UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Analytical results and sample locality maps of stream-sediment and heavy-mineral-concentrate samples from Behind the Rocks (UT-060-140A), Indian Creek (UT-060-164), Butler Wash (UT-060-169), and Bridger Jack Mesa (UT-060-167) Wilderness Study Areas, Grand and San Juan Counties, Utah

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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 Behind the Rocks, Indian Creek, Butler Wash, and Bridger Jack Mesa Wilderness Study Areas, Grand and San Juan Counties, Utah.

INTRODUCTION

In July, 1986, the U.S. Geological Survey conducted a reconnaissance geochemical survey of the Behind the Rocks (UT-060-140A) (12,635 acres, 19.7 mi^2), Indian Creek (UT-060-164) (6,870 acres, 10.7 mi^2), Butler Wash (UT-010-169) (24,190 acres, 37.8 mi^2), and Bridger Jack Mesa (UT-060-167) (5,290 acres, 8.3 mi^2) Wilderness Study Areas (WSA's) in Grand and San Juan Counties, Utah.

All of the above wilderness study areas border Canyonlands National Park on the east and south except Behind the Rocks WSA which is at the western edge of Moab (see figs. 1 and 2). Access to Behind the Rocks WSA is by a dirt road up Pritchett Canyon from the northwest. Access to the other WSA's is by dirt roads branching off State Road 211 which provides access to the Needles area in Canyonlands National Park, branching off U.S. Highway 163 between Moab and Monticello.

Rocks of the Behind the Rocks WSA consist of continental sedimentary rocks of largely Triassic age. The Chinle Formation is overlain sucessively by the Wingate Sandstone, Kayenta Formation, and Navajo Sandstone. Rocks of the Indian Creek WSA are composed entirely of the Permian Cutler Formation. Butler Wash WSA is composed of marine and continental sedimentary rocks of Permian-Pennsylvanian age to Triassic. The Rico Formation is the oldest and is overlain by the Cedar Mesa sandstone member of the Permian Cutler Formation and the Organ Rock Tongue member of the Cutler Formation. The Triassic Moenkopi Formation is filled in at places at the top by the Moss Back member of the Triassic Chinle Formation. Bridger Jack Mesa WSA is composed of sedimentary rocks of Triassic age. The Moss Back member at the base is overlain by Wingate sandstone and the Kayenta Formation. The geology of the area is described by Williams (1964).

All of the WSA's are of very rugged terrain and difficult access. Indian Creek and Butler Wash WSA's are deeply dissected canyons. Bridger Jack Mesa WSA is a flat-lying steep walled mesa. Behind the Rocks WSA features a prominent escarpment along the eastern boundary and is dissected by west-flowing tributaries to the Colorado River.

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

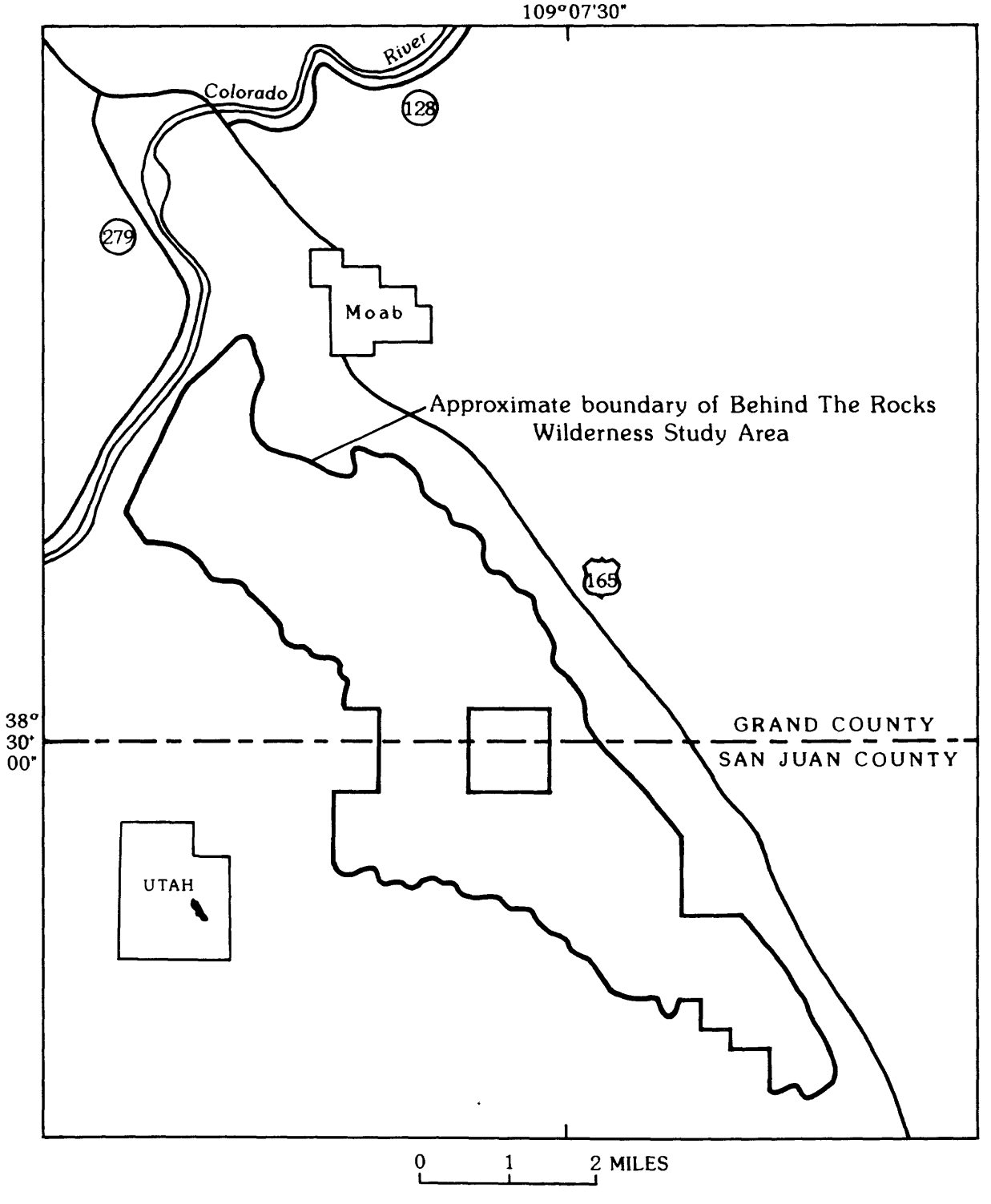

Figure 1. Index map showing location of the Behind the Rocks Wilderness Study Area, Grand and San Juan Counties, Utah.

