Prepared as part of the Alaska Water Resources Evaluation
in cooperation with
ALASKA DEPARTMENT OF NATURAL RESOURCES,
DIVISION OF GEOLOGICAL AND GEOPHYSICAL SURVEYS

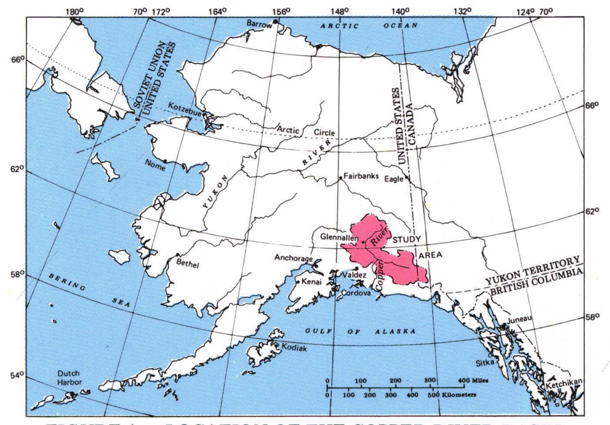


FIGURE 1. -- LOCATION OF THE COPPER RIVER BASIN.

INTRODUCTION

The Copper River drainage basin above Chitina, Alaska, covers an area of approximately 20,600 mi^2, of which about 1,200 mi^2 are in the Yukon Territory of Canada (fig. 1). The total population of this area is 2,736 (1980 census). Glennallen, with a population of 488, is the largest community, followed in size by Copper Center, 213; Tonsina, 137; and Gulkana, 111. The Copper River basin is crossed by the trans-Alaska pipeline and the Glenn and Richardson Highways. These highways serve as important transportation links between the ports of Anchorage and Valdez and the interior and northern areas of Alaska.

Prior to 1898 only a few prospectors and government expeditions had entered the Copper River basin and the area's only residents were Ahtna Indians. After 1898 the basin was explored by many in search of its mineral wealth. During the period 1899-1901, a military trail and telegraph line were constructed from Valdez northward through the basin to Eagle, on the Yukon River. The Copper River and Northwestern Railroad, completed in 1911, linked the Kennecott copper mines near McCarthy with the seaport of Cordova. These mines, which produced 1.2 billion pounds of copper and 9 million troy ounces of byproduct silver from 1913-1938 (Douglass, 1964, p. 11), represented the principal economic endeavor of the Copper River basin.

The current economy of the area is based on tourism, recreation (mainly hunting and fishing), retail trade, employment associated with State and Federal government, and the trans-Alaska pipeline. The potential for metallic mineral development (copper, gold, nickel, chromium, and cobalt) is moderate to high. There is also some potential for the development of geothermal resources.

The Copper River and its tributaries make up one of the most prolific fish-producing stream systems in Alaska. Each summer thousands of anadromous fish (sockeye, chinook, and coho salmon) migrate up the Copper, Gulkana, Tazlina, Klutina, Tonsina, and Chitina Rivers.

PHYSIOGRAPHY

The Copper River basin is rimmed on the east, south, and west by the Wrangell, St. Elias, Chugach, and Talkeetna Mountains, and on the north by the Alaska Range (fig. 2). The most prominent mountains in the area are the great shield and composite volcanos of the Wrangell Mountains, which include Mt. Wrangell (still active), Mt. Sanford, Mt. Drum, and Mt. Blackburn. Land surface altitude in the Alaska portion of the basin ranges from about 450 ft, near Chitina, to 16,523 ft at Mt. Blackburn. At the eastern end of the basin, in Canada, the altitude reaches 19,850 ft at Mt. Logan.

The Copper River Lowland (the dark and light green areas in figure 2) is a relatively smooth plain that ranges in altitude from approximately 1,000 to 3,000 ft (Wahrhaftig, 1965). The valleys of the Copper River and its tributaries are incised in this plain. The western part of the Copper River Lowland is a somewhat rolling terrain with morainal and stagnant-ice topography. The area between the Copper River Lowland and the Alaska Range has been referred to as the Gulkana Upland. This upland area of rounded, east-west trending ridges and intervening lowlands ranges from about 3,000 to about 5,000 ft altitude (yellow area). Surrounding the lowland and uplands areas are foothills and low mountains (orange area) and higher mountains (brown area).

