discontinuous deposits of brown sandy clay on stream-valley walls. Missouri River tributaries contain reddish-brown silt resembling loess.	Yield small quantities of water to wells. Terrace deposits along Stranger Creek and the Delaware River may yield moderate supplies.
				Loess		0–40	Wind-deposited brown to reddish-brown noncalcareous slightly sandy silt, generally in upland position. Locally may be older than Wisconsin age.	Yields no water to wells.
				Nortonville Clay		0–45	Light-gray compact clay. Locally may be slightly sandy and contain sparse pebbles. May contain reddish-brown weathered streaks.	Yields no water to wells.
		?		Cedar Bluffs Till		0–100	Heterogeneous mixture of clay, silt, and gravel. Brown, reddish brown, yellowish brown, or light gray. Erratics common. Locally contains lenses of gravel.	The clay yields little or no water to wells. Sand lenses within the till yield small and erratic yields of relatively soft water.

Continued above

Continued from below

System	Series	Glaciation and alternating glacials	Group	Formation or rock unit	Member	Thickness[1] (feet)	Lithology	Hydrology[2]
Quaternary	Pleistocene	Kansan		Glaciofluvial deposits		0–70	Outwash composed of fine to coarse quartz sand, silt, gravel, and boulders. Occurs locally between the Cedar Bluffs and Nickerson Tills.	Moderate quantities of water are possible almost everywhere. Locally yields as much as 250 gpm to wells.
				Nickerson Till		0–90	Heterogeneous mixture of clay, silt, sand, and gravel. Dark gray to bluish gray with some reddish-brown streaks. Contains less erratics than Cedar Bluffs Till. Local lenses of gravel.	The clay yields little or no water to wells. Sand lenses within the till yield small quantities of water.
				Atchison Formation		0–100	Well-graded finely crossbedded fine to very fine silty sand. Very thin layers of clay sparsely scattered throughout. Gravel often at base. Generally confined to buried valleys.	Yields moderate to large quantities of water to properly developed wells. For maximum yields the very fine sand must be kept out of well. Water contains high concentrations of iron.
		?		Fluvial deposits		0–25	Limestone and chert gravel derived locally from older rocks. Contains some igneous material. Confined to buried valleys just above bedrock.	Yield moderate quantities of water almost everywhere and locally yields as much as 300 gpm from properly developed wells. Water contains high concentrations of iron.
		Nebraskan(?)						
Pennsylvanian	Virgil		Wabaunsee	Root Shale	Friedrich Shale	5–10	Gray to yellowish-brown calcareous micaceous sandy shale. Only the lower 5 feet is exposed in Atchison County.	Not known to yield water to wells.
				Stotler Limestone	Grandhaven Limestone	5–10	Tannish-gray fossiliferous hard massive limestone and gray calcareous sandy shale. The Dover Limestone Member is the most prominent scarp marker.	Not known to yield water to wells.
					Dry Shale			
					Dover Limestone			
				Pillsbury Shale		15–30	Light-brown to bluish-gray noncalcareous sandy shale. Locally contains soft brown sandstone.	Locally may yield very small quantities of water to wells in sandstone.
				Zeandale Limestone	Maple Hill Limestone	15–20	Upper limestone is tannish gray, impure, medium hard, and fossiliferous. Intervening shale is brown, noncalcareous, silty, and sandy and contains a thin coal bed near the top. Lower limestone is one bed of grayish-brown fossiliferous hard massive limestone.	Not known to yield water to wells.
					Wamego Shale			
					Tarkio Limestone			
				Willard Shale		30–40	Gray to brownish-gray noncalcareous micaceous sandy shale. Locally contains an impure sandstone in upper part.	Yields very small quantities of water locally to wells in sandstone beds. Water becomes increasingly saline downdip from outcrop.
				Emporia Limestone	Elmont Limestone	20–30	Upper limestone is bluish gray to brown, hard, and fossiliferous. Intervening shale is gray to greenish-gray, calcareous, and blocky. Lower limestone is two or three beds of bluish-gray to brown slightly fossiliferous hard, dense limestone.	Not known to yield water to wells.
					Harveyville Shale			
					Reading Limestone			
				Auburn Shale		30–40	Gray to light-gray shale, limy in lower part, silty and sandy in middle part, and very limy in upper part. Contains a thin black platy shale near middle part.	Not known to yield water to wells.
				Bern Limestone	Wakarusa Limestone	20–30	Consists of an upper bluish-gray to brown fossiliferous hard dense limestone, a gray to greenish-gray shale, and a lower gray to brown fossiliferous medium-hard limestone.	Not known to yield water to wells. Locally might yield very small quantities to wells in weathered and fractured zones near outcrop area.
					Soldier Creek Shale			
					Burlingame Limestone			
				Scranton Shale	Silver Lake Shale	50–80	Tan to bluish-gray silty sandy shale. The limestones are 1 to 3 feet thick, gray, fossiliferous, and silty. Contains a thin coal just below the Rulo Limestone Member. The shales are not well exposed and the limestones are exposed only in the southwestern part of the county.	Might yield very small quantities of water locally to wells in sandy lenses.
					Rulo Limestone			
					Cedar Vale Shale			
					Happy Hollow Limestone			
					White Cloud Shale			
