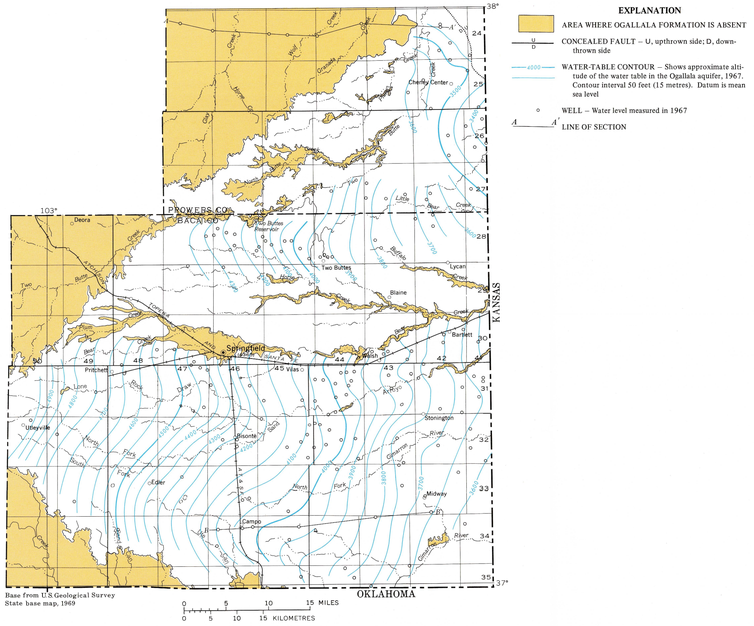
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
COLORADO WATER CONSERVATION BOARD

WATER RESOURCES INVESTIGATIONS 16–74
OPEN FILE REPORT



Base from U.S Geological Survey
State base map, 1969

OGALLALA AQUIFER

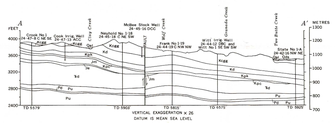
The above map of Baca and southern Prowers Counties, Colorado, shows areas of occurrence and approximate altitude of the water table in the Ogallala aquifer in 1967. Water-level records available for the Ogallala show that there has been little change in the altitude of the water table from 1964 to 1972. (See selected hydrographs below.) The thickness of the Ogallala Formation ranges widely throughout the area—from about 300 feet (91 metres) in south-central Baca County (as shown on section *B–B'*) and 360 feet (110 metres) in eastern Prowers County to zero at many places. (See stratigraphic table.)

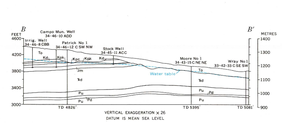
INTRODUCTION

The only dependable source of water for all uses in Baca and southern Prowers Counties is ground water. Ground water is withdrawn from the three principal aquifers is the area—the Ogallala, the Dakota, and the Cheyenne-Dockum.

In 1966 the U.S. Geological Survey began a study to define and describe the geohydrologic system and to determine the effects of pumping withdrawals from the system. This report draws upon information and data from periodic fieldwork from 1966 to 1971 and from several published sources, including McLaughlin (1954) and Voegeli and Hershey (1965), as well as upon water-level data collected by Colorado State University beginning in 1955.

The authors extend their warm thanks to water-well drillers, owners, and operators who provided information on well construction, formations penetrated by wells, water-level fluctuations, and general cooperative assistance. The assistance extended by county and municipal officials in identifying land ownership and similar aid from Mr. Roy Mathews, realtor, Springfield, Colo., is appreciated. Special thanks are extended to independent oil producers Robert Beams, Dallas, Tex., and Mr. Jack Trigg, Boulder, Colo., who provided the authors with geophysical logs and other data for many oil-test wells in the study area.





STRATIGRAPHIC SECTIONS

SELECTED REFERENCES

Hershey, L. A., and Major, T. J., 1973, Water-level records, 1969–73, and hydrogeologic data for Baca and southern Prowers Counties, Colorado: Colorado Water Conserv. Board Basic-Data Release 32, 17 p.

McLaughlin, T. G., 1954, Geology and ground-water resources of Baca County, Colorado: U.S. Geol. Survey Water-Supply Paper 1256, 232 p.

Richards, D. B., Hershey, L. A., and Glanzman, R. K., 1968, Hydrogeologic data for Baca and southern Prowers Counties, Colorado: Colorado Water Conserv. Board Basic-Data Release 19, 123 p.