Glaciation has been the major force in creating present-day landforms in the basin. Glaciers and glacial lakes have at one time or another covered most of the area and glacier ice and perennial snowfields now cover approximately 17 percent, or about 3,500 mi^2, of the basin.

PHYSIOGRAPHY

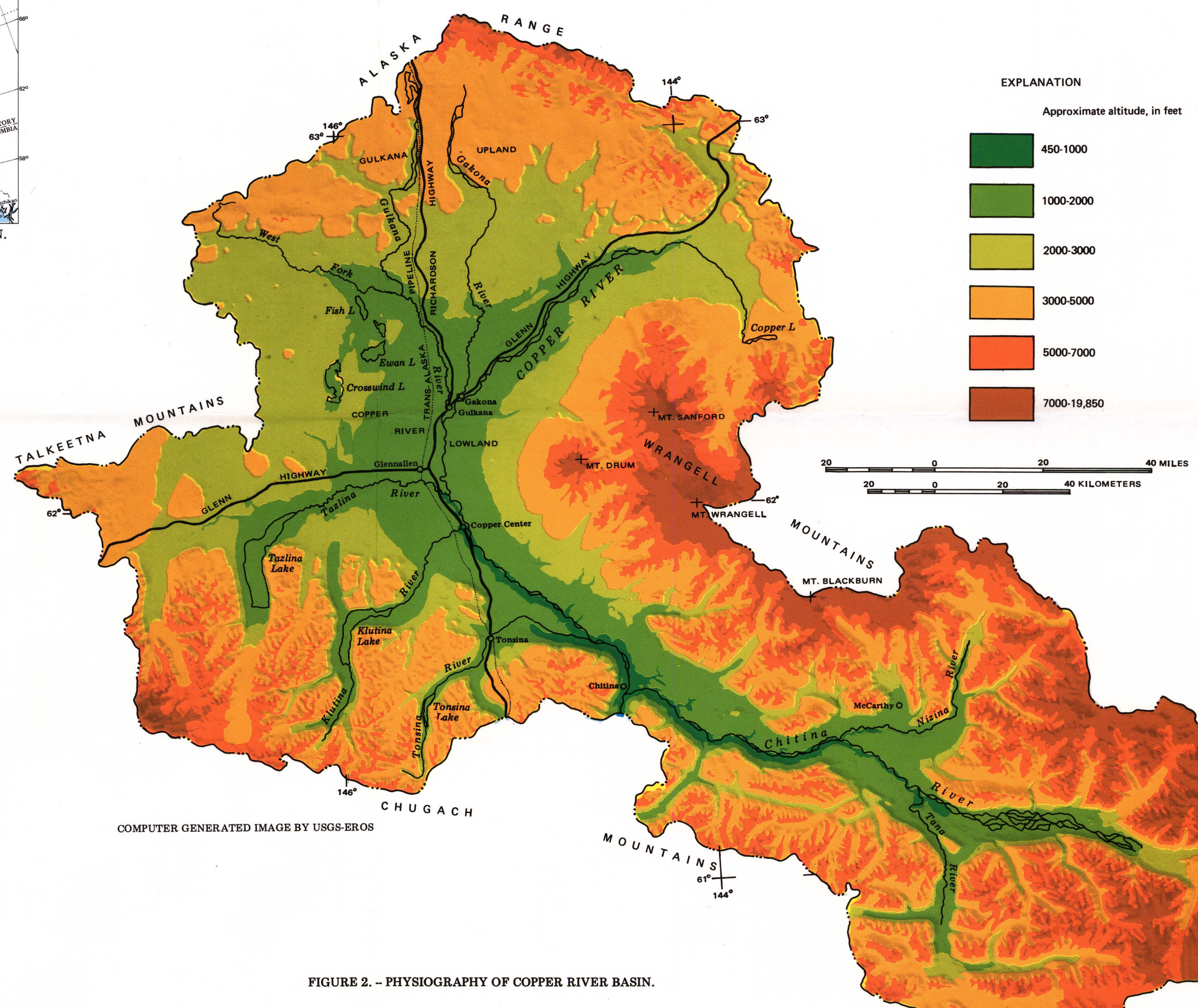


FIGURE 2. -- PHYSIOGRAPHY OF COPPER RIVER BASIN.

