UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Analytical results and sample locality maps of stream-sediment, heavy-mineral-concentrate, and rock samples from the Negro Bill Canyon (UT-060-138) and the Mill Creek Canyon (UT-060-139A) Wilderness Study Areas, Grand County, Utah

By

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Open-File Report 90-464

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1990

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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 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 Negro Bill Canyon and the Mill Creek Canyon Wilderness Study Areas (WSA's), Grand County, Utah.

INTRODUCTION

In May 1988, the U.S. Geological Survey conducted a reconnaissance geochemical survey of the closely adjacent Negro Bill Canyon (UT-060-138) and Mill Creek Canyon (UT-060-139A) Wilderness Study Areas in Grand County, Utah (fig. 1). Hereafter, these two WSA's and the intervening area will be referred to as the "study area". The combined area of the Negro Bill Canyon WSA (7,620 acres) and the Mill Creek Canyon WSA (9,780 acres) is 17,400 acres or 27.2 square miles.

Both WSA's are only a few miles from Moab. Access to the lower part of Negro Bill Canyon is from State Highway 128 in the canyon of the Colorado River. Access to the lower part of Mill Creek Canyon is from State Highway 191 on the southern outskirts of Moab. The upper or eastern portions of both WSA's are reached from the Sand Flats Road.

The study area is in the Paradox Basin fold and fault belt in the Colorado Plateau physiographic province. It is underlain by the northeastern limb of the Moab Valley-Spanish Valley salt anticline that collapsed when the upper part of the salt core dissolved and was removed by groundwater. The rock units exposed within the study area consist of relatively flat-lying Jurassic sandstone with minor amounts of shale and siltstone. Sedimentary rock units as old as middle Permian may underlie the area at depth. The Precambrian basement beneath the study area is probably about 7,000 feet below sea level (personal communication with Mike Diggles, Water Mineral Resource, 1990).

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 a limited number of 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 unaltered or unmineralized rock samples provide background geochemical data for individual rock units. 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.

