UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Analytical results and sample locality map of stream-sediment, heavy-mineral-concentrate, and rock samples from the Bull Gulch Wilderness Study Area (CO-070-430), Eagle County, Colorado

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STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine their mineral values, if any. 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 Bull Gulch Wilderness Study Area, Eagle County, Colorado.

INTRODUCTION

In 1984, the U.S. Geological Survey conducted a reconnaissance geochemical survey of the Bull Gulch WSA, Eagle County, Colorado.

The Bull Gulch WSA comprises about 15 mi^2 (9,778 acres) in the northwestern corner of Eagle County, Colorado, and lies on the east side of the Colorado River (see plate 1). Access to the study area is provided on the west by County Road #301.

The Bull Gulch study area is an irregularly shaped area that has a maximum length N-S of about 9 miles, and a maximum width E-W of about 4 mi. The highest elevation is just over 10,000 ft near the middle of the eastern boundary, and the lowest is about 6,300 ft on the Colorado River near the center of the western boundary. High mesas near the central eastern border slope westward toward the Colorado River and become progressively more dissected by short tributary creeks in that direction. The western part of the area close to the river is heavily timbered with pine, juniper, and desert cedar, but many of the higher mesas in the eastern part of the area are nearly treeless and covered with low shrubs, chiefly sage brush, or with grass.

The following geologic description is based on information from Tweto, et al (1978):

Excluding rocks in the terrace gravels along the Colorado River, the oldest rock exposed in the area is the Eagle Valley Evaporite of Pennsylvanian age. This formation, which crops out along the southwestern border of the area, consists of gypsum, anhydrite and interbedded siltstone, and intertongues eastward with the Minturn Formation, about 3,000 feet of dominantly gray and pale yellow sandstone, gritty sandstone and conglomerate, and shale containing scattered beds and reefs of carbonate rocks. The Minturn Formation is exposed in a belt about 1-mile wide along the western border of the wilderness study area extending northward to about Jack Flat.

These formations are overlain eastward by Permian-Pennsylvanian rocks that crop out in a belt 1- to 2-miles wide extending northward through the central part of the study area to about the latitude of Bull Gulch. Two to three thousand feet of maroon and grayish-red sandstone, conglomerate and mudstone comprise the Maroon Formation, which is capped by the 100-ft thick Weber Formation that, in the study area, consists of yellow-gray sandstone. Yet another belt, of largely Triassic rocks, is exposed along the river in the northern prong of the wilderness study area and in a south-trending irregular belt in the eastern part of the area. This belt consists of a 500-ft section of the State Bridge Formation, orange-red to red-brown siltstone and sandstone, and the Chinle Formation, brownish-red and purplish-red calcareous siltstone, mudstone and sandstone.

Above the Chinle Formation along the eastern border of the area from the vicinity of Big Red Hill northward, are the Morrison and Entrada Formations of Upper Jurassic age. The Morrison is variegated shale and mudstone and light gray sandstone with local beds of gray and greenish-gray limestone, and is about 500-ft thick. The Entrada consists of a 100-ft thick light gray to orange, crossbedded sandstone.

Just east of Jack Flat in the northwestern part of the area is an explosive breccia pipe of Miocene or Pliocene age about half a mile in diameter. Dark basalt flows of similar age cover the southeastern corner of the study area, cut off from the main part of the area by a large northwesterly trending fault.

METHODS OF STUDY

Sample Media

Analyses of the stream-sediment samples represent the chemistry of the rock material eroded from the drainage basin upstream from each sample site. Such information is useful in identifying those basins which contain concentrations of elements that may be related to mineral deposits. Heavy-mineral-concentrate samples provide information about the chemistry of certain minerals in rock material eroded from the drainage basin upstream from each sample site. The selective concentration of minerals, many of which may be ore-related, permits determination of some elements that are not easily detected in stream-sediment samples.

Analyses of altered or mineralized rocks, where present, may provide useful geochemical information about the major- and trace-element assemblages associated with a mineralizing system.

