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 Gunnison Gorge Wilderness Study Area (CO-030-388), Delta and Montrose Counties, 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 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 Gunnison Gorge Wilderness Study Area (WSA), Delta and Montrose Counties, Colorado.

## INTRODUCTION

In August 1987, the U.S. Geological Survey conducted a reconnaissance geochemical survey of the Gunnison Gorge Wilderness Study Area (CO-030-388) in northeast Montrose and southeast Delta Counties, Colorado (fig. 1). The WSA lies along the canyon of the Gunnison River, adjacent to and downstream (west) from the Black Canyon of the Gunnison National Monument for approximately 13 miles to near Gunnison Forks, the confluence with the North Fork. The 21,038 acre (33 square mile) WSA is 6 miles northeast of Montrose and 12 miles southeast of Delta.

Access to the rim of the canyon is along jeep roads and off-trail hiking over rugged terrain. The canyon bottom is reached by four trails descending the west side of the steep canyon or by raft.

The gorge formed by superimposition of the Gunnison River, in which down-cutting through a relatively soft cover of sedimentary rocks trapped the course of the river in underlying hard crystalline rocks in the core of the Gunnison uplift. The gorge is characterized by flaring canyon walls of Mesozoic sedimentary rocks at the top, surmounting an inner gorge cut through a variety of Proterozoic igneous and metamorphic rocks. Upstream along the Gunnison River and southeast of the study area, the upper canyon walls are less defined by sedimentary rocks than by Tertiary volcanic welded tuffs, but the spectacular lower walls still consist of Proterozoic basement rocks.

The Mesozoic sedimentary section in the study area consists of, from oldest to youngest, Entrada Sandstone, Wanakah Formation, Jurassic Morrison Formation, Burro Canyon Formation, and Cretaceous Dakota Sandstone. The Cretaceous Mancos Shale, which overlies the Dakota Sandstone, occurs mainly outside of the study area. The Tertiary volcanic rocks that overlie the sedimentary section to the east are not found within the study area.

The Proterozoic basement rocks consist of a variety of igneous and metamorphic rocks in the vicinity of the study area. The most abundant rock type in the study area is the Pitts Meadow Granodiorite which is intruded by felsite, pegmatite, several types of granitic rock, and diabase. Amphibolite, mica schist, and several gneiss units crop out in the southern part of the study area.