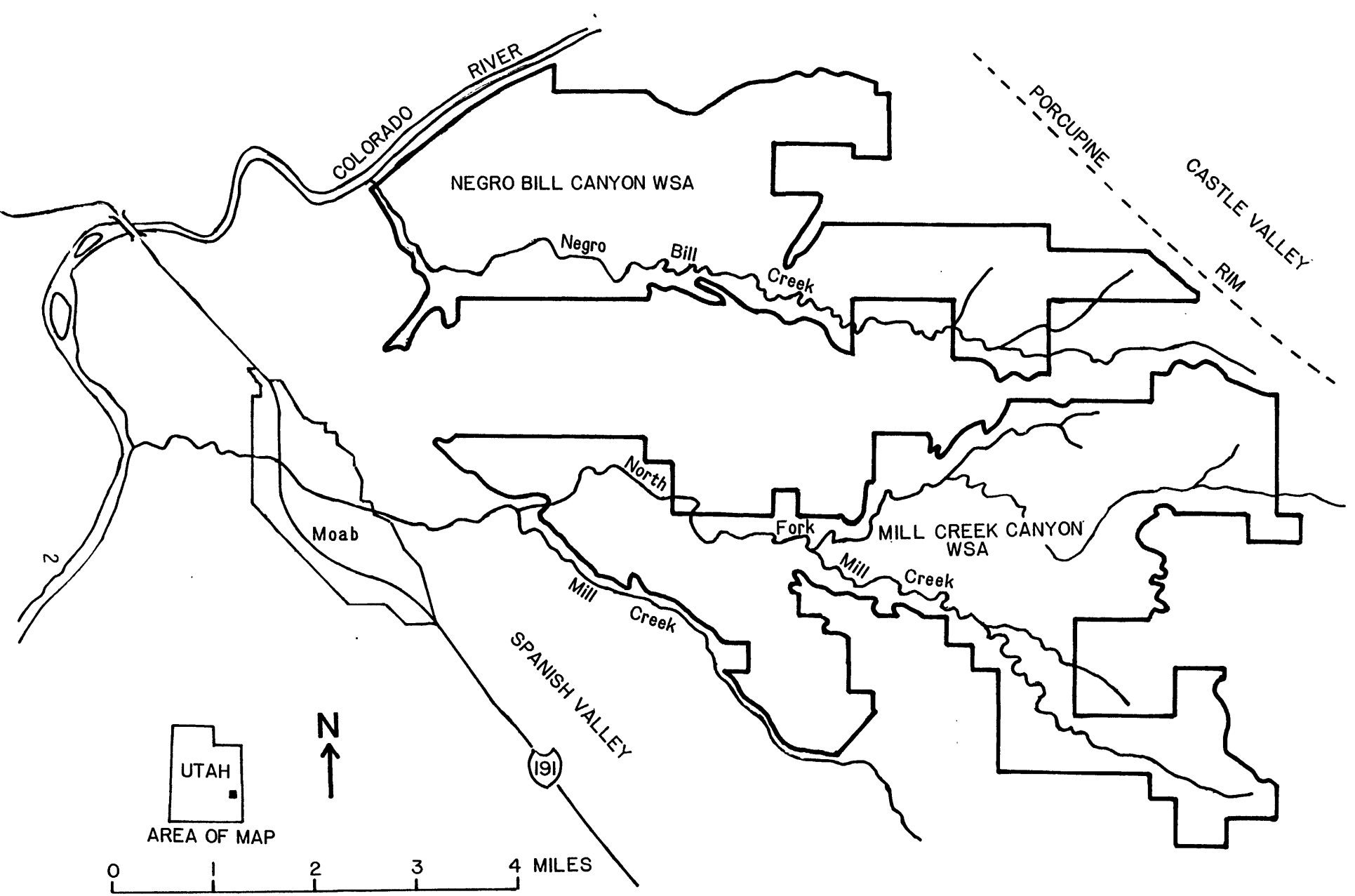

Figure 1.--Location of the Negro Bill Canyon and the Mill Creek Canyon Wilderness Study Areas, Grand County, Utah

Sample Collection

Samples were collected at a total of 33 sites (plate 1). At all sites, both a stream-sediment sample and a heavy-mineral-concentrate sample were collected. Sampling density was about one sample site per 0.82 square miles. The area of the drainage basins sampled ranged from 0.2 to 5 square miles. Sufficient heavy-mineral-concentrate for spectrographic analysis (5 mg) was recovered from all sample sites. Eight rock samples were collected.

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) stream as shown on USGS topographic maps (scale = 1:24,000). Each sample was composited from several localities within an area that may extend as much as 50 feet from the site plotted on the map.

Heavy-mineral-concentrate samples

Heavy-mineral-concentrate samples were collected from the same active alluvium as the stream-sediment samples. Each bulk sample was screened with a 2.0-mm (10-mesh) screen to remove the coarse material. The less than 2.0-mm fraction was panned until most of the quartz, feldspar, organic material, and clay-sized material were removed.

Rock samples

Rock samples were collected from outcrop of unmineralized rock. A description of the rock type collected is given in table 6.

Sample Preparation

The stream-sediment samples were air dried, then sieved using 80-mesh (0.17-mm) stainless-steel sieves. The portion of the sediment passing through the sieve was saved for analysis.

Samples that had been panned in the field were air dried and sieved to -35 mesh; bromoform (specific gravity 2.85) was used to remove the remaining quartz and feldspar. The resultant heavy-mineral sample was separated into three fractions using a large electromagnet by placing the sample in contact with the face of the magnet(in this case a modified Frantz Isodynamic Separator). The most magnetic material (removed at a setting of 0.25 ampere), primarily magnetite, was not analyzed. The second fraction (removed at a setting of 1.75 ampere), largely ferromagnesium silicates and iron oxides, was saved for archival storage. The third fraction (the nonmagnetic 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 degrees and a tilt of 10 degrees with a current of 0.2 ampere to remove the magnetite and ilmenite, and a current of 0.6 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

Stream-sediment and rock samples were analyzed for 35 elements using a semiquantitative, direct-current arc emission spectrographic method (Grimes and Marranzino, 1968). Heavy-mineral-concentrate samples were analyzed for the same elements plus platinum and palladium by the same method. 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 intervals 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, sodium, phosporus, and titanium) are given in weight percent; all others are given in parts per million (micrograms/gram). Analytical data are listed in tables 3, 4, and 5 for stream-sediment, heavy-mineral-concentrate, and rock samples, respectively.

Other Methods

The stream-sediment and rock samples from the WSA were also analyzed by inductively coupled plasma emission spectroscopy (ICP), atomic absorption spectroscopy (AA), and ultraviolet fluorimetry (UF). Arsenic (As), bismuth (Bi), cadmium (Cd), antimony (Sb), and zinc (Zn) were analyzed by ICP, gold (Au) was analyzed by flame AA, and uranium (U) by UF. Limits of determination and references are listed in table 2.

Analytical results using these methods are listed in tables 3 and 5.

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 (Van Trump and Miesch, 1977).

DESCRIPTION OF DATA TABLES

Tables 3, 4, and 5 list the results of analyses for the stream-sediment, heavy-mineral-concentrate, and rock samples 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 plate 1. Columns in which the element headings show the letter "s" following the element symbol are emission spectrographic analyses, "icp" indicates inductively couple plasma analyses, "aa" indicates atomic absorption analyses, and "uf" indicates ultraviolet fluorimetry. A letter "N" in the tables indicates that a given element was looked for but not detected at the lower

limit of determination (LLD) shown for that element in table 1. For emission spectrographic analyses, a "less than" symbol (<) entered in the tables in front of the LLD indicates that an element was observed but was below the lowest reporting value. For ICP and AA analyses, a "less than" symbol (<) entered in the tables in front of the LLD indicates that an element was below the lowest reporting value. 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 the tables in place of the analytical value. Because of the formatting used in the computer program that produced the data tables, some of the elements listed in these tables (Fe, Mg, Ca, Ti, Ag, and Be) 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.