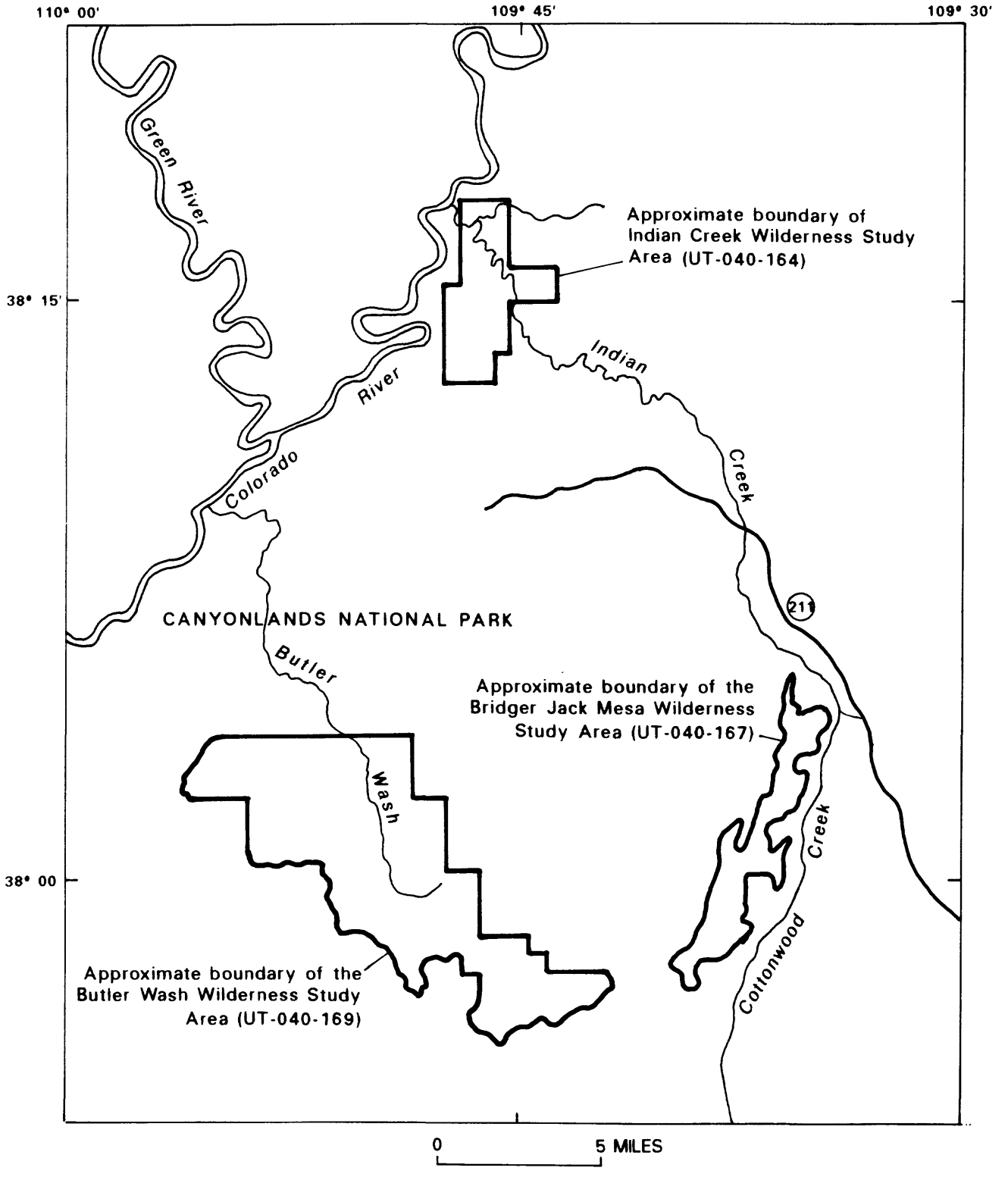

FIG. 2 Index map showing locations of the Indian Creek, Butler Wash, and Bridger Jack Mesa Wilderness Study Areas, San Juan County, Utah

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.

Sample Collection

Samples were collected at a total of 53 sites, 8 in Indian Creek WSA, 17 in Behind the Rocks WSA, 21 in Butler Wash WSA, and 7 in Bridger Jack Mesa WSA. In data tables 3 and 4, samples from Behind the Rocks WSA are designated with a BR prefix and samples from Indian Creek WSA are designated with an IC prefix. Samples from Butler Wash and Bridger Jack Mesa WSA's are both designated with BB prefix. Samples BB003 through BB023 are from Butler Wash and samples BB001, BB002, and BB024 through BB028 are from Bridger Jack Mesa. At all sites, both a stream-sediment sample and a heavy-mineral-concentrate sample were collected (an insufficient amount of sample BB003H was available for analysis). Sampling density was about one sample site per 1.4 mi^2. The area of the drainage basins sampled ranged from 0.2 to 2.0 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) 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 ft 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.

Sample Preparation

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

After the samples were air dried, 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 concentrate 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 and 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 0.1 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.

Sample Analysis

Spectrographic Method

The stream-sediment and heavy-mineral-concentrate 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 all WSA's (Behind the Rocks, Indian Creek, Butler Wash, and Bridger Jack Mesa) are listed in tables 3 and 4 for stream-sediment and heavy-mineral-concentrate samples respectively.

Chemical Methods

Samples from the four study areas were also analyzed by inductively coupled plasma atomic emission spectroscopy (ICP), atomic absorption spectroscopy (AA), and delayed neutron analysis (DNA). Stream-sediment samples were analyzed by ICP for arsenic (As), antimony (Sb), bismuth (Bi), cadmium (Cd), and zinc (Zn), by AA for gold (Au) and by DNA for uranium (U) and thorium (Th). Limits of determination and references are listed in table 2.

Analytical results using these methods for stream-sediment samples are listed in table 3.

DATA STORAGE SYSTEM

Upon completion of all analytical work, the analytical results were entered into either the Branch of Geochemistry computer data base called PLUTO or RASS (Rock Analysis Storage System). These data bases contain 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 and 4 list the results of analyses for the stream-sediment and heavy-mineral concentrate samples for each of the four areas, respectively. For the 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 (plates 1-4). Columns in which the element headings show the letter "s" below the element symbol are emission spectrographic analyses; "aa" indicates atomic absorption analyses; "icp" indicates inductively coupled plasma-atomic emission spectroscopy; "dna" indicates delayed neutron 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. For emission spectrographic analyses, a "less than" symbol (<) entered in the tables in front of the lower limit of determination indicates that an element was observed but was below the lowest reporting value. For AA and ICP analyses, a "less than" symbol (<) entered in the tables in front of the lower limit of determination 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" (>) was entered in the tables in front of the upper limit of determination. Because of the formatting used in the computer program that produced tables 3 and 4, some of the elements listed in these tables (Fe, Mg, Ca, and Ti) 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 th extra zeros.

