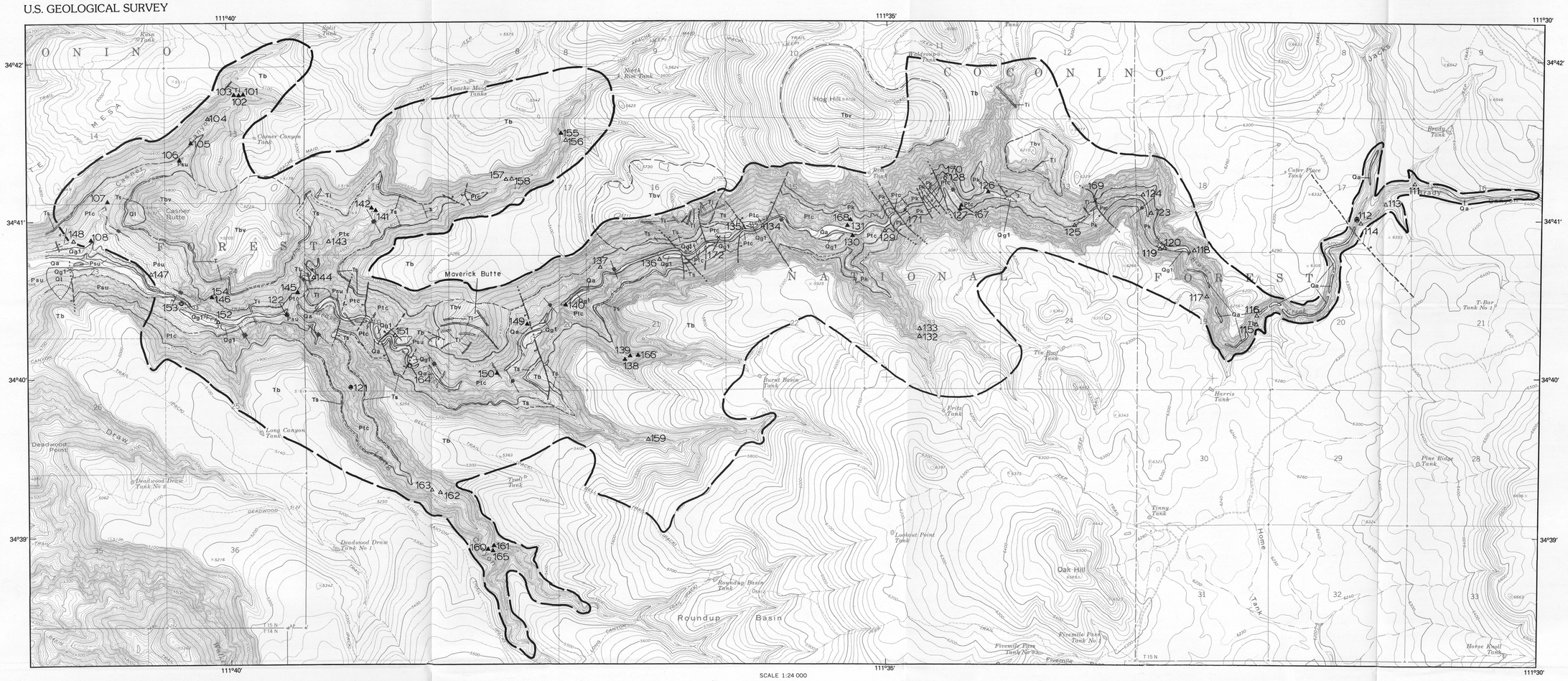
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1558-B



Base from U.S. Geological Survey
Casner Butte, 1965; Apache Maid Mountain, 1965

Geology from Ulrich and others (1983)

EXPLANATION OF GEOCHEMICAL DATA

SAMPLE LOCALITY--Showing sample number and type

- △ 134 Stream sediment
- ▲ 154 Heavy-mineral concentrate and stream sediment
- × 172 Rock
- ○ 164 Water
- ⊗ 153 Water and stream sediment
- ◉ 122 Water, stream sediment, and heavy-mineral concentrate
- APPROXIMATE BOUNDARY OF ROADLESS AREA

(Note: The following correlation, description of map units, and list of symbols are for the geologic base map shown in gray.)