ACKNOWLEDGEMENTS

The authors wish to thank R.M. O'Leary and M.J. Malcolm for their assistance in the preparation and analysis of these samples.

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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, except as noted]

Elements	Lower determination limit	Upper determination limit
	Percent	
Calcium (Ca)	.05	20
Iron (Fe)	0.05	20
Magnesium (Mg)	.02	10
Sodium (Na)	0.2	5
Phosphorus (P)	0.2	10
Titanium (Ti)	.002	1
	Parts per million	
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)	10	2,000
Chromium (Cr)	10	5,000
Copper (Cu)	5	20,000
Gallium (Ga)	5	500
Germanium (Ge)	10	100
Lanthanum (La)	50	1,000
Manganese (Mn)	10	5,000
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
Thorium (Th)	100	2,000
Vanadium (V)	10	10,000
Tungsten (W)	20	10,000
Yttrium (Y)	10	2,000
Zinc (Zn)	200	10,000
Zirconium (Zr)	10	1,000
Palladium (Pd)*	5	1,000
Platinum (Pt)*	20	1,000

*Determined in heavy-mineral-concentrate samples only. Limits are for heavy-mineral-concentrate samples.

TABLE 2.--Other Methods Used

[AA, atomic absorption spectroscopy; ICP, inductively coupled plasma emission spectroscopy; UF, ultraviolet fluorimetry]

Element determined	Sample type	Method	LLD (PPM)	References
Arsenic (As)	Seds/Rx	ICP	5	Crock and others,
Bismuth (Bi)	"	"	2	1987.
Cadmium (Cd)	"	"	0.1	
Antimony (Sb)	"	"	2	
Zinc (Zn)	"	"	2	
Gold (Au)	"	AA	0.05	Thompson and others, .. 1968; O'Leary and ..... Meier, 1986.
Uranium (U)	"	UF	0.1	Centanni and others, .. 1956; O'Leary and ..... Meier, 1986.

TABLE 3--ANALYTICAL RESULTS OF STREAM-SEDIMENT SAMPLES FROM THE NEGRO BILL CANYON AND MILL CREEK CANYON WILDERNESS STUDY AREAS, GRAND COUNTY, UTAH.

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

Sample	Latitude	Longtude	Ca-pct. s	Fe-pct. s	Mg-pct. s	Na-pct. s	P-pct. s	Ti-pct. s	Ag-ppm s	As-ppm s
NB001	38 33 33	109 26 29	.70	1.0	1.00	<.2	N	.10	N	N
NB002	38 33 32	109 24 29	.70	1.0	.70	<.2	N	.05	N	N
NB003	38 33 35	109 26 53	1.00	.5	.70	N	N	.05	N	N
NB004	38 34 1	109 24 48	.70	.5	.50	N	N	.05	N	N
NB005	38 33 18	109 26 22	.50	.5	.30	<.2	N	.05	N	N
NB006	38 34 12	109 25 36	.50	.5	.30	N	N	.05	N	N
NB007	38 33 3	109 25 4	1.00	1.0	.70	N	N	.15	N	N
NB008	38 31 47	109 26 53	.15	.3	.10	N	N	.05	N	N
NB009	38 32 34	109 28 2	<.05	.3	.10	N	N	.05	N	N
NB010	38 32 36	109 24 56	.50	.5	.20	N	N	.05	N	N
NB011	38 31 42	109 26 54	.70	.7	.50	<.2	N	.07	N	N
NB012	38 35 22	109 26 46	.70	.3	.70	N	N	.05	N	N
NB013	38 32 43	109 26 20	.30	.5	.30	N	N	.07	N	N
NB014	38 35 25	109 26 42	.50	.3	.50	N	N	.05	N	N
NB015	38 32 41	109 26 22	.30	.5	.30	N	N	.07	N	N
NB016	38 35 54	109 27 57	.50	.5	.50	N	N	.07	N	N
NB017	38 32 32	109 24 25	.50	.3	.20	N	N	.05	N	N
NB018	38 36 11	109 30 1	1.50	.5	1.00	N	N	.07	N	N
NB019	38 35 36	109 26 52	1.00	.7	1.00	N	N	.07	N	N
NB020	38 35 49	109 30 44	.10	.3	.10	N	N	.05	N	N
NB021	38 35 45	109 27 12	.50	1.0	1.00	<.2	N	.07	N	N
NB022	38 33 45	109 30 21	.30	.3	.15	<.2	N	.05	N	N
NB023	38 35 46	109 29 14	.70	.5	.50	<.2	N	.07	N	N
NB024	38 33 50	109 30 19	.20	.3	.30	N	N	.05	N	N
NB025	38 36 12	109 30 10	.20	.3	.30	N	N	.05	N	N
NB027	38 35 46	109 31 18	.10	.3	.15	N	N	.05	N	N
NB029	38 36 50	109 31 39	.15	.5	.15	N	N	.05	N	N
NB031	38 37 34	109 30 19	1.50	1.5	1.00	.3	N	.15	N	N
NB033	38 37 55	109 29 6	1.00	3.0	1.50	1.0	N	.20	N	N
NB035	38 31 18	109 21 33	5.00	2.0	1.00	.7	N	.15	N	N
NB037	38 33 19	109 21 16	.15	1.5	.15	<.2	N	.10	N	N
NB039	38 35 13	109 22 41	.50	1.0	.70	<.2	N	.07	N	N
NB041	38 33 58	109 28 26	.30	.3	.50	N	N	.05	N	N

