PREPARED IN COOPERATION WITH THE
COLORADO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WATER RESOURCES,
OFFICE OF THE STATE ENGINEER; THE DENVER BOARD OF WATER COMMISSIONERS;
AND ADAMS, ARAPAHOE, DOUGLAS, ELBERT, AND EL PASO COUNTIES

INTRODUCTION

The Denver ground-water basin underlies a 6,700-square-mile area extending from Greeley in the north to Colorado Springs in the south, and from the Front Range in the west to near Limon in the east. The four major bedrock aquifers that occur in the basin are the Laramie-Fox Hills aquifer (the deepest aquifer), the Arapahoe aquifer, the Denver aquifer, and the Dawson aquifer (the uppermost aquifer). The Dawson aquifer, which is the subject of this report, underlies an area of about 1,200 square miles in east-central Colorado (index map, fig. 1) and is a primary source of water for rural residents of western Elbert, eastern Douglas, and northern El Paso Counties. Of the estimated 3,600 wells completed in the aquifer, almost all supply drinking water to residents and livestock, as little water for irrigation of commercial crops is supplied from the aquifer.

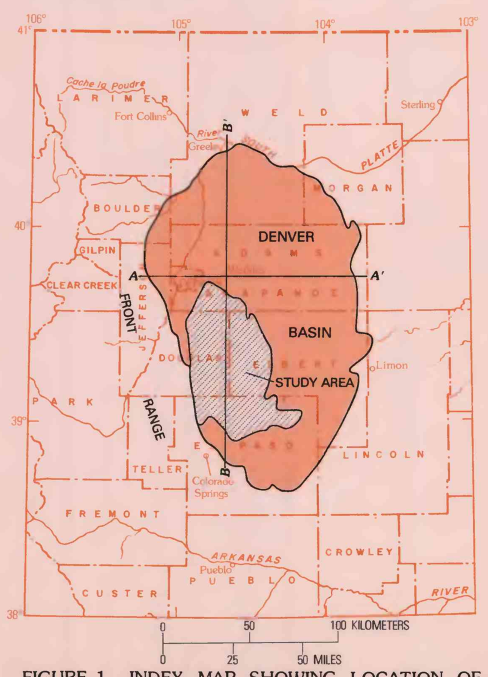

FIGURE 1.—INDEX MAP SHOWING LOCATION OF DENVER BASIN, STUDY AREA, AND GENERALIZED GEOLOGIC SECTIONS

The continuing increase in population in rural communities and suburban areas around Denver has produced increasing demands for ground-water supplies. As a result, the number of wells obtaining water from the Dawson aquifer has steadily increased, and the increased pumpage has caused local water-level declines in the aquifer. In sparsely populated areas, water-level declines have not been significant, however, near more urbanized areas, water-level declines have been significant and have caused some wells to "go dry." In these situations, landowners have had to drill deeper wells, sometimes at considerable expense, to reestablish their water supply. Continued increases in population will likely cause increasing water-supply problems for residents who depend on this bedrock aquifer for water.

This study was undertaken to better define the water-supply potential of the four major bedrock aquifers in the Denver basin. Findings relating to the Dawson aquifer made during the first 2 years of the investigation are presented in this report to provide water users with timely ground-water resource information that can be used to better manage and develop the water supply of the aquifer. The hydrologic data used in preparing these maps are available in the Colorado District Office of the U.S. Geological Survey in Lakewood, Colo. Similar study results pertaining to the three other aquifers in the basin are being compiled.

Funding for the study was provided jointly by the U.S. Geological Survey; the Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer; the Denver Board of Water Commissioners; and Adams, Arapahoe, Douglas, Elbert, and El Paso Counties.

GEOLOGIC CHARACTERISTICS

The geologic formations containing the four aquifers of the Denver basin are the Fox Hills Sandstone, the Laramie and Arapahoe Formations of Late Cretaceous age, the Denver Formation of Late Cretaceous and early Tertiary age, and the Dawson Arkose of Tertiary age (Romero, 1976). These formations occur in a sequence of layers as shown by the generalized geologic sections drawn from west to east and from south to north through the basin (fig. 2). The northern, eastern, and southern parts of the basin form a shallow bowl, the sides of which dip gently toward the west-central part of the basin. Along the western edge of the basin, sedimentary formations are upturned along the Precambrian crystalline rocks of the Front Range and dip steeply to the east as a result of faulting and the gradual upward movement of the Rocky Mountains. The Pierre Shale of Late Cretaceous age underlies the Fox Hills Sandstone and is considered to be the base of the major bedrock-aquifer system due to its qreat thickness (as much as 8,000 feet) and its minimal permeability.