## 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.

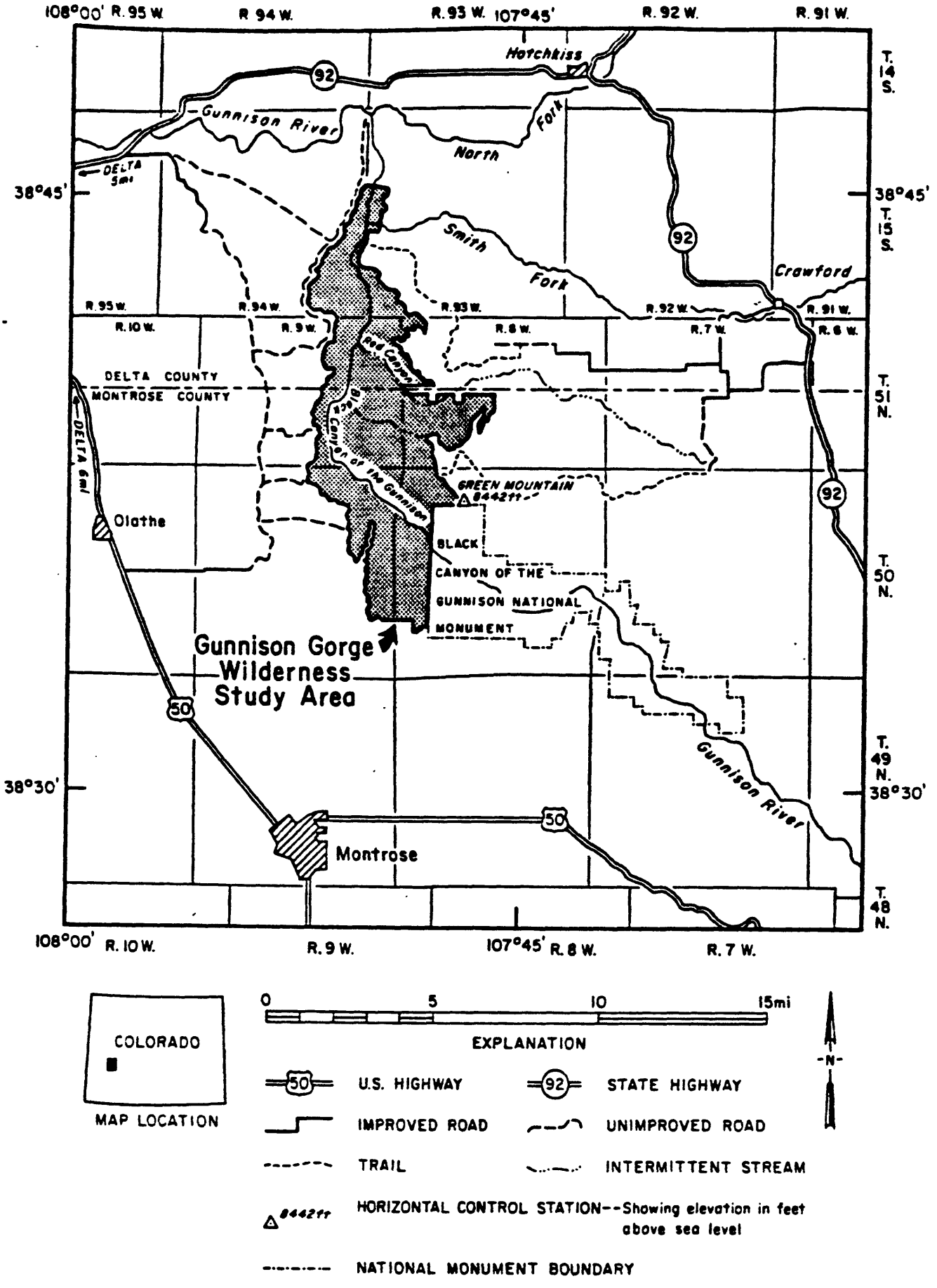


Figure 1.--Index map of the Gunnison Gorge Wilderness Study Area, Delta and Montrose Counties, Colorado.

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.

## Sample Collection

Samples were collected at 10 sites in the WSA (see plate 1). All but one were on tributary drainages near their confluence with the Gunnison River. The remaining site was on the Gunnison River. Every tributary drainage to the river within the WSA was sampled. At all sites, both a stream-sediment sample and a heavy-mineral-concentrate sample were collected. Sampling density was about one sample site per 3.3 square miles or one site per 1.3 linear river miles. The area of the drainage basins sampled ranged from 0.2 to 20 square miles. Sufficient heavy-mineral-concentrate for spectrographic analysis (5 mg) was recovered from all sites. Seven rock samples were collected from five of the sites.

### 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 outcrops of unmineralized rock. A description of the rock type collected at each site is given in table 6.

## 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 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.

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

## Sample Analysis

### Spectrographic Method

Stream-sediment, heavy-mineral-concentrate, and rock samples were analyzed for 35 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 stream sediments, heavy-mineral concentrates, and rocks are listed in tables 3, 4, and 5 respectively.

### Chemical Methods

The stream-sediment and rock samples were also analyzed by inductively coupled plasma atomic emission spectroscopy (ICP) for arsenic (As), bismuth (Bi), cadmium (Cd), antimony (Sb), and zinc (Zn). In addition, the stream-sediment samples were analyzed by atomic absorption emission spectroscopy (AA) for gold (Au) and by ultraviolet fluorimetry (UF) for uranium (U). 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 (VanTrump and Miesch, 1976).