ACKNOWLEDGEMENTS

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TABLE 1.--Limits of determination for the spectrographic analysis of 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 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.--Chemical methods used

[AA = atomic absorption; ICP = inductively coupled plasma spectroscopy; DNA = delayed neutron analysis]

Element or constituent determined	Sample type	Method	Determination limit (micrograms/ gram or ppm)	Analyst	Reference
Gold (Au)	sediments	AA	0.1	Kay Kennedy	Modification of Thompson and others, 1968.
Arsenic (As)	sediments	ICP	5	P.H. Briggs	Crock and others, 1983.
Antimony (Sb)	sediments	ICP	2		
Zinc (Zn)	sediments	ICP	2		
Bismuth (Bi)	sediments	ICP	2		
Cadmium (Cd)	sediments	ICP	0.1		
Thorium (Th)	sediments	DNA	--	R.B. Vaughn	McKown, 1987.
Uranium (U)	sediments	DNA	--	R.B. Vaughn	McKown, 1987.

TABLE 3. SPECTROGRAPHIC, AA, DNA, & ICP ANALYSES OF STREAM-SEDIMENT SAMPLES FROM BEHIND THE ROCKS, INDIAN CREEK, BUTLER WASH, AND BRIDGER JACK MESA WILDERNESS STUDY AREAS, GRAND AND SAN JUAN COUNTIES, UTAH.

[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
BB001S	38 1 28	109 37 27	.70	1.50	3.00	.15	150	N	N	N	30	150	N
BB002S	37 59 51	109 39 29	1.00	2.00	5.00	.15	500	N	N	N	50	700	<1
BB003S	37 57 36	109 43 32	.30	.50	1.00	.03	30	N	N	N	30	100	N
BB004S	37 57 28	109 43 39	.30	.15	.70	.03	20	N	N	N	30	30	N
BB005S	37 57 35	109 43 46	1.50	2.00	5.00	.15	500	N	N	N	70	300	N
BB006S	37 56 47	109 45 50	.50	1.00	2.00	.05	70	N	N	N	50	150	N
BB007S	37 56 51	109 45 54	.50	.70	1.00	.05	50	N	N	N	30	200	N
BB008S	37 57 17	109 45 39	.30	.70	2.00	.05	50	N	N	N	50	150	N
BB009S	37 58 27	109 45 6	.50	.30	.70	.03	20	N	N	N	30	70	N
BB010S	37 59 47	109 46 23	.30	.20	1.00	.03	30	N	N	N	30	100	N
BB011S	38 0 7	109 46 57	.15	.30	1.50	.03	20	N	N	N	30	150	N
BB012S	38 1 3	109 47 29	.30	.70	1.50	.03	20	N	N	N	30	150	N
BB013S	38 0 12	109 49 49	.20	.50	1.50	.02	10	N	N	N	20	50	N
BB014S	38 0 11	109 49 34	.30	.30	1.00	.03	<10	N	N	N	50	70	N
BB015S	37 59 41	109 49 38	.20	.30	2.00	.03	20	N	N	N	50	50	N
BB016S	37 59 43	109 49 25	.70	.50	5.00	.05	30	N	N	N	50	150	N
BB017S	38 1 42	109 50 7	.20	.70	1.50	.03	20	N	N	N	20	70	N
BB018S	38 3 32	109 50 38	.20	.50	2.00	.05	30	N	N	N	30	100	N
BB019S	38 3 33	109 51 10	.20	.20	.50	.02	10	N	N	N	30	50	N
BB020S	38 3 36	109 52 28	.30	.50	.70	.03	15	N	N	N	30	100	N
BB021S	38 2 44	109 52 50	.20	1.00	2.00	.05	30	N	N	N	50	150	N
BB022S	38 2 40	109 52 43	.20	.50	2.00	.03	30	N	N	N	30	100	N
BB023S	38 3 34	109 54 40	.30	.70	2.00	.03	30	N	N	N	50	150	N
BB024S	37 57 49	109 38 56	2.00	2.00	10.00	.20	700	N	N	N	70	700	1
BB025S	37 59 8	109 37 31	.50	.10	1.00	.03	10	N	N	N	30	70	N
BB026S	38 1 1	109 36 22	1.00	1.50	7.00	.15	500	N	N	N	100	700	<1
BB027S	38 3 0	109 35 29	1.00	1.50	1.50	.15	150	N	N	N	30	200	N
BB028S	38 4 38	109 35 19	.70	.70	1.50	.15	70	N	N	N	50	300	N
BR001S	38 31 54	109 34 49	.50	.20	.50	.07	70	N	N	N	50	300	N
BR002S	38 31 47	109 34 44	.70	.20	.70	.05	50	N	N	N	30	150	N
BR003S	38 31 26	109 33 57	.70	.50	.70	.05	70	N	N	N	30	200	N
BR004S	38 31 10	109 33 46	.70	.30	.50	.10	50	N	N	N	50	150	N
BR005S	38 30 56	109 33 23	.30	.30	.30	.07	30	N	N	N	70	200	N
BR006S	38 30 5	109 33 7	.50	.20	.70	.10	70	N	N	N	30	200	N
BR007S	38 29 39	109 32 10	.30	.15	.30	.07	50	N	N	N	30	100	N
BR008S	38 29 44	109 32 7	.30	.15	.50	.10	30	N	N	N	30	200	N
BR009S	38 29 8	109 33 0	.20	.10	.10	.02	20	N	N	N	50	70	N
BR010S	38 28 41	109 31 43	.50	.20	.20	.03	50	N	N	N	30	150	N
BR011S	38 28 24	109 30 9	.30	.10	.20	.03	30	N	N	N	50	70	N
BR012S	38 28 2	109 29 43	.20	.10	.20	.07	30	N	N	N	30	150	N
BR013S	38 28 8	109 29 45	.50	.20	.30	.07	50	N	N	N	50	200	N
BR014S	38 26 57	109 28 10	.50	.10	.20	.07	50	N	N	N	30	200	N
BR015S	38 26 31	109 27 31	.10	.07	.05	.03	20	N	N	N	30	70	N
BR016S	38 32 41	109 35 35	.50	.20	.70	.07	150	N	N	N	50	300	N
BR017S	38 33 15	109 35 9	.70	.70	1.00	.10	150	N	N	N	70	300	N