CONVERSION TABLE

Multiply	By	To obtain
inch (in.)	25.40	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
acre	0.4047	hectare
square mile (mi^2)	2.590	square kilometer (km^2)
acre-foot (acre-ft)	1,233	cubic meter (m^3)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer [$(m^3/s)/km^2$]
gallon per minute (gal/min)	0.06308	liter per second (L/s)
gallon per day (gal/d)	0.003785	cubic meter per day (m^3/d)
ounce, avoirdupois (oz)	28.35	gram (g)
pound, avoirdupois (lb)	453.6	gram (g)
ton, short	0.9072	megagram (Mg)
ton per square mile per year [$(ton/mi^2)/yr$]	0.3503	megagram per square kilometer per year [$(Mg/km^2)/a$]
degree Fahrenheit (°F)	5/9(°F-32)	degree Celsius (°C)
micromho per centimeter at 25° Celsius (µmho/cm at 25° C)	1.000	microsiemens per centimeter at 25° Celsius (µS/cm at 25° C)

Other abbreviations in this report are:

µg/L, microgram per liter
mg/L, milligram per liter
ppm, parts per million

Note: National Geodetic Vertical Datum of 1929 (NGVD of 1929), the reference surface to which relief features and altitude data are related, and formerly called mean sea level, is herein called sea level.

GEOLOGY AND GROUND WATER

GEOLOGY AND GROUND WATER

The mountains rimming the Copper River basin consist of a great diversity of rock types. The Wrangell and St. Elias Mountains consist of volcanic rocks that overlie deformed older sedimentary, volcanic, and metamorphic rocks. Some granitic masses intrude these older rocks. The Chugach Mountains to the south are made up mainly of metamorphic rocks with some igneous intrusions. The Talkeetna Mountains are comprised mainly of sedimentary and metamorphic rocks capped in places by flat-lying basalt flows. The part of the Alaska Range that borders the basin on the north consists of sedimentary and volcanic rocks,and folded, faulted and metamorphosed rocks. Ground-water availability in the bedrock units is relatively untested. Because of limited saturated thickness and low permeability, wells developed in these aquifers will probably not yield more than 50 gal/min.

A thick, complex assemblage of gravel, sand, silt, and clay fills the interior of the Copper River basin. A large volume of these materials consists of glacial-lake deposits which underlie an area of nearly 4,000 mi^2 (fig. 7). These lake deposits, which are as thick as 500 ft (Wahrhaftig, 1965), are generally fine-grained and poorly sorted. The low permeability of these deposits, coupled with the prevalent permafrost restricts their water-transmitting properties, making them poor aquifers. Ground water is somewhat more abundant in flood-plain deposits along the major streams in the basin.

Ground-Water Development -- A number of shallow wells (10-40 ft deep) have been developed in the Copper River Lowland. These wells, which yield less than 20 gal/min, produce water from the unfrozen unconsolidated deposits above the permafrost or from unfrozen flood-plain and terrace deposits along the major streams. Some of the wells that produce water from above the permafrost freeze during the winter. More than 50 wells, ranging in depth from 12 to 170 ft, have been developed in the Copper Center area. Most of these wells yield water of rather poor quality.

Wells drilled through the permafrost also commonly yield water of poor quality. In general, any well drilled deeper than 200 ft will probably produce ground water of unacceptable quality for human consumption. However, a few of the wells that have been drilled through the permafrost have produced potable water.

The sand and gravel deposits that should be present in the alluvial fans and glaciofluvial deposits flanking the surrounding mountains are a possible source of ground water, but are as yet untested. However, these potential aquifers are located in remote, relatively inaccessible areas, distant from the center of the basin where most of the population resides.

Springs -- Several springs (fig. 7) produce water high in chloride and therefore are not a potable ground-water resource. Some of these saline springs have formed cones or "mud volcanos" from the sediment they discharge (Grantz and others, 1962). Some fresh-water springs, for example those along Mendeltna and Squirrel Creeks, also occur but most are too far from present-day population centers to be considered water-supply sources.

