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 Cottonwood Canyon Wilderness Study Area, Washington County, Utah

By

David E. Detra*, James E. Kilburn*,

Janet L. Jones*, and David L. Fey*

Open-File Report 88-274

*DFC, Box 25046, MS 973, Denver, CO 80225

1988

CONTENTS

ILLUSTRATIONS

TABLES

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 Cottonwood Canyon Wilderness Study Area (UT-040-046), Washington County, Utah.

INTRODUCTION

In April 1986, the U.S. Geological Survey conducted a reconnaissance goechemical survey of Cottonwood Canyon Wilderness Study Area, Washington County, Utah.

The Cottonwood Canyon Wilderness Study Area comprises about 9,853 acres (15.4 mi^2) in the southwest corner of Washington County, Utah, and lies about 10 mi north of St. George, Utah (see fig. 1).

Access to the study area is provided on the east by I-15 and on the west by an unpaved road out of Middleton heading up Black Gulch. Access within the area is limited and only a few four-wheel-drive and pack trails exist.

The study area lies along the transition zone separating the Basin and Range on the west from the Colorado Plateau on the east. The area is dominantly covered by flat-lying to gently dipping sandstone of Triassic to Jurassic age, with minor exposures of Quaternary basalt. The main sandstone exposed in this area is Navajo sandstone which is approximately 1,500-2,000 ft thick.

The study area lies along the west limb of the Virgia anticline. Further effects of Cenozoic deformation can be seen to the north and west. The Silver Reef mining area lies directly to the north and east of the area.

Elevations range from about 3,200 ft at the intersection of Cottonwood Canyon with the eastern boundary to about 5,300 ft at Twin Peaks in the northwest corner of the area.

The area consists of relatively flat benches and deeply cut canyons and ravines. Relief is high particularly in the western part where many of these steep walled canyons exist. Drainage is southeasterly across the area and many of the larger drainages begin north of the area in the Pine Mountain. An open forest of juniper trees extends southward from the north part of the area down to about 3,700 ft; the remainder is covered by sparse desert shrubs. The climate of the area is semiarid.