TABLE 3. SPECTROGRAPHIC, AA, DNA, & ICP ANALYSES OF STREAM-SEDIMENT SAMPLES FROM BEHIND THE ROCKS, INDIAN CREEK, BUTLER WASH, AND BRIDGER JACK MESA WILDERNESS STUDY AREAS, GRAND AND SAN JUAN COUNTIES, UTAH.--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
BB001S	N	N	<5	50	5	N	N	N	<5	<10	N	<5	N
BB002S	N	N	<5	10	5	<20	N	N	5	15	N	<5	N
BB003S	N	N	N	N	<5	N	N	N	<5	N	N	N	N
BB004S	N	N	N	N	N	N	N	N	N	N	N	N	N
BB005S	N	N	<5	10	10	20	N	N	10	10	N	5	N
BB006S	N	N	N	10	<5	N	N	N	<5	N	N	N	N
BB007S	N	N	N	N	<5	N	N	N	<5	N	N	N	N
BB008S	N	N	N	N	N	N	N	N	<5	N	N	<5	N
BB009S	N	N	N	N	N	N	N	N	N	N	N	N	N
BB010S	N	N	N	<10	N	N	N	N	N	N	N	N	N
BB011S	N	N	N	N	N	N	N	N	<5	N	N	N	N
BB012S	N	N	N	10	N	N	N	N	<5	N	N	N	N
BB013S	N	N	N	N	N	N	N	N	N	N	N	N	N
BB014S	N	N	N	N	N	N	N	N	N	N	N	N	N
BB015S	N	N	N	N	N	N	N	N	N	N	N	N	N
BB016S	N	N	N	N	N	N	N	N	<5	N	N	N	N
BB017S	N	N	N	N	<5	N	N	N	N	N	N	N	N
BB018S	N	N	N	N	N	N	N	N	N	N	N	N	N
BB019S	N	N	N	N	N	N	N	N	N	N	N	N	N
BB020S	N	N	N	N	N	N	N	N	N	N	N	N	N
BB021S	N	N	N	N	N	N	N	N	N	N	N	N	N
BB022S	N	N	N	N	N	N	N	N	N	N	N	N	N
BB023S	N	N	N	N	<5	N	N	N	<5	N	N	N	N
BB024S	N	N	5	20	10	20	N	N	10	N	N	7	N
BB025S	N	N	N	<10	N	N	N	N	N	N	N	N	N
BB026S	N	N	<5	10	5	N	N	N	7	<10	N	5	N
BB027S	N	N	N	<10	5	N	N	N	<5	N	N	N	N
BB028S	N	N	N	N	<5	N	N	N	<5	N	N	N	N
BR001S	N	N	N	<10	<5	N	N	N	<5	N	N	<5	N
BR002S	N	N	N	N	<5	N	N	N	<5	N	N	N	N
BR003S	N	N	N	N	<5	N	N	N	<5	N	N	N	N
BR004S	N	N	N	N	<5	N	N	N	<5	N	N	N	N
BR005S	N	N	N	N	<5	N	N	N	<5	N	N	N	N
BR006S	N	N	N	N	<5	N	N	N	N	<10	N	N	N
BR007S	N	N	N	N	N	N	N	N	N	N	N	N	N
BR008S	N	N	N	N	<5	N	N	N	N	N	N	N	N
BR009S	N	N	N	N	N	N	N	N	N	N	N	N	N
BR010S	N	N	N	N	N	N	N	N	<5	N	N	N	N
BR011S	N	N	N	<10	N	N	N	N	<5	N	N	N	N
BR012S	N	N	N	150	<5	N	N	N	N	N	N	N	N
BR013S	N	N	N	N	N	N	N	N	N	N	N	N	N
BR014S	N	N	N	N	<5	N	N	N	N	N	N	N	N
BR015S	N	N	N	N	N	N	N	N	N	N	N	N	N
BR016S	N	N	N	N	<5	N	N	N	<5	<10	N	N	N
BR017S	N	N	N	100	<5	N	N	N	<5	10	N	<5	N

TABLE 3. SPECTROGRAPHIC, AA, DNA, & ICP ANALYSES OF STREAM-SEDIMENT SAMPLES FROM BEHIND THE ROCKS, INDIAN CREEK, BUTLER WASH, AND BRIDGER JACK MESA WILDERNESS STUDY AREAS, GRAND AND SAN JUAN COUNTIES, UTAH.--Continued