TABLE 3--ANALYTICAL RESULTS OF STREAM-SEDIMENT SAMPLES FROM THE NEGRO BILL CANYON AND MILL CREEK CANYON WILDERNESS STUDY AREAS, GRAND COUNTY, UTAH.--Continued

Sample	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	Ga-ppm s	Ge-ppm s
NB001	N	70	300	N	N	N	N	20	5	N	N
NB002	N	50	300	N	N	N	N	10	<5	N	N
NB003	N	70	500	N	N	N	N	<10	5	N	N
NB004	N	50	500	N	N	N	N	15	<5	N	N
NB005	N	70	300	N	N	N	N	N	<5	N	N
NB006	N	50	300	N	N	N	N	<10	N	N	N
NB007	N	150	500	N	N	N	N	<10	<5	N	N
NB008	N	50	300	N	N	N	N	<10	<5	N	N
NB009	N	50	200	N	N	N	N	N	N	N	N
NB010	N	30	300	N	N	N	N	10	<5	N	N
NB011	N	30	500	N	N	N	N	30	<5	N	N
NB012	N	50	300	N	N	N	N	<10	<5	N	N
NB013	N	50	500	N	N	N	N	10	<5	N	N
NB014	N	50	200	N	N	N	N	N	N	N	N
NB015	N	100	500	N	N	N	N	50	<5	N	N
NB016	N	70	300	N	N	N	N	30	<5	N	N
NB017	N	30	200	N	N	N	N	70	N	N	N
NB018	N	150	700	N	N	N	N	<10	5	N	N
NB019	N	30	700	N	N	N	N	10	<5	N	N
NB020	N	50	200	N	N	N	N	15	N	N	N
NB021	N	70	300	N	N	N	N	<10	5	N	N
NB022	N	50	200	N	N	N	N	N	<5	N	N
NB023	N	150	500	N	N	N	N	<10	<5	N	N
NB024	N	50	300	N	N	N	N	N	N	N	N
NB025	N	70	300	N	N	N	N	N	N	N	N
NB027	N	70	300	N	N	N	N	N	N	N	N
NB029	N	100	200	N	N	N	N	<10	N	N	N
NB031	N	150	500	N	N	N	<10	10	5	<5	N
NB033	N	70	1,000	1.5	N	N	15	30	10	50	N
NB035	N	100	1,000	N	N	N	<10	20	7	15	N
NB037	N	30	500	N	N	N	N	<10	<5	N	N
NB039	N	50	500	N	N	N	N	10	<5	N	N
NB041	N	30	300	N	N	N	N	<10	N	N	N

TABLE 3--ANALYTICAL RESULTS OF STREAM-SEDIMENT SAMPLES FROM THE NEGRO BILL CANYON AND MILL CREEK CANYON WILDERNESS STUDY AREAS, GRAND COUNTY, UTAH.--Continued