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

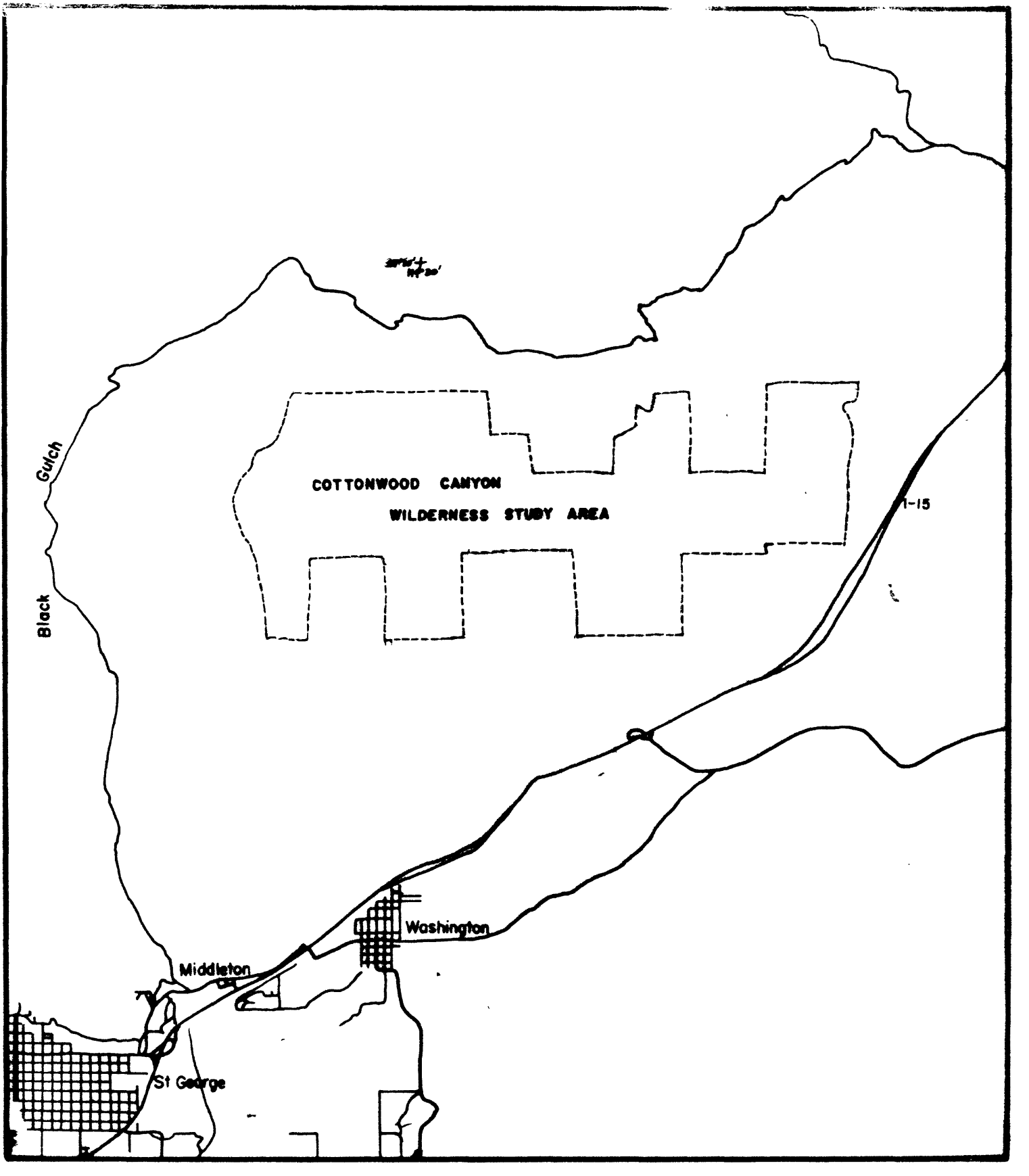

Figure 1. Location map of the Cottonwood Canyon Wilderness Study Area, Washington County, Utah (scale 1:100,000).

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. On the other hand, 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 38 sites (plate 1). At nearly all of those sites, both a stream-sediment sample and a heavy-mineral-concentrate sample were collected. Where suitable outcrop was available, rock samples were collected. Average sampling density was about one sample site per .4 mi^2 for the stream sediments, heavy-mineral concentrates, and the rocks. The area of the drainage basins sampled ranged from .5 mi^2 to 2 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 USGS topographic maps (scale = 1:24,000).

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 outcrops or exposures in the vicinity of the plotted site locations. Samples were collected from unaltered and/or altered and/or mineralized rocks.

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.

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 analysis/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 0.2 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

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 Cottonwood Canyon Wilderness Study Area are listed in tables 3-5.

Chemical methods

Other methods of analysis used on samples from the Cottonwood Canyon Wilderness Study Area 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, 1977).

DESCRIPTION OF DATA TABLES

Tables 3-5 list the results of 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 (Fe, Mg, Ca, Ti, Ag, and Be) 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.

REFERENCES CITED

Crock, J. G., Briggs, P. H., Jackson, L. L., and Lichte, F. F., 1987, analytical methods for the analysis of stream sediments and rocks from wilderness study areas: U.S. Geological Survey Open-File Report 87-84, p. 22-28.

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.

McKown, D. M., and Millard, H. T., 1987, Determination of uranium and thorium by delayed neutron counting, in U.S. Geological Survey Bulletin 1770: Methods in Geochemical Analysis, ed., P. A. Baedecker, Chapter 9, p. 314-346.

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.

VanTrump, George, Jr., and Miesch, A. T., 1977, The U.S. Geological Survey RASS-STATPAC system for management and statistical reduction of geochemical data: Computers and Geosciences, v. 3, p. 475-488.

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.--Chemical methods used

[AA = atomic absorption; ICP = inductively coupled plasma spectroscopy; DNA = delayed 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)	ICP	5	Crock and others, 1987.
Antimony (Sb)	ICP	2	
Zinc (Zn)	ICP	2	
Bismuth (Bi)	ICP	2	
Cadmium (Cd)	ICP	.1	
Uranium (U)	DNA	.1	McKown and Millard, 1987.
Thorium (Th)	DNA	1	

