



GEOHYDROLOGIC MAP

INTRODUCTION

Cimarron County, in the Oklahoma Panhandle, depends almost entirely on ground water for its water supply. Where present, the Ogallala Formation is the principal aquifer. The western half of the county is also underlain by the Dakota Sandstone and the Clayey Sandstone Member of the Purgatoire Formation, both of which may yield enough water for irrigation. In some places, these sandstones are the only sources of ground water. Alluvial deposits and Triassic rocks yield water, but their potential for supply of irrigation water is not known.

As a result of accelerated development of ground water for irrigation that began in 1955, water levels in the Ogallala have declined in a few areas of the county. Continued rapid increase in ground-water development from the Ogallala could cause widespread excessive lowering of the water table. Because of locally declining water levels, possible salt-water contamination, and other problems, the Oklahoma Water Resources Board requested the U.S. Geological Survey to provide basic data needed for efficient development and management of the ground-water resources. This report summarizes general information on the availability and chemical quality of ground water in the county. Although the maps in this report show only approximate conditions, they will be useful in planning further development of ground-water supplies. Additional studies are needed to determine the volume and chemical quality of available water stored in the major aquifers, annual changes in water levels, the rate of water-level decline in heavily pumped areas, and the estimated long-term yield of the major aquifers.

GROUND-WATER OCCURRENCE

Ground water in the Ogallala and other aquifers of Cimarron County occurs in the pores between the sand and gravel particles, or in rock fractures and other openings. In most of the county, water in the Ogallala is unconfined, and the water level in wells does not rise above the water table. Locally, however, the aquifer is overlain by fine-grained material, such as clay, so that the water is under artesian pressure, and the water level in wells rises above the saturated zone. The level to which water rises in wells penetrating the artesian aquifers is the potentiometric level or surface.

Water in alluvium is unconfined. In aquifers below the Ogallala the water is both confined and unconfined, depending on the local geologic conditions.

RECHARGE

Recharge of ground water to aquifers in Cimarron County is primarily from precipitation percolating down from land surface to the water table. Precipitation records at Boise City, which date back to 1908, show that the wettest year was 1919 (38.97 inches), and the wettest month was October 1930 (9.77 inches). The driest year was 1956 (6.95 inches). The graph of average monthly distribution of precipitation shows that about 74 percent falls during the spring and summer; mostly during intense thunderstorms of short duration on areas of only a few square miles. The graph showing wet and dry periods indicates when precipitation was above the 1926-65 average (wet) or below this average (dry).

An accurate determination of total recharge from precipitation cannot be made at this time. However, in Grant and Stanton Counties in southwestern Kansas where the Ogallala aquifer is geologically and hydrologically similar, annual recharge from precipitation is about one-third inch (Fader and others, 1964, p. 46). Assuming that recharge in Cimarron County is one-fourth to one-half inch, annual recharge would be 20 to 40 thousand acre-feet.

The time it takes downward-percolating water to reach the water table depends upon the permeability or ability of rock materials to transmit water and the depth to the water table. Recharge from precipitation may take as long as 7 years to reach the water table in the Ogallala (Marine, 1963, p. 9).

Other sources of recharge include ponds or lakes, water applied for irrigation, streamflow, and subsurface inflow from adjacent areas.

Rising water levels in wells adjacent to lakes and ponds filled with water show that some recharge is derived from this source (Schoff, 1943, p. 234). Most of these lake bottoms are relatively impermeable, so the amount of recharge by lake-bottom seepage probably is small.

Recharge from flood-irrigated land is highly variable depending upon the duration of flooding, type of soil, and

other factors. Recharge from sprinkler-irrigated lands is probably insignificant.

The amount of recharge from streamflow depends on the rate and duration of flow, amount and type of sediment in the water, permeability and gradient of the streambed, and distance of the stream surface above the water table. Recharge from both the North Canadian and Cimarron Rivers occurs in the eastern half of the county (Schoff, 1943, p. 235-236), but the amount is unknown.

Recharge by subsurface inflow is mainly from adjacent parts of New Mexico. The amount of subsurface inflow is unknown, but data from aquifer tests in adjacent areas provide a basis for estimating the rate of movement through the Ogallala Formation at about 100 feet per year and through the Dakota Sandstone at about 10 feet per year.