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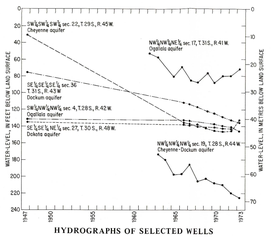
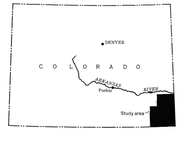
_____1965, Geology and ground-water resources of Prowers County, Colorado: U.S. Geol. Survey Water-Supply Paper 1772, 102 p.



HYDROGRAPHS OF SELECTED WELLS

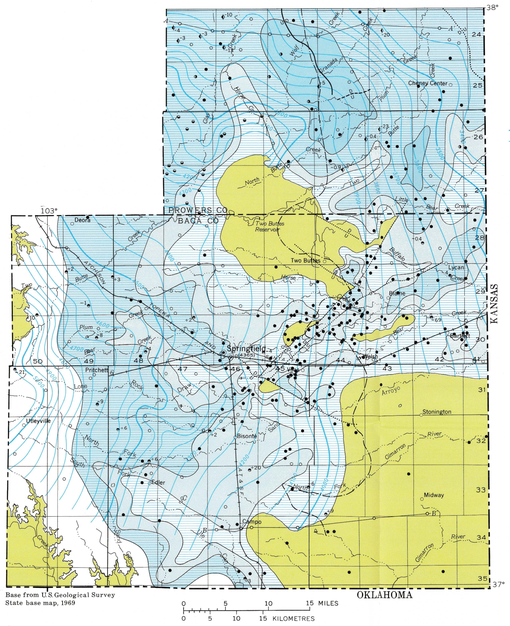


GEOHYDROLOGY OF BACA AND SOUTHERN PROWERS COUNTIES, SOUTHEASTERN COLORADO

By
Lloyd A. Hershey and Eugene R. Hampton

1975

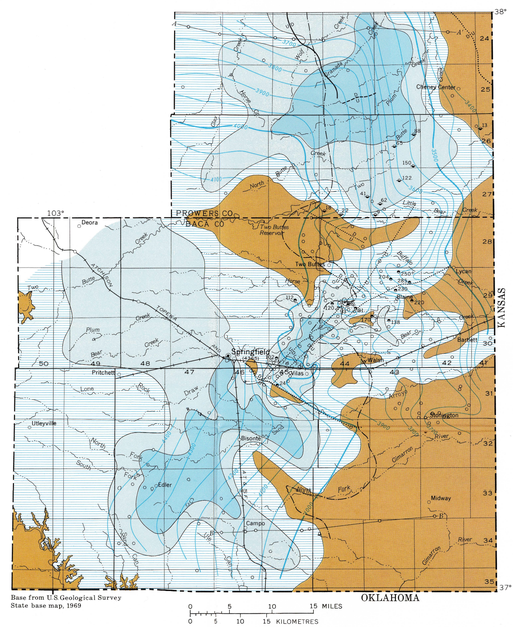
POTENTIOMETRIC SURFACE AND SATURATED THICKNESS



Base from U.S Geological Survey
State base map, 1969

DAKOTA AQUIFER

Approximate altitude of the potentiometric surface of the Dakota aquifer and the saturated thickness of the Dakota Sandstone are shown on the above map. This map is based on water-level measurements during 1956 to 1969. Thickness of the formation ranges from 0 to 240 feet (0 to 73 metres), as shown on sections *A–A'* and *B–B'*. Saturated thickness ranges from about 230 feet (70 metres) in southeastern Prowers County to zero where the formation is absent. Water-level declines in wells that tap the Dakota (1956–67) were as much as 23 feet (7 metres) in the northern part of the area near or in areas of substantial pumpage. Water levels in Dakota wells in central Baca County have generally risen during 1947–67.



Base from U.S Geological Survey
State base map, 1969

CHEYENNE–DOCKUM AQUIFER

Approximate altitude of the potentiometric surface of the Cheyenne-Dockum aquifer and saturated thickness of the Cheyenne aquifer are shown on the above map. The potentiometric surface and saturated thickness were determined from water levels measured in wells known to tap the Cheyenne-Dockum aquifer in 1967. Levels in wells that tap the Cheyenne-Dockum have declined as much as 285 feet (87 metres) during 1947-67 and 150 feet (46 metres) during 1962-66, as shown by the values on the map. Note the declining trend of water levels in Cheyenne-Dockum wells shown on the hydrographs. The geologic sections show that the depth to the top of the Cheyenne Sandstone member is as much as 600 feet (183 metres). The Cheyenne is not present in southeastern Baca County nor along the Baca-Prowers County line.