The Dawson Arkose is exposed at the surface or buried under a thin layer of soil in large areas of western Elbert, northern El Paso, and eastern Douglas Counties. In a roughly triangular area between Castle Rock, Peyton, and Kiowa, the Dawson Arkose is intermittently buried under scattered remnants of the overlying Castle Rock Conglomerate of Oligocene age. The conglomerate sometimes forms prominent cliffs such as those at Castle Rock and generally does not yield water to wells. The Dawson aquifer is primarily located in the Dawson Arkose, and is assumed to extend from near the base of the formation to the potentiometric surface (a surface that shows the elevation of the standing water levels in wells completed in the aquifer). However, because the geologic contact between the Dawson Arkose and the underlying Denver Formation is not always easily discernible, the lower limit of the aquifer may not always coincide with the actual base of the formation. As a result, the size, shape, and thickness of the Dawson aquifer does not necessarily correspond to the size, shape, and thickness of the Dawson Arkose.

The sediments that form the Dawson aquifer primarily consist of conglomerate, sandstone, and shale varying from light gray to yellow brown, with beds of pale green shale in some areas. The conglomerates and sandstones are generally coarse grained and poorly to moderately well consolidated. In most of the aquifer in Arapahoe, Douglas, and Elbert Counties, a layer of shale 100 to 250 feet thick separates an upper and lower sequence of conglomerate, sandstone, and minor amounts of shale. In the southern part of the aquifer, the intervening shale is absent and conglomerate, sandstone, and minor amounts of shale occur in a continuous sequence 600 feet or more thick. Individual conglomerate and sandstone beds are commonly lens shaped and range in thickness from a few inches to as much as 200 feet. Conglomerate and sandstone beds that are penetrated by one well may be of a different thickness or absent in an adjacent well because of this lens-shaped layering. The conglomerate and sandstone are much more coarse grained than the shale. This allows ground water to flow through the void spaces between the grains of sand and gravel in the conglomerate and sandstone, while little water is able to flow through the shale. The aquifer thus consists of a complex pattern of interconnected beds of permeable and relatively impermeable sediments that differ in their ability to store water and transmit water from one area to another.

The map showing the elevation and configuration of the base of the Dawson aquifer (fig. 3) indicates that the base ranges in elevation from a high of about 6,800 feet near Colorado Springs to a low of about 5,200 feet near Castle Rock. The base of the aquifer seems to be offset by as much as 300 feet as a result of movement along a fault tentatively located north and east of Monument. The aquifer limit shown on the map is the approximate extent of saturated sediments in the Dawson Arkose. Beyond this limit, it is unlikely that a well completed in the Dawson Arkose would yield usable quantities of water, although adequate quantities of water may be found in deeper bedrock aquifers.

When the elevation of the base of the aquifer is subtracted from the elevation of the land surface, a map can be made which shows the depth to the base of the aquifer. These depths are shown on the adjacent map (fig. 4) and were calculated for each section (1 square mile) of land in the area using average land-surface elevations in each section. The depth to the base of the aquifer is as much as 1,400 feet near Castle Rock but is between 500 and 1,000 feet throughout most of the area. This map provides a quick means of estimating the depth to the base of the aquifer but is somewhat generalized due to the use of average land-surface elevations. If, for example, a water well is to be drilled into the Dawson aquifer, this map shows the approximate well depth required to fully penetrate the aquifer. A more accurate depth estimate can be made by subtracting the elevation of the base of the aquifer at the well site from the land-surface elevation at the well site.

The thickness of the Dawson aquifer is normally less than the depth to the base of the aquifer because saturated sediments do not extend to land surface in most areas. The approximate thickness of the aquifer can be calculated by subtracting the elevation of the base of the aquifer from the elevation of the potentiometric surface (fig. 7, shown on the second map sheet). This aquifer thickness does not take into consideration the possible effect of any alluvial aquifers that may overlie the Dawson aquifer. Because alluvial aquifers 20 to 100 feet thick commonly occur in the valleys of larger streams in the area, the actual thickness of the Dawson aquifer under an alluvial aquifer may be 20 to 100 feet less than the above calculation indicates. The thickness of the bedrock aquifer includes the thickness of the water-yielding conglomerate and sandstone as well as the thickness of the nonwater-yielding shale. Because the thickness of the water-yielding beds are of particular interest, the map of total conglomerate and sandstone thickness (fig. 5) was prepared to show the thickness of only these materials. Near the margins of the aquifer there is less than 100 feet of water-yielding material in the aquifer while between Castle Rock and Black Forest 350 to 400 feet of material occurs. A comparison of total aquifer thickness and total conglomerate and sandstone thickness within the aquifer indicates that the Dawson aquifer contains about 45 percent conglomerate and sandstone and 55 percent shale.

