DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
COLORADO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER RESOURCES

WATER-RESOURCES INVESTIGATIONS 76-70
SHEET 1 OF 2

INTRODUCTION

This report presents the results of an investigation of the ground-water resources of the Crystal River and Cattle Creek drainage basins, an area of about 450 mi² (1,170 km²) in west-central Colorado south and southeast of Glenwood Springs. The investigation was begun in 1974 by the U.S. Geological Survey in cooperation with the Colorado Division of Water Resources, Office of the State Engineer.

The purpose of the investigation was to describe the geologic units, the aquifers and their characteristics, and the availability and chemical quality of ground water in the study area. Parts of the area have undergone rapid population growth in recent years. This rapid growth has resulted in an increased demand for additional domestic, industrial, and municipal water supplies. A knowledge of the occurrence of ground water will permit a more efficient allocation of the resource.

The investigation included identifying the aquifer units, and describing their hydrologic characteristics. This was accomplished by reviewing published geologic maps, obtaining well data, and conducting aquifer tests on selected wells throughout the study area. Samples of water were collected from wells and springs, and analyzed to define the chemical quality of water in the aquifers. Geologic information used in the preparation of this report is from published reports by Orlander, Lamm, and Florquist (1974), Mutschler (1969), Godwin (1968), Gaskill and Godwin (1966), Bass and Northrop (1963), and Donnell (1962), and an unpublished thesis by Welder (1954). Basic hydrologic data presented in this report were collected during the fall of 1974 and the spring of 1975.

AVAILABILITY OF GROUND WATER

Rock types in the two drainage areas include basalt, sandstone, shale, and evaporites (gypsum and anhydrite). Unconsolidated deposits include clay, silt, sand, gravel, and boulders (geologic map and table describing geologic units). Ground-water supplies are available from all rock types and the unconsolidated deposits. However, well yields are greatest from aquifers in the basalts and in the alluvium (hydrologic map and table describing geologic units).