Sample Collection

Samples were collected at 26 sites (plate 1). At nearly all of those sites, both a stream-sediment sample and a heavy-mineral-concentrate sample were collected. Sampling density was about 1 sample site per square mile. The area of the drainage basins sampled ranged from 1/2 mi^2 to 3 mi^2.

Stream-sediment samples

The stream-sediment samples consisted of active alluvium collected primarily from first-order (unbranched) and second-order (below the junction of two first-order) streams as shown on plate 1.

Heavy-mineral-concentrate samples

Heavy-mineral-concentrate samples were collected from the same active alluvium as the stream-sediment samples. Each bulk sample (about 10 pounds) was panned until most of the quartz, feldspar, organic material, and clay-sized material were removed.

Rock samples

Rock samples were collected from outcrops or exposures in the vicinity of the plotted site location. Samples were collected from altered and/or mineralized rocks.

Sample Preparation

The stream-sediment samples were air dried, then sieved using 100 mesh (0.15 mm) stainless steel sieves. The portion of the sediment passing through the sieve was saved for analysis.

After air drying, bromoform (specific gravity 2.8) was used to remove the remaining quartz and feldspar from the heavy-mineral-concentrate samples that had been panned in the field. The resultant heavy-mineral sample was separated into three fractions using a large electromagnet (in this case a modified Frantz Isodynamic Separator). The most magnetic material, primarily magnetite, was not analyzed. The second fraction, largely ferromagnesian silicates and iron oxides, was saved for archival storage. The third fraction (the least magnetic material which may include the nonmagnetic ore minerals, zircon, sphene, etc.) was split using a Jones splitter. One split was hand-ground for spectrographic analysis; the other split was saved for mineralogical analysis. These magnetic separates are the same separates that would be produced by using a Frantz Isodynamic Separator set at a slope of 15° and a tilt of 10° with a current of 0.1 ampere to remove the magnetite and ilmenite, and a current of 1.0 ampere to split the remainder of the sample into paramagnetic and nonmagnetic fractions.

Rock samples were crushed and then pulverized to minus 0.15 mm with ceramic plates.

Sample Analysis

Spectrographic Method

The stream-sediment, heavy-mineral-concentrate, and rock samples were analyzed for 31 elements using a semiquantitative, direct-current arc emission spectrographic method (Grimes and Marranzino, 1968). The elements analyzed and their lower limits of determination are listed in table 1. Spectrographic results were obtained by visual comparison of spectra derived from the sample against spectra obtained from standards made from pure oxides and carbonates. Standard concentrations are geometrically spaced over any given order of magnitude of concentration as follows: 100, 50, 20, 10, and so forth. Samples whose concentrations are estimated to fall between those values are assigned values of 70, 30, 15, and so forth. The precision of the analytical method is approximately plus or minus one reporting interval at the 83 percent confidence level and plus or minus two reporting intervals at the 96 percent confidence level (Motooka and Grimes, 1976). Values determined for the major elements (iron, magnesium, calcium, and titanium) are given in weight percent; all others are given in parts per million (micrograms/gram). Analytical data for samples from the Bull Gulch WSA are listed in tables 3-5.

Chemical Methods

Other methods of analysis used on samples from the Bull Gulch WSA are summarized in table 2.

Analytical results for stream-sediment, heavy-mineral-concentrate, and rock samples are listed in tables 3, 4, and 5, respectively.

ROCK ANALYSIS STORAGE SYSTEM

Upon completion of all analytical work, the analytical results were entered into a computer-based file called Rock Analysis Storage System (RASS). This data base contains both descriptive geological information and analytical data. Any or all of this information may be retrieved and converted to a binary form (STATPAC) for computerized statistical analysis or publication (VanTrump and Miesch, 1976).

