DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
WYOMING STATE ENGINEER

HYDROLOGIC INVESTIGATIONS
ATLAS HA-558 (SHEET 1 OF 3)

INTRODUCTION

This is the eighth in a series of hydrologic atlases prepared by the U.S. Geological Survey in cooperation with the Wyoming State Engineer to describe in general the water resources of the State. The area of this investigation and areas of other hydrologic atlases in Wyoming are shown on the index map.

Northwestern Wyoming includes Yellowstone and Grand Teton National Parks and many other points of tourist interest. Water supplies that are sufficient in quantity, suitable in quality, and safe for human consumption are needed but are not always available near some of these places. The increasing number of tourists and residents and the shifting of overnight accommodations for tourists from the national parks to nearby areas may result in the need for development of additional water supplies in northwestern Wyoming.

Use of Metric Units

Because use of the metric system is increasing in the United States, values for units of measure are given in metric as well as in English units in the text of this report. Metric equivalents of English units are given in parentheses following the English units. Metric equivalents of English units used in this report may be determined by the following conversion factors:

Inches (in.)	×25.4	=Millimetres (mm)
Feet (ft)	× .3048	=Metres (m)
Miles (mi)	× 1.609	=Kilometres (km)
Square miles (mi^2)	× 2.590	=Square kilometres (km^2)
Gallons per minute (gal/min)	× 3.7854	=Litres per minute (l/min)
Cubic feet per second (ft^3/s)	× .02832	=Cubic metres per second (m^3/s)
Feet squared per day (ft^2/d)	× .0929	=Metres squared per day (m^2/d)
Feet per mile (ft/mi)	× .1894	=Metres per kilometre (m/km)

Climate

Annual precipitation in northwestern Wyoming ranges from about 13 in. (330 mm) near the northern border to as much as 70 in. (1,780 mm) in the southern part of the Teton Range. Average annual precipitation at most weather stations in northwestern Wyoming ranges from 15 to 22 in. (380 to 560 mm). Although mountains and valleys locally influence the amount of precipitation, it generally increases with altitude. Precipitation occurs as snow during the winter, as rain and snow during the spring and fall, and generally as rain during the summer. Brief snow storms, however, occasionally occur in summer at higher altitudes.

Average annual air temperatures range from about 35° to 40°F (1.5° to 4.5°C) in most of the area. During most years, maximum temperatures are near 90°F (32°C) and minimum temperatures are less than −30°F (−34°C).

Previous Investigations

Geologic and hydrologic investigations in northwestern Wyoming began in the 19th Century. Many geologic studies have been made in the area since that time. Love and Reed (1968) and Keefer (1972) summarized the geology in and near Grand Teton and Yellowstone National Parks, respectively, and the reader is referred to these publications for descriptions of the geology of northwestern Wyoming. Hydrologic investigations have been mainly of thermal waters in Yellowstone National Park and water resources in Yellowstone and Grand Teton National Parks.

The Geological Survey made studies of hydrologic conditions in Yellowstone National Park (Gordon and others, 1962; Lowry and Gordon, 1964; and Cox, 1973) and in Grand Teton National Park (McGreevy and Gordon, 1964; and Cox, 1974) in cooperation with the National Park Service. Selected hydrologic data collected during the studies in the parks were used in the preparation of this report.

Location Numbers

Wells and springs in Wyoming are usually numbered by the Geological Survey according to their location within the Federal system of land subdivision. Data-collection sites on streams are usually given an 8-digit station number and are located by the universal system of latitude and longitude. Yellowstone National Park and much of the rest of northwestern Wyoming have not been officially subdivided, and the common Geological Survey well- and spring-numbering system is not used in this report. Station numbers are not used in this report. Instead, wells, springs, and data-collection sites on streams are identified by means of a number that is based on latitude and longitude. The number serves not only to identify the well, spring, or site on a stream but also to locate it on a map. The first six digits represent degrees, minutes, and seconds of latitude; "N" refers to north latitude and is used to break the string of numbers; the next seven digits are degrees, minutes, and seconds of west longitude.

