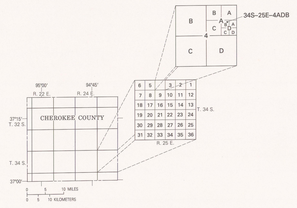
INTRODUCTION

Sedimentary rocks of Late Cambrian through Early Cretaceous age in Kansas are part of a regional flow system of hydraulically connected aquifers and confining units. Future demands for water require that these deeply buried rocks be studied to describe hydrologic properties and ground-water flow conditions and to provide information that will serve as the basis for decisions that concern the protection and management of the water resources contained therein. To this end, the U.S. Geological Survey, as part of its Central Midwest Regional Aquifer-System Analysis (CMRASA), began a 5-year hydrologic investigation of this regional flow system in Arkansas, Colorado, Kansas, Missouri, Nebraska, New Mexico, Oklahoma, South Dakota, and Texas (Jorgensen and Signor, 1981).

This chapter is one of nine contained in a Hydrologic Investigations Atlas HA-722, which presents a description of the physical framework (Chapters B–F) and the geohydrology (Chapters G–I) of principal aquifers and confining systems in Upper Cambrian through Lower Cretaceous rocks in Kansas. The stratigraphic relations of these geohydrologic systems are discussed in detail in Chapter A of the atlas (Wolf and others, 1990). This chapter (Chapter I) describes the geohydrology of the lower aquifer unit in the Western Interior Plains aquifer system. The physical framework of the lower aquifer unit is presented in Chapter F (Hansen and others, in press).

Maps in this chapter are based on existing data from selected geophysical and lithologic logs, drill-stem tests, water-level measurements, water-quality analyses, and published maps of stratigraphically equivalent units. An index to the hydrologic data compiled for the CMRASA in Kansas is presented in Spinazola and others (1987). Data used to construct the maps are, for the most part, temporally varied and do not reflect aquifer conditions for any specific time period.

Wells in this report are numbered according to a modification of the U.S. Bureau of Land Management's system of land subdivision. In this system, the first of set of digits of a well number indicates the township south (S) of the Kansas-Nebraska State line; the second set, the range east (E) or west (W) of the sixth principal meridian; the third set, the section in which the well is situated. The first letter of the third set of digits denotes the quarter section or 160-acre tract; the second, the quarter-quarter section, or 40-acre tract; and the third, the quarter-quarter-quarter section or 10-acre tract. Subdivisions of each section are designated "A," "B," "C," "D" in a counterclockwise direction that begins in the northeast quadrant. In the following example diagram, well 34S–25E–4ADB is located in the northwest quarter in the southeast quarter of the northeast quarter of section 4, township 34 south, range 25 east.



CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
barrel (bbl)	0.1590	cubic meter
gallon per minute (gal/min)	0.06309	liter per second
million gallons per day (Mgal/d)	0.003785	million cubic meters per day
cubic foot per day per square foot times foot of aquifer thickness [(ft³/d)/ft²] ft	0.09290	cubic meter per day per square meter times meter of aquifer thickness

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

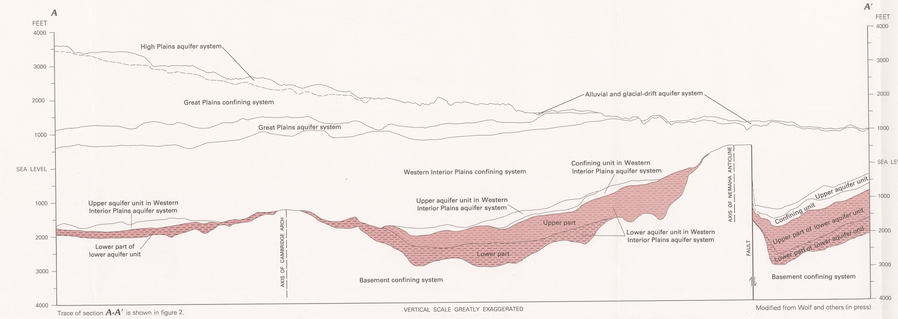
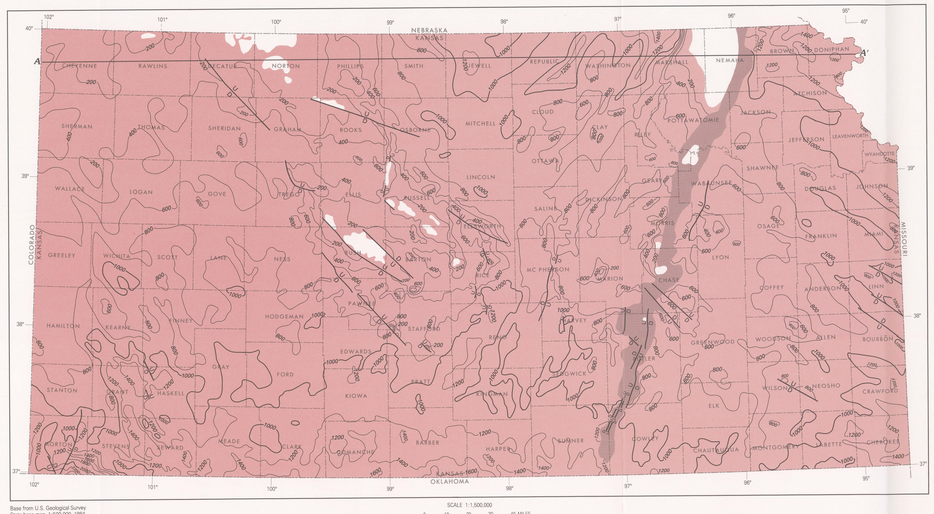