DESCRIPTION OF DATA TABLES

Tables 3-5 list the analyses for the samples of stream sediment, heavy-mineral concentrate, and rock, respectively. For the three tables, the data are arranged so that column 1 contains the USGS-assigned sample numbers. These numbers correspond to the numbers shown on the site location maps (plate 1). Columns in which the element headings show the letter "s" below the element symbol are emission spectrographic analyses; "aa" indicates atomic absorption analyses. A letter "N" in the tables indicates that a given element was looked for but not detected at the lower limit of determination shown for that element in table 1. If an element was observed but was below the lowest reporting value, a "less than" symbol (<) was entered in the tables in front of the lower limit of determination. If an element was observed but was above the highest reporting value, a "greater than" symbol (>) was entered in the tables in front of the upper limit of determination. If an element was not looked for in a sample, two dashes (--) are entered in tables 3-5 in place of an analytical value. Because of the formatting used in the computer program that produced tables 3-5, some of the elements listed in these tables (for example, Fe, Mg, Ca, Ti, and Ag) may carry one or more nonsignificant digits to the right of the significant digits. The analysts did not determine these elements to the accuracy suggested by the extra zeros.

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REFERENCES CITED

Grimes, D. J., and Marranzino, A. P., 1968, Direct-current arc and alternating-current spark emission spectrographic field methods for the semiquantitative analysis of geologic materials: U.S. Geological Survey Circular 591, 6 p.

Millard, H. T., Jr., and Keaton, B. A., 1982, Precision of uranium and thorium determinations by delayed neutron counting: Journal of Radioanalytical Chemistry, v. 72, p. 489-500.

Motooka, J. M., and Grimes, D. J., 1976, Analytical precision of one-sixth order semiquantitative spectrographic analyses: U.S. Geological Survey Circular 738, 25 p.

Tweto, Ogden, Moench, R. H., and Reed, J. C., Jr., Geologic map of the Leadville 1° X 2° quadrangle, northeastern Colorado: U.S. Geological Survey Miscellaneous Investigative Map I-999.

VanTrump, George, Jr., and Miesch, A. T., 1976, The U.S. Geological Survey RASS-STATPAC system for management and statistical reduction of geochemical data: Computers and Geosciences, v. 3, p. 475-488.

Viets, J. G., 1978, Determination of silver, bismuth, cadmium, copper, lead, and zinc in geologic materials by atomic absorption spectrometry with tricaprylylmethylammonium chloride: Analytical Chemistry, v. 50, p. 1097-1101.

Ward, F. N., Nakagawa, H. M., Harms, T. F., and Van Sickle, G. H., 1969, Atomic-absorption methods useful in geochemical exploration: U.S. Geological Survey Bulletin 1289, 45 p.

TABLE 1.--Limits of determination for the spectrographic analysis of rocks and stream sediments, based on a 10-mg sample

[The spectrographic limits of determination for heavy-mineral-concentrate samples are based on a 5-mg sample, and are therefore two reporting intervals higher than the limits given for rocks and stream sediments]

Elements	Lower determination limit	Upper determination limit
	Percent	
Iron (Fe)	0.05	20
Magnesium (Mg)	.02	10
Calcium (Ca)	.05	20
Titanium (Ti)	.002	1
	Parts per million	
Manganese (Mn)	10	5,000
Silver (Ag)	0.5	5,000
Arsenic (As)	200	10,000
Gold (Au)	10	500
Boron (B)	10	2,000
Barium (Ba)	20	5,000
Beryllium (Be)	1	1,000
Bismuth (Bi)	10	1,000
Cadmium (Cd)	20	500
Cobalt (Co)	5	2,000
Chromium (Cr)	10	5,000
Copper (Cu)	5	20,000
Lanthanum (La)	20	1,000
Molybdenum (Mo)	5	2,000
Niobium (Nb)	20	2,000
Nickel (Ni)	5	5,000
Lead (Pb)	10	20,000
Antimony (Sb)	100	10,000
Scandium (Sc)	5	100
Tin (Sn)	10	1,000
Strontium (Sr)	100	5,000
Vanadium (V)	10	10,000
Tungsten (W)	50	10,000
Yttrium (Y)	10	2,000
Zinc (Zn)	200	10,000
Zirconium (Zr)	10	1,000
Thorium (Th)	100	2,000