CORRELATION OF MAP UNITS

Qa, Ql	Holocene and Pleistocene	QUATERNARY
Qgl	Pleistocene	
UNCONFORMITY		
Tb, Tbv, Ti	Pliocene(?) and Miocene	TERTIARY
Ts	Miocene or older	
UNCONFORMITY		
Pk, Ptc, Psu	Lower Permian	PERMIAN

DESCRIPTION OF MAP UNITS

- Qa ALLUVIUM (QUATERNARY)--Modern flood-plain deposits and lower terrace gravels; silt, sand, and gravel in main Wet Beaver Creek drainage
- Ql LANDSLIDE DEPOSITS (QUATERNARY)--Slump block or loose rubble; mostly basaltic debris
- Qgl GRAVEL (PLEISTOCENE)--Primarily basaltic pebbles, cobbles, and boulders as large as 2 ft in diameter; generally 10-30 ft above flood plain
- Tb BASALT FLOW(S) AND PYROCLASTIC DEPOSITS (TERTIARY)--Basalt flows, tuff, cinders, and spatter. Tuff commonly occurs at base of thick sequence of flows; as much as 1,000 ft thick
- Tbv BASALT VENT MATERIAL (TERTIARY)--Cinder cone, scoria, tuff, spatter, and small flows
- Ti INTRUSIVE BASALT (TERTIARY)--Dikes and plugs; probable feeders for eroded basaltic vents. Dikes shown on map as open-ended due to indefinite extensions in outcrop
- Ts SEDIMENTARY ROCKS (TERTIARY)--Conglomerate, sandstone, limestone, and gravel; locally contains abundant lower Paleozoic and Precambrian clasts. Maximum thickness is 140 ft
- Pk KAIBAB FORMATION (LOWER PERMIAN)--Very pale orange, grayish-orange, and pale-yellowish-orange cherty dolomite, sandy dolomite, and limestone; 280 ft thick
- Ptc TOROWEAP FORMATION AND COCONINO SANDSTONE, UNDIVIDED (LOWER PERMIAN)--Crossbedded, light-gray to yellow-gray sandstone; 500 ft thick
- Psu SUPAI FORMATION, UPPER (LOWER PERMIAN)--Orange-red siltstone, sandstone, and shale; interbedded light-gray sandstone tongues in upper part. Exposed thickness is 550 ft
- Gray limestone and shale marker bed, probably the Fort Apache Limestone Member of the Supai. Unit is 5-15 ft thick and occurs about 350 ft below top of formation

——— CONTACT--Dashed where approximately located; short-dashed where inferred; dotted where concealed

———•——— FAULT--Short-dashed where inferred; dotted where concealed. Ball and bar on downthrown side

STRIKE AND DIP OF BEDS

———•——— STRIKE OF VERTICAL JOINTS

———— VERTICAL SHEAR ZONE ALONG PROMINENT JOINT--No apparent displacement

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a geochemical survey of the Wet Beaver Roadless Area (03045) in the Coconino National Forest, Coconino and Yavapai Counties, Ariz. The Wet Beaver Roadless Area was classified as a further planning area during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

INTRODUCTION

The geochemical survey of the Wet Beaver Roadless Area was conducted in May 1982 by the U.S. Geological Survey to aid in a mineral resource appraisal of the area. A total of 64 stream-sediment samples, 30 heavy-mineral concentrates from stream sediment, 7 rock samples, and 7 water samples was collected by S. C. Rose, D. E. Hendzel, and W. J. Gerstel, with helicopter support from Jack Ruby, pilot for Helicopters Unlimited.