FIGURE 1.—Geohydrologic section showing relation of lower aquifer unit of Western Interior Plains aquifer system to other geohydrologic systems (modified from Wolf and others, 1990).



EXPLANATION

- AREA OF LOWER AQUIFER UNIT
- AREA WHERE LOWER AQUIFER UNIT IS ABSENT
- AREA OF ABRUPTLY CHANGING THICKNESS
- —200— LINE OF EQUAL THICKNESS OF LOWER AQUIFER UNIT—Interval 200 feet
- U/D FAULT—U, upthrown side; D, downthrown side
- A—A' TRACE OF SECTION

FIGURE 2.—Geohydrologic map showing extent and thickness of lower aquifer unit (modified from Hansen and others, in press).

TABLE 1. Generalized stratigraphic units and related geohydrologic systems

SYSTEM	Series	Provincial series	Geologic unit	Geohydrologic systems: Subdivisions	Geohydrologic systems: Major systems
QUATERNARY	Holocene		Undifferentiated Quaternary deposits		Alluvial and glacial-drift aquifer system
	Pleistocene				
TERTIARY	Miocene		Ogallala Formation		High Plains aquifer system
CRETACEOUS	Upper		Undifferentiated Upper Cretaceous rocks		Great Plains confining system
	Lower		Dakota Formation	Upper aquifer unit	Great Plains aquifer system
			Kiowa Shale	Confining unit	
			Cheyenne Sandstone	Lower aquifer unit	
JURASSIC	Upper		Morrison Formation	Upper unit	Western Interior Plains confining system
			Undifferentiated Upper Jurassic rocks		
PERMIAN	Upper		Big Basin Formation	Lower unit	
	Lower		Day Creek Dolomite Whitehorse Formation Nippewalla Group Dog Creek Formation Blaine Formation Flowerpot Shale Cedar Hills Sandstone Salt Plains Formation Harper Sandstone Sumner Group Stone Corral Formation Nirosenach Shale Wellington Formation Chase Group Council Grove Group Admire Group		
PENNSYLVANIAN	Upper	Virgilian	Wabaunsee Group Shawnee Group Douglas Group		
		Missourian	Undifferentiated Missourian rocks		
	Middle	Desmoinesian	Undifferentiated Desmoinesian rocks		
		Atokan	Undifferentiated Atokan rocks		
	Lower	Morrowan	Undifferentiated Morrowan rocks		
MISSISSIPPIAN	Upper	Chesterian	Undifferentiated Chesterian rocks		
		Meramecian	Undifferentiated Upper and Lower Mississippian rocks	Upper aquifer unit	Western Interior Plains aquifer system
	Lower	Osagean			
		Kinderhookian	Undifferentiated Lower Mississippian and Upper Devonian rocks	Confining unit	
DEVONIAN			Hunton Formation	Upper part of lower aquifer unit	
SILURIAN					
ORDOVICIAN	Upper		Maquoketa Shale		
	Middle		Viola Limestone Simpson Group		
	Lower		Arbuckle Group	Lower part of lower aquifer unit	
CAMBRIAN	Upper				
PRECAMBRIAN			Igneous, metamorphic, and metasedimentary rocks		Basement confining system

DESCRIPTION OF PHYSICAL CHARACTERISTICS

The Western Interior Plains aquifer system in Kansas consists of rocks of Late Cambrian through Late Mississippian age. In the extreme southeastern corner of the State and in Arkansas, Missouri, and Oklahoma, rocks in the system also have been included in a CMRASA subregional analysis of the Ozark Plateaus aquifer system (Imes, 1990). For ease of mapping and convenience of discussion and to avoid problems related to interpretation of stratigraphic and hydrologic differences, only the terminology for the Western Interior Plains aquifer system is used in this chapter.