TABLE 3. RESULTS FROM THE ANALYSES OF STREAM-SEDIMENT SAMPLES FROM THE COTTONWOOD CANYON WILDERNESS STUDY AREA, 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
CC001S	37 11 25	113 30 59	.70	.20	1.00	.070	100	N	N	N	15	100
CC002S	37 11 27	113 30 54	.07	.05	.15	.010	<10	N	N	N	10	100
CC003S	37 11 5	113 31 10	.50	.30	.20	.070	70	N	N	N	<10	100
CC004S	37 13 43	113 24 42	.10	.05	.50	.020	30	N	N	N	10	100
CC005S	37 11 24	113 25 28	.10	.05	.15	.030	30	N	N	N	10	100
CC006S	37 11 21	113 25 28	1.50	.50	1.00	.100	300	N	N	N	15	200
CC007S	37 12 9	113 31 23	.50	.20	.70	.070	50	N	N	N	20	150
CC008S	37 12 8	113 31 25	1.00	.30	1.50	.070	100	N	N	N	20	150
CC009S	37 11 44	113 30 29	.05	.03	.15	.020	<10	N	N	N	20	100
CC010S	37 11 44	113 30 31	.10	<.02	<.05	.030	<10	N	N	N	10	50
CC011S	37 13 32	113 24 20	.10	.02	.20	.030	10	N	N	N	<10	70
CC012S	37 12 59	113 30 29	.05	.05	.20	.020	10	N	N	N	10	200
CC013S	37 12 9	113 25 42	.05	<.02	<.05	.015	<10	N	N	N	15	30
CC014S	37 12 8	113 25 37	.10	<.02	.20	.030	20	N	N	N	10	100
CC100S	37 13 6	113 24 13	.20	.30	.30	.070	30	N	N	N	20	100
CC101S	37 12 53	113 26 50	1.50	.30	1.00	.100	100	N	N	N	10	150
CC102S	37 12 0	113 26 45	1.50	.50	1.00	.150	150	N	N	N	10	100
CC103S	37 11 53	113 26 17	.30	.05	.15	.050	20	N	N	N	10	100
CC104S	37 11 54	113 26 6	.05	<.02	<.05	.030	10	N	N	N	<10	20
CC105S	37 10 50	113 25 56	.50	.10	.30	.070	100	N	N	N	10	150
CC106S	37 10 45	113 29 55	.07	<.02	N	.015	10	N	N	N	10	70
CC107S	37 11 44	113 29 35	.30	.70	.20	.050	70	N	N	N	20	500
CC108S	37 13 44	113 26 26	1.50	.30	1.00	.150	100	N	N	N	15	200
CC109S	37 14 6	113 29 48	5.00	.70	1.50	.500	200	N	N	N	30	200
CC110S	37 14 34	113 30 47	.50	.30	3.00	.070	150	N	N	N	30	200
CC111S	37 13 30	113 31 46	1.00	.10	3.00	.050	100	N	N	N	10	100
CC200S	37 13 24	113 24 21	.10	.07	1.00	.020	30	N	N	N	10	70
CC201S	37 12 34	113 27 52	2.00	1.00	5.00	.150	200	N	N	N	20	300
CC202S	37 12 31	113 27 53	.20	.10	.15	.070	30	N	N	N	10	100
CC203S	37 11 59	113 26 47	1.00	.50	2.00	.100	150	N	N	N	15	200
CC204S	37 11 47	113 26 14	1.50	.50	1.50	.200	150	N	N	N	10	100
CC205S	37 10 59	113 27 22	.05	<.02	N	.015	20	N	N	N	30	30
CC206S	37 10 43	113 27 6	.05	<.02	<.05	.010	30	N	N	N	20	50
CC207S	37 11 35	113 28 55	.20	.02	<.05	.070	20	N	N	N	20	200
CC208S	37 11 10	113 28 38	.10	<.02	<.05	.015	30	N	N	N	10	70
CC209S	37 12 54	113 28 50	1.00	.30	1.00	.100	70	N	N	N	10	150
CC210S	37 13 37	113 29 19	1.00	.30	1.00	.100	100	N	N	N	10	150

TABLE 3. RESULTS FROM THE ANALYSES OF STREAM-SEDIMENT SAMPLES FROM THE COTTONWOOD CANYON WILDERNESS STUDY AREA, UTAH--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	Sc-ppm s
CC001S	<1	N	N	7	10	<5	20	N	N	10	N	N	<5
CC002S	N	N	N	N	N	N	N	N	N	N	N	N	N
CC003S	N	N	N	7	15	N	N	N	N	20	N	N	N
CC004S	N	N	N	N	N	N	N	N	N	N	N	N	N
CC005S	N	N	N	N	10	N	N	N	N	N	N	N	N
CC006S	N	N	N	15	20	10	50	N	N	10	N	N	7
CC007S	<1	N	N	5	10	<5	N	N	N	<5	N	N	N
CC008S	<1	N	N	10	15	5	N	N	N	15	N	N	<5
CC009S	<1	N	N	N	N	N	N	N	N	N	N	N	N
CC010S	N	N	N	N	N	N	N	N	N	N	N	N	N
CC011S	N	N	N	N	N	N	N	N	N	N	N	N	N
CC012S	N	N	N	N	N	N	N	N	N	N	N	N	N
CC013S	N	N	N	N	N	N	N	N	N	N	N	N	N
CC014S	N	N	N	N	N	N	N	N	N	N	N	N	N
CC100S	<1	N	N	N	<10	<5	N	N	N	N	N	N	N
CC101S	<1	N	N	10	15	10	30	N	N	10	N	N	5
CC102S	<1	N	N	10	20	10	20	N	N	10	N	N	7
CC103S	<1	N	N	N	N	N	N	N	N	N	N	N	N
CC104S	<1	N	N	N	N	N	N	N	N	N	N	N	N
CC105S	<1	N	N	N	<10	<5	N	N	N	N	N	N	N
CC106S	<1	N	N	N	N	N	N	N	N	N	N	N	N
CC107S	<1	N	N	5	20	N	N	N	N	30	N	N	N
CC108S	<1	N	N	10	20	7	N	N	N	10	N	N	5
CC109S	<1	N	N	20	100	20	70	7	<20	50	10	N	10
CC110S	<1	N	N	5	10	7	N	N	N	5	<10	N	N
CC111S	<1	N	N	7	10	5	N	N	N	10	N	N	N
CC200S	<1	N	N	N	N	N	N	N	N	N	N	N	N
CC201S	<1	N	N	15	50	20	30	N	N	15	20	N	7
CC202S	<1	N	N	N	10	N	N	N	N	7	N	N	N
CC203S	<1	N	N	10	20	7	20	N	N	15	N	N	7
CC204S	<1	N	N	10	30	7	20	N	N	15	N	N	7
CC205S	<1	N	N	N	N	N	N	N	N	<5	N	N	N
CC206S	<1	N	N	N	N	N	N	N	N	N	N	N	N
CC207S	N	N	N	N	N	N	N	N	N	N	N	N	N
CC208S	N	N	N	N	N	N	N	N	N	N	N	N	N
CC209S	<1	N	N	10	15	7	<20	N	N	10	N	N	5
CC210S	<1	N	N	10	15	7	<20	N	N	10	N	N	5