Table 2.--Commonly used chemical methods

[AA = atomic absorption; AC = neutron activation]

Element or constituent determined	Method	Determination limit (micrograms/ gram or ppm)	Reference
Gold (Au)	AA	0.05	Thompson and others, 1968
Arsenic (As)	AA	5 or 10	Modification of Viets, 1978
Antimony (Sb)	AA	2	
Zinc (Zn)	AA	5	
Bismuth (Bi)	AA	1	
Cadmium (Cd)	AA	0.1	
Uranium (U)	AC	0.2	Millard and Keaton, 1982
Thorium (Th)	AC	1.0	

TABLE 3.--Analyses of stream-sediment samples from the Bull Gulch Wilderness Study Area, Eagle County, Colorado.
[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown.]

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
BG01SD	39 42 55	106 55 43	5.0	1.5	3.0	1.00	700	N	N	N	15	700
BG02SD	39 43 54	106 56 48	1.5	.7	1.5	.15	300	N	N	N	30	300
BG03SD	39 43 55	106 56 51	1.0	.7	2.0	.15	300	N	N	N	30	300
BG04SD	39 44 15	106 57 44	3.0	1.5	2.0	.50	700	N	N	N	15	700
BG05SD	39 44 37	106 57 56	2.0	1.0	2.0	.30	300	N	N	N	15	300
BG06SD	39 47 2	106 59 10	1.5	1.0	3.0	.15	300	N	N	N	15	300
BG07SD	39 47 1	106 58 35	1.5	1.5	3.0	.20	300	N	N	N	30	300
BG08SD	39 47 14	106 58 25	1.5	2.0	3.0	.20	300	N	N	N	15	300
BG09SD	39 47 42	106 58 15	1.5	1.5	3.0	.20	300	N	N	N	30	300
BG10SD	39 46 10	106 58 12	1.5	1.0	3.0	.20	300	N	N	N	15	300
BG11SD	39 48 37	106 57 19	1.5	1.0	3.0	.15	300	N	N	N	20	300
BG12SD	39 47 58	106 57 27	1.5	1.0	2.0	.30	300	N	N	N	30	500
BG13SD	39 47 54	106 57 34	1.5	1.5	3.0	.20	300	N	N	N	30	300
BG14SD	39 51 11	106 55 34	.7	.7	1.5	.15	200	N	N	N	50	300
BG15SD	39 50 34	106 56 12	.7	.7	2.0	.15	200	N	N	N	50	200
BG16SD	39 50 18	106 56 32	.7	.7	3.0	.15	300	N	N	N	30	300
BG17SD	39 50 10	106 56 33	1.0	1.5	3.0	.20	300	N	N	N	50	300
BG18SD	39 49 47	106 57 8	1.0	1.5	3.0	.20	300	N	N	N	30	300
BG19SD	39 49 9	106 55 22	.7	1.0	3.0	.15	300	N	N	N	50	300
BG20SD	39 49 9	106 55 19	1.0	1.0	2.0	.20	300	N	N	N	15	300
BG21SD	39 46 47	106 58 24	1.5	1.5	3.0	.20	300	N	N	N	20	300
BG22SD	39 46 44	106 58 26	1.5	1.0	3.0	.20	300	N	N	N	20	500
BG25SD	39 48 27	106 56 46	2.0	1.5	3.0	.20	300	N	N	N	20	300
BG26SD	39 48 38	106 57 3	1.5	1.5	3.0	.20	300	N	N	N	20	300
BG27SD	39 48 29	106 57 5	1.5	1.0	3.0	.15	300	N	N	N	30	500
BG31SD	39 47 39	106 58 15	2.0	2.0	3.0	.20	300	N	N	N	20	500