DESCRIPTION OF THE GEOLOGIC UNITS AND THEIR HYDROLOGIC CHARACTER

System	Series	Geologic unit	Thickness in feet (metres)	Physical character	Hydrologic character	Water supply and chemical quality
Quaternary	Pleistocene and Holocene	Dune sand (Qds)	0–60 (0–18)	Sand, very fine to coarse.	Commonly not saturated, transmits water to underlying aquifers.	Not known to yield water to wells.
		Valley-fill deposits (Qal)	0–80 (0–24)	Sand, gravel, silt, and clay, generally poorly sorted.	Yields water to wells in the valleys of Clay, Two Buttes, Horse, and Bear Creeks, and Cimarron River. Saturated thickness generally is less than 30 feet (9 metres).	Source of water for irrigation and public-supply wells. Reported yields are as great as 700 gpm (gallons per minute) or 44 l/s (litres per second) and average 400 gpm (25 l/s). Water is a calcium sulfate type; dissolved-solids concentration ranges from 600 to 1,000 mg/l (milligrams per litre).
Tertiary	Miocene(?) and Pliocene	Ogallala Formation (To)	0–360 (0–110)	Sand, gravel, clay, and caliche. Generally grades from fine sediments near the surface to sand and gravel at the base. Locally, beds of sand and gravel are cemented by calcium carbonate (mortar beds).	Yields water to irrigation wells in the area west and northeast of the town of Two Buttes, and south and southwest of Bartlett. Well yields vary widely because saturated thickness ranges from less than 10 feet (3 metres) to more than 100 feet (30 metres).	Important source of water for irrigation, domestic, and stock wells. Well yields average 600 gpm (38 l/s) and reported yields are as great as 2,000 gpm (190 l/s). About 36 percent of the irrigation wells withdraw all or part of their water from this aquifer. The water is a calcium bicarbonate type when dissolved-solids concentrations are low; it changes to a calcium sulfate type when the dissolved-solids concentration exceeds about 600 mg/l. Dissolved-solids concentration ranges from 220 to 1,000 mg/l.
Cretaceous	Upper Cretaceous	Carlile Shale	0–200 (0–61)	Carlile Shale: Shale, dark-gray. Contains a few very thin, gray, crystalline limestone beds and some disseminated pyrite.	Low-permeability confining bed; acts as a barrier to movement of ground water.	Yields less than 5 gpm (0.3 l/s) to a few springs. The water contains high concentrations of sulfate and is unsuitable for most uses.
		Greenhorn Limestone and Graneros Shale undivided, (Kcgg)	0–200 (0–61)	Greenhorn Limestone: Limestone and shale, gray to black, interbedded. Lower part of unit contains thin platy petroliferous limestone beds and thin layers of bentonite.	Low-permeability confining bed; acts as a barrier to movement of ground water.	Yields less than 5 gpm (0.3 l/s) to a few stock wells. The water is a calcium sulfate type with dissolved-solids concentration of about 1,500 mg/l.
			0–100 (0–30)	Graneros Shale: Shale, black; contains stringers of gypsum and bentonite, and thin crystalline limestone beds.	Low-permeability confining bed; acts as a barrier to movement of ground water.	Yields less than 5 gpm (0.3 l/s). The water contains high concentrations of sulfate and is unsuitable for most uses.
	Lower Cretaceous	Dakota Sandstone (Kd)	0–240 (0–73)	Sandstone, gray to brown, and interbedded sandy shale, siltstone, and clay. Sandstone beds are crossbedded, and sometimes contain limonite and coal. The beds vary in degree of cementation from quartzitic to friable and locally are fractured.	Well yields vary widely owing to changes in percentage of clay and shale, extent of fracturing and degree of cementation. Water is confined in southeastern Prowers County and western Baca County where the formation is overlain by shale. Ground-water withdrawal for irrigation has caused some dewatering. The aquifer is unconfined in the area north of Vilas and Walsh, and along Clay Creek in Prowers County.	Important source of water for domestic, stock, public-supply, and irrigation wells. Measured well yields average 500 gpm (32 l/s) and reported yields are as great as 1,500 gpm (95 l/s). About 28 percent of irrigation wells in the study area withdraw all or part of their water from this aquifer. The water generally is a calcium magnesium bicarbonate type. Sulfate becomes the dominant anion when dissolved-solids concentration exceeds about 680 mg/l. Dissolved-solids concentration ranges from 140 to 1,800 mg/l.
		Kiowa Shale Member (Kpk)	0–200 (0–61)	Shale, dark-gray to black, locally sandy; contains thin beds of sandstone near the top. Near the middle contains a lenticular sandstone bed that ranges from 5 to 20 feet (2 to 6 metres) thick. Contact with overlying formation gradational when unit is sandy.	Low-permeability confining bed; generally acts as a barrier to movement of ground water. Locally, sand beds and numerous unplugged test holes provide hydraulic connection between the overlying and the underlying aquifers.	A few stock wells tapping the shale where sandy and fractured yield less than 20 gpm (1 l/s). The water contains high concentrations of sulfate and is unsuitable for most uses.