TABLE 3. RESULTS FROM THE ANALYSES OF STREAM-SEDIMENT SAMPLES FROM THE COTTONWOOD CANYON WILDERNESS STUDY AREA, UTAH--Continued

Sample	Sn-ppm s	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
CC001S	N	100	30	N	<10	N	50	N	<.1	8	<2	.1	<2	21
CC002S	N	N	N	N	N	N	30	N	<.1	<5	<2	<.1	<2	3
CC003S	N	100	20	N	N	N	100	N	<.1	<5	<2	<.1	<2	13
CC004S	N	100	<10	N	N	N	20	N	<.1	<5	<2	<.1	<2	3
CC005S	N	N	N	N	N	N	50	N	<.1	<5	<2	<.1	<2	4
CC006S	N	200	50	N	15	N	70	N	<.1	<5	<2	.3	<2	18
CC007S	N	100	15	N	10	N	100	N	<.1	<5	<2	.1	<2	16
CC008S	N	100	30	N	10	N	200	N	<.1	5	<2	.3	<2	30
CC009S	N	N	<10	N	N	N	50	N	<.1	<5	<2	<.1	<2	2
CC010S	N	N	<10	N	N	N	200	N	<.1	<5	<2	<.1	<2	2
CC011S	N	N	10	N	<10	N	150	N	<.1	<5	<2	<.1	<2	3
CC012S	N	N	N	N	N	N	100	N	<.1	<5	<2	<.1	<2	4
CC013S	N	N	<10	N	N	N	20	N	<.1	<5	<2	<.1	<2	<2
CC014S	N	N	<10	N	N	N	70	N	<.1	<5	<2	<.1	<2	2
CC100S	N	N	10	N	<10	N	200	N	<.1	<5	<2	<.1	<2	7
CC101S	N	200	50	N	<10	N	70	N	<.1	<5	<2	.2	<2	19
CC102S	N	150	50	N	10	N	50	N	<.1	<5	<2	.2	<2	11
CC103S	N	N	<10	N	<10	N	70	N	<.1	<5	<2	<.1	<2	9
CC104S	N	N	<10	N	N	N	30	N	<.1	<5	<2	<.1	<2	13
CC105S	N	100	30	N	N	N	500	N	<.1	<5	<2	<.1	<2	4
CC106S	N	N	<10	N	N	N	20	N	<.1	<5	<2	<.1	<2	3
CC107S	N	N	10	N	N	N	50	N	<.1	<5	<2	<.1	<2	5
CC108S	N	150	70	N	<10	N	50	N	<.1	<5	<2	.1	<2	10
CC109S	N	300	150	N	20	N	300	N	<.1	<5	<2	.3	<2	21
CC110S	N	100	20	N	10	N	700	N	<.1	<5	<2	.3	<2	21
CC111S	N	N	20	N	10	N	100	N	<.1	6	<2	.3	<2	23
CC200S	N	N	<10	N	N	N	150	N	<.1	<5	<2	<.1	<2	3
CC201S	N	300	70	N	20	N	200	N	<.1	<5	<2	.3	<2	20
CC202S	N	N	20	N	<10	N	50	N	<.1	<5	<2	<.1	<2	5
CC203S	N	200	50	N	10	N	150	N	<.1	<5	<2	.2	<2	15
CC204S	N	150	70	N	10	N	100	N	<.1	<5	<2	.1	<2	10
CC205S	N	N	N	N	N	N	70	N	<.1	<5	<2	<.1	<2	<2
CC206S	N	N	<10	N	N	N	20	N	<.1	<5	<2	<.1	<2	<2
CC207S	N	N	<10	N	N	N	100	N	<.1	<5	<2	<.1	<2	2
CC208S	N	N	<10	N	N	N	200	N	<.1	<5	<2	<.1	<2	2
CC209S	N	150	50	N	10	N	30	N	<.1	<5	<2	.1	<2	12
CC210S	N	150	50	N	10	N	70	N	<.1	<5	<2	.1	<2	13