Geographic setting

The Wet Beaver Roadless Area is near Rimrock, Ariz., about 35 mi south of Flagstaff, Ariz. (fig. 1). The roadless area covers about 9,890 acres (15.4 sq mi) of the Coconino National Forest, between lat 34°37'30" and lat 34°42'30" N., and between long 111°30'00" and long 111°42'00" W. The roadless area consists of one major canyon system, trending primarily east-west, formed by Wet Beaver Creek and its tributaries. Elevations within the roadless area range from 6,470 ft on the east slope of Hog Hill down to about 4,000 ft at the mouth of Wet Beaver Creek canyon, near the western boundary of the roadless area. Wet Beaver Creek drops about 2,380 ft over a distance of 13.7 mi from where it enters the roadless area from the east to the mouth of the canyon, just east of the Beaver Creek Ranger Station. Wet Beaver Creek joins Dry Beaver Creek about 9 mi to the southwest to form Beaver Creek, which then flows into the Verde River near the town of Camp Verde.

Perennial springs exist in several places in the roadless area, most issuing from the base of the Coconino Sandstone. Total discharge is about 1,200-1,500 gallons of water per minute into Wet Beaver Creek (Twenter and Metzger, 1963, p. 94).

The roadless area is accessible along its western boundary by U.S. Forest Service roads that extend about 1.2 mi into the canyon, either from Camp Verde or from the Sedona interchange on Interstate Highway I-17. From the U.S. Forest Service roads, the surrounding mesas are accessible by pack trails that traverse the steep canyon walls. Various points along the canyon rim can be reached by unimproved roads, jeep trails, and pack trails. The canyon floor is accessible only on foot. Deep pools are common on canyon-bottom traverses, and many areas are accessible only by swimming.

Geologic setting

The Wet Beaver Roadless Area is on the northeast edge of the Mogollon Rim, which forms the southwestern margin of the Colorado Plateau. Wet Beaver Creek and its tributaries have cut precipitous canyons through a series of upper Tertiary basaltic rocks unconformably overlying Permian sedimentary rocks. The unconformity truncates increasingly older rocks from east to west and is locally marked by a thin gravel and conglomerate deposit (Ts). Basaltic tuffs commonly underlie the thick sequence of flows, and an intrusive basaltic plug is exposed near the confluence of Long Canyon and Wet Beaver Creek (Ulrich and others, 1983).

The Permian sedimentary rocks exposed in the canyon walls include, in ascending order, the Supai, Coconino, Toroweap, and Kaibab formations. The Supai Formation, exposed only in the west end of Wet Beaver Creek canyon, is red siltstone, sandstone, and limestone. The Coconino Sandstone and Toroweap Formation, exposed above the Supai and in the eastern part of the canyon, are yellowish to buff, cross-bedded, eolian sandstone; these formations are shown here undivided. Overlying these is the Kaibab Formation, a grayish, medium- to fine-grained, fossiliferous limestone. The total stratigraphic thickness of these four formations is about 1,600 ft.

The structural setting is one of variable local dips and a gentle regional dip to the east. Steep normal faults strike mainly northwest or north and have a net displacement of about 1,300 ft, down to the west. Basaltic vent locations are in part controlled by faults and, where deeply eroded, are characterized by numerous dikes (Ulrich and others, 1983).

No mines, prospects, or mineral occurrences are known to exist within the roadless area.

SAMPLE COLLECTION

The stream-sediment sampling density for the geochemical survey of the Wet Beaver Roadless Area averaged 1.5 samples per sq mi. Each stream-sediment sample, collected wherever possible from first-order channels, was a composite of the streambed material sieved through a 2-mm stainless-steel screen. Approximately 1 lb of this material was collected at each sample locality. For heavy-mineral concentrates, collected at about 50 percent of the stream-sediment sample localities, approximately 10 lb of the screened streambed composite was panned down to 3 oz of material.

Water samples were taken from springs and ephemeral first-order streams. Two samples were collected at each site: one 60 ml, the other 250 ml. The 60-ml samples, used for the determination of selected cations, were filtered through 0.45-micrometer filters and stabilized by the addition of a few drops of concentrated nitric acid. The 250-ml samples, used for the determination of pH, alkalinity, conductivity, and selected anions, were neither filtered nor acidified.

Rock samples were collected from various stratigraphic units in the roadless area to obtain geochemical background information. The Coconino Sandstone was sampled somewhat more extensively because it is known to contain slightly anomalous amounts of silver (2-7 parts per million) in an area about 15 mi south of the Wet Beaver Roadless Area (Ulrich, 1983).