TABLE 3.--Analyses of stream-sediment samples from the Bull Gulch Wilderness Study Area, Eagle County, Colorado.--Continued

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s
BG01SD	1.5	N	N	20	150	30	70	N	20	70	15	N
BG02SD	N	N	N	7	30	10	N	N	N	10	15	N
BG03SD	1.5	N	N	7	30	15	30	N	N	15	15	N
BG04SD	1.0	N	N	15	70	15	30	N	N	30	15	N
BG05SD	1.0	N	N	7	30	15	30	N	N	20	15	N
BG06SD	1.0	N	N	7	30	15	30	N	N	15	15	N
BG07SD	1.0	N	N	7	30	15	30	N	N	15	15	N
BG08SD	1.0	N	N	7	70	15	50	N	N	20	15	N
BG09SD	1.0	N	N	7	70	15	50	N	N	20	15	N
BG10SD	1.0	N	N	7	30	15	30	N	N	15	15	N
BG11SD	1.0	N	N	7	50	15	30	N	N	10	15	N
BG12SD	1.0	N	N	7	70	15	30	N	N	15	15	N
BG13SD	1.0	N	N	7	50	15	30	N	N	15	15	N
BG14SD	1.0	N	N	N	20	7	N	N	N	7	15	N
BG15SD	1.0	N	N	N	30	7	N	N	N	10	15	N
BG16SD	1.0	N	N	5	20	7	30	N	N	7	15	N
BG17SD	1.0	N	N	7	30	15	30	N	N	15	15	N
BG18SD	1.0	N	N	7	70	10	30	N	N	15	15	N
BG19SD	1.0	N	N	5	50	10	30	N	N	7	15	N
BG20SD	1.0	N	N	5	30	15	30	N	N	15	15	N
BG21SD	N	N	N	7	50	20	30	N	N	20	15	N
BG22SD	N	N	N	5	50	15	30	N	N	15	10	N
BG25SD	N	N	N	5	50	20	30	N	N	15	10	N
BG26SD	N	N	N	5	30	15	N	N	N	15	10	N
BG27SD	N	N	N	5	30	15	70	N	N	10	15	N
BG31SD	1.0	N	N	7	50	30	30	N	N	20	15	N

TABLE 3.--Analyses of stream-sediment samples from the Pull Gulch Wilderness Study Area, Eagle County, Colorado.--Continued

Sample	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	Th-ppm ac	U-ppm ac
BG01SD	15	N	500	200	N	20	N	150	N	11.00	2.67
BG02SD	7	N	100	30	N	15	N	300	N	8.03	4.05
BG03SD	7	N	150	30	N	15	N	150	N	8.02	3.14
BG04SD	7	N	300	100	N	15	N	200	N	11.00	3.42
BG05SD	7	15	300	70	N	15	N	150	N	9.38	2.69
BG06SD	7	N	200	70	N	15	N	150	N	6.20	4.05
BG07SD	7	N	300	70	N	15	N	150	N	11.50	3.75
BG08SD	7	N	300	70	N	15	N	70	N	10.60	5.33
BG09SD	7	N	300	70	N	15	N	150	N	9.16	5.69
BG10SD	7	N	150	50	N	15	N	150	N	9.62	3.66
BG11SD	7	N	200	30	N	15	N	150	N	7.71	3.12
BG12SD	7	N	300	70	N	30	N	300	N	13.50	4.01
BG13SD	7	N	300	50	N	15	N	150	N	8.61	3.45
BG14SD	<5	N	100	20	N	15	N	300	N	7.05	2.13
BG15SD	5	N	150	20	N	20	N	300	N	7.23	2.25
BG16SD	5	N	150	30	N	15	N	150	N	7.07	2.38
BG17SD	7	N	300	50	N	15	N	100	N	7.08	2.68
BG18SD	7	15	300	70	N	15	N	150	N	9.79	2.74
BG19SD	7	N	150	30	N	15	N	150	N	7.91	2.08
BG20SD	7	N	500	70	N	15	N	150	N	12.20	3.49
BG21SD	7	N	300	50	N	10	N	150	N	7.52	3.90
BG22SD	7	N	300	50	N	15	N	200	N	8.84	4.25
BG25SD	7	N	300	70	N	15	N	300	N	12.60	4.68
BG26SD	7	N	150	30	N	10	N	150	N	7.84	3.31
BG27SD	5	N	200	50	N	15	N	500	N	12.50	4.36
BG31SD	7	N	300	70	N	15	N	150	N	9.91	5.26