GEOLOGY

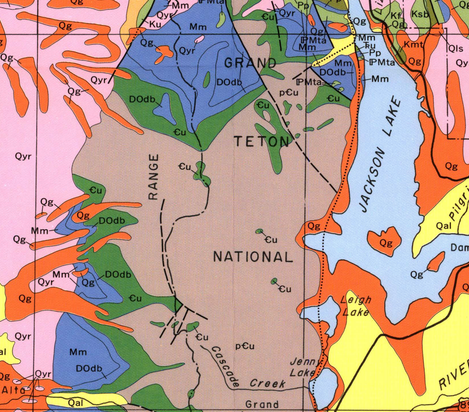
Most of central and western Yellowstone National Park is a plateau area that coincides with a large caldera and nearby areas that contain great thicknesses of rhyolitic volcanic rocks. North of the plateau are faulted and uplifted blocks of the Gallatin and Beartooth Ranges. East of the plateau is the Absaroka Range composed mostly of thick accumulations of andesitic volcanic rocks. To the south are the Teton Range, Jackson Hole, and anticlinal uplifts of the Gros Ventre and Washakie Ranges. The Teton Range is an uplifted block west of the Teton fault. Jackson Hole is a folded and faulted downwarp east of the Teton fault. The Hoback Basin, south of the Gros Ventre Range, is the northernmost part of the much larger Green River structural basin.

Rocks ranging in age from Precambrian to Quaternary crop out in northwestern Wyoming. The geologic units shown on the geologic map are those most convenient for presenting the water-bearing properties of the rocks. Other studies may divide the geology into different units. For example, the surficial and volcanic rocks have been greatly subdivided in studies of glaciation and vulcanism, respectively.

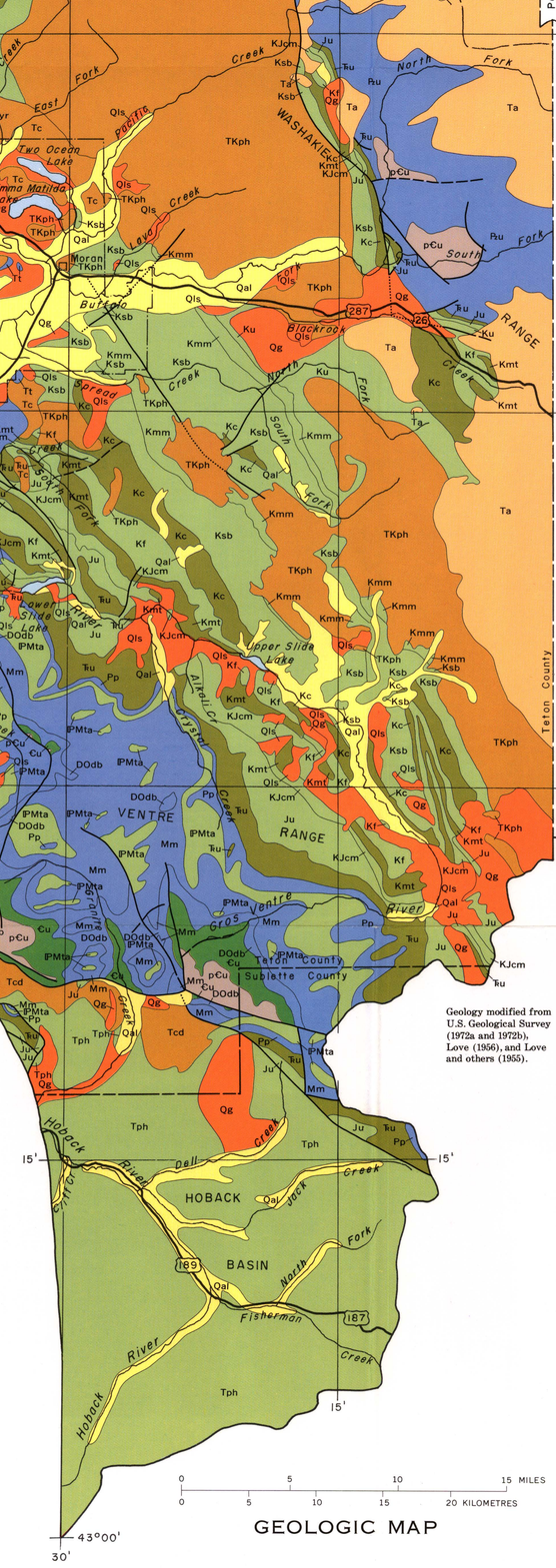
Most data from wells are related to Tertiary and Quaternary rocks. Because data from wells are not available from most Precambrian, Paleozoic, and Mesozoic rock units, the interpretations of the water-bearing properties are based on the lithology of the rocks and the water-bearing properties of similar rocks in other areas. Rock units with similar water-bearing properties are shown in the same color on the geologic map. The generalized section of rocks exposed in northwestern Wyoming presents thickness, lithology, and water-bearing properties from reported values and the author's interpretations.