Two aquifer units and an intervening confining unit are identified within the Western Interior Plains aquifer system. The upper aquifer unit in the aquifer system consists of limestone, cherty limestone, and dolomite rocks of Mississippian age. It is stratigraphically equivalent, in part, to the Springfield Plateau aquifer of the Ozark Plateaus aquifer system (Imes, 1990). Rocks in the upper aquifer unit in the Western Interior Plains aquifer system underlie nearly all of Kansas and are described in Chapters D and H of this Hydrologic Investigations Atlas.

The upper aquifer unit is underlain throughout most of the eastern one-half of Kansas by predominately shale sequences of Devonian through Early Kinderhookian age, which are known as the confining unit in the Western Interior Plains aquifer system. Where present, these rocks separate the upper and lower aquifer units. The confining unit is stratigraphically equivalent, in part, to the Ozark confining unit of the Ozark Plateaus aquifer system (Imes, 1990). In western Kansas, where the confining unit is absent, the upper aquifer unit has directly above the lower aquifer unit in the Western Interior Plains aquifer system, and both function as one aquifer. The stratigraphic relation of the lower aquifer unit to other geohydrologic systems in Kansas is shown in figure 1 and table 1.

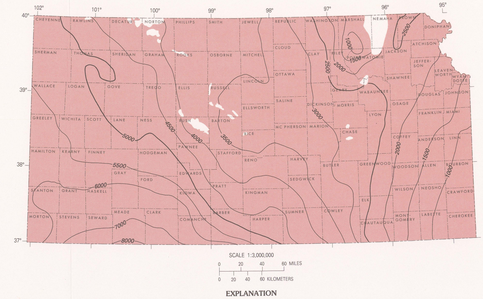
The lower aquifer unit in the Western Interior Plains aquifer system is composed of deeply buried sedimentary rocks of Late Cambrian through Middle Devonian age that underlie most of Kansas, except in several areas of northeastern, central, and northwestern Kansas along the crests of ancient uplifts (fig. 2). The lower aquifer unit is stratigraphically equivalent to the Ozark aquifer of the Ozark Plateaus aquifer system (Imes, 1990). Thickness of the unit ranges from a few feet near its limit to about 2,400 feet in the southwestern part of Kansas (fig. 2). Depth to the top of the lower aquifer unit ranges from less than 1,000 feet below land surface in the southeastern part of the State and in Marshall County, northeastern Kansas, to more than 8,000 feet below land surface in Meade County, southwestern Kansas (fig. 3).

The lower aquifer unit includes marine and nonmarine sedimentary rocks of the Arbuckle Group, the Simpson Group, the Viola Limestone, the Maquoketa Shale, and the Hunton Formation (table 1) that act together as an aquifer unit. The Arbuckle Group of Late Cambrian and Early Ordovician age consists mainly of dolomite and limestone that lie unconformably on top of the Precambrian basement confining system. Where the Arbuckle (fig. 4) was exposed to erosion on top and along the flanks of uplifted areas, the dolomite and limestone were deeply weathered, and increased porosity and permeability developed (Merriam, 1963). Consequently, the upper part of the Arbuckle contains significant oil and gas reservoirs in central and south-central Kansas and is a major source of freshwater in the southeastern part of the State (Carr and others, 1986). Depths to the top of the Arbuckle range from about 500 feet in the southeast to as much as 7,500 feet in the southwest, and the unit thickens from 200 to 400 feet in the north to as much as 1,200 to 1,400 feet in the southern part of the State (fig. 4).

The Simpson Group and Viola Limestone of Middle Ordovician age are thin units that are absent from large areas of northwestern and southeastern Kansas and along the crests of ancient uplifts (figs. 5, 6). The Simpson, which is composed of sandstone, shale, and carbonate beds, reaches a maximum thickness of about 250 feet in Harper County (Cole, 1975). The degree of cementation of sandstone within the Simpson affects the vertical and lateral movement of fluids through the unit (Carr and others, 1986). The Viola Limestone consists of dolomite and limestone strata, and maximum thicknesses range from 250 to 300 feet in basin areas. Charsonveth (1966) described the Viola as being quite porous locally, and Carr and others (1986) thought that secondary porosity may have developed in the Viola from solution weathering through joints and fractures formed by uplift and erosion.

Dolomitic shale and silty dolomite characterize the Maquoketa Shale of Late Ordovician age (Zeller, 1968). Deposits of the Maquoketa Shale are only in parts of northeastern, north-central, and east-central Kansas (fig. 7), and have maximum thicknesses of less than 200 feet (Cole, 1975). Isolated occurrences of the unit in Barber, Comanche, Edwards, and Stafford Counties support the conclusion of Adkison (1972) that the Maquoketa was much more extensive before its subsequent erosion. The dominance of shale and silty dolomite in the Maquoketa Shale limits its permeability and restricts vertical movement of fluids through the unit (Carr and others, 1986).