Sample	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	Au-ppm aa	As-ppm icp	Bi-ppm icp	Cd-ppm icp	Sb-ppm icp	Zn-ppm icp	Th-ppm dna	U-ppm dna
BB001S	100	15	N	10	N	300	N	<.1	<5	<2	.2	<2	8	3.20	1.390
BB002S	300	20	N	15	N	500	N	<.1	<5	<2	.3	3	11	4.21	1.700
BB003S	N	<10	N	N	N	200	N	<.1	<5	<2	.1	<2	5	<1.70	1.010
BB004S	N	N	N	N	N	50	N	<.1	<5	<2	.1	<2	3	2.90	.823
BB005S	200	20	N	10	N	150	N	<.1	<5	<2	.2	3	11	4.60	1.520
BB006S	N	<10	N	N	N	100	N	<.1	<5	<2	.2	<2	3	<1.80	1.090
BB007S	<100	10	N	N	N	200	N	<.1	5	<2	.1	<2	6	3.60	1.420
BB008S	100	<10	N	N	N	300	N	<.1	<5	<2	.2	<2	3	<1.50	.790
BB009S	<100	10	N	N	N	200	N	<.1	<5	<2	.1	<2	<2	2.60	1.030
BB010S	<100	10	N	N	N	500	N	<.1	<5	<2	.2	<2	2	2.40	.960
BB011S	100	<10	N	N	N	100	N	<.1	<5	<2	<.1	<2	<2	2.10	.549
BB012S	<100	<10	N	N	N	300	N	<.1	<5	<2	.1	<2	3	3.10	.938
BB013S	N	<10	N	N	N	200	N	<.1	<5	<2	.2	<2	3	2.30	1.150
BB014S	N	<10	N	N	N	150	N	<.1	<5	<2	<.1	<2	<2	1.60	.596
BB015S	<100	N	N	N	N	300	N	<.1	<5	<2	.1	<2	2	2.30	.755
BB016S	<100	10	N	N	N	500	N	<.1	<5	<2	.1	<2	4	2.40	.720
BB017S	N	<10	N	N	N	150	N	<.1	<5	<2	.1	<2	2	1.90	.898
BB018S	N	<10	N	N	N	700	N	<.1	<5	<2	.2	<2	3	2.70	1.130
BB019S	<100	N	N	N	N	700	N	<.1	<5	<2	<.1	<2	2	2.50	.881
BB020S	N	<10	N	20	N	700	N	<.1	<5	<2	.1	<2	3	3.60	1.240
BB021S	N	<10	N	N	N	70	N	<.1	<5	<2	<.1	<2	2	2.40	.576
BB022S	N	<10	N	N	N	300	N	<.1	<5	<2	<.1	<2	<2	2.00	.828
BB023S	N	<10	N	N	N	100	N	<.1	<5	<2	.1	<2	7	<1.70	1.190
BB024S	500	20	N	30	N	300	N	<.1	<5	<2	.3	<2	11	5.21	1.470
BB025S	<100	10	N	N	N	700	N	<.1	<5	<2	.2	<2	2	2.70	1.230
BB026S	200	15	N	15	N	150	N	<.1	<5	<2	.3	2	11	5.00	1.500
BB027S	<100	15	N	10	N	200	N	<.1	<5	<2	.2	<2	8	4.08	1.130
BB028S	100	10	N	N	N	200	N	<.1	<5	<2	.2	<2	7	2.90	1.340
BR001S	N	<10	N	N	N	100	N	<.1	<5	<2	.1	<2	6	<1.70	.892
BR002S	<100	10	N	N	N	100	N	<.1	<5	<2	.1	<2	5	1.90	.738
BR003S	N	<10	N	N	N	200	N	<.1	<5	<2	<.1	<2	8	2.80	.786
BR004S	N	<10	N	N	N	150	N	<.1	<5	<2	.2	<2	7	2.30	.884
BR005S	N	<10	N	N	N	200	N	<.1	<5	<2	<.1	<2	5	<1.70	1.190
BR006S	<100	<10	N	N	N	300	N	<.1	<5	<2	<.1	<2	<2	1.90	.776
BR007S	N	<10	N	N	N	100	N	<.1	<5	<2	<.1	<2	4	<1.40	.894
BR008S	N	<10	N	N	N	300	N	<.1	<5	<2	<.1	<2	5	<1.50	.733
BR009S	N	<10	N	N	N	100	N	<.1	<5	<2	<.1	<2	3	<1.50	.824
BR010S	<100	<10	N	N	N	70	N	<.1	<5	<2	<.1	<2	5	1.80	.623
BR011S	N	10	N	N	N	700	N	<.1	<5	<2	<.1	<2	4	2.00	.665
BR012S	N	<10	N	N	N	300	N	<.1	<5	<2	.1	<2	4	<1.40	.735
BR013S	N	<10	N	N	N	500	N	<.1	<5	<2	<.1	<2	5	<1.60	.860
BR014S	N	<10	N	N	N	1,000	N	<.1	<5	<2	<.1	<2	4	<1.30	.579
BR015S	<100	N	N	N	N	200	N	<.1	<5	<2	<.1	<2	3	1.50	.403
BR016S	N	10	N	N	N	300	N	<.1	<5	<2	.1	<2	9	<1.40	.893
BR017S	<100	10	N	N	N	700	N	<.1	<5	<2	.2	<2	9	2.30	1.550

TABLE 3. SPECTROGRAPHIC, AA, DNA, & ICP ANALYSES OF STREAM-SEDIMENT SAMPLES FROM BEHIND THE ROCKS, INDIAN CREEK, BUTLER WASH, AND BRIDGER JACK MESA WILDERNESS STUDY AREAS, GRAND AND SAN JUAN COUNTIES, UTAH.--Continued

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
IC001S	38 14 52	109 45 0	1.00	.50	1.00	.05	70	N	N	N	50	300	N
IC002S	38 14 44	109 45 8	2.00	1.50	5.00	.15	150	N	N	N	30	300	<1
IC003S	38 15 14	109 45 13	.70	.50	3.00	.07	50	N	N	N	30	200	N
IC004S	38 15 34	109 44 58	3.00	.15	1.50	.10	200	N	N	N	50	200	N
IC005S	38 15 57	109 45 18	2.00	1.50	5.00	.20	500	N	N	N	20	700	<1
IC006S	38 16 5	109 45 51	1.00	.30	5.00	.10	100	N	N	N	20	150	N
IC007S	38 16 25	109 46 16	2.00	1.00	7.00	.20	500	N	N	N	30	500	<1
IC008S	38 17 18	109 46 7	1.50	2.00	3.00	.15	300	N	N	N	20	500	N

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
IC001S	N	N	N	N	<5	N	N	N	<5	N	N	N	N
IC002S	N	N	<5	20	5	20	N	N	5	15	N	5	N
IC003S	N	N	N	N	<5	N	N	N	<5	N	N	N	N
IC004S	N	N	N	70	<5	70	N	N	<5	N	N	<5	N
IC005S	N	N	<5	10	5	20	N	N	5	15	N	5	N
IC006S	N	N	N	<10	<5	N	N	N	<5	<10	N	N	N
IC007S	N	N	<5	20	5	70	N	N	<5	10	N	5	N
IC008S	N	N	<5	N	5	<20	N	N	<5	10	N	<5	N

Sample	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	Au-ppm aa	As-ppm icp	Bi-ppm icp	Cd-ppm icp	Sb-ppm icp	Zn-ppm icp	Th-ppm dna	U-ppm dna
IC001S	N	10	N	N	N	1,000	N	<.1	<5	<2	.3	<2	7	5.11	2.280
IC002S	100	20	N	15	N	300	N	<.1	<5	<2	.8	<2	10	7.12	1.940
IC003S	N	10	N	N	N	50	N	<.1	<5	<2	.3	<2	8	4.25	1.660
IC004S	N	30	N	20	N	700	N	<.1	<5	<2	1.4	<2	10	13.90	4.140
IC005S	200	50	N	15	N	150	N	<.1	<5	<2	.4	<2	10	4.40	2.130
IC006S	<100	15	N	N	N	150	N	<.1	<5	<2	.3	<2	8	3.70	1.510
IC007S	100	50	N	30	N	1,000	N	<.1	<5	<2	.9	<2	9	11.60	3.750
IC008S	300	20	N	10	N	500	N	<.1	<5	<2	.3	<2	9	3.80	1.650

TABLE 4.--SPECTROGRAPHIC ANALYSES OF HEAVY-MINERAL-CONCENTRATE SAMPLES FROM BEHIND THE ROCKS, INDIAN CREEK, BUTLER WASH, AND BRIDGER JACK MESA WILDERNESS STUDY AREAS, GRAND AND SAN JUAN COUNTIES, UTAH.