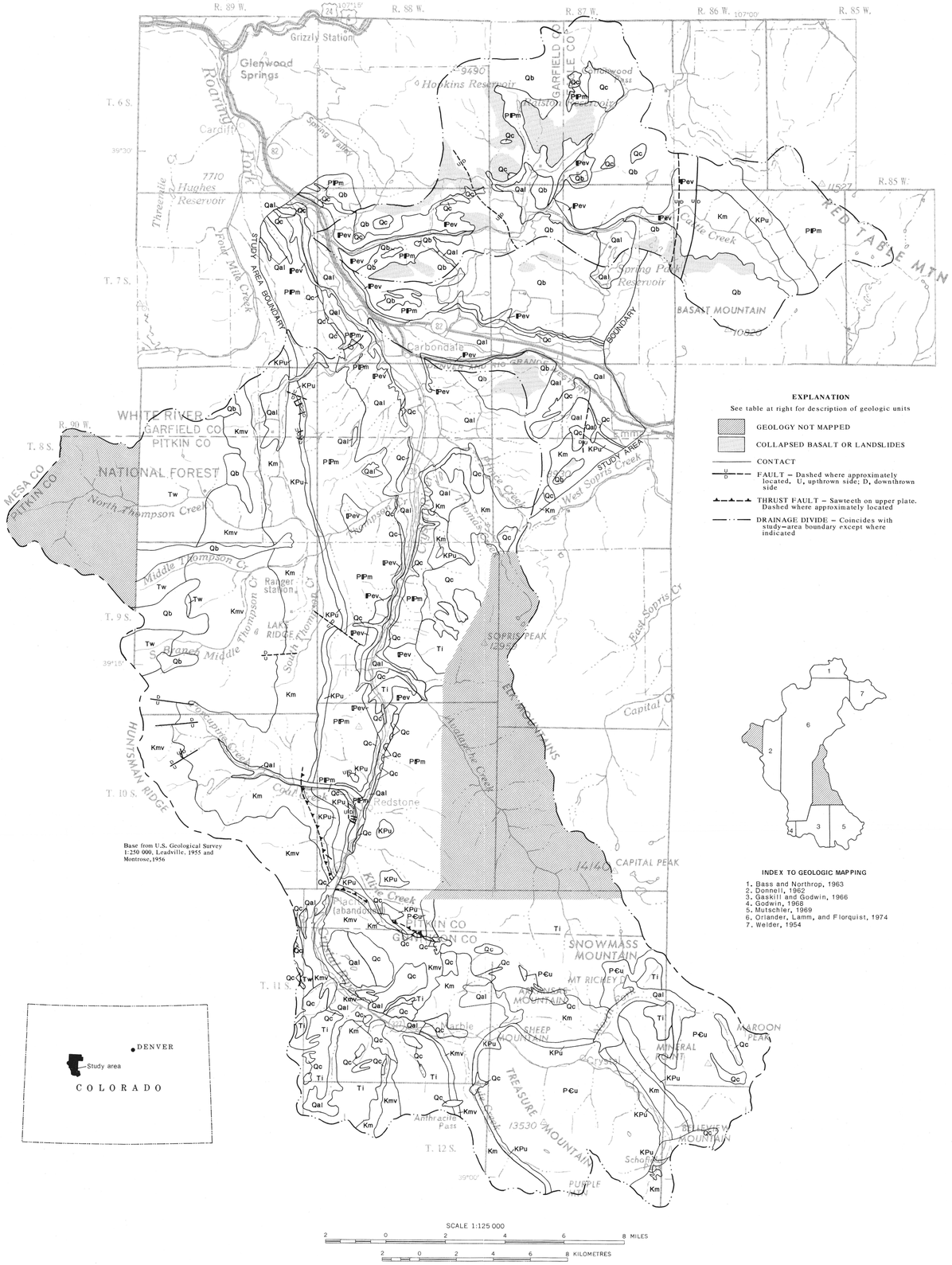
The most extensive aquifer in the Cattle Creek drainage basin is the basalt which overlies the Maroon Formation and the Eagle Valley Evaporite. Ground water, stored in the fractures of the basalt, is perched on top of the Maroon Formation and the Eagle Valley Evaporite. Ground-water discharge is by leakage into the underlying sedimentary rocks, by flow of springs into the Cattle Creek and the Roaring Fork River valleys, and by withdrawals through domestic and stock wells. Well yields reported at the time of well completion generally ranged from 25 to 50 gal/min (1.6 to 3.1 l/s), although in areas of collapsed basalt the reported yields were as much as 100 gal/min (6.3 l/s).

Aquifers in the alluvium include valley-fill sands and gravels, alluvial fans, and glacial deposits. These aquifers are primarily in the valleys of the Crystal River, the Roaring Fork River, and Cattle Creek, although extensive alluvial fans are present in the upland areas immediately south of Carbondale. Discharge from these aquifers supports base flow in the streams. Reported well yields range from 25 to 75 gal/min (1.6 to 4.7 l/s); however, a properly constructed well completed in the valley-fill sands and gravels could probably yield several hundred gallons per minute.

Water supplies also can be developed from springs in colluvium. Deposits of colluvium, including landslide deposits, slope talus, and mud flows, are found in the higher upland areas and valley edges of the basins, particularly in the vicinity of Marble, Colo. In this area, extensive mudflows and landslide deposits have been developed on the Mancos Shale. Many springs discharge near the contact of the unconsolidated material and the underlying bedrock. Discharges of the springs are generally low, vary in time and place, and are dependent on the season of the year, the areal extent, the relative grain size of the deposits, and the topographic relief of the colluvial deposits.

The water-yielding capabilities of aquifers in the sedimentary rocks vary widely and are largely dependent on fracture porosity and permeability. Reported yields of wells completed in fractured rock are low, and generally range from less than 5 to 25 gal/min (0.3 to 1.6 l/s), although a few isolated wells are reported to yield 50 gal/min (3.2 l/s). Springs in sedimentary rocks also may be developed for water supplies. In general, the yields of these springs are dependent on the same factors as springs in the colluvium. However, springs in the sedimentary rocks are more likely to be perennial and have higher yields than springs in the colluvium.