Base from U.S. Geological Survey 1:250,000 quadrangles

Geology modified from U.S. Geological Survey (1972a and 1972b), Love (1956), and Love and others (1955).



INDEX MAP OF WYOMING SHOWING AREA OF THIS INVESTIGATION AND AREAS OF OTHER REPORTS IN THE HYDROLOGIC ATLAS SERIES



GEOLOGIC MAP

EXPLANATION

Qal	Alluvium and glacial-outwash deposits	QUATERNARY	CENOZOIC
Qls	Landslide deposits		
Ql	Lacustrine deposits		
Qg	Glacial-moraine deposits		
Qyr	Rhyolite tuff and flows	Yellowstone Group (Order may not reflect relative age)	
Qyb	Basalt flows		
QTb	Bivouac Formation	TERTIARY OR QUATERNARY	
Tt	Teewinot Formation	TERTIARY	
Tcd	Camp Davis Formation		
Tv	Volcanic rocks undivided		
Tc	Colter Formation		
Ta	Absaroka Volcanic Supergroup		
Tph	Pass Peak[1] and Hoback Formations, undivided		
TKph	Pinyon Conglomerate and Harebell Formation, undivided	CRETACEOUS AND TERTIARY	
Kmm	Meeteetse and Mesaverde Formations, undivided	CRETACEOUS	MESOZOIC
Ksb	Unnamed lenticular sandstone, shale, and coal and Bacon Ridge Sandstone		

[1] The Pass Peak Conglomerate of Eardley and others, 1944, is herein adopted as the Pass Peak Formation as redefined by Steidtmann, 1971.

Kc	Cody Shale	CRETACEOUS	MESOZOIC
Ku	Cretaceous rocks undivided		
Kf	Frontier Formation		
Kmt	Mowry and Thermopolis Shales, undivided		
KJcm	Cloverly and Morrison Formations, undivided	JURASSIC AND CRETACEOUS	
Ju	Jurassic rocks, undivided	JURASSIC	
Tu	Triassic rocks, undivided	TRIASSIC	
(North) Ps	Shedhorn Sandstone	PERMIAN	PALEOZOIC
(South) Pp	Phosphoria Formation		
(North) IPMqa	Quadrant Sandstone and Amsden Formation, undivided	MISSISSIPPIAN AND PENNSYLVANIAN	
(South) IPMta	Tensleep Sandstone and Amsden Formation, undivided		
Mm	Madison Limestone	MISSISSIPPIAN	
(North) DOtb	Three Forks and Jefferson Formations and Bighorn Dolomite, undivided	ORDOVICIAN AND DEVONIAN	
(South) DOdb	Darby Formation and Bighorn Dolomite, undivided		
Cu	Cambrian rocks, undivided	CAMBRIAN	
pCu	Precambrian rocks, undivided		PRECAMBRIAN
Pu	Paleozoic rocks undivided		PALEOZOIC