TABLE 4.--Analyses of heavy-mineral-concentrate samples from the Pull Gulch Wilderness Study Area, Eagle County, Colorado.

[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown.]

Sample	Latitude	Longitude	Fe-pct. S	Mg-pct. S	Ca-pct. S	Ti-pct. S	Mn-ppm S	Ag-ppm S	As-ppm S	Au-ppm S	B-ppm S	Ba-ppm S
BG01	39 42 55	106 55 43	.5	.20	15	2.0	1,500	N	N	N	100	10,000
BG02	39 43 54	106 56 48	.3	.15	15	>2.0	700	N	N	N	70	>10,000
BG03	39 43 55	106 56 51	.5	.15	20	>2.0	1,000	N	N	N	70	>10,000
BG04	39 44 15	106 57 44	.3	.30	10	1.5	500	N	N	N	70	>10,000
BG05	39 44 37	106 57 56	.3	.15	7	>2.0	500	N	N	N	50	>10,000
BG06	39 47 2	106 59 10	.3	.50	15	1.5	1,000	N	N	N	70	>10,000
BG07	39 47 1	106 58 35	.2	.15	20	2.0	1,500	N	N	N	70	>10,000
BG08	39 47 14	106 58 25	.3	.30	20	.7	1,000	N	N	N	50	>10,000
BG09	39 47 42	106 58 15	.7	.70	50	1.0	2,000	N	N	N	70	>10,000
BG10	39 43 10	106 58 12	.5	.20	15	2.0	1,000	N	N	N	50	>10,000
BG11	39 48 37	106 57 19	1.5	.50	50	>2.0	1,000	15	N	N	100	>10,000
BG12	39 47 58	106 57 27	.2	.15	10	2.0	500	N	N	N	50	>10,000
BG13	39 47 54	106 57 34	.3	.20	20	2.0	1,500	N	N	N	50	>10,000
BG14	39 51 11	106 55 34	.3	.20	3	2.0	200	N	N	N	150	>10,000
BG15	39 50 34	106 56 12	.2	.20	2	>2.0	100	N	N	N	100	>10,000
BG16	39 50 18	106 56 32	.3	.20	5	>2.0	300	N	N	N	50	>10,000
BG17	39 50 10	106 56 33	.3	.50	5	1.0	300	N	N	N	30	>10,000
BG18	39 49 47	106 57 8	<.1	.07	2	.5	200	N	N	N	20	>10,000
BG19	39 49 9	106 55 22	.2	.30	7	2.0	300	N	N	N	150	>10,000
BG20	39 49 9	106 55 19	.7	.20	10	2.0	700	N	N	N	70	>10,000
BG21	39 46 47	106 58 24	.5	.10	20	1.0	1,000	N	N	N	30	>10,000
BG22	39 46 44	106 58 26	1.5	.10	30	>2.0	1,000	N	N	N	50	>10,000
BG23	39 47 11	106 58 17	1.0	.30	20	.7	1,000	N	N	N	30	>10,000
BG24	39 47 11	106 58 17	2.0	1.00	15	1.0	700	N	N	N	50	>10,000
BG25	39 48 27	106 56 46	1.0	.20	1	1.0	700	N	N	N	30	>10,000
BG26	39 48 38	106 57 3	.7	.50	7	1.5	500	N	N	N	30	>10,000
BG27	39 48 29	106 57 2	3.0	.70	15	1.0	1,000	200	N	N	50	>10,000
BG31	39 47 39	106 58 15	5.0	.07	5	1.5	100	15	N	N	20	>10,000