DESCRIPTION OF THE GEOLOGIC UNITS AND THEIR HYDROLOGIC CHARACTER

System	Series	Geologic unit	Thickness in feet (metres)	Physical character	Hydrologic character	Water supply and chemical quality
Cretaceous	Lower Cretaceous	Cheyenne Sandstone Member (Kpc)	0–250 (0–76)	Sandstone, white to brown, fine-grained, friable, and massive. Contains sandy siltstone, gray and green shale, and some conglomerate beds that range in thickness from less than 1 to 10 feet (0.3 to 3 metres). Contact with underlying formation is gradational. Present throughout the area except in the vicinity of Two Buttes and in southeastern Baca County.	Well yields vary widely owing to degree of cementation and extent of fracturing. Important source of water for irrigation wells where the sandstone is thick and friable. During drilling, loss of fluid circulation is common in fractured or poorly cemented zones. Generally water is confined where overlain by shale. However, ground-water withdrawal for irrigation in the area between the towns of Two Buttes and Vilas, has caused some dewatering. In the vicinity of Two Buttes the aquifer is hydraulically connected with the Ogallala, and in the eastern one-third of the area the aquifer is hydraulically connected with the Entrada Sandstone and Dockum Group.	Most important source of water for irrigation and public-supply wells. Measured yields average 500 gpm (32 l/s), and reported yields are as great as 3,000 gpm (190 l/s). About 66 percent of the irrigation wells in the study area withdraw all or part of their water from this aquifer. The water is a mixed type (calcium, magnesium, sodium, bicarbonate, sulfate, and chloride). Dissolved-solids concentration ranges from 210 to 1,900 mg/l.
		Purgatoire Formation				
Jurassic	Upper Jurassic	Morrison Formation (Jm)	0–450 (0–137)	Shale, variegated green, red, gray, and maroon, and sandstone, limestone, and siltstone. Sandstone beds are cemented, thin-bedded, limy, and gray in color.	Low-permeability confining bed; acts as a barrier to movement of ground water. Sandstones generally have low permeability.	Yields less than 5 gpm (0.3 l/s) to a few stock and domestic wells. May contain water suitable for domestic use near the outcrop; contains high concentrations of sodium and sulfate elsewhere.
		Entrada Sandstone (Je)	0–100 (0–30)	Sandstone, buff, red, yellow, and gray, fine- to medium-grained; massive to crossbedded; locally silty and clayey. Differentiation between this sandstone and sandstone of overlying and underlying formations is difficult.	Yields water to wells in vicinity of Two Buttes Reservoir and in the outcrop area in southwestern corner of Baca County, where formation is fractured. Generally of low permeability except where fractured.	Minor source of water for irrigation, stock, and domestic wells. Aquifer furnishes water to six irrigation wells in Baca County. Well yields are less than 100 gpm (6 l/s). The water is a calcium sulfate type. Dissolved-solids concentration ranges from 400 to 600 mg/l.
Triassic	Upper Triassic	Dockum Group (Ktd)	200–500 (61–152)	Sandstone, shale, mudstone, and marl. Sandstone is light-gray to medium-red, thin-bedded, fine- to coarse-grained, loosely cemented and generally fractured. Shale, mudstone, and marl are variegated green and purple, causing confusion in differentiation from the Morrison. Probably underlies all of Baca and southern Prowers Counties. Comparable with Cheyenne in the areal persistence of loosely-cemented sandstone beds.	Well yields vary owing to change in percentage of shale, degree of cementation, and extent of fracturing. Yields water to irrigation wells in Stonington area and in southeastern Baca County. Water may be confined or unconfined. In southeastern Baca County, the aquifer is overlain by the Ogallala.	Source of water for irrigation in southeastern Baca County. Well yields are reported to be as great as 2,600 gpm (164 l/s) and to average 1,500 gpm (95 l/s). Water is a mixed type (calcium, magnesium, sodium, bicarbonate, sulfate, chloride). Dissolved-solids concentration ranges from 280 to 1,250 mg/l.
Permian	Upper Permian	Permian undivided (Pu)	More than 500 (152)	Mudstone and siltstone, dark-red to orange-red.	Low-permeability confining bed; acts as a barrier to vertical movement of ground water.	Not known to yield water to wells.
		Day Creek Dolomite (Pd)	30–50 (9–15)	Dolomite and anhydrite, gray, vuggy.	Not determined in Colorado. Yields water to wells in western Kansas.	Not determined in Colorado. Reported to yield high sulfate water to wells in western Kansas.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1974—677-307/26