Ground-water circulation in sedimentary-rock aquifers is controlled partly by the characteristics of the individual rock units and partly by the regional geologic structure. Rock units in the Cattle Creek and the eastern part of the Crystal River drainage basins have a low angle of dip; ground-water discharge is to the streams. West of the Crystal River, however, the sedimentary rocks have a steep dip to the west and southwest except where locally controlled by intrusives. The direction of ground-water flow in these bedrock aquifers is to the west and southwest, not to the Crystal River or its tributaries.



EXPLANATION

See table at right for description of geologic units

- GEOLOGY NOT MAPPED
- COLLAPSED BASALT OR LANDSLIDES
- CONTACT
- FAULT – Dashed where approximately located. U, upthrown side; D, downthrown side
- THRUST FAULT – Sawteeth on upper plate. Dashed where approximately located
- DRAINAGE DIVIDE – Coincides with study-area boundary except where indicated

INDEX TO GEOLOGIC MAPPING

1. Bass and Northrop, 1963
2. Donnell, 1962
3. Gaskill and Godwin, 1966
4. Godwin, 1968
5. Mutschler, 1969
6. Orlander, Lamm, and Florquist, 1974
7. Welder, 1954

GEOLOGIC MAP

GEOLOGY

Description of geologic units and their hydrologic properties

System	Series	Geologic unit	Symbol	Maximum thickness (feet)	Physical characteristics	Hydrologic characteristics
QUATERNARY	Holocene	Colluvium	Qc	50	Clay, silt, sand, gravel, and boulders. Generally poorly sorted and angular. Formed as a result of debris accumulation at foot of slopes.	Reported well yields are as much as 25 gal/min. Source of water for many springs. Water quality dependent on composition of parent material.
		Alluvium	Qal	200	Clay, silt, sand, and gravel. Deposits are moderately to poorly sorted and consist of either angular or rounded fragments.	Reported well yields are as much as 75 gal/min. Important source of water in Carbondale area. Water quality variable and dependent on underlying bedrock and source of alluvial material. Water is a calcium sulfate type or a calcium bicarbonate type. Dissolved-solids concentration ranges from 245 to 1,460 mg/l. Selenium occurs in excess of U.S. Public Health Service (1962) drinking-water standards where alluvium is in contact with the Eagle Valley Evaporite. Hydraulic conductivity values range from 1.0 ft/d in the Cattle Creek valley to 100 ft/d in the Roaring Fork River valley.
	Pleistocene	Basalt	Qb	1,000	Olivine basalt, dark-gray, moderately to highly vesicular and often dense. Commonly jointed and fractured and weathers to a reddish-brown color.	Reported well yields generally range from 25 to 50 gal/min; yields of 100 gal/min are not uncommon in collapsed areas. Basalt is primary source of water in Cattle Creek drainage basin; no information available for basalt in western part of Crystal River drainage basin. Water is a calcium bicarbonate type. Dissolved-solids concentration ranges from 111 to 475 mg/l. Hydraulic conductivity values range from 1.0 to 40 ft/d.
TERTIARY	Pliocene Miocene Oligocene	Igneous rocks	Ti	Indeterminate	Predominantly granodiorite and quartz monzonite, light-gray to brown, medium-grained, dense, and hard. Fracturing and jointing common.	No information available. Not an aquifer in study area.
	Eocene	Wasatch Formation	Tw	6,000	Claystone, mudstone, and shale with interbeds of siltstone and conglomerate. Coarser grained beds tend to be arkosic and lenticular.	No information available. Not an aquifer in study area.
CRETACEOUS	Upper Cretaceous	Mesaverde Formation	Kmv	2,700	Interbedded sandstone, shaly sand, shale, and coal. Sandstones are tan in color, massive, and form prominent ridges. Shales are greenish gray and locally carbonaceous. Coals are economically important.	Data for only one well obtained; water is a calcium bicarbonate type. Dissolved-solids concentration is 181 mg/l.
		Mancos Shale	Km	4,000	Dark-gray shale, with interbedded sandstone, siltstone, and limestone. Shales are calcareous and slightly carbonaceous. Locally fossiliferous.	Data for only one well obtained; water is a calcium bicarbonate type. Dissolved-solids concentration is 237 mg/l.