Ground-Water Quality -- The quality of most ground water in the inhabited areas of the Copper River basin (mainly the Copper River Lowland) is rather poor. As a general rule, throughout the Copper River Lowland the quality of the ground water decreases with increasing depth. The saline springs are merely the surface manifestation of saline ground water present in the marine sedimentary rocks that underlie much of the glacial-lake deposits. Upward movement of water (as evidenced by the springs) from these older sedimentary rocks has probably affected the quality of water in the overlying unconsolidated aquifers.

Grantz and others (1962) reported that dissolved-solids concentrations of water from 9 of the 11 saline springs shown on figure 7 ranged from about 9,000 ppm to 35,000 ppm. Sodium ranged from about 700 ppm to 10,000 ppm and chloride from 5,700 to 15,000 ppm (parts per million are approximately equivalent to milligrams per liter).

Chemically, the ground water in the unconsolidated aquifers of the Copper River Lowland is characterized by high concentrations of dissolved solids, sodium, chloride, iron, and manganese. Table 1, based on a rather limited number of analyses, indicates the ground-water quality from wells in selected areas of the lowland.

Table 1.--Range in concentration of chemical constituents in ground water

[Generally accepted limit for dissolved solids in drinking water is 500 mg/L. The recommended limits for public water supply for chloride is 250 mg/L; for iron, 300 µg/L; and for manganese, 50 µg/L (U.S. Environmental Protection Agency, 1977). The number of determinations for the constituents is in parentheses.]

Area	Number of wells sampled	Range in well depth (ft)	Dissolved solids (mg/L)	Sodium (mg/L)	Chloride (mg/L)	Iron (µg/L)	Manganese (µg/L)
Copper Center	29	42- 76	260- 1,560(37)	18- 320(37)	4- 660(41)	870(1)	120(1)
Gakona	5	16- 60	260- 1,810(6)	12- 350(6)	11-1,000(6)	20-2,000(4)	10-790(4)
Glennallen	19	20-502	210- 3,960(32)	6- 770(30)	0-2,400(35)	40-2,800(5)	160-420(5)
Gulkana	4	293-354	260-10,000(9)	4-1,150(9)	1-6,500(10)	--	--
Kenny Lake	3	49-236	190- 232(2)	5- 26(2)	1- 3(3)	20(1)	110(1)
Tazlina	9	15-190	490- 3,440(11)	47- 700(10)	60-2,100(12)	260-5,800(5)	30-520(5)
Tonsina	5	14- 46	77- 170(3)	2- 24(3)	2- 5(3)	70(1)	60(1)
Range for all determinations		14-502	77-10,000	2-1,150	0-6,500	20-5,800	10-790

CLIMATE

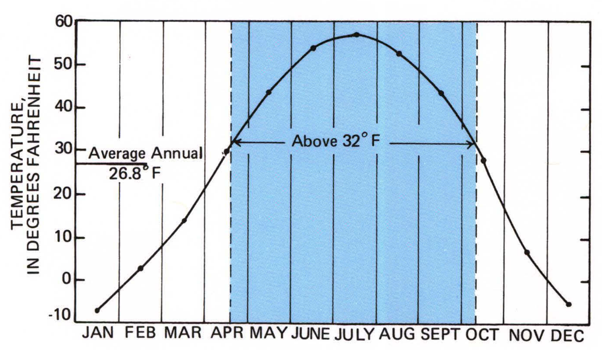


FIGURE 3. -- AVERAGE MONTHLY TEMPERATURE AT GULKANA AIRPORT (1943-81). (From records of the National Weather Service)