				Howard Limestone	Utopia Limestone	10–20	Alternating beds of bluish-gray (weathering to brown) fossiliferous hard, dense limestone and dark-gray to tannish-gray calcareous silty shale. The persistent Nodaway coal bed is present in the Aarde Shale Member. Exposures are confined to the north-central part of the county.	Not known to yield water to wells.
					Winzeler Shale			
					Church Limestone			
					Aarde Shale			
				Severy Shale		30–45	Gray to tan sandy shale, clayey and noncalcareous in upper part and silty and calcareous in lower part. Good exposures not found in the county.	Not known to yield water to wells.
			Shawnee	Topeka Limestone	Coal Creek Limestone	20–30	Alternating beds of bluish-gray to gray (weathering to brown) fossiliferous hard to medium-hard limestone, and bluish-gray to black somewhat fossiliferous calcareous silty shale. Locally, thin coal beds occur in the shale. Exposures are limited to the north-central part of the county, and usually only beds below the Jones Point Shale Member are well exposed.	Not known to yield water to wells. Locally might yield very small quantities to wells in weathered and fractured zones near outcrop area.
					Holt Shale			
					Du Bois Limestone			
					Turner Creek Shale			
					Sheldon Limestone			
					Jones Point Shale			
					Curzon Limestone			
					Iowa Point Shale			
					Hartford Limestone			
				Calhoun Shale		15–25	Bluish-gray platy to blocky silty sandy shale.	Not known to yield water to wells.
				Deer Creek Limestone	Ervine Creek Limestone	30–40	Alternating beds of limestone and shale. Limestone is gray to white weathering to brown, fossiliferous, dense, and hard. Lower two limestones are single bedded to massive. Shales are gray to black, blocky to fissile, and clayey to silty.	Not known to yield water to wells. Locally might yield very small quantities to wells in weathered and fractured zones near outcrop area.
					Undiff. Larsh and Burroak Shales			
					Rock Bluff Limestone			
					Oskaloosa Shale			
					Ozawkie Limestone			
				Tecumseh Shale		65–75	Gray to green blocky micaceous shale interspersed with beds of light-gray to brown platy micaceous fine-grained sandstone.	Not known to yield water to wells.
				Lecompton Limestone	Avoca Limestone	35–45	Alternating beds of limestone and shale. Limestones are tan to gray, blocky, hard, and slightly fossiliferous. Shales are yellowish tan, olive, gray, and black, silty, clayey, and blocky to fissile.	Not known to yield water to wells. Locally might yield very small quantities to wells near outcrop area.
					King Hill Shale			
					Beil Limestone			
					Queen Hill Shale			
					Big Springs Limestone			
					Doniphan Shale			
					Spring Branch Limestone			
				Kanwaka Shale	Stull Shale	50–60	Shales are gray, bluish gray, or grayish green, clayey, silty, and platy. Locally contains coal and carbonaceous seams. Tan thin-bedded fine-grained shaly sandstone somuch in Stull Shale Member. Clay Creek Limestone Member is gray abundantly fossiliferous somewhat shaly dense limestone.	Small yields of good-quality water may be obtained locally from wells in sandy lenses near outcrop area.
					Clay Creek Limestone			
					Jackson Park Shale			
				Oread Limestone	Kereford Limestone	35–45	Alternating beds of limestone and shale. Locally the Kereford Limestone Member is absent. Limestones are dark gray to brown, fossiliferous, dense, and hard. Lower two limestones are single bedded and thin, whereas the Plattsmouth Limestone Member is wavy bedded to massive and thick. The shales are gray to black, clayey to silty, and blocky to fissile. Because of its black color, the Heebner Shale Member commonly is used as a reference bed in subsurface drilling.	Not known to yield water to wells. Locally might yield very small quantities to wells near outcrop area.
					Heumader Shale			
					Plattsmouth Limestone			
					Heebner Shale			
					Leavenworth Limestone			
					Snyderville Shale			
					Toronto Limestone			
			Douglas	Lawrence Formation	Unnamed	110–160	Beds of grayish-green tan and maroon calcareous clayey sandy shale in upper part. Commonly contains one or two thin beds of coal. The Amazonia Limestone Member may be absent. The Ireland Sandstone Member is a thick buff to tan crossbedded fine-grained sandstone. The Robbins Shale Member is a gray argillaceous sandy shale. The Haskell (?) Limestone Member is a gray very calcareous abundantly fossiliferous shale.	The Ireland Sandstone Member and other sandy or fractured zones yield small quantities of water to wells near the Missouri River in the southeastern part of the county. Water becomes increasingly saline downdip to the west-northwest.
					Amazonia Limestone			
					Ireland Sandstone			
					Robbins Shale			
					Haskell(?) Limestone			
				Stranger Formation	Vinland Shale	20+	Gray to tan very sandy shale and locally tan blocky fine-grained sandstone. Only the upper 20 feet is exposed in Atchison County.	Not known to yield water to wells.

[1] Not drawn to scale.
[2] In this report, "very small quantities" refers to yields generally less than 1 gpm; "small quantities," 1 to 10 gpm; "moderate quantities," 10 to 100 gpm; "large quantities," 100 to 500 gpm; and "very large quantities," more than 500 gpm.

GEOHYDROLOGY OF ATCHISON COUNTY, NORTHEASTERN KANSAS

By
John R. Ward
1973

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1973—W10324

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