Contact

Fault

Dashed where approximately located; dotted where concealed

Coloring based on predominant lithology

Sand and gravel	Andesite
Clay to boulders	Sandstone
Rhyolite and basalt	Shale
Conglomerate	Shale, sandstone, and limestone
Limestone and dolomite	Gneiss and schist

Generalized section of rocks exposed in northwestern Wyoming

Erathem	System	Geologic unit: North	Geologic unit: South	Approximate maximum thickness (feet)	Lithology	Water-bearing properties
CENOZOIC	QUATERNARY	Alluvium and glacial-outwash deposits		200	Silt, sand, gravel, and cobbles.	Yields from a few to 2,000 gal/min per well in Jackson Hole and may yield as much as 500 gal/min per well in Yellowstone National Park. Yields as much as several cubic feet per second to individual springs.
		Landslide deposits		100	Heterogeneous mass ranging from clay to boulders.	Probably would not yield more than a few gallons per minute per well. Yields water to numerous springs.
		Lacustrine deposits		500	Clay, silt, sand, and gravel.	Yields from a few to 46 gal/min per well near Yellowstone Lake. May yield only a few gallons per minute per well in Jackson Hole.
		Glacial-moraine deposits		200	Poorly sorted material ranging from clay to boulders.	Yields from a few to 118 gal/min per well from sand and gravel near Jackson Lake.
		Yellowstone Group		10,000+	Rhyolitic ash, welded tuff, lava flows, breccia, and glass.	May yield a few tens of gallons per minute per well from porous and fractured zones. Yields as much as 200 gal/min to individual springs. Yields water to numerous fumaroles and hot springs in Yellowstone National Park.
				1,000	Basaltic lava flows.	May yield a few tens of gallons per minute per well from brecciated zones and fractures.
	TERTIARY OR QUATERNARY	Bivouac Formation		1,000	Poorly cemented conglomerate with a rhyolitic welded tuff.	May yield a few tens of gallons per minute per well from conglomerate.
	TERTIARY	Teewinot Formation		6,000	Mostly limestone, sandstone, claystone, and tuff.	Yields as much as 120 gal/min per well from fractures and solution channels in limestone.
		Camp Davis Formation		5,000	Conglomerate and claystone.	May yield a few tens of gallons per minute per well from conglomerate.
		Colter Formation		7,000	Volcanic conglomerate, tuff, sandstone, claystone, basalt, and andesite.	May yield a few gallons per minute per well from conglomerate and sandstone and from fractures in basalt and andesite.
		Absaroka Volcanic Supergroup		5,000	Andesitic, basaltic, and dacitic volcaniclastic rocks.	Probably would not yield more than a few gallons per minute per well.
		Pass Peak Formation		1,500	Conglomerate, sandstone, and shale.	May yield a few tens of gallons per minute per well from conglomerate and sandstone.
		Hoback Formation		15,000	Sandstone, siltstone, and shale.	May yield a few tens of gallons per minute per well from sandstone.
		Volcanic rocks undivided			Volcanic rocks.	Yields a few tens of gallons per minute per well from fractures near Jackson.
	CRETACEOUS AND TERTIARY	Pinyon Conglomerate		2,500	Conglomerate, sandstone, claystone, and coal.	May yield a few tens of gallons per minute per well.
MESOZOIC	CRETACEOUS	Harebell Formation	Landslide Creek Formation	5,000	Conglomerate, sandstone, siltstone, and shale.	May yield a few tens of gallons per minute per well from conglomerate and sandstone.
		Meeteetse Formation		700	Sandstone, siltstone, shale, coal, and bentonite.	May yield a few gallons per minute per well from sandstone.
		Mesaverde Formation		1,000	Sandstone and shale.	
		Everts Formation, Eagle Sandstone, and Telegraph Creek Formation undivided	Unnamed lenticular sandstone, shale, and coal and Bacon Ridge Sandstone undivided	2,000	Sandstone, shale, and coal.	
		Cody Shale		2,000	Shale and thin beds of sandstone and bentonite.	Probably would not yield more than a few gallons per minute per well.