TABLE 4. RESULTS FROM THE ANALYSES OF HEAVY-MINERAL-CONCENTRATE SAMPLES FROM THE COTTONWOOD CANYON WILDERNESS STUDY AREA, 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
CC001C	37 11 25	113 30 59	.5	.15	.30	1.0	70	N	N	N
CC002C	37 11 27	113 30 54	.5	.10	.20	.7	70	N	N	N
CC003C	37 11 5	113 31 10	.5	.10	<.10	1.5	70	N	N	N
CC004C	37 13 43	113 24 42	.3	.05	.20	1.5	50	N	N	N
CC005C	37 11 24	113 25 28	.7	.15	.20	1.5	100	N	N	N
CC006C	37 11 21	113 25 28	2.0	1.00	1.00	1.5	500	N	N	N
CC007C	37 12 9	113 31 23	.5	.10	.30	1.0	70	N	N	N
CC008C	37 12 8	113 31 25	.7	.15	.20	1.5	100	N	N	N
CC009C	37 11 44	113 30 29	.5	<.05	.10	.7	70	N	N	N
CC010C	37 11 44	113 30 31	.5	<.05	<.10	.5	50	N	N	N
CC011C	37 13 32	113 24 20	.5	<.05	.10	1.0	70	N	N	N
CC012C	37 12 59	113 30 29	.3	<.05	.10	.5	50	N	N	N
CC013C	37 12 9	113 25 42	1.5	<.05	<.10	2.0	100	N	N	N
CC014C	37 12 8	113 25 37	.7	<.05	<.10	1.0	100	N	N	N
CC100C	37 13 6	113 24 13	1.0	.05	.10	2.0	200	N	N	N
CC101C	37 12 53	113 26 50	.5	<.05	.10	1.5	70	N	N	N
CC102C	37 12 0	113 26 45	.7	.20	.50	.5	70	N	N	N
CC103C	37 11 53	113 26 17	1.5	.15	.20	1.5	150	N	N	N
CC104C	37 11 54	113 26 6	.7	<.05	<.10	1.0	100	N	N	N
CC105C	37 10 50	113 25 56	.7	<.05	<.10	1.0	100	N	N	N
CC106C	37 10 45	113 29 55	1.0	.05	<.10	2.0	100	N	N	N
CC107C	37 11 44	113 29 35	.5	<.05	<.10	1.0	100	N	N	N
CC108C	37 13 44	113 26 26	2.0	.05	.15	.3	20	N	N	N
CC109C	37 14 6	113 29 48	1.5	.50	.70	.7	100	N	N	N
CC110C	37 14 34	113 30 47	.5	<.05	<.10	.7	70	N	N	N
CC111C	37 13 30	113 31 46	1.0	.05	<.10	.5	150	N	N	N
CC200C	37 13 24	113 24 21	.5	.15	.20	.5	70	N	N	N
CC	37 12 34	113 27 52	.2	.05	.20	.2	50	N	N	N
CC202C	37 12 31	113 27 53	1.0	<.05	<.10	2.0	70	N	N	N
CC203C	37 11 59	113 26 47	2.0	1.00	.70	1.5	500	N	N	N
CC204C	37 11 47	113 26 14	.7	.10	.30	.5	70	N	N	N
CC205C	37 10 59	113 27 22	.5	N	N	.7	70	N	N	N
CC206C	37 10 43	113 27 6	.5	<.05	<.10	1.0	100	N	N	N
CC207C	37 11 35	113 28 55	.7	.07	<.10	1.5	70	N	N	N
CC208C	37 11 10	113 28 38	.5	<.05	N	1.0	50	N	N	N
CC209C	37 12 54	113 28 50	1.0	.70	1.50	1.5	300	N	N	N
CC210C	37 13 37	113 29 19	1.0	1.00	2.00	2.0	300	N	N	N

TABLE 4. RESULTS FROM THE ANALYSES OF HEAVY-MINERAL-CONCENTRATE SAMPLES FROM THE COTTONWOOD CANYON WILDERNESS STUDY AREA, 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
CC001C	50	>10,000	2	N	N	N	20	N	150	N	<50
CC002C	70	>10,000	N	N	N	N	50	N	<50	N	N
CC003C	100	>10,000	N	N	N	N	30	N	N	N	N
CC004C	100	>10,000	N	N	N	N	<20	N	N	N	N
CC005C	100	>10,000	N	N	N	N	70	<10	100	N	N
CC006C	150	>10,000	<2	N	N	15	70	N	200	N	N
CC007C	50	>10,000	N	N	N	N	20	N	100	N	N
CC008C	70	>10,000	<2	N	N	N	30	N	200	N	<50
CC009C	50	>10,000	N	N	N	N	50	N	N	N	N
CC010C	50	>10,000	N	N	N	N	<20	<10	N	N	N
CC011C	70	>10,000	N	N	N	N	<20	10	N	N	N
CC012C	30	>10,000	N	N	N	N	<20	<10	N	70	N
CC013C	100	5,000	N	N	N	10	100	N	N	N	N
CC014C	200	>10,000	N	N	N	10	100	N	N	N	N
CC100C	200	>10,000	N	N	N	10	150	N	N	N	N
CC101C	200	>10,000	N	N	N	N	50	N	N	N	N
CC102C	100	>10,000	N	N	N	N	20	10	50	N	N
CC103C	150	10,000	N	N	N	10	150	<10	50	N	N
CC104C	100	5,000	N	N	N	10	70	N	50	N	N
CC105C	150	>10,000	N	N	N	10	70	N	N	N	N
CC106C	200	>10,000	N	N	N	10	150	N	N	N	<50
CC107C	200	>10,000	N	N	N	10	50	N	N	N	N
CC108C	30	>10,000	N	N	N	10	<20	N	N	N	N
CC109C	70	>10,000	N	N	N	10	20	<10	100	N	N
CC110C	50	>10,000	N	N	N	N	20	N	N	N	N
CC111C	100	10,000	N	N	N	N	300	N	N	N	N
CC200C	70	7,000	N	N	N	N	30	N	N	N	N
CC	50	5,000	N	N	N	N	30	N	N	N	N
CC202C	300	>10,000	<2	N	N	N	150	N	N	N	N
CC203C	200	>10,000	<2	N	N	15	70	10	100	N	<50
CC204C	50	>10,000	N	N	N	N	100	N	100	N	N
CC205C	70	>10,000	N	N	N	N	70	N	N	N	N
CC206C	150	10,000	N	N	N	N	100	N	N	N	N
CC207C	200	7,000	N	N	N	N	100	N	N	N	N
CC208C	50	7,000	N	N	N	N	20	N	N	N	N
CC209C	100	>10,000	<2	N	N	10	70	<10	150	N	<50
CC210C	300	>10,000	<2	N	N	10	50	10	200	N	<50