Sample	La-ppm s	Mn-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	Th-ppm s
NB001	N	150	N	N	<5	N	N	N	N	N	N
NB002	N	150	N	N	<5	N	N	N	N	N	N
NB003	N	100	N	N	<5	N	N	N	N	N	N
NB004	N	70	N	N	5	N	N	N	N	N	N
NB005	N	70	N	N	<5	N	N	N	N	N	N
NB006	N	50	N	N	<5	N	N	N	N	N	N
NB007	N	100	N	N	<5	N	N	N	N	N	N
NB008	N	70	N	N	N	N	N	N	N	N	N
NB009	N	10	N	N	N	N	N	N	N	N	N
NB010	N	30	N	N	N	N	N	N	N	N	N
NB011	N	70	N	N	<5	N	N	N	N	N	N
NB012	N	50	N	N	N	N	N	N	N	N	N
NB013	N	30	N	N	N	N	N	N	N	N	N
NB014	N	30	N	N	<5	N	N	N	N	N	N
NB015	N	50	N	N	<5	N	N	N	N	N	N
NB016	N	50	N	N	<5	N	N	N	N	N	N
NB017	N	20	N	N	N	N	N	N	N	N	N
NB018	N	150	N	N	5	N	N	N	N	N	N
NB019	N	150	N	N	5	N	N	N	N	N	N
NB020	N	20	N	N	<5	N	N	N	N	N	N
NB021	N	150	N	N	5	N	N	N	N	N	N
NB022	N	50	N	N	<5	N	N	N	N	N	N
NB023	N	70	N	N	<5	N	N	N	N	N	N
NB024	N	20	N	N	<5	N	N	N	N	N	N
NB025	N	20	N	N	<5	N	N	N	N	N	N
NB027	N	50	<5	N	<5	N	N	N	N	N	N
NB029	N	30	N	N	<5	N	N	N	N	N	N
NB031	N	300	N	N	7	<10	N	N	N	N	N
NB033	<50	500	N	N	15	20	N	<5	N	N	N
NB035	N	500	N	N	10	<10	N	N	N	<100	N
NB037	N	100	N	N	<5	N	N	N	N	N	N
NB039	N	150	N	N	5	N	N	N	N	N	N
NB041	N	30	N	N	<5	N	N	N	N	N	N

TABLE 3--ANALYTICAL RESULTS OF STREAM-SEDIMENT SAMPLES FROM THE NEGRO BILL CANYON AND MILL CREEK CANYON WILDERNESS STUDY AREAS, GRAND COUNTY, UTAH.--Continued

Sample	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	As-ppm icp	Bi-ppm icp	Cd-ppm icp	Sb-ppm icp	Zn-ppm icp	U-ppm uf	Au-ppm aa
NB001	20	N	N	N	300	<5	<2	<.1	<2	6	.20	<.05
NB002	15	N	N	N	200	<5	<2	<.1	<2	4	.25	<.05
NB003	20	N	N	N	150	<5	<2	<.1	<2	2	.10	<.05
NB004	20	N	N	N	150	<5	<2	<.1	<2	3	.15	<.05
NB005	20	N	N	N	100	<5	<2	<.1	<2	4	.20	<.05
NB006	10	N	N	N	200	<5	<2	<.1	<2	3	.10	<.05
NB007	20	N	N	N	300	<5	<2	<.1	<2	3	.20	<.05
NB008	10	N	N	N	200	<5	<2	<.1	<2	<2	.60	<.05
NB009	<10	N	N	N	200	<5	<2	<.1	<2	<2	.10	<.05
NB010	10	N	N	N	100	<5	<2	<.1	<2	11	.10	<.05
NB011	15	N	N	N	70	<5	<2	<.1	<2	3	.15	<.05
NB012	10	N	N	N	200	<5	<2	<.1	<2	2	.15	<.05
NB013	10	N	N	N	500	<5	<2	<.1	<2	3	.15	<.05
NB014	<10	N	N	N	150	<5	<2	<.1	<2	3	.15	<.05
NB015	10	N	N	N	300	<5	<2	<.1	<2	4	.15	<.05
NB016	10	N	N	N	200	<5	<2	<.1	<2	3	.15	<.05
NB017	15	N	N	N	200	<5	<2	<.1	<2	2	.15	<.05
NB018	20	N	N	N	100	<5	<2	<.1	<2	2	.15	<.05
NB019	20	N	N	N	70	<5	<2	<.1	<2	3	.10	<.05
NB020	10	N	N	N	70	<5	<2	<.1	<2	<2	.10	<.05
NB021	20	N	N	N	70	<5	<2	<.1	<2	3	.20	<.05
NB022	10	N	N	N	70	<5	<2	<.1	<2	3	.15	<.05
NB023	10	N	N	N	100	<5	<2	<.1	<2	3	.15	<.05
NB024	<10	N	N	N	100	<5	<2	<.1	<2	2	.25	<.05
NB025	<10	N	N	N	70	<5	<2	<.1	<2	3	.20	<.05
NB027	<10	N	N	N	70	<5	<2	<.1	<2	2	.10	<.05
NB029	<10	N	N	N	100	<5	<2	<.1	<2	2	.20	<.05
NB031	70	N	N	N	200	<5	<2	<.1	<2	7	.25	<.05
NB033	70	N	70	N	500	<5	<2	.2	<2	18	.90	<.05
NB035	100	N	10	N	500	<5	<2	.2	<2	12	.30	<.05
NB037	50	N	N	N	300	<5	<2	<.1	<2	7	.15	<.05
NB039	30	N	N	N	70	<5	<2	<.1	<2	5	.40	<.05
NB041	10	N	N	N	200	<5	<2	<.1	<2	2	.65	<.05

TABLE 4--ANALYTICAL RESULTS OF HEAVY-MINERAL-CONCENTRATE SAMPLES FROM THE NEGRO BILL CANYON AND MILL CREEK CANYON WILDERNESS STUDY AREAS, GRAND COUNTY, UTAH.