ANALYTICAL TECHNIQUES

Prior to analysis, stream-sediment samples were sieved to minus-250-micrometer (minus-60 mesh) size and the sieved material pulverized to minus-62-micrometer (minus-200 mesh) size. Heavy minerals were separated from the panned samples in bromoform (specific gravity 2.86). The heavy minerals were then passed under a hand magnet to remove the magnetite and further separated into a magnetic and nonmagnetic fraction on a Frantz Isodynamic Separator[1] set at 0.6 amperes. The nonmagnetic fraction was ground by hand with an agate mortar and pestle. Rock samples were crushed and pulverized to minus-62 micrometers.

All stream-sediment, nonmagnetic heavy-mineral-concentrate, and rock samples were analyzed for 31 elements by a six-step, semiquantitative emission-spectrographic method. The rock and stream-sediment samples were further analyzed for zinc, cadmium, bismuth, antimony, and arsenic by atomic-absorption-spectrophotometry techniques, and for uranium by fluorimetric procedures. Water samples were analyzed for sulfate, chlorine, fluorine, and nitrate by ion chromatography; for calcium, magnesium, sodium, potassium, lithium, silica, and zinc by flame atomic-absorption spectrophotometry; for copper, molybdenum, arsenic, iron, manganese, and aluminum by flameless atomic-absorption spectrometry; for uranium by laser-excited fluorescence; for specific conductance by conductivity bridge; and for alkalinity by Gran's plot potentiometric titration.

A complete listing of all analytical methods and results for the Wet Beaver Roadless Area, along with statistical analyses using U.S. Geological Survey STATPAC programs (VanTrump and Miesch, 1977), is available as an open-file report (Gerstel and others, 1983).

RESULTS

The results of the investigation of the Wet Beaver Roadless Area indicate the presence of geochemical anomalies of barium, chromium, lead, and strontium. Determination of anomalous values was based on subjective interpretation. The lower grouping of values in a bimodal distribution, roughly centered about a mean value, was interpreted as the normal background concentration. The grouping of higher values in this type of distribution was taken to be anomalous. Analytical data for the samples of unmineralized rock representing the various stratigraphic units of the area were used in the interpretation.

Percentile rankings based on the results of geochemical analyses of the 64 stream-sediment and 30 heavy-mineral-concentrate samples appear in tables 1 and 2, respectively. All qualified values in the raw data, those falling either above or below the limits of detection for the methods of analysis, were replaced with unqualified values using the USGS Edstat computer program (VanTrump and Miesch, 1977) and defined according to step intervals on the spectrographic scale.

Results of analysis of stream-sediment samples from the Wet Beaver Roadless Area did not indicate any significant geochemical anomalies. A few scattered stream-sediment samples showed values for iron, calcium, chromium, lanthanum, lead, and zirconium that are higher than the generally accepted background values for rock types in the region, but suites of associated elements do not indicate any type of mineralized deposit. Chromium in concentrations of 1,000 parts per million or greater (mean value 604 ppm) was found in 6.4 percent of the stream-sediment samples. The chromium probably comes from minerals sparsely disseminated in the basalts, and therefore the anomalous amounts do not indicate deposits of chromium ore. This interpretation is further supported by the fact that most of the greater chromium values are shown by samples from streams draining large areas of Tertiary basalts.

A few heavy-mineral-concentrate samples were found to contain anomalous concentrations of magnesium, calcium, manganese, barium, lanthanum, nickel, lead, and strontium, but these values seem, for the most part, to reflect average background values for the lithologic units drained by the stream channels sampled. Lead in anomalous concentrations was detected in three of the concentrate samples, but the lack of anomalous concentrations of any other elements usually found in association with high lead values, such as copper and zinc, suggests that the stream sediment may have been contaminated.