[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
BB001H	38 1 28	109 37 27	1.0	.70	2.00	1.0	200	N	N	N
BB002H	37 59 51	109 39 29	.7	1.00	7.00	2.0	500	N	N	N
BB004H	37 57 28	109 43 39	1.0	.20	1.00	>2.0	70	N	N	N
BB005H	37 57 35	109 43 46	.7	.20	1.50	>2.0	100	N	N	N
BB006H	37 56 47	109 45 50	.5	1.00	2.00	>2.0	150	N	N	N
BB007H	37 56 51	109 45 54	.5	.50	.70	1.5	70	30	N	50
BB008H	37 57 17	109 45 39	.2	.50	1.00	1.5	50	N	N	N
BB009H	37 58 27	109 45 6	1.0	.50	.70	2.0	100	N	N	N
BB010H	37 59 47	109 46 23	.7	2.00	7.00	>2.0	300	N	N	N
BB011H	38 0 7	109 46 57	.5	.50	10.00	>2.0	500	N	N	N
BB012H	38 1 3	109 47 29	1.0	.70	2.00	>2.0	100	N	N	N
BB013H	38 0 12	109 49 49	1.5	.70	1.50	>2.0	100	N	N	N
BB014H	38 0 11	109 49 34	3.0	.70	2.00	>2.0	200	N	N	N
BB015H	37 59 41	109 49 38	1.5	1.50	5.00	>2.0	200	N	N	N
BB016H	37 59 43	109 49 25	.2	.20	1.00	>2.0	50	N	N	N
BB017H	38 1 42	109 50 7	.7	2.00	5.00	>2.0	100	N	N	N
BB018H	38 3 32	109 50 38	.7	1.50	2.00	>2.0	150	N	N	N
BB019H	38 3 33	109 51 10	.5	1.50	2.00	>2.0	100	N	N	N
BB020H	38 3 36	109 52 28	1.0	.30	1.00	>2.0	30	N	N	N
BB021H	38 2 44	109 52 50	1.0	1.50	10.00	>2.0	500	N	N	N
BB022H	38 2 40	109 52 43	2.0	3.00	10.00	>2.0	200	N	N	N
BB023H	38 3 34	109 54 40	.7	.50	1.00	>2.0	70	N	N	N
BB024H	37 57 49	109 38 56	1.0	1.00	10.00	2.0	500	N	N	N
BB025H	37 59 8	109 37 31	.5	1.50	7.00	>2.0	300	N	N	N
BB026H	38 1 1	109 36 22	.7	.70	7.00	2.0	300	N	N	N
BB027H	38 3 0	109 35 29	.5	.20	.50	1.0	50	N	N	N
BB028H	38 4 38	109 35 19	1.0	.30	2.00	1.0	300	N	N	N
BR001H	38 31 54	109 34 49	1.5	.20	.30	>2.0	200	N	N	N
BR002H	38 31 47	109 34 44	1.0	.70	1.00	>2.0	500	N	N	N
BR003H	38 31 26	109 33 57	1.5	.30	.20	>2.0	70	N	N	<20
BR004H	38 31 10	109 33 46	.5	.70	.70	>2.0	150	N	N	N
BR005H	38 30 56	109 33 23	1.5	.10	.10	>2.0	30	20	<500	200
BR006H	38 30 5	109 33 7	1.0	.30	.50	>2.0	100	N	N	N
BR007H	38 29 39	109 32 10	2.0	.50	.30	>2.0	200	N	N	N
BR008H	38 29 44	109 32 7	3.0	.30	.30	>2.0	100	N	700	N
BR009H	38 29 8	109 33 0	.3	.20	.20	>2.0	70	N	N	N
BR010H	38 28 41	109 31 43	1.0	.50	.30	>2.0	100	N	N	N
BR011H	38 28 24	109 30 9	.3	.07	.10	>2.0	30	N	<500	N
BR012H	38 28 2	109 29 43	1.0	.15	.20	>2.0	150	N	<500	N
BR013H	38 28 8	109 29 45	1.0	.15	.15	>2.0	50	N	N	N
BR014H	38 26 57	109 28 10	.5	<.05	N	>2.0	50	N	N	N
BR015H	38 26 31	109 27 31	.5	.05	N	>2.0	30	N	N	N
BR016H	38 32 41	109 35 35	.3	.10	.20	>2.0	100	N	N	N
BR017H	38 33 15	109 35 9	.5	.10	<.10	>2.0	30	N	N	N
IC001H	38 14 52	109 45 0	.7	.70	2.00	>2.0	150	N	N	N

TABLE 4.--SPECTROGRAPHIC ANALYSES OF HEAVY-MINERAL-CONCENTRATE SAMPLES FROM BEHIND THE ROCKS, INDIAN CREEK, BUTLER WASH, AND BRIDGER JACK MESA WILDERNESS STUDY AREAS, GRAND AND SAN JUAN COUNTIES, UTAH.--Continued