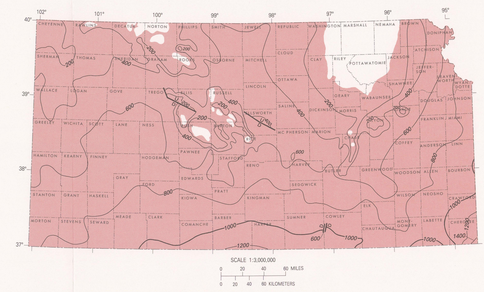
The Hunton Formation includes limestone and dolomite of Silurian through Middle Devonian age (Zeller, 1968, p. 15, 16). The Hunton is present in northeastern and north-central Kansas except where it has eroded from the highest parts of uplifted areas (fig. 8). This formation (fig. 8), attains a maximum thickness of 650 feet (Merriam, 1963). Although limited hydrologic data are inconclusive, permeability of the Hunton is considered by Carr and others (1986) to be small; however, in some places, Devonian rocks in the formation are coarsely crystalline and porous, but because of the Hunton's limited areal extent in Kansas, movement of fluids within this unit is not considered significant (Carr and others, 1986).



EXPLANATION

- AREA OF LOWER AQUIFER UNIT
- AREA WHERE LOWER AQUIFER UNIT IS ABSENT
- —1000— LINE OF EQUAL DEPTH TO TOP OF LOWER AQUIFER UNIT—Interval 500 and 1000 feet

FIGURE 3.—Geohydrologic map showing depth to top of lower aquifer unit.



EXPLANATION

- AREA OF ARBUCKLE GROUP
- AREA WHERE ARBUCKLE GROUP IS ABSENT
- —200— LINE OF EQUAL THICKNESS OF ARBUCKLE GROUP—Interval 200 feet
- U/D FAULT—U, upthrown side; D, downthrown side

FIGURE 4.—Geologic map showing extent and thickness of Arbuckle Group (modified from Cole, 1975).

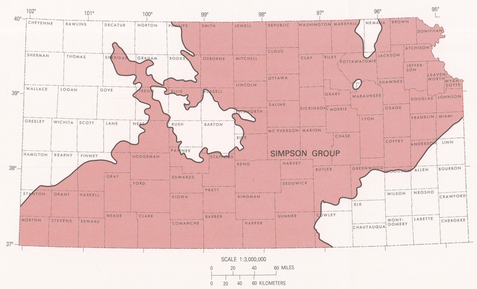


FIGURE 5.—Geologic map showing extent of Simpson Group (modified from Cole, 1975).

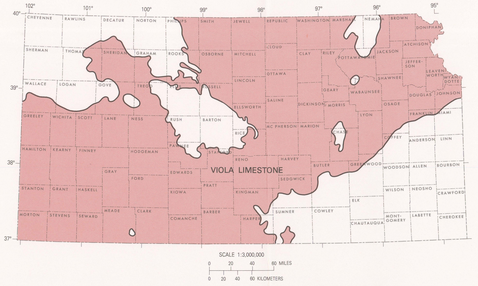


FIGURE 6.—Geologic map showing extent of Viola Limestone (modified from Cole, 1975).

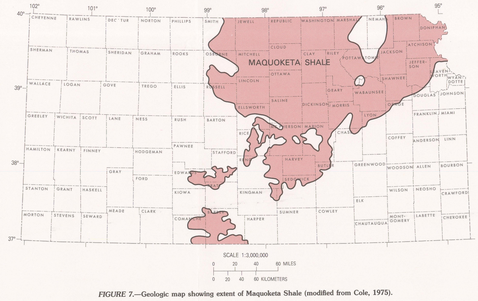


FIGURE 7.—Geologic map showing extent of Maquoketa Shale (modified from Cole, 1975).

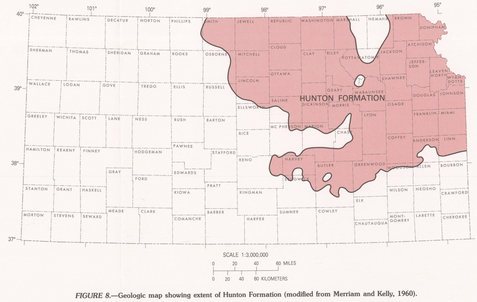


FIGURE 8.—Geologic map showing extent of Hunton Formation (modified from Merriam and Kelly, 1960).

GEOHYDROLOGIC SYSTEMS IN KANSAS—GEOHYDROLOGY OF THE LOWER AQUIFER UNIT IN THE WESTERN INTERIOR PLAINS AQUIFER SYSTEM

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