TABLE 4. RESULTS FROM THE ANALYSES OF HEAVY-MINERAL-CONCENTRATE SAMPLES FROM THE COTTONWOOD CANYON WILDERNESS STUDY AREA, 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
CC001C	N	N	N	30	N	700	70	N	200	N	>2,000	N
CC002C	N	N	N	50	70	700	70	N	200	N	>2,000	<200
CC003C	<10	20	N	30	30	700	100	N	300	N	>2,000	N
CC004C	N	N	N	50	N	1,000	100	N	200	N	>2,000	N
CC005C	N	N	N	50	N	300	100	N	300	N	>2,000	N
CC006C	<10	50	N	50	20	1,000	150	N	200	N	>2,000	N
CC007C	N	100	N	30	N	500	70	N	300	N	>2,000	N
CC008C	<10	20	N	30	N	1,000	100	N	300	N	>2,000	N
CC009C	N	70	N	70	N	1,500	100	N	300	N	>2,000	N
CC010C	N	N	N	50	N	300	50	N	200	N	>2,000	N
CC011C	<10	N	N	50	70	1,500	50	N	300	N	>2,000	N
CC012C	N	100	N	50	N	2,000	150	N	200	N	>2,000	N
CC013C	<10	20	N	50	N	500	150	N	500	N	>2,000	N
CC014C	<10	N	N	70	N	200	100	N	300	N	>2,000	N
CC100C	<10	N	N	70	N	500	150	N	300	N	>2,000	N
CC101C	<10	N	N	70	N	700	100	N	300	N	>2,000	N
CC102C	N	N	N	10	N	700	50	N	100	N	>2,000	N
CC103C	<10	N	N	50	30	N	100	N	300	N	>2,000	N
CC104C	<10	N	N	70	N	200	100	N	500	N	>2,000	<200
CC105C	<10	N	N	50	N	200	100	N	500	N	>2,000	N
CC106C	<10	N	N	50	N	200	100	N	500	N	>2,000	N
CC107C	<10	30	N	70	N	300	100	N	500	N	>2,000	N
CC108C	N	N	N	10	N	300	50	N	100	N	>2,000	N
CC109C	<10	N	N	20	N	700	50	N	200	N	>2,000	N
CC110C	<10	50	N	50	N	2,000	70	N	500	N	>2,000	<200
CC111C	<10	<20	N	30	N	300	70	N	200	N	>2,000	N
CC200C	N	N	N	20	N	200	50	N	200	N	>2,000	N
CC	N	N	N	N	N	200	20	N	20	N	>2,000	N
CC202C	N	<20	N	100	N	N	150	N	500	N	>2,000	N
CC203C	10	N	N	50	N	1,500	150	N	200	N	>2,000	N
CC204C	N	N	N	20	N	700	50	N	150	N	>2,000	N
CC205C	N	N	N	70	N	N	70	N	500	N	>2,000	N
CC206C	N	N	N	50	N	N	70	N	300	N	>2,000	N
CC207C	<10	N	N	70	N	N	100	N	500	N	>2,000	N
CC208C	<10	N	N	70	N	N	70	N	500	N	>2,000	N
CC209C	<10	20	N	30	N	1,000	100	N	300	N	>2,000	N
CC210C	<10	<20	N	30	N	1,500	100	N	200	N	>2,000	N