Sample	B-ppm s	Ba-ppm s	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
BB001H	200	>10,000	N	N	N	N	150	20	<50	N	<50
BB002H	30	>10,000	N	N	N	N	20	N	70	N	50
BB004H	150	>10,000	7	N	N	N	150	N	300	N	N
BB005H	70	>10,000	10	N	N	N	70	N	100	N	N
BB006H	50	>10,000	2	N	N	N	50	N	200	N	<50
BB007H	50	>10,000	5	N	N	N	150	N	50	N	N
BB008H	30	>10,000	2	N	N	N	70	N	N	N	<50
BB009H	50	>10,000	3	N	N	N	100	N	70	N	<50
BB010H	70	>10,000	7	N	N	N	100	N	50	N	N
BB011H	300	>10,000	15	<20	N	N	200	N	150	N	N
BB012H	100	10,000	5	N	N	N	50	N	50	N	<50
BB013H	200	10,000	10	N	N	N	50	N	150	N	N
BB014H	1,500	1,500	10	N	N	N	500	N	1,000	N	<50
BB015H	500	>10,000	10	N	N	N	200	N	100	N	N
BB016H	70	10,000	7	N	N	N	20	N	<50	N	N
BB017H	150	>10,000	7	N	N	N	70	N	50	N	N
BB018H	300	>10,000	7	N	N	N	50	N	70	N	N
BB019H	70	>10,000	5	N	N	N	70	N	N	N	N
BB020H	300	>10,000	10	N	N	N	100	N	500	N	<50
BB021H	150	10,000	7	N	N	N	100	N	70	N	<50
BB022H	500	>10,000	10	N	N	N	100	N	<50	N	<50
BB023H	150	1,500	5	N	N	N	100	N	70	N	<50
BB024H	150	>10,000	N	N	N	N	300	N	100	N	<50
BB025H	100	>10,000	N	N	N	N	70	N	70	N	<50
BB026H	100	>10,000	N	N	N	N	150	N	100	N	<50
BB027H	100	>10,000	N	N	N	N	30	N	N	N	<50
BB028H	300	>10,000	N	N	N	N	500	N	<50	N	N
BR001H	700	>10,000	3	N	<50	N	100	N	<50	N	N
BR002H	200	>10,000	<2	N	N	N	70	N	<50	N	N
BR003H	500	>10,000	2	N	N	N	150	N	50	N	N
BR004H	200	>10,000	<2	N	N	N	300	N	<50	N	N
BR005H	200	>10,000	2	N	N	N	200	N	N	N	<50
BR006H	300	>10,000	<2	N	N	N	500	N	<50	N	N
BR007H	2,000	>10,000	2	N	N	N	3,000	N	200	N	<50
BR008H	200	>10,000	2	N	N	N	150	N	<50	N	<50
BR009H	200	>10,000	2	N	N	N	150	N	70	N	<50
BR010H	500	>10,000	2	N	N	N	150	N	<50	N	<50
BR011H	150	>10,000	2	N	N	N	100	N	N	N	N
BR012H	70	>10,000	2	N	N	N	150	N	N	N	N
BR013H	150	>10,000	2	N	N	N	100	N	<50	N	N
BR014H	100	1,500	3	N	N	N	100	N	N	N	N
BR015H	100	7,000	3	N	N	N	30	N	N	N	N
BR016H	150	10,000	<2	N	N	N	50	N	N	N	N
BR017H	100	2,000	2	N	N	N	100	N	<50	N	N
IC001H	100	>10,000	2	N	N	N	150	N	150	N	N

TABLE 4.--SPECTROGRAPHIC ANALYSES OF HEAVY-MINERAL-CONCENTRATE SAMPLES FROM BEHIND THE ROCKS, INDIAN CREEK, BUTLER WASH, AND BRIDGER JACK MESA WILDERNESS STUDY AREAS, GRAND AND SAN JUAN COUNTIES, UTAH.--Continued

Sample	Ni-ppm s	Pb-ppm s	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
BB001H	<10	<20	N	<10	N	>10,000	100	N	200	N	>2,000	N
BB002H	<10	30	N	10	N	>10,000	100	N	300	N	>2,000	N
BB004H	N	50	N	200	N	500	70	N	2,000	N	>2,000	N
BB005H	N	50	N	>200	N	1,000	50	N	1,500	N	>2,000	N
BB006H	N	30	N	50	N	>10,000	70	N	700	N	>2,000	N
BB007H	N	30	N	200	N	>10,000	50	N	1,000	N	>2,000	N
BB008H	N	<20	N	20	N	>10,000	30	N	500	N	>2,000	N
BB009H	N	30	N	70	N	>10,000	150	N	1,000	N	>2,000	N
BB010H	N	100	N	200	N	500	70	N	1,500	N	>2,000	N
BB011H	N	70	N	>200	N	>10,000	100	N	2,000	N	>2,000	N
BB012H	N	30	N	100	N	>10,000	150	N	1,500	N	>2,000	N
BB013H	N	70	N	>200	N	N	100	N	2,000	N	>2,000	N
BB014H	<10	50	N	200	N	500	200	N	2,000	N	>2,000	N
BB015H	<10	150	N	150	N	500	100	N	2,000	N	>2,000	N
BB016H	N	30	N	150	N	N	50	N	2,000	N	>2,000	N
BB017H	N	30	N	150	N	500	50	N	1,500	N	>2,000	N
BB018H	N	20	N	150	N	700	100	N	2,000	N	>2,000	N
BB019H	<10	20	N	100	N	>10,000	50	N	1,000	N	>2,000	N
BB020H	N	70	N	200	N	200	100	N	2,000	N	>2,000	N
BB021H	N	50	N	100	N	<200	100	N	2,000	N	>2,000	N
BB022H	<10	50	N	100	N	300	100	N	1,000	N	>2,000	N
BB023H	N	30	N	70	N	<200	100	N	1,000	N	>2,000	N
BB024H	<10	<20	N	<10	N	>10,000	150	N	150	N	>2,000	N
BB025H	N	<20	N	15	N	>10,000	100	N	500	N	>2,000	N
BB026H	<10	<20	N	<10	N	>10,000	100	N	300	N	>2,000	N
BB027H	N	N	N	<10	N	3,000	70	N	200	N	>2,000	N
BB028H	N	20	N	<10	N	>10,000	70	N	300	N	>2,000	N
BR001H	N	70	N	200	N	700	100	N	1,500	N	>2,000	N
BR002H	N	50	N	100	N	500	70	N	500	N	>2,000	N
BR003H	N	100	N	150	N	200	100	N	1,500	N	>2,000	N
BR004H	N	20	N	100	N	700	70	N	700	N	>2,000	N
BR005H	N	20	N	>200	N	200	100	N	1,500	N	>2,000	N
BR006H	N	20	N	150	N	700	70	N	1,500	N	>2,000	N
BR007H	N	50	N	200	N	500	100	N	1,500	N	>2,000	N
BR008H	N	30	N	200	N	<200	200	N	1,000	N	>2,000	N
BR009H	N	20	N	100	N	200	70	N	1,500	N	>2,000	N
BR010H	N	20	N	100	N	N	70	N	1,000	N	>2,000	N
BR011H	N	20	N	200	N	500	70	N	1,500	N	>2,000	N
BR012H	N	50	N	200	N	200	70	N	1,500	N	>2,000	N
BR013H	N	30	N	>200	N	<200	100	N	1,500	N	>2,000	N
BR014H	N	30	N	>200	N	N	100	N	1,500	N	>2,000	N
BR015H	N	20	N	200	N	N	70	N	2,000	N	>2,000	N
BR016H	N	500	N	100	N	N	50	N	700	N	>2,000	N
BR017H	N	5,000	N	200	N	<200	70	N	1,500	N	>2,000	N
IC001H	N	<20	N	50	N	>10,000	100	N	1,000	N	>2,000	N

TABLE 4.--SPECTROGRAPHIC ANALYSES OF HEAVY-MINERAL-CONCENTRATE SAMPLES FROM BEHIND THE ROCKS, INDIAN CREEK, BUTLER WASH, AND BRIDGER JACK MESA WILDERNESS STUDY AREAS, GRAND AND SAN JUAN COUNTIES, UTAH.--Continued