Erathem	System	Geologic unit: North	Geologic unit: South	Approximate maximum thickness (feet)	Lithology	Water-bearing properties
MESOZOIC	CRETACEOUS	Frontier Formation		1,000	Sandstone, shale, and bentonite.	May yield a few tens of gallons per minute per well from sandstone. Yields a few gallons per minute to individual springs in the Gros Ventre Range.
		Mowry and Thermopolis Shales undivided		900	Shale, sandstone, and bentonite.	May yield a few tens of gallons per minute per well from sandstone beds in Thermopolis Shale.
	JURASSIC AND CRETACEOUS	Kootenai and Morrison Formations undivided	Cloverly and Morrison Formations undivided	650	Sandstone and claystone.	Probably would not yield more than a few gallons per minute per well.
	JURASSIC	Ellis Group	Sundance and Gypsum Spring Formations undivided	700	Sandstone, shale, and limestone.	May yield a few gallons per minute per well from sandstone and from fractures and solution channels in limestone.
	TRIASSIC(?) AND JURASSIC(?)		Nugget Sandstone	350	Sandstone.	May yield a few tens of gallons per minute per well.
	TRIASSIC	Thaynes, Woodside, and Dinwoody Formations undivided	Chugwater and Dinwoody Formations undivided	2,000	Siltstone and shale.	Probably would not yield more than a few gallons per minute per well.
PALEOZOIC	PERMIAN	Shedhorn Sandstone	Phosphoria Formation	250	Sandstone, dolomite, and shale.	May yield as much as 10 gal/min per well from sandstone and from fractures and solution channels in dolomite.
	MISSISSIPPIAN AND PENNSYLVANIAN	Quadrant Sandstone and Amsden Formation undivided	Tensleep Sandstone and Amsden Formation undivided	700	Sandstone and shale.	May yield a few tens of gallons per minute per well from sandstone. Yields as much as 100 gal/min to individual springs in the Gros Ventre Range.
	MISSISSIPPIAN	Madison Limestone		1,000	Limestone and thin beds of shale.	May yield several hundred gallons per minute per well from solution channels in limestone. Yields as much as 10 ft^3/s to individual springs.
	DEVONIAN	Three Forks and Jefferson Formations undivided	Darby Formation	350	Shale and dolomite.	Probably would not yield more than a few gallons per minute per well.
	ORDOVICIAN	Bighorn Dolomite		450	Dolomite.	May yield as much as 100 gal/min per well from fractures and solution channels.
	CAMBRIAN	Snowy Range Formation and Pilgrim Limestone undivided	Gallatin Limestone	200	Limestone and shale.	May yield as much as 100 gal/min per well from solution channels in limestone. Yields as much as 1 ft^3/s to individual springs in the Gros Ventre Range.
		Park Shale, Meagher Limestone, and Wolsey Shale undivided	Gros Ventre Formation	600	Shale, siltstone, and limestone.	Probably would not yield more than a few gallons per minute per well.
		Flathead Sandstone		200	Sandstone.	May yield a few tens of gallons per minute per well.
PRECAMBRIAN		Metamorphic and igneous rocks			Mostly gneiss, schist, and granite.	May yield a few tens of gallons per minute per well from fractures. Yields as much as 200 gal/min to individual springs in the Teton Range.

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WATER RESOURCES OF NORTHWESTERN WYOMING

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