TABLE 5. RESULTS FROM THE ANALYSES OF ROCK SAMPLES FROM THE COTTONWOOD CANYON WILDERNESS STUDY AREA, 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
CC015RA	0 0 0B	0 0 0B	2.00	3.00	5.00	.150	300	150.0	N	N	100	200	<1
CC007R	37 12 9	113 31 23	1.00	.05	.05	.070	100	N	N	N	50	200	<1
CC009R	37 11 44	113 30 29	.70	.50	>20.00	.050	300	N	N	N	10	50	N
CC009RA	37 11 44	113 30 29	1.00	.30	1.00	.100	200	N	N	N	100	150	<1
CC012R	37 12 59	113 30 29	.50	.20	2.00	.070	200	N	N	N	100	100	<1
CC012RA	37 12 59	113 30 29	<.05	N	5.00	<.002	N	N	N	N	N	N	<1
CC012RB	37 12 59	113 30 29	.15	<.02	.05	.020	N	N	N	N	10	70	<1
CC013R	37 12 9	113 25 42	.10	<.02	<.05	.020	10	N	N	N	10	100	<1
CC100RA	37 13 6	113 24 13	1.50	1.50	3.00	.150	500	N	N	N	50	1,000	<1
CC100RB	37 13 6	113 24 13	.50	1.00	2.00	.100	300	N	N	N	50	500	<1
CC101RA	37 12 53	113 26 50	.20	.03	<.05	.070	20	N	N	N	50	150	<1
CC101RB	37 12 53	113 26 50	2.00	1.00	3.00	.200	300	N	N	N	30	1,000	1
CC102R	37 12 0	113 26 45	.20	.05	.05	.070	200	N	N	N	30	200	<1
CC103R	37 11 53	113 26 17	.20	.03	<.05	.050	50	N	N	N	15	200	<1
CC104R	37 11 54	113 26 6	.20	.03	<.05	.030	20	N	N	N	10	200	<1
CC105R	37 10 50	113 25 56	.50	2.00	7.00	.100	500	N	N	N	50	2,000	<1
CC106R	37 10 45	113 29 55	.10	.02	.05	.020	10	N	N	N	10	150	<1
CC107RA	37 11 44	113 29 35	.15	1.00	>20.00	.020	70	N	N	N	10	200	N
CC107RB	37 11 44	113 29 35	.20	.03	2.00	.030	300	N	N	N	20	200	<1
CC108RA	37 13 44	113 26 26	.20	.05	.05	.070	20	N	N	N	50	200	<1
CC108RB	37 13 44	113 26 26	3.00	1.50	2.00	.300	700	N	N	N	20	700	1
CC109RA	37 14 6	113 29 48	3.00	1.00	3.00	.300	500	N	N	N	20	700	1
CC109RB	37 14 6	113 29 48	.10	.03	.15	.050	200	N	N	N	10	200	<1
CC110R	37 14 34	113 30 47	.50	1.50	>20.00	.070	300	N	N	N	30	50	N
CC200R	37 13 24	113 24 21	.30	.70	1.00	.100	150	N	N	N	50	300	<1
CC201R	37 12 34	113 27 52	.20	.05	.07	.030	10	N	N	N	30	100	<1
CC202R	37 12 31	113 27 53	.30	.03	<.05	.100	30	N	N	N	30	200	<1
CC203R	37 11 59	113 26 47	.20	.03	<.05	.020	15	N	N	N	10	200	<1
CC204R	37 11 47	113 26 14	.20	.03	.10	.050	30	N	N	N	30	200	<1
CC205R	37 10 59	113 27 22	.15	.03	<.05	.030	30	N	N	N	20	200	<1
CC206R	37 10 43	113 27 6	.10	.02	1.50	.020	500	N	N	N	15	300	<1
CC207R	37 11 35	113 28 55	.20	.02	.05	.030	30	N	N	N	20	200	<1
CC208R	37 11 10	113 28 38	.10	.03	<.05	.050	200	N	N	N	10	300	<1
CC209R	37 12 54	113 28 50	2.00	1.00	2.00	.200	500	N	N	N	30	500	1
CC210R	37 13 37	113 29 19	2.00	1.50	3.00	.200	700	<.5	N	N	30	700	1

TABLE 5. RESULTS FROM THE ANALYSES OF ROCK SAMPLES FROM THE COTTONWOOD CANYON WILDERNESS STUDY AREA, 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
CC015RA	N	N	15	70	200	20	10	N	20	15	N	10	N
CC007R	N	N	5	10	5	N	N	N	10	N	N	<5	N
CC009R	N	N	N	15	5	N	N	N	N	N	N	N	N
CC009RA	N	N	N	15	7	70	N	N	5	N	N	5	N
CC012R	N	N	N	10	5	50	N	N	N	N	N	<5	N
CC012RA	N	N	N	N	N	N	N	N	N	N	N	N	N
CC012RB	N	N	N	N	N	N	N	N	N	N	N	N	N
CC013R	N	N	N	N	N	N	N	N	N	N	N	N	N
CC100RA	N	N	7	20	15	20	N	N	5	10	N	7	N
CC100RB	N	N	5	30	10	N	N	N	5	N	N	<5	N
CC101RA	N	N	N	N	N	N	N	N	N	N	N	N	N
CC101RB	N	N	20	50	30	70	N	N	15	15	N	10	N
CC102R	N	N	N	<10	N	N	N	N	N	N	N	N	N
CC103R	N	N	N	<10	N	N	N	N	N	N	N	N	N
CC104R	N	N	N	10	N	N	N	N	N	N	N	N	N
CC105R	N	N	5	20	10	N	N	N	N	N	N	N	N
CC106R	N	N	N	N	N	N	N	N	N	N	N	N	N
CC107RA	N	N	N	10	5	N	N	N	N	N	N	N	N
CC107RB	N	N	N	N	N	N	N	N	N	N	N	N	N
CC108RA	N	N	N	15	N	N	N	N	N	<10	N	N	N
CC108RB	N	N	20	30	50	70	N	N	30	20	N	10	N
CC109RA	N	N	20	30	30	50	N	N	20	20	N	15	N
CC109RB	N	N	N	<10	5	N	N	N	N	N	N	N	N
CC110R	N	N	N	15	10	N	N	N	5	15	N	N	N
CC200R	N	N	N	15	5	N	N	N	<5	N	N	N	N
CC201R	N	N	N	10	5	N	N	N	N	10	N	N	N
CC202R	N	N	N	10	N	N	N	N	N	N	N	N	N
CC203R	N	N	N	<10	N	N	N	N	5	N	N	N	N
CC204R	N	N	N	10	N	N	N	N	N	N	N	N	N
CC205R	N	N	N	10	N	N	N	N	N	N	N	N	N
CC206R	N	N	N	N	10	N	N	N	N	N	N	N	N
CC207R	N	N	N	10	N	N	N	N	N	N	N	N	N
CC208R	N	N	N	10	N	N	N	N	N	N	N	N	N
CC209R	N	N	20	50	30	50	7	N	15	15	N	10	N
CC210R	N	N	20	50	70	70	7	N	20	20	N	10	N