DISCHARGE

Pumpage from irrigation wells accounts for the largest part of ground-water discharge in Cimarron County. Records show that during 1966 about 70,300 acres were irrigated with ground water. Assuming an average application of 1.2 acre-feet per year per acre, groundwater pumpage for irrigation during 1966 was estimated to be 80,000 acre-feet. This estimate illustrates the magnitude of increase in pumpage over the 175 acre-feet per year estimated for 1938-40 (Schoff, 1943, p. 246).

Streams that have cut their channels below the water table receive water from the ground-water reservoir. The quantity of ground water discharged into the Cimarron River in the northwestern part of the county was estimated to be 720 acre-feet per year during October 1938 to September 1940. Discharge of springs into ravines and draws in other parts of the county was estimated to be 640 acre-feet per year (Schoff, 1943, p. 243).

Ground water is discharged by evaporation and transpiration in areas where water levels are close to the land surface on stream flood plains. These areas are easily

identified by abundant growths of cottonwood trees and other phreatophytes. An estimate of this discharge cannot be made until additional data are available.

Most of the ground water discharged by subsurface outflow moves eastward into Texas County. A small quantity may move into Texas and Kansas as shown by a contour map of the water table for the Ogallala aquifer (Schoff, 1943, p. 174).

STORAGE

Changes in ground-water storage are reflected by changes in water levels. When recharge exceeds discharge, ground-water storage increases and water levels rise; conversely, when ground-water is taken from storage, water levels decline. Measurements of water levels in Cimarron County began in July 1938 near the end of the 1931-40 drought. At the end of the drought, water levels in many wells were at an all-time low and the amount of water in storage was considerably reduced. During 1941-51, when precipitation generally was above average, water levels rose, as shown by hydrographs 2, 5, 7, and 8 indicating a continued increase in ground-water storage. Water levels in some wells, shown by hydrograph 6, did not rise because pumpage from nearby wells removed water as fast as or faster than it could be added to storage.

Although precipitation during 1952-57 was below average, water levels in the Ogallala aquifer continued to rise, as shown by hydrographs 4 and 7, indicating that precipitation that had fallen during the previous wet period was still being added to storage. This delayed rise also continued in some areas underlain by the Dakota Sandstone and the Dockum Group, as shown by hydrographs 2, 5, and 8. The lack of correlation between water-level fluctuations and precipitation in the Morrison Formation, shown by hydrograph 10, may be the result of the very slow rate of increase in storage because of low permeability.

Ground-water storage in the alluvium varies in response to streamflow. Thus, water-level fluctuations are highly erratic,

shown by hydrographs 3A, 3B, and 9, and the long-term general trends are obscure. Similar erratic fluctuations of water levels in the Ogallala Formation are caused by the pumping of irrigation wells.

CHEMICAL QUALITY

The suitability of water for domestic, municipal, stock, industrial, or irrigation use is, in part, determined by the dissolved-solids content. Standards governing the chemical quality of water for domestic or municipal use have been established by the U.S. Public Health Service (1962). These standards place an upper limit of 500 mg/l (milligrams per liter) on the dissolved-solids content of drinking water where better quality water is not available and also place maximum limits on concentrations of fluoride and other selected constituents. In some parts of Cimarron County the dissolved-solids and fluoride content of ground water exceed these standards.

Water for stock is subject to the same quality limitations as those established for human consumption. However, most animals apparently can tolerate water that would be considered unsatisfactory for human beings (Hem, 1970, p. 324).

The usefulness of water for irrigation is governed by its chemical quality (Hem, 1970, p. 324-333). The dissolved-solids content or the specific electrical conductance (EC) along with the relative proportion of sodium to calcium plus magnesium (called sodium-adsorption ratio or SAR) are

used to evaluate the suitability of water for irrigation. Generally, water with an EC and SAR less than 2,000 and 5, respectively, is classed as having a low sodium hazard. Some constituents, such as boron, in irrigation water may have a toxic effect on certain crops, but this has not been a problem in Cimarron County.

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RECONNAISSANCE OF THE GROUND-WATER RESOURCES OF CIMARRON COUNTY, OKLAHOMA

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