TABLE 4.--Analyses of heavy-mineral-concentrate samples from the Bull Gulch Wilderness Study Area, Eagle County, Colorado.--Continued

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s
BG01	2	N	N	N	30	N	300	N	N	10	100
BG02	2	N	N	N	30	N	200	N	<50	N	30
BG03	3	N	N	N	100	N	200	N	N	N	30
BG04	2	N	N	N	100	N	100	N	<50	N	50
BG05	2	N	N	N	50	N	200	N	<50	N	100
BG06	3	N	N	N	30	100	200	10	N	N	20,000
BG07	2	N	N	N	30	N	200	30	N	N	1,000
BG08	2	N	N	N	150	N	200	500	N	N	3,000
BG09	3	N	N	N	100	10	500	200	N	10	2,000
BG10	3	N	N	N	50	<10	200	N	<50	N	500
BG11	2	N	N	30	100	20	150	N	50	15	15,000
BG12	2	N	N	N	50	N	100	N	<50	10	50
BG13	5	N	N	N	70	N	300	N	<50	N	70
BG14	2	N	N	N	30	<10	300	N	<50	10	20
BG15	<2	N	N	N	50	N	100	N	<50	N	20
BG16	<2	N	N	N	50	N	500	N	<50	10	50
BG17	2	N	N	N	20	N	50	N	<50	N	N
BG18	<2	N	N	N	20	N	50	N	N	10	20
BG19	<2	N	N	N	50	N	100	30	<50	N	N
BG20	2	N	N	N	50	N	150	N	<50	N	150
BG21	3	N	N	N	30	N	200	N	<50	N	100
BG22	2	N	N	N	50	N	200	N	<50	N	70
BG23	3	N	N	N	30	N	200	70	N	N	300
BG24	2	N	N	N	150	N	100	100	N	10	300
BG25	2	N	N	N	30	N	70	N	N	N	100
BG26	<2	N	N	N	20	N	70	N	N	N	150
BG27	2	N	N	N	100	N	500	50	N	N	200
BG31	2	N	50	50	20	N	100	100	N	10	10,000

TABLE 4.--Analyses of heavy-mineral-concentrate samples from the Bull Gulch Wilderness Study Area, Eagle County, Colorado.--Continued

Sample	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
BG01	N	--	N	700	150	N	1,000	N	>2,000	N
BG02	N	--	N	2,000	150	N	1,000	N	>2,000	N
BG03	N	--	N	1,500	200	N	1,500	N	>2,000	<200
BG04	N	--	N	1,500	70	N	500	N	>2,000	N
BG05	N	--	N	2,000	100	N	1,000	N	>2,000	200
BG06	N	--	N	>10,000	70	N	700	N	>2,000	N
BG07	N	--	N	>10,000	100	N	1,500	N	>2,000	N
BG08	N	--	N	>10,000	70	N	1,000	N	>2,000	N
BG09	N	--	N	>10,000	50	N	2,000	N	>2,000	N
BG10	N	--	N	7,000	150	N	1,000	N	>2,000	N
BG11	N	--	N	>10,000	200	N	1,000	N	>2,000	<200
BG12	N	--	N	>10,000	100	N	500	N	>2,000	<200
BG13	N	--	150	7,000	150	N	1,500	N	>2,000	N
BG14	N	--	N	10,000	100	N	500	N	>2,000	N
BG15	N	--	300	10,000	100	N	300	N	>2,000	N
BG16	N	--	N	10,000	150	N	300	N	>2,000	<200
BG17	N	--	N	>10,000	50	N	200	N	>2,000	N
BG18	N	--	N	>10,000	50	N	150	N	>2,000	N
BG19	N	--	N	5,000	150	N	200	N	>2,000	200
BG20	N	--	N	>10,000	150	N	700	N	>2,000	<200
BG21	N	--	N	>10,000	100	N	1,000	N	>2,000	N
BG22	N	--	N	>10,000	100	N	1,000	N	>2,000	N
BG23	N	--	N	>10,000	70	N	1,000	N	>2,000	N
BG24	N	--	N	>10,000	100	N	300	N	>2,000	N
BG25	N	--	N	>10,000	70	N	500	N	>2,000	N
BG26	N	--	N	7,000	50	N	200	N	>2,000	N
BG27	N	--	N	>10,000	100	N	500	N	>2,000	<200
BG31	N	--	N	10,000	50	N	700	1,500	>2,000	N