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

Sample	Latitude	Longtude	Ca-pct.	Fe-pct.	Mg-pct.	Na-pct.	P-pct.	Ti-pct.	Ag-ppm	As-ppm	Au-ppm	B-ppm
			s	s	s	s	s	s	s	s	s	s
NB001	38 33 33	109 26 29	2.0	1.0	2.00	N	<.5	>2.0	1	N	N	200
NB002	38 33 32	109 24 29	.5	1.0	.30	N	<.5	>2.0	N	N	N	100
NB003	38 33 35	109 26 53	2.0	1.0	2.00	N	.5	>2.0	N	N	N	200
NB004	38 34 1	109 24 48	3.0	3.0	2.00	N	.5	>2.0	N	N	N	700
NB005	38 33 18	109 26 22	.5	2.0	.50	N	1.0	>2.0	N	N	N	200
NB006	38 34 12	109 25 36	.5	1.5	.30	N	.7	>2.0	N	N	N	300
NB007	38 33 3	109 25 4	.5	1.5	1.00	N	.5	>2.0	N	N	N	500
NB008	38 31 47	109 26 53	N	5.0	.10	N	<.5	>2.0	N	N	N	1,000
NB009	38 32 34	109 28 2	N	2.0	.05	N	<.5	>2.0	N	N	N	500
NB010	38 32 36	109 24 56	<.1	.7	.15	N	.5	>2.0	N	N	N	200
NB011	38 31 42	109 26 54	.5	2.0	.20	N	.7	>2.0	N	N	N	300
NB012	38 35 22	109 26 46	.7	3.0	1.50	N	.5	>2.0	N	N	N	1,500
NB013	38 32 43	109 26 20	<.1	3.0	.20	N	N	>2.0	N	N	N	300
NB014	38 35 25	109 26 42	.5	1.0	.70	N	N	>2.0	N	N	N	200
NB015	38 32 41	109 26 22	N	2.0	.10	N	N	>2.0	N	N	N	500
NB016	38 35 54	109 27 57	.5	2.0	.50	N	<.5	>2.0	N	N	N	1,000
NB017	38 32 32	109 24 25	.7	.5	.50	N	.7	>2.0	N	N	N	200
NB018	38 36 11	109 30 1	5.0	2.0	2.00	N	.7	>2.0	N	N	N	1,000
NB019	38 35 36	109 26 52	1.0	2.0	1.00	N	N	>2.0	N	N	N	200
NB020	38 35 49	109 30 44	N	3.0	.15	N	N	>2.0	N	N	N	700
NB021	38 35 45	109 27 12	2.0	2.0	2.00	N	<.5	>2.0	N	N	N	700
NB022	38 33 45	109 30 21	.5	1.0	.20	N	.5	>2.0	N	N	N	300
NB023	38 35 46	109 29 14	<.1	2.0	.30	N	N	>2.0	N	N	N	500
NB024	38 33 50	109 30 19	.2	1.5	.20	N	<.5	>2.0	N	N	N	150
NB025	38 36 12	109 30 10	1.0	5.0	.30	N	.7	>2.0	N	N	N	1,000
NB027	38 35 46	109 31 18	.5	3.0	.50	N	<.5	>2.0	N	N	N	700
NB029	38 36 50	109 31 39	N	2.0	.10	N	N	>2.0	N	N	N	200
NB031	38 37 34	109 30 19	.7	5.0	.50	N	.5	>2.0	N	N	N	700
NB033	38 37 55	109 29 6	7.0	1.0	.30	N	7.0	1.5	N	N	N	50
NB035	38 31 18	109 21 33	5.0	1.5	.15	N	3.0	>2.0	<1	N	100	100
NB037	38 33 19	109 21 16	.5	1.0	.10	N	1.0	>2.0	N	N	N	150
NB039	38 35 13	109 22 41	.3	2.0	.30	N	N	>2.0	N	N	N	1,000
NB041	38 33 58	109 28 26	.7	3.0	.30	N	.5	>2.0	N	N	N	300

TABLE 4--ANALYTICAL RESULTS OF HEAVY-MINERAL-CONCENTRATE SAMPLES FROM THE NEGRO BILL CANYON AND MILL CREEK CANYON WILDERNESS STUDY AREAS, GRAND COUNTY, UTAH.--Continued