TABLE 5. RESULTS FROM THE ANALYSES OF ROCK SAMPLES FROM THE COTTONWOOD CANYON WILDERNESS STUDY AREA, 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
CC015RA	100	70	N	20	N	100	N	<.1	6	<2	.5	5	22	--	--
CC007R	N	20	N	N	N	200	N	<.1	15	<2	<.1	12	31	<1.20	.841
CC009R	150	30	N	10	N	50	N	<.1	<5	<2	.1	<2	8	<1.20	.530
CC009RA	N	50	N	50	N	100	N	<.1	<5	<2	<.1	<2	7	4.60	4.590
CC012R	100	30	N	15	N	50	N	<.1	<5	<2	<.1	<2	7	<2.60	5.530
CC012RA	200	<10	N	N	N	N	N	<.1	<5	<2	<.1	<2	<2	<.92	<.081
CC012RB	N	<10	N	N	N	70	N	<.1	<5	<2	<.1	<2	<2	<.98	.234
CC013R	N	<10	N	N	N	30	N	<.1	<5	<2	<.1	<2	<2	<.98	.209
CC100RA	150	50	N	30	N	200	N	<.1	<5	<2	.1	3	14	9.07	2.810
CC100RB	100	30	N	15	N	300	N	<.1	<5	<2	.1	3	8	5.30	2.290
CC101RA	N	<10	N	N	N	100	N	<.1	<5	<2	<.1	<2	<2	1.60	.382
CC101RB	500	100	N	20	N	70	N	<.1	<5	<2	<.1	<2	13	22.00	4.970
CC102R	N	<10	N	<10	N	100	N	<.1	<5	<2	<.1	<2	3	<1.10	.387
CC103R	N	<10	N	<10	N	100	N	<.1	<5	<2	<.1	<2	2	1.40	.325
CC104R	N	<10	N	<10	N	50	N	<.1	<5	<2	<.1	<2	2	1.20	.278
CC105R	150	20	N	15	N	200	N	<.1	<5	<2	.2	6	<2	2.90	1.120
CC106R	N	<10	N	<10	N	70	N	<.1	<5	<2	<.1	<2	<2	<.98	.242
CC107RA	200	10	N	N	N	20	N	<.1	<5	<2	.1	3	3	<1.30	.883
CC107RB	N	10	N	N	N	100	N	<.1	<5	<2	<.1	<2	11	1.20	.295
CC108RA	N	10	N	<10	N	100	N	<.1	<5	<2	<.1	<2	<2	<1.10	.325
CC108RB	500	100	N	15	N	150	N	<.1	<5	<2	<.1	<2	35	18.80	4.400
CC109RA	700	100	N	20	N	200	N	<.1	<5	<2	<.1	<2	32	20.40	4.200
CC109RB	N	10	N	10	N	70	N	<.1	<5	<2	<.1	6	<2	<1.30	.265
CC110R	150	30	N	<10	N	30	N	<.1	<5	<2	1.3	2	150	<1.80	1.070
CC200R	N	20	N	<10	N	300	N	<.1	<5	<2	<.1	<2	2	2.20	.797
CC201R	N	<10	N	<10	N	100	N	<.1	<5	<2	<.1	<2	3	<1.30	.344
CC202R	N	20	N	<10	N	>1,000	N	<.1	<5	<2	<.1	<2	<2	1.80	.482
CC203R	N	10	N	N	N	100	N	<.1	<5	<2	<.1	<2	3	<1.20	.253
CC204R	N	10	N	<10	N	500	N	<.1	<5	<2	<.1	<2	2	<1.20	.310
CC205R	N	10	N	<10	N	200	N	<.1	<5	<2	<.1	<2	2	<1.30	.313
CC206R	N	<10	N	N	N	70	N	<.1	<5	<2	<.1	<2	5	1.40	.180
CC207R	N	10	N	N	N	100	N	<.1	<5	<2	<.1	<2	<2	<1.30	.180
CC208R	N	<10	N	N	N	50	N	<.1	<5	<2	<.1	<2	<2	<1.20	.271
CC209R	500	100	N	20	N	500	N	<.1	<5	<2	<.1	<2	28	20.80	4.470
CC210R	500	70	N	20	N	100	N	<.1	<5	<2	<.1	<2	36	22.30	5.240