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
IC002H	38 14 44	109 45 8	2.0	.15	5.00	2.0	150	N	N	N
IC003H	38 15 14	109 45 13	1.0	.50	10.00	>2.0	200	N	N	N
IC004H	38 15 34	109 44 58	1.0	.10	7.00	2.0	200	N	N	N
IC005H	38 15 57	109 45 18	1.5	3.00	20.00	2.0	1,000	N	N	N
IC006H	38 16 5	109 45 51	2.0	2.00	20.00	>2.0	1,000	N	N	N
IC007H	38 16 25	109 46 16	1.0	.50	15.00	2.0	500	N	N	N
IC008H	38 17 18	109 46 7	.7	5.00	20.00	2.0	1,000	N	N	N

Sample	B-ppm s	Ba-ppm s	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
IC002H	70	>10,000	3	N	N	N	70	N	500	N	<50
IC003H	50	>10,000	5	N	N	N	50	N	150	N	<50
IC004H	50	>10,000	7	N	N	N	30	N	200	N	<50
IC005H	30	>10,000	2	N	N	N	70	N	300	N	50
IC006H	70	>10,000	5	N	N	N	100	N	500	N	<50
IC007H	70	>10,000	10	N	N	N	30	N	500	N	<50
IC008H	70	>10,000	N	N	N	N	70	10	300	N	<50

Sample	Ni-ppm s	Pb-ppm s	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
IC002H	<10	20	N	50	N	700	100	N	1,000	N	>2,000	N
IC003H	<10	20	N	150	N	300	100	N	1,000	N	>2,000	N
IC004H	N	70	N	150	N	500	70	N	1,500	N	>2,000	N
IC005H	N	70	N	70	N	>10,000	150	N	1,000	N	>2,000	N
IC006H	N	20	N	150	N	5,000	150	N	2,000	N	>2,000	N
IC007H	N	30	N	150	N	1,000	100	N	2,000	N	>2,000	N
IC008H	N	30	N	20	N	>10,000	150	N	700	N	>2,000	N

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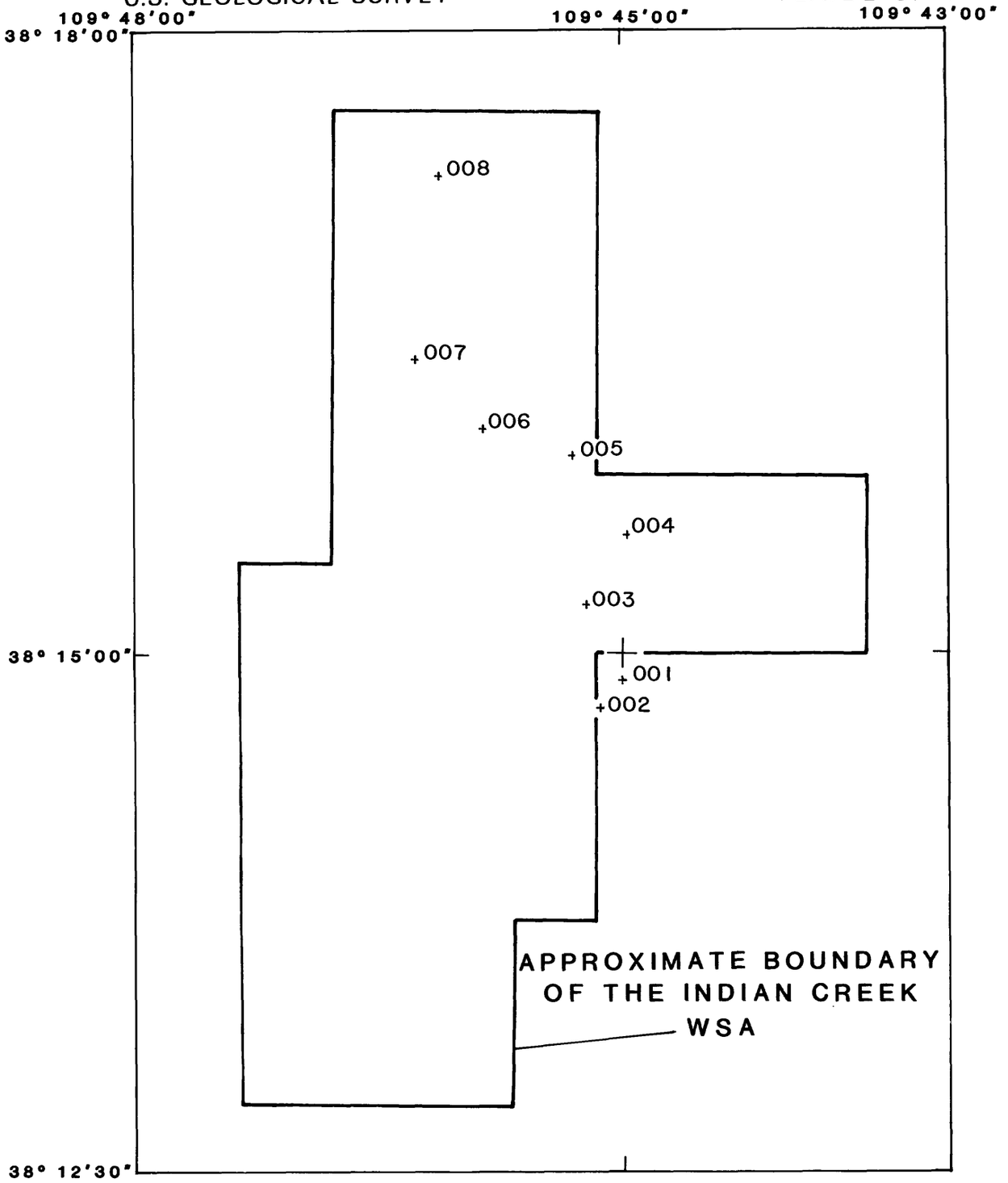

Base from the U.S. Geological Survey; Harts Point, Upheaval Dome, and The Needles, 1:62,500

SCALE 1:50 000

1 ½ 0 1 2 3 MILES

1 .5 0 1 2 3 KILOMETERS

LOCALITIES OF STREAM-SEDIMENT AND HEAVY-MINERAL CONCENTRATE SAMPLES FROM INDIAN CREEK WILDERNESS STUDY AREA, SAN JUAN COUNTY, UTAH

By

J. H. Bullock, Jr., H. N. Barton, K. Kennedy, R. B. Vaughn and P. H. Briggs

1989

This map is preliminary and has not been edited or reviewed for conformity with U. S. Geological Survey editorial standards.

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