Analysis of rock samples from the Coconino Sandstone failed to detect any trace of the silver anomaly found in the area south of Wet Beaver Creek Canyon. Analysis of rock samples from other lithologic units in the roadless area and vicinity also failed to detect any areas of mineralized rock. Only two of the rock samples revealed any concentrations of elements above background. Sample WB 171R (loc. 171 on map), Coconino Sandstone, showed higher than normal concentrations of iron, arsenic, cobalt, copper, lead, vanadium, and zinc; and sample WB 169R3 (loc. 169 on map), volcanic tuff from a fault area in the north wall of Wet Beaver Canyon, showed high values for iron, manganese, barium, cobalt, chromium, copper, lanthanum, nickel, vanadium, and yttrium. However, neither of these samples is sufficient evidence to indicate the presence of any sort of mineral deposit in either geologic setting.

Results of analysis of the water samples revealed only values expected for the desert environment and rock types in the roadless area. The inadequate availability of spring water or flowing first-order streams in the Wet Beaver Canyon makes water an inconclusive sample medium in this survey.

[1]Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

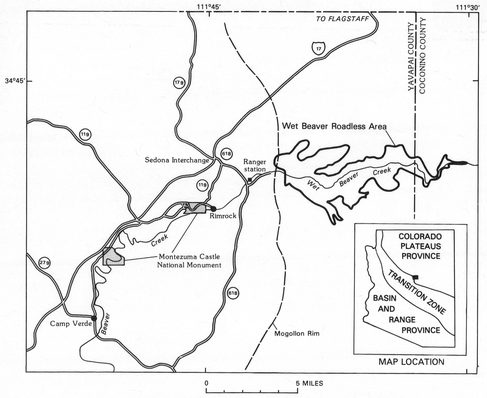


Figure 1.--Index map of the Wet Beaver Roadless Area (03045) showing locations of access roads, major streams, and area boundaries. Map inset at lower right shows location of Wet Beaver Roadless Area in relation to major physiographic zones of Arizona.

Table 1.--Statistical percentile ranking of elements in stream-sediment samples from the Wet Beaver Roadless Area

[Values in parts per million unless otherwise noted. Symbols used: <, less than the value shown; >, greater than the value shown. Elements not detected have been eliminated from this table. Appropriate unqualified values at step intervals of the spectrographic determination scale were substituted for qualified values]

Element	Percentiles			
	75th	90th	95th	99th
Fe (pct.)	8.5	10	10	12.9
Mg (pct.)	6	10	10	10
Ca (pct.)	5	10	10	20
Ti (pct.)	1	1	1	1
Mn	2,000	3,000	5,000	>5,000
B	70	85	100	100
Ba	1,000	1,000	1,250	1,500
Co	50	50	70	100
Cr	700	1,000	1,250	2,500
Cu	100	150	150	175
La	70	70	70	100
Ni	200	200	200	500
Pb	70	100	100	100
Sc	20	20	30	30
Sr	500	700	700	700
V	200	250	300	300
Y	30	30	30	50
Zr	400	500	500	1,000
As	5	5	5	12.5
Zn	142	167	180	197.5
Cd	.5	.6	.6	.7
Sb	<1	<1	1	1.5
U	.9	1	1.2	2.05

Table 2.--Statistical percentile ranking of elements in heavy-mineral-concentrate samples from the Wet Beaver Roadless Area

[Values in parts per million unless otherwise noted. Symbols used: <, less than the value shown; >, greater than the value shown. Elements not detected have been eliminated from this table. Appropriate unqualified values at step intervals of the spectrographic determination scale were substituted for qualified values]

Element	Percentiles			
	75th	90th	95th	99th
Fe (pct.)	1	1.25	1.75	2
Mg (pct.)	1	2	2	3.5
Ca (pct.)	5	10	10	10
Ti (pct.)	1.5	2	>2	>2
Mn	300	1,000	1,000	1,000
B	70	125	175	200
Ba	1,500	1,750	3,500	7,500
Co	10	12.5	15	17.5
Cr	300	600	700	850
Cu	10	20	25	65
La	50	100	125	175
Ni	70	125	150	150
Pb	<40	<20	30	90
Sc	10	50	50	60
Sr	500	700	850	1,500
V	150	175	200	250
Y	200	500	600	850
Zr	>2,000	>2,000	>3,500	>5,000

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GEOCHEMICAL MAP OF THE WET BEAVER ROADLESS AREA, COCONINO AND YAVAPAI COUNTIES, ARIZONA

By

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1985

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