Sample	Ba-ppm s	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	Ga-ppm s	Ge-ppm s	La-ppm s	Mn-ppm s	Mo-ppm s	Nb-ppm s
NB001	>10,000	N	N	N	N	150	N	N	N	N	500	N	<50
NB002	>10,000	2	N	N	N	20	N	N	N	N	50	N	N
NB003	>10,000	<2	N	N	N	100	N	10	N	<100	300	N	<50
NB004	>10,000	2	N	N	N	300	N	<10	N	100	500	N	<50
NB005	>10,000	2	N	N	N	150	N	N	N	<100	200	N	<50
NB006	>10,000	3	N	N	N	50	N	<10	N	<100	100	N	<50
NB007	>10,000	2	N	N	N	70	N	N	N	<100	300	N	<50
NB008	7,000	3	N	N	N	500	N	10	N	N	300	N	N
NB009	700	3	N	N	N	300	N	N	N	N	70	N	N
NB010	>10,000	5	N	N	N	50	N	<10	N	N	100	N	N
NB011	>10,000	2	N	N	N	100	N	N	N	<100	200	N	<50
NB012	>10,000	3	N	N	N	200	N	<10	N	500	300	N	<50
NB013	>10,000	5	N	N	N	300	N	10	N	N	150	N	N
NB014	>10,000	N	N	N	N	50	N	N	N	N	200	N	<50
NB015	>10,000	5	N	N	N	100	N	<10	N	<100	200	N	N
NB016	>10,000	<2	N	N	N	500	N	<10	N	150	300	N	<50
NB017	>10,000	3	N	N	N	20	N	<10	N	N	300	N	<50
NB018	>10,000	2	N	N	N	150	N	N	N	100	500	N	50
NB019	>10,000	N	N	N	N	100	N	<10	N	N	300	N	<50
NB020	2,000	2	N	N	N	200	N	<10	N	<100	70	N	N
NB021	>10,000	<2	N	N	N	150	N	<10	N	<100	500	N	<50
NB022	>10,000	3	N	N	N	30	N	N	N	N	100	N	<50
NB023	10,000	2	N	N	N	100	N	<10	N	<100	150	N	N
NB024	10,000	2	N	N	N	<20	N	N	N	N	100	N	N
NB025	5,000	5	N	N	N	70	N	N	N	700	200	N	<50
NB027	5,000	N	N	N	N	70	N	N	N	<100	700	N	50
NB029	10,000	3	N	N	N	70	N	10	N	<100	150	N	N
NB031	>10,000	2	N	N	N	200	N	<10	N	150	300	N	N
NB033	>10,000	5	N	N	N	70	N	<10	N	1,000	500	N	N
NB035	>10,000	N	N	N	N	50	N	N	N	700	300	N	<50
NB037	>10,000	<2	N	N	N	30	70	N	N	200	200	N	<50
NB039	>10,000	3	N	N	N	200	N	N	N	150	500	N	50
NB041	>10,000	2	N	N	N	50	N	<10	N	100	300	N	<50

TABLE 4--ANALYTICAL RESULTS OF HEAVY-MINERAL-CONCENTRATE SAMPLES FROM THE NEGRO BILL CANYON AND MILL CREEK CANYON WILDERNESS STUDY AREAS, GRAND COUNTY, UTAH.--Continued

Sample	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	Th-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Pd-ppm s	Pt-ppm s
NB001	N	50	N	30	N	200	N	150	N	1,000	N	>2,000	N	N
NB002	N	<20	N	50	N	N	N	150	N	1,000	N	>2,000	N	N
NB003	<10	<20	N	15	N	200	N	100	N	500	N	>2,000	N	N
NB004	N	20	N	70	N	<200	N	200	N	1,000	N	>2,000	N	N
NB005	N	<20	N	30	N	<200	N	150	N	700	N	>2,000	N	N
NB006	N	20	N	50	N	<200	N	150	N	1,000	N	>2,000	N	N
NB007	N	<20	N	30	N	<200	N	150	N	1,000	N	>2,000	N	N
NB008	<10	50	N	50	N	N	N	200	N	1,500	N	>2,000	N	N
NB009	N	20	N	15	N	N	N	100	N	700	N	>2,000	N	N
NB010	N	<20	N	100	N	<200	N	100	N	1,500	N	>2,000	N	N
NB011	N	20	N	50	N	200	N	150	N	1,000	N	>2,000	N	N
NB012	N	<20	N	200	N	<200	N	300	N	1,500	N	>2,000	N	N
NB013	N	20	N	500	N	N	N	200	N	2,000	N	>2,000	N	N
NB014	N	<20	N	20	N	<200	N	100	N	700	N	>2,000	N	N
NB015	N	20	N	150	N	N	N	150	N	1,500	N	>2,000	N	N
NB016	N	30	N	30	N	N	N	200	N	1,000	N	>2,000	N	N
NB017	N	20	N	50	N	200	N	100	N	700	N	>2,000	N	N
NB018	N	20	N	30	N	200	N	200	N	1,000	N	>2,000	N	N
NB019	N	<20	N	30	N	<200	N	150	N	700	N	>2,000	N	N
NB020	N	<20	N	70	N	N	N	200	N	1,500	N	>2,000	N	N
NB021	N	<20	N	30	N	<200	N	200	N	1,000	N	>2,000	N	N
NB022	N	20	N	30	N	<200	N	100	N	1,000	N	>2,000	N	N
NB023	N	<20	N	70	N	N	N	150	N	1,500	N	>2,000	N	N
NB024	N	<20	N	70	N	N	N	150	N	1,500	N	>2,000	N	N
NB025	N	30	N	100	N	N	N	200	N	1,500	N	>2,000	N	N
NB027	N	<20	N	20	N	N	N	150	N	700	N	>2,000	N	N
NB029	N	<20	N	70	N	N	N	150	N	1,500	N	>2,000	N	N
NB031	N	700	N	100	N	300	N	200	N	1,500	N	>2,000	N	N
NB033	N	30	N	15	N	1,500	N	70	N	1,000	N	>2,000	N	N
NB035	N	<20	N	N	N	7,000	N	100	N	200	N	>2,000	N	N
NB037	N	1,000	N	10	N	1,000	N	150	N	700	N	>2,000	N	N
NB039	N	20	N	50	N	<200	N	200	N	1,500	N	>2,000	N	N
NB041	N	<20	N	50	N	<200	N	200	N	1,000	N	>2,000	N	N