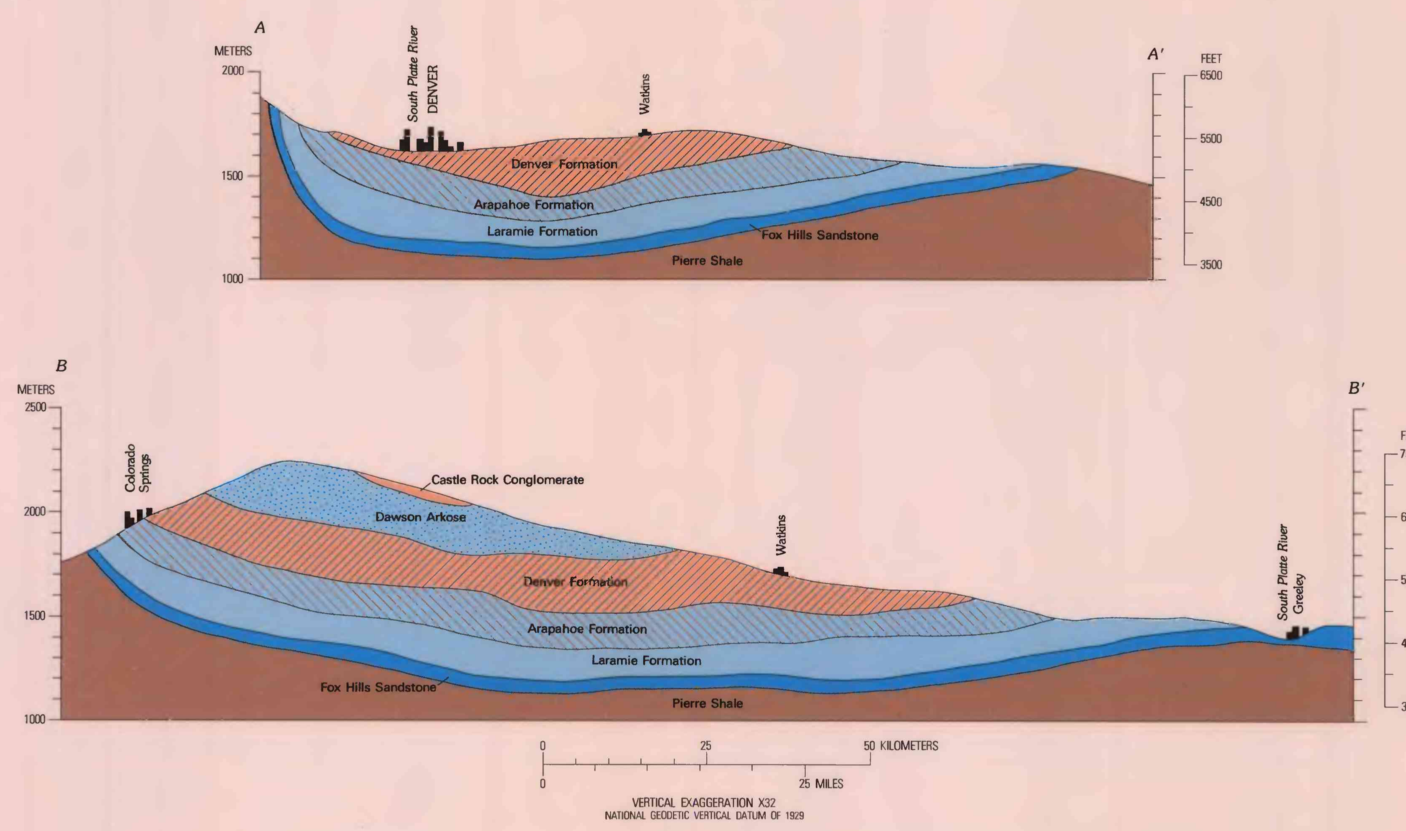

FIGURE 2.—GENERALIZED GEOLOGIC SECTIONS THROUGH THE DENVER BASIN

FIGURE 3.—MAP SHOWING ELEVATION AND CONFIGURATION OF THE BASE OF THE AQUIFER

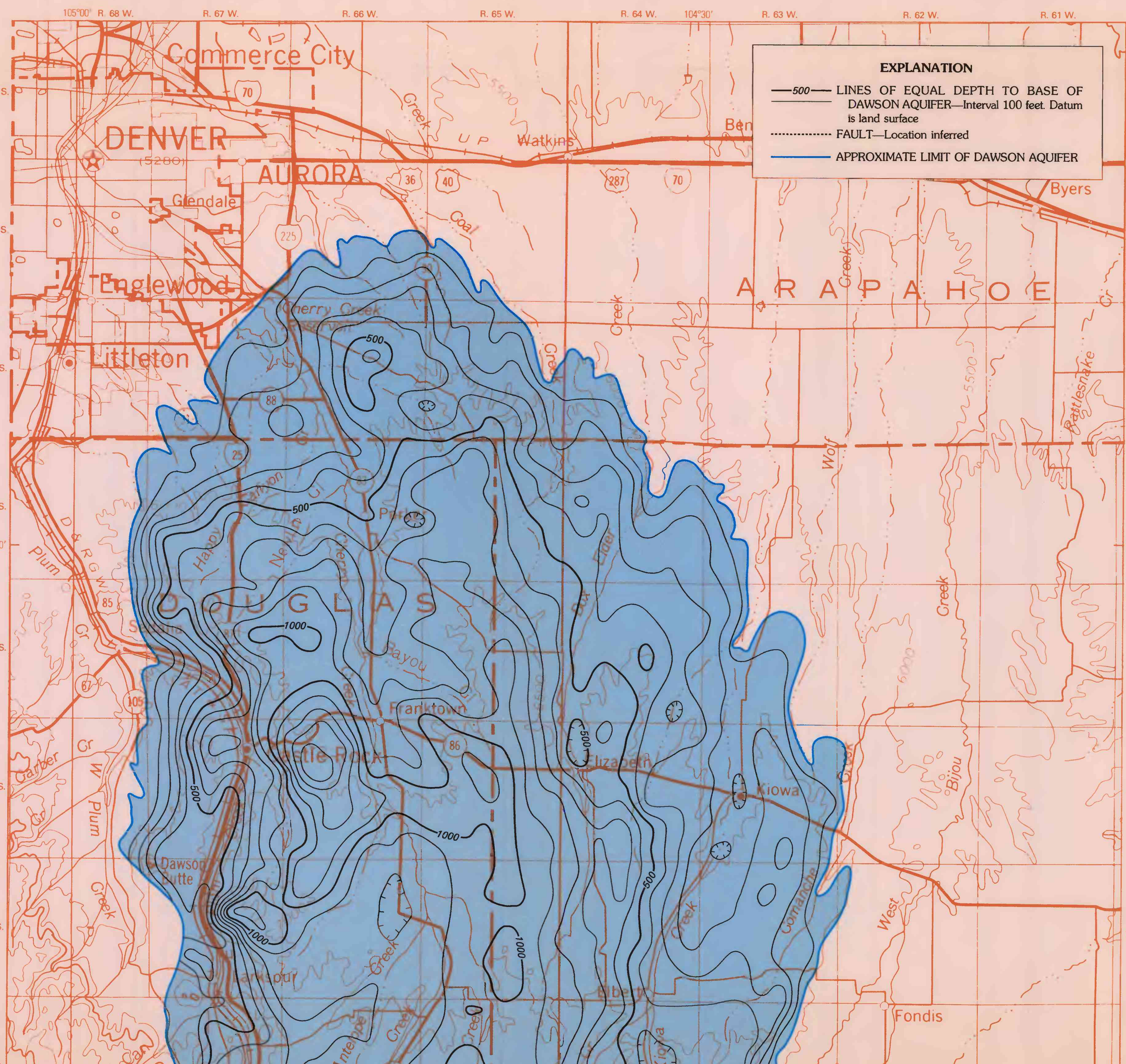

FIGURE 4.—MAP SHOWING DEPTH TO THE BASE OF THE AQUIFER