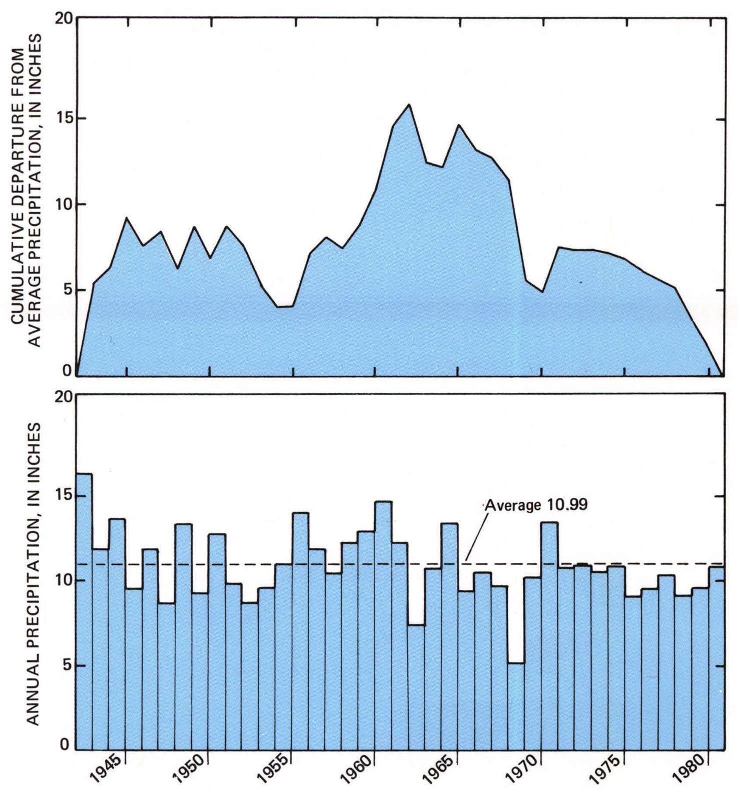


FIGURE 4. -- ANNUAL PRECIPITATION AND CUMULATIVE DEPARTURE FROM AVERAGE AT GULKANA AIRPORT. (From records of the National Weather Service)

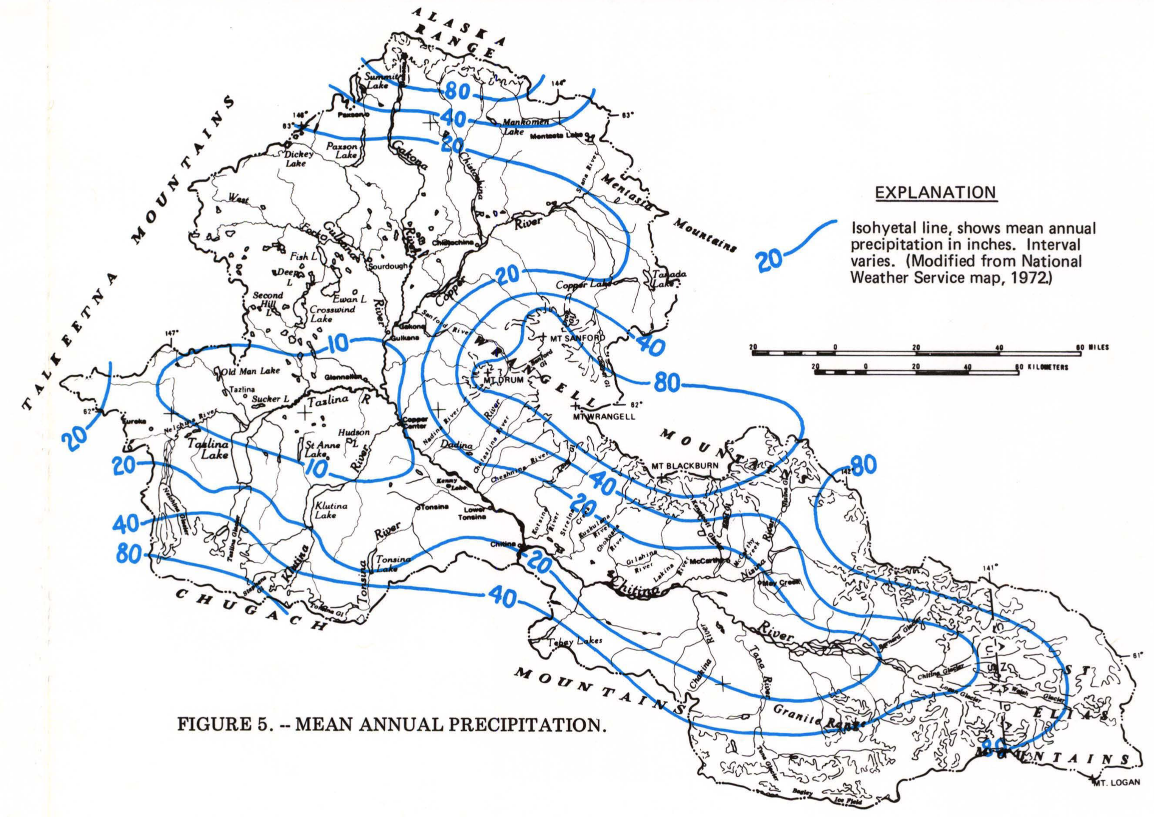


FIGURE 5. -- MEAN ANNUAL PRECIPITATION.