## DESCRIPTION OF DATA TABLES

Tables 3, 4, and 5 list the analyses for 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 the site location map (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, "uf" indicates ultraviolet fluorimetry analyses, and "ICP" indicates inductively coupled plasma 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 the 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) 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


Centanni, F.A., Ross, A.M., and DeSesa, M.A., 1956, Fluorometric determinations of uranium: Analytical Chemistry, v. 28, p. 1,651.

Crock, J.G., Briggs, P.H., Jackson, L.L., and Lichte, F.E., 1987, Analytical methods for the analysis of stream sediments and rocks from Wilderness Study Areas: U.S. Geological Survey Open-File Report 87-84, 35 p.

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

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.

O'Leary, R.M., and Meier, A.L., 1986, Analytical methods used in geochemical exploration, 1984: U.S. Geological Survey Circular 948, 48 p.

Thompson, C.E., Nakagawa, H.M., and Van Sickle, G.H., 1968, Rapid analysis for gold in geologic materials, in Geological Survey research 1968: U.S. Geological Survey Professional Paper 600-B, p. B130-B132.

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 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 listed, except as noted]

| Elements | Lower determination limit | Upper determination limit |
|---|---|---|
| | Weight percent | |
| Calcium (Ca) | 0.05 | 20 |
| Iron (Fe) | .05 | 20 |
| Magnesium (Mg) | .02 | 10 |
| Sodium (Na) | .2 | 5 |
| Phosphorus (P) | .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.--Analytical methods used other than emission spectrography

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

| Element determined | Sample type | Method | Lower determination limit, ppm | References |
|---|---|---|---|---|
| Arsenic (As) | rock/stream sediment | ICP | 5 | Crock and others, 1987. |
| Antimony (Sb) | rock/stream sediment | ICP | 2 | |
| Bismuth (Bi) | rock/stream sediment | ICP | 2 | |
| Cadmium (Cd) | rock/stream sediment | ICP | 0.1 | |
| Zinc (Zn) | rock/stream sediment | ICP | 2 | |
| Uranium (U) | rock/stream sediment | UF | 0.1 | Centanni and others, 1956; O'Leary and Meier, 1986. |
| Gold (Au) | stream sediment | AA | 0.1 | Thompson and others, 1968; O'Leary and Meier, 1986. |

TABLE 3--ANALYTICAL RESULTS OF STREAM-SEDIMENT SAMPLES FROM THE GUNNISON GORGE WILDERNESS STUDY AREA, DELTA AND MONTROSE COUNTIES, COLORADO.

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

| Sample | Latitude | Longtude | 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 | Bi-ppm s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GG001S | 38 37 18 | 107 49 53 | 1.5 | 1.0 | 7.0 | .15 | 300 | N | N | N | 20 | 1,500 | <1 | N |
| GG002S | 38 37 48 | 107 50 13 | 2.0 | 1.0 | 3.0 | .20 | 300 | N | N | N | 20 | 700 | <1 | N |
| GG003S | 38 38 13 | 107 51 25 | 2.0 | .7 | 5.0 | .20 | 500 | N | N | N | 50 | 3,000 | <1 | N |
| GG004S | 38 39 47 | 107 50 58 | 2.0 | 1.5 | 3.0 | .30 | 500 | N | N | N | 50 | 1,500 | 1 | N |
| GG005S | 38 39 53 | 107 50 52 | 2.0 | 3.0 | 10.0 | .20 | 300 | N | N | N | 50 | 700 | <1 | N |
| GG006S | 38 41 7 | 107 50 30 | 1.0 | .3 | 2.0 | .15 | 500 | N | N | N | 30 | 3,000 | <1 | N |
| GG007S | 38 41 40 | 107 50 5 | 1.5 | 1.5 | 3.0 | .30 | 300 | N | N | N | 30 | 1,500 | <1 | N |
| GG008S | 38 43 18 | 107 50 57 | 1.5 | .7 | 2.0 | .20 | 300 | <.5 | N | N | 50 | 1,500 | <1 | N |
| GG009S | 38 44 13 | 107 50 14 | 10.0 | 2.0 | 10.0 | .70 | 1,500 | N | N | N | 10 | 2,000 | 1 | N |
| GG010S | 38 42 19 | 107 50 9 | >20.0 | 1.5 | .5 | 1.00 | 5,000 | N | N | N | <10 | 500 | N | N |