	Lower Cretaceous	Dakota Sandstone and Burro Canyon Formation	KPu	300	Predominantly light-gray, very fine to medium, well-sorted, well-cemented, sandstone with shale and siltstone interbeds. Chert-pebble conglomerates are common. The sandstone weathers to a rust-brown color and forms ridges.	No information available. May be an aquifer in outcrop area.
JURASSIC	Upper Jurassic	Morrison Formation		325	Varicolored shale with interbedded light-gray sandstone and siltstone and dark-gray limestone. Sandstone beds are more prominent in the lower part of the formation; limestone beds, in the middle.	No information available. May be an aquifer in outcrop area.
		Entrada Sandstone		150	Sandstone, yellowish-gray to gray, very fine to medium, well-sorted, cross-bedded, and calcareous. Weathers to an orange-gray color; forms ridges.	No information available. May be an aquifer in outcrop area.
TRIASSIC	Upper Triassic	Chinle Formation		1,000	Interbedded siltstone, shale, and limestone-pebble conglomerate. Reddish brown in color.	No information available. Not considered an aquifer in study area.
PERMIAN	Lower Triassic and Upper Permian	State Bridge Formation		2,700	Shaly siltstone, with interbedded silty and shaly medium-grained sandstones and silty shales. Reddish brown and calcareous in places. Crossbedding and ripple marks locally present.	Data for only one well obtained; water is a calcium bicarbonate type. Dissolved-solids concentration is 489 mg/l.
	Upper Permian	Weber Sandstone	PPm	100	Very fine to medium-grained, poorly sorted, red to gray sandstone with interbedded siltstone and shale. The gray color in the lower beds is due to a hydrocarbon stain on quartz grains. Some conglomerates locally present.	No information available. May be an aquifer in outcrop area.
PENNSYLVANIAN	Lower Permian and Upper Pennsylvanian	Maroon Formation		5,000	Red, calcareous, arkosic sandstone and shale with interbedded siltstone, grayish-purple limestone, and arkosic conglomerate. Conglomerates are generally massive, containing igneous, metamorphic, and isolated limestone pebbles. Sandstones and shales are often micaceous, nodular, and green in color. Crossbedding and ripple marks are locally present.	Reported well yields range from 5 to 25 gal/min. Where fractured extensively, may yield greater quantities of water to wells. Important source of water in Carbondale area and Crystal River drainage basin. Water is a calcium bicarbonate type in the Cattle Creek and Carbondale areas and a sodium bicarbonate type in the Crystal River drainage basin. Dissolved-solids concentration ranges from 194 to 1,160 mg/l.
	Middle Pennsylvanian	Eagle Valley Evaporite	IPev	3,000	Interbedded gypsum, dark-gray to black shale, and gypsiferous siltstone. Shales are predominantly calcareous and contain interbeds of brownish sandstone. Gypsum is generally massive, white, and weathers to a dark gray. The formation as a whole weathers to a yellowish-gray color. Some beds may be halitic.	Reported well yields range from 5 to 25 gal/min. Used as a source of water in the Carbondale and Cattle Creek areas. Water is a calcium sulfate type. Dissolved-solids concentration ranges from 247 to 2,630 mg/l. The occurrence of selenium is localized; concentrations in excess of U.S. Public Health Service (1962) drinking-water standards occur in the Cattle Creek and Carbondale areas.
MISSISSIPPIAN AND OLDER	Lower Pennsylvanian and older	Minturn Formation Gothic Formation of Langenheim (1952) Belden Formation Leadville Limestone Chaffee Formation Manitou Dolomite Peerless Formation Sawatch Quartzite	PCu	4,650	Limestone, dolomite, sandstone, siltstone, shale, quartzite, and some conglomerate. Rocks are generally brownish, light gray to dark gray, hard, calcareous, and may be slightly to strongly metamorphosed.	No information available.

OPEN-FILE REPORT

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AVAILABILITY AND CHEMICAL QUALITY OF GROUND WATER IN THE CRYSTAL RIVER AND CATTLE CREEK DRAINAGE BASINS NEAR GLENWOOD SPRINGS, WEST-CENTRAL COLORADO

By
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1976