TABLE 5.--Analyses of rock samples from the Bull Gulch Wilderness Study Area, Eagle County, Colorado.
[N, not detected; <, detected but below the limit of determination shown; >, determined to be greater than the value shown.]

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s
BG2RS	39 49 41	106 56 40	1.5	.5	1.5	.20	300	5.0	N	N	N	3,000	1.5
BG6RS	39 48 17	106 57 21	1.0	5.0	>20.0	.05	1,500	2.0	N	N	N	100	N
BG7RS	39 48 11	106 57 19	2.0	3.0	10.0	.15	1,500	N	N	N	N	300	N
BG28R	39 48 32	106 57 10	1.0	.2	5.0	.10	500	N	N	N	10	700	N
BG29R	39 48 19	106 57 8	15.0	1.5	5.0	.15	500	N	N	N	150	700	1.0
BG30R	39 48 10	106 57 12	3.0	3.0	15.0	.05	1,000	N	N	N	N	1,500	N
BG31R	39 47 39	106 58 15	.7	2.0	15.0	.15	1,500	N	N	N	N	500	N
BG10RS	39 48 14	106 57 14	.5	1.5	5.0	.10	500	N	N	N	10	300	N

TABLE 5.--Analyses of rock samples from the Bull Gulch Wilderness Study Area, Eagle County, Colorado.--Continued

Sample	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s
BG2RS	N	N	N	15	500	70	5	N	7	30	N	5	N
BG6RS	N	N	5	15	100	50	N	N	10	15	N	N	N
BG7RS	N	N	10	30	50	50	N	N	50	10	N	7	N
BG28R	N	N	N	15	15	N	N	N	10	15	N	N	N
BG29R	N	N	7	30	30	N	N	N	20	15	N	7	N
BG30R	N	N	15	20	7	N	N	N	20	30	N	N	N
BG31R	N	N	N	20	15	50	N	N	7	10	N	N	N
BG10RS	N	N	5	30	20	N	5	N	10	150	N	N	N

TABLE 5.--Analyses of rock samples from the Bull Gulch Wilderness Study Area, Eagle County, Colorado.--Continued

Sample	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Bi-ppm aa	Cd-ppm aa	Sb-ppm aa	Zn-ppm aa
BG2RS	2,000	70	N	10	N	200	N	N	N	.1	N	45
BG6RS	300	70	N	15	N	30	N	18	N	.5	6	78
BG7RS	100	50	N	30	N	200	N	N	N	.4	4	38
BG28R	200	20	N	N	N	100	N	9	N	.3	N	66
BG29R	300	150	N	10	N	70	N	11	N	3.7	2	76
BG30R	300	20	N	15	N	30	N	N	N	2.6	6	250
BG31R	300	20	N	20	N	150	N	N	N	.4	3	17
BG10RS	150	20	N	N	N	70	N	18	N	7.2	3	140

Table 6.--Brief field description of rock samples listed in table 5, Bull Gulch Wilderness Study Area

Sample number	Sample type	Sample source
BG 2RS	Rhyolite dike	Outcrop
BG 6RS	Brecciated sandstone	Outcrop
BG 7RS	" "	Outcrop
BG 28R	" "	Outcrop
BG 29R	" "	Outcrop
BG 30R	" "	Outcrop
BG 31R	Hematitic sandstone	Float
BG 10RS	Brecciated sandstone	Prospect