| Sample | 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 | Sr-ppm s | V-ppm s | W-ppm s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GG001S | N | N | 10 | 15 | N | <5 | N | <5 | 10 | N | <5 | N | 700 | 50 | N |
| GG002S | N | <10 | 10 | 20 | N | N | N | 5 | 15 | N | 5 | N | 150 | 50 | N |
| GG003S | N | N | 15 | 15 | N | N | N | <5 | 20 | N | 5 | N | 200 | 50 | N |
| GG004S | N | <10 | 10 | 20 | N | N | <20 | 5 | 20 | N | 7 | N | 200 | 70 | N |
| GG005S | N | <10 | 10 | 30 | N | N | N | <5 | 30 | N | 5 | N | 500 | 70 | N |
| GG006S | N | N | 15 | 10 | N | N | N | <5 | 10 | N | <5 | N | 300 | 50 | N |
| GG007S | N | N | 15 | 15 | N | N | N | <5 | 20 | N | <5 | N | 300 | 50 | N |
| GG008S | N | N | 30 | 15 | N | N | N | N | 10 | N | <5 | N | 200 | 50 | N |
| GG009S | N | 20 | 10 | 10 | <50 | N | N | 10 | 15 | N | 10 | N | 500 | 200 | N |
| GG010S | N | 150 | 150 | 70 | 70 | N | N | 30 | 100 | N | 15 | N | 150 | 1,000 | N |

| Sample | Y-ppm s | Zn-ppm s | Zr-ppm s | Ga-ppm s | Ge-ppm s | Na-pct. s | P-pct. s | Th-ppm s | As-ppm icp | Bi-ppm icp | Cd-ppm icp | Sb-ppm icp | Zn-ppm icp | Au-ppm aa | U-ppm uf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GG001S | <10 | N | 200 | 10 | N | .2 | N | N | <5 | <2 | .2 | <2 | 12 | <.05 | .55 |
| GG002S | 15 | N | 200 | 15 | N | .3 | N | N | <5 | <2 | .3 | <2 | 18 | <.05 | .85 |
| GG003S | 10 | N | 1,000 | 30 | N | .7 | N | N | <5 | <2 | .3 | <2 | 15 | <.05 | .65 |
| GG004S | 20 | N | 500 | 30 | N | 1.0 | N | N | <5 | <2 | .3 | <2 | 20 | <.05 | .65 |
| GG005S | 10 | N | 200 | 50 | N | 1.0 | N | N | <5 | <2 | .3 | <2 | 16 | <.05 | .55 |
| GG006S | 10 | N | 150 | 5 | N | .2 | N | N | <5 | <2 | .2 | <2 | 18 | .15 | .80 |
| GG007S | 20 | N | 1,000 | 30 | N | 1.0 | N | N | <5 | <2 | .3 | <2 | 21 | <.05 | .80 |
| GG008S | 15 | N | 300 | 15 | N | .5 | N | N | 7 | <2 | .3 | <2 | 22 | <.05 | .90 |
| GG009S | 30 | <200 | 300 | 70 | N | 2.0 | N | N | <5 | <2 | 1.8 | <2 | 78 | <.05 | 1.40 |
| GG010S | 100 | 300 | >1,000 | 300 | N | 1.0 | N | N | 6 | 5 | 7.3 | <2 | 360 | <.05 | 1.80 |