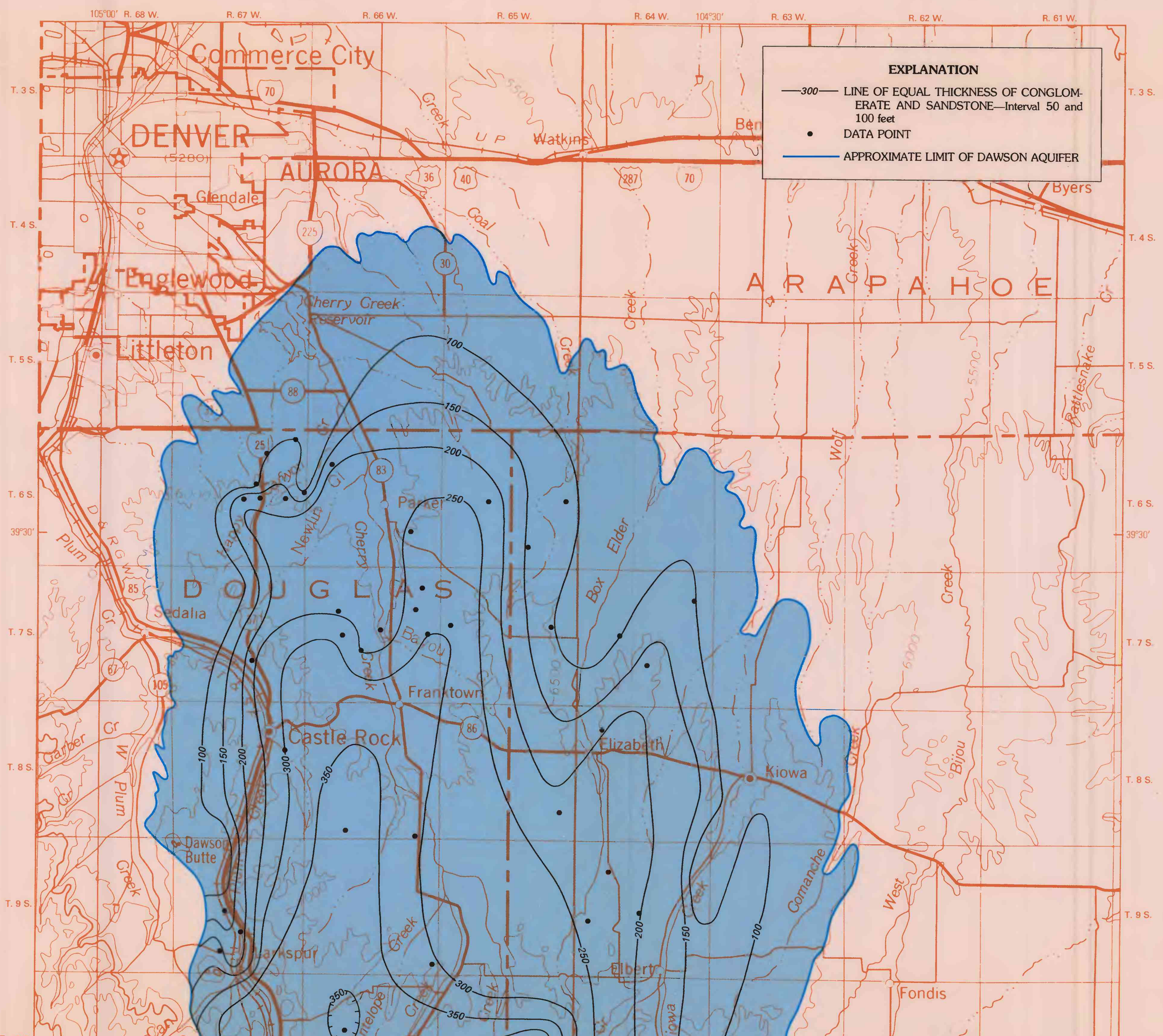

FIGURE 5.—MAP SHOWING TOTAL THICKNESS OF CONGLOMERATE AND SANDSTONE IN THE AQUIFER

Base from U.S. Geological Survey
1:500,000 State base map, 1969

SCALE 1:250 000
5 0 5 10 15 20 25 MILES
5 0 5 10 15 20 25 KILOMETERS
CONTOUR INTERVAL 500 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1981—W80485

GEOLOGIC STRUCTURE, HYDROLOGY, AND WATER QUALITY OF THE DAWSON AQUIFER IN THE DENVER BASIN, COLORADO

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John C. Romero, Colorado Division of Water Resources
1981

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