TABLE 5--ANALYTICAL RESULTS OF ROCK SAMPLES FROM THE NEGRO BILL CANYON AND MILL CREEK CANYON WILDERNESS STUDY AREAS, GRAND COUNTY, UTAH.

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

Sample	Latitude	Longtude	Ca-pct. s	Fe-pct. s	Mg-pct. s	Na-pct. s	P-pct. s	Ti-pct. s	Ag-ppm s	As-ppm s
NB003 R	38 33 35	109 26 53	.15	.50	.20	N	N	.050	N	N
NB022 R	38 33 45	109 30 21	.50	2.00	2.00	5.0	N	.100	N	N
NB025 R	38 36 12	109 30 10	N	.50	.03	N	N	.030	N	N
NB029 R	38 36 50	109 31 39	5.00	.70	10.00	.5	N	.050	N	N
NB031 R	38 37 34	109 30 19	5.00	.70	10.00	.7	N	.030	N	N
NB033 R	38 37 55	109 29 6	.05	.15	.10	N	N	.050	N	N
NB035 R	38 31 27	109 22 25	2.00	.05	.02	N	N	N	N	N
NB035 X	38 31 18	109 21 33	.15	.15	<.02	N	N	N	N	N

Sample	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	Ga-ppm s	Ge-ppm s
NB003 R	N	N	500	N	N	N	N	N	<5	N	N
NB022 R	N	N	1,000	<1	N	N	<10	<10	15	100	N
NB025 R	N	<10	150	N	N	N	N	N	N	N	N
NB029 R	N	15	150	N	N	N	15	10	10	5	N
NB031 R	N	15	70	N	N	N	<10	20	5	<5	N
NB033 R	N	N	70	N	N	N	N	<10	10	N	N
NB035 R	N	N	300	N	N	N	N	N	N	N	N
NB035 X	N	10	20	N	N	N	N	N	<5	N	N

Sample	La-ppm s	Mn-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	Th-ppm s
NB003 R	N	70	N	N	<5	N	N	N	N	N	N
NB022 R	N	500	N	N	N	20	N	<5	N	200	N
NB025 R	N	15	N	N	N	N	N	N	N	N	N
NB029 R	<50	20	N	N	10	<10	N	N	N	<100	N
NB031 R	N	1,000	N	N	5	N	N	N	N	150	N
NB033 R	N	10	N	N	N	N	N	N	N	N	N
NB035 R	N	1,000	N	N	N	N	N	N	N	N	N
NB035 X	N	50	N	N	N	N	N	N	N	N	N

Sample	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	As-ppm icp	Bi-ppm icp	Cd-ppm icp	Sb-ppm icp	Zn-ppm icp	U-ppm uf	Au-ppm aa
NB003 R	30	N	N	N	70	6	<2	<.1	<2	<2	.10	<.05
NB022 R	100	N	<10	N	70	<5	<2	.3	<2	46	.80	<.05
NB025 R	N	N	N	N	30	<5	<2	<.1	<2	<2	.20	<.05
NB029 R	30	N	20	N	20	<5	<2	.2	<2	9	.50	<.05
NB031 R	200	N	N	N	10	<5	<2	<.1	<2	<2	.75	<.05
NB033 R	70	N	N	N	10	<5	<2	<.1	<2	<2	.30	<.05
NB035 R	N	N	N	N	N	<5	<2	<.1	<2	<2	.55	<.05
NB035 X	N	N	N	N	N	<5	<2	<.1	<2	<2	.25	<.05

TABLE 6.--Rock Descriptions

Sample	Description
NB003R	Navajo sandstone
NB022R	conglomerate
NB025R	Kayenta sandstone
NB029R	conglomerate
NB031R	limestone
NB033R	conglomerate
NB035R	chert
NB035X	chert