TABLE 4--ANALYTICAL RESULTS OF HEAVY-MINERAL-CONCENTRATE SAMPLES FROM THE GUNNISON GORGE WILDERNESS STUDY AREA, DELTA AND MONTROSE COUNTIES, 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GG001C | 38 37 18 | 107 49 53 | .20 | .30 | 1.5 | .5 | 50 | <1 | N | N | N | >10,000 |
| GG002C | 38 37 48 | 107 50 13 | .30 | .30 | 3.0 | 1.0 | 200 | <1 | N | N | 20 | >10,000 |
| GG003C | 38 38 13 | 107 51 25 | .20 | .20 | 1.5 | .7 | 50 | N | N | N | N | >10,000 |
| GG004C | 38 39 47 | 107 50 58 | .20 | .50 | 5.0 | 1.0 | 70 | N | N | N | <20 | >10,000 |
| GG005C | 38 39 53 | 107 50 52 | .20 | .50 | 1.0 | .3 | 100 | N | N | N | N | >10,000 |
| GG006C | 38 41 7 | 107 50 30 | 3.00 | .20 | 2.0 | 1.0 | 150 | 2 | N | N | N | >10,000 |
| GG007C | 38 41 40 | 107 50 5 | .15 | .20 | .7 | .3 | 70 | <1 | N | N | N | >10,000 |
| GG008C | 38 43 18 | 107 50 57 | .10 | .15 | 2.0 | .7 | 100 | 1 | N | N | <20 | >10,000 |
| GG009C | 38 44 13 | 107 50 14 | .15 | .15 | 3.0 | .2 | 150 | N | N | N | 50 | >10,000 |
| GG010C | 38 42 19 | 107 50 9 | .20 | .10 | 2.0 | .7 | 200 | 20 | N | N | <20 | >10,000 |

| 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 | Sn-ppm s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GG001C | N | N | N | N | N | N | N | N | N | N | 200 | N | N | N |
| GG002C | N | N | N | N | N | N | <100 | N | N | N | <20 | N | N | N |
| GG003C | N | N | N | N | N | <10 | <100 | N | N | N | <20 | N | 20 | N |
| GG004C | N | N | N | N | N | N | N | N | N | N | 20 | N | 15 | N |
| GG005C | N | N | N | N | N | <10 | N | 20 | N | N | 150 | N | N | N |
| GG006C | 15 | N | N | N | N | N | N | N | N | N | 20 | N | <10 | N |
| GG007C | N | N | N | N | N | N | 100 | N | N | N | 150 | N | <10 | N |
| GG008C | N | N | N | N | N | N | 100 | N | <50 | N | N | N | <10 | N |
| GG009C | N | N | N | N | N | N | 150 | N | N | N | N | N | 15 | N |
| GG010C | 7 | 500 | 50 | N | N | 10 | <100 | 30 | <50 | N | 1,000 | N | 70 | 700 |

| Sample | Sr-ppm s | V-ppm s | W-ppm s | Y-ppm s | Zn-ppm s | Zr-ppm s | Ga-ppm s | Ce-ppm s | Na-pct. s | P-pct. s | Th-ppm s | Pt-ppm s | Pd-ppm s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GG001C | >10,000 | <20 | N | 50 | N | >2,000 | N | N | N | N | N | N | N |
| GG002C | 10,000 | 30 | N | 100 | N | >2,000 | N | N | N | 1.0 | N | N | N |
| GG003C | 10,000 | 20 | N | 200 | N | >2,000 | N | N | N | <.5 | N | N | N |
| GG004C | 7,000 | 20 | N | 200 | N | >2,000 | N | N | N | .5 | N | N | N |
| GG005C | >10,000 | 20 | N | 70 | N | >2,000 | <10 | N | N | N | N | N | N |
| GG006C | 10,000 | 50 | N | 100 | N | >2,000 | <10 | N | N | 1.0 | N | N | N |
| GG007C | 10,000 | <20 | N | 70 | N | >2,000 | N | N | N | N | N | N | N |
| GG008C | 10,000 | <20 | N | 70 | N | >2,000 | N | N | N | .7 | N | N | N |
| GG009C | 7,000 | 20 | N | 150 | N | >2,000 | 10 | N | N | 1.0 | N | N | N |
| GG010C | 2,000 | 30 | 700 | 500 | 1,000 | >2,000 | 20 | N | 1.5 | 2.0 | N | N | N |