CLIMATE

The Copper River basin (above Chitina) lies mainly within the continental climatic zone of Alaska. Temperature extremes in the basin range from about -65° F to 90° F. The annual average temperature at Gulkana Airport near Glennallen for the period 1943-1981 was a subfreezing 26.8° F. The average monthly temperature is above 32° F for about one-half the year (fig. 3). The rather short growing season for the basin is indicated by weather records showing that the average time interval between freezing (32° F) spring and fall temperatures during the 22-year period 1960-1981 at Gulkana Airport was 71 days. During the same period the time between freezing temperatures ranged from 46 days in 1968 to 104 days in 1967.

Average annual precipitation (fig. 4) at Gulkana Airport (1943-1981) was 10.99 in. and the annual precipitation ranged from 5.26 in. in 1969 to 16.38 in. in 1943. The upward trend of the cumulative-departure curve on figure 4 shows a relatively wet period from 1956 through 1962 and a somewhat dryer period from 1963 until 1970. Precipitation has been average or slightly below average since 1972.

A map of areal distribution of precipitation in the Copper River basin (fig. 5) shows that while the lowlands receive less than 20 in. annually, the mountainous areas receive from 40 to more than 80 in. Nearly all of the precipitation that falls above an altitude of 6,000 ft is snow (L. R. Mayo, U. S. Geological Survey, oral commun., 1983). The basin-wide annual average precipitation is 33 in. or 36 million acre-ft. Assuming no long-term change in ground-water storage, about 75 percent (27 million acre-ft) leaves the basin as runoff (surface-water outflow). The remaining 9 million acre-ft is returned to the atmosphere by evaporation, plant transpiration, and sublimation (fig. 6).

Because the average annual air temperature is below freezing, permafrost, or perennially frozen ground, underlies most of the Copper River basin except along major stream valleys and beneath lakes. The reported thickness of permafrost ranges from a few feet to as much as 250 ft (Nichols, 1956). The permafrost table under the Copper River Lowland area is usually within 5 ft of the surface.