TABLE 5--ANALYTICAL RESULTS OF ROCK SAMPLES FROM THE GUNNISON GORGE WILDERNESS STUDY AREA, DELTA AND MONTROSE COUNTIES, 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GG001R | 38 57 18 | 107 49 53 | 7 | 1 | 1.5 | .50 | 1,500 | N | N | N | <10 | 1,500 | 1.5 |
| GG001X | 38 37 18 | 107 49 53 | 1 | 2 | 5.0 | .15 | 300 | N | N | N | 30 | 1,000 | N |
| GG002R | 38 37 48 | 107 50 13 | 10 | 5 | 3.0 | .70 | 1,000 | N | N | N | 20 | 1,000 | 2.0 |
| GG004R | 38 39 47 | 107 50 58 | 10 | 7 | 5.0 | .50 | 1,500 | N | N | N | <10 | 700 | 3.0 |
| GG004X | 38 39 47 | 107 50 58 | 3 | 2 | 3.0 | .30 | 200 | .5 | N | N | 50 | 500 | <1.0 |
| GG007R | 38 41 40 | 107 50 5 | 15 | 5 | 3.0 | .70 | 1,500 | N | N | N | <10 | 150 | <1.0 |
| GG008R | 38 43 18 | 107 50 57 | 15 | 5 | 7.0 | .70 | 3,000 | N | N | N | <10 | 100 | 10.0 |

| 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 | Sr-ppm s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GG001R | N | N | 10 | 10 | 30 | 50 | N | <20 | N | 15 | N | 20 | N | 300 |
| GG001X | N | N | N | N | <5 | N | N | N | N | 10 | N | N | N | 200 |
| GG002R | N | N | 30 | 200 | 70 | 70 | N | N | 100 | 30 | N | 20 | N | 300 |
| GG004R | N | N | 50 | 150 | 50 | <50 | N | N | 150 | 20 | N | 20 | N | 300 |
| GG004X | N | N | <10 | 15 | 50 | N | N | 20 | 5 | 50 | N | 7 | N | 200 |
| GG007R | N | N | 70 | <10 | 20 | N | N | N | 20 | 10 | N | 50 | N | 300 |
| GG008R | N | N | 70 | 50 | 10 | N | N | N | 100 | <10 | N | 50 | N | 200 |

| Sample | V-ppm s | W-ppm s | Y-ppm s | Zn-ppm s | Zr-ppm s | Ga-ppm s | Ge-ppm s | Na-pct. s | P-pct. s | Th-ppm s | As-ppm icp | Bi-ppm icp | Cd-ppm icp | Sb-ppm icp | Zn-ppm icp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GG001R | 70 | N | 70 | N | 500 | 100 | N | 5.0 | N | N | <5 | 3 | .4 | <2 | 74 |
| GG001X | 50 | N | N | N | 500 | 15 | N | <.2 | N | N | <5 | <2 | .2 | <2 | 11 |
| GG002R | 200 | N | 30 | N | 200 | 150 | N | 5.0 | N | N | <5 | <2 | .1 | <2 | 27 |
| GG004R | 200 | N | 20 | N | 70 | 150 | N | 5.0 | N | N | <5 | <2 | .3 | <2 | 30 |
| GG004X | 100 | N | 20 | N | 500 | 70 | N | .2 | N | N | 21 | <2 | .3 | <2 | 41 |
| GG007R | 300 | N | 15 | <200 | 50 | 100 | N | 3.0 | N | N | <5 | 2 | .5 | <2 | 33 |
| GG008R | 500 | N | 30 | <200 | 100 | 70 | N | 1.5 | N | N | <5 | <2 | .2 | <2 | 19 |

TABLE 6

DESCRIPTION OF ROCK SAMPLES

GG001R.....gneiss
GG001X.....entrada sandstone
GG002R.....hornblendite
GG004R.....gneiss
GG004X.....entrada sandstone
GG007R.....gneiss
GG008R.....gneiss