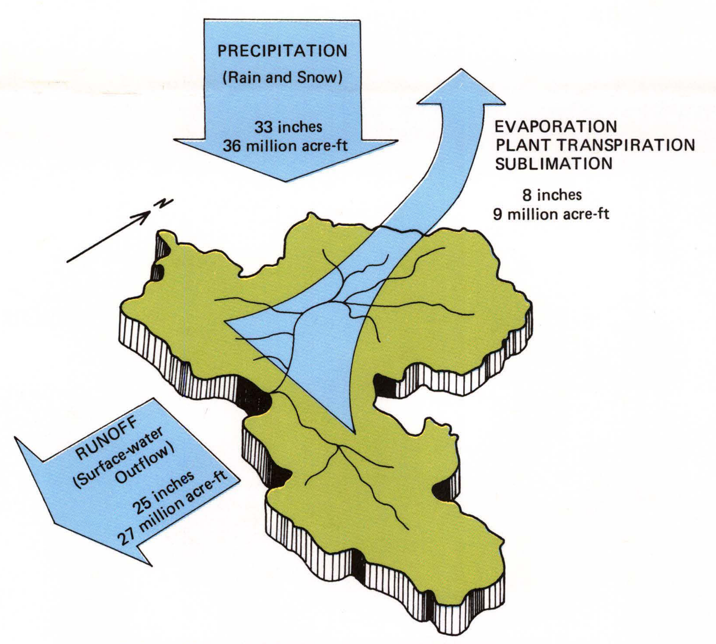
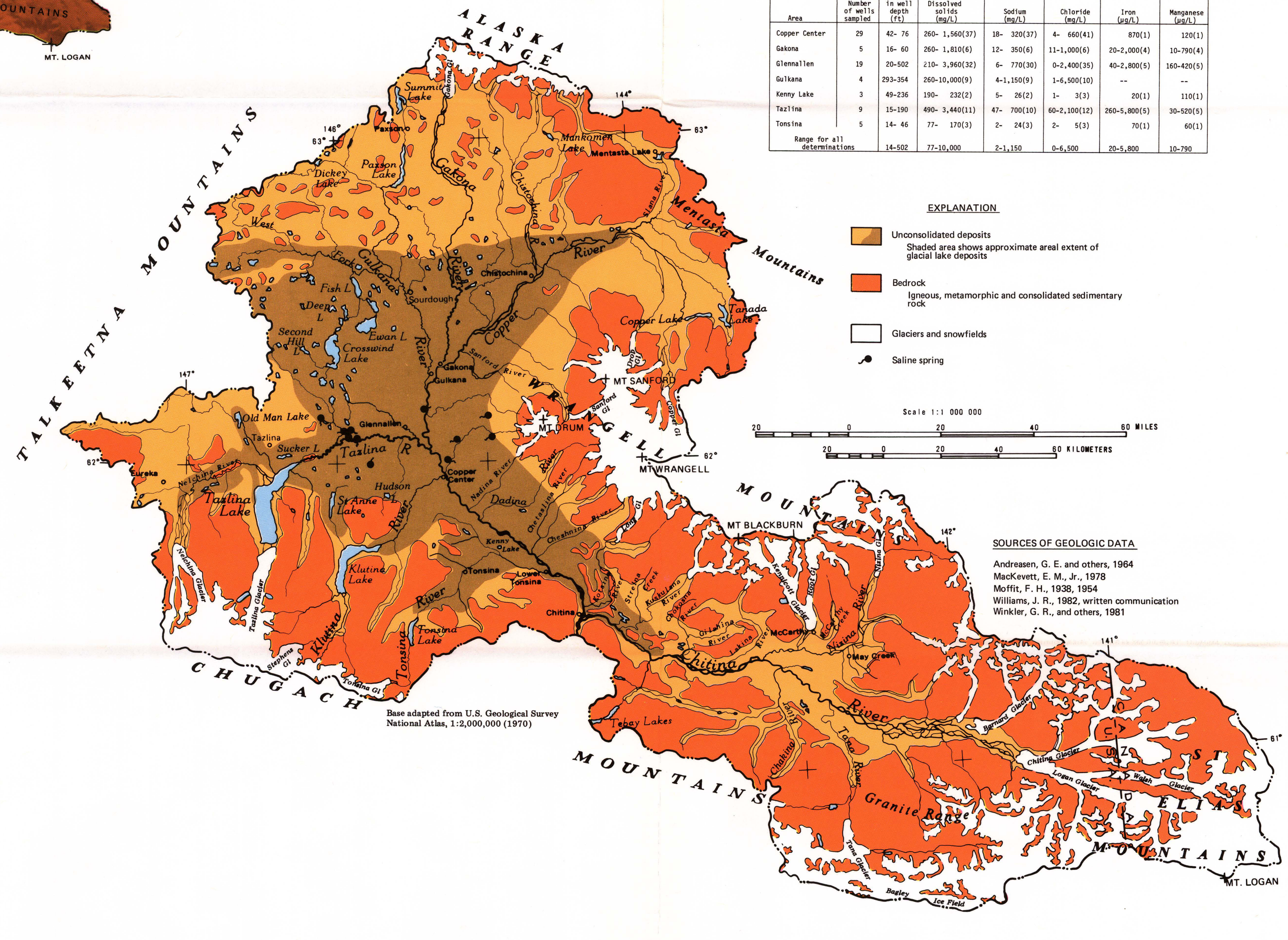


FIGURE 6. -- AVERAGE ANNUAL WATER BUDGET.



SOURCES OF GEOLOGIC DATA

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FIGURE 7. -- GENERALIZED GEOLOGIC MAP.

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WATER RESOURCES OF THE COPPER RIVER BASIN, ALASKA

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1985

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