STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents partial results of a geochemical survey of the Buffalo Peaks Wilderness Study Area, Pike and San Isabel National Forests, Lake, Park, and Chaffee Counties, Colo. The Buffalo Peaks Wilderness Study Area was classified as a wilderness study area by Public Law 96-560, December 22, 1980.

INTRODUCTION

This report presents results of geochemical studies carried out in June and July of 1982 in the Buffalo Peaks Wilderness Study Area, Colo. (see index map). Samples of water were collected from 84 streams and 18 springs draining the study area. Tabulations of the analyses and a sample locality map are in Ficklin and others (1984). The geochemistry of stream sediments and panned concentrates of the study area is in Nowlan and Gerstel (1985). The geology of the study area and vicinity is in Hedlund (1985). The mineral resource potential of the study area is described in Hedlund and others (1983). This report (1) assists in the assessment of the mineral resource potential of the Buffalo Peaks Wilderness Study Area; and (2) compares analyses of water samples with analyses of stream-sediment and panned-concentrate samples (Nowlan and Gerstel, 1985).

Geology and mineralization

The Buffalo Peaks Wilderness Study Area is a major part of the Mosquito Range, which is structurally part of the east flank of the northwest-trending Sawatch anticline. Precambrian igneous and metamorphic rocks of the core of the anticline are exposed in the west two-thirds of the study area while bedrock in the east one-third is made up mostly of east-dipping Paleozoic sedimentary rocks. The Precambrian rocks include older Proterozoic migmatite, amphibolite, and granodiorite intruded by younger Proterozoic granitic rocks. The Paleozoic sedimentary rocks include Cambrian Sawatch Quartzite, Ordovician Manitou Dolomite, Ordovician Harding Sandstone, Ordovician Fremont Dolomite, Devonian and Mississippian(?) Chaffee Group (dolomite, sandstone, and limestone), Lower Mississippian Leadville Limestone, Pennsylvanian Belden Formation (shale, sandstone, minor amounts of limestone and siltstone), and Middle Pennsylvanian Minturn Formation (sandstone and minor conglomerate; some shale, gypsum, and limestone). In the vicinity of East and West Buffalo Peaks, the sequence of Paleozoic sedimentary rocks is covered by Tertiary extrusive rocks.

Major faults throughout the study area are generally parallel to the northwest trend of the Sawatch anticline and the Arkansas River valley, which is an expression of the Arkansas River segment of the Rio Grande depression. Some faults are probably of late Precambrian age with major recurrent displacement on most faults during Laramide time and in the Miocene and Pliocene.

The study area is bounded by several areas of known mineralization (Hedlund and others, 1983). Silver, zinc, and lead in the vicinity of Weston Pass (map A), on the northeastern border of the study area, were mined until about 1918; ores containing these metals are in the form of disseminations, vug fillings, and bedding replacement bodies within silicified fault breccias in carbonate rocks. Gold and silver were mined from veins in the Granite area (index map and map A), on the northwestern border of the study area, until about 1880, and minor prospecting activity still continues. The veins are quartz-pyrite-gold veins that are generally in migmatite, contain anomalous concentrations of boron, and are probably related to the intrusion of associated rhyolite dikes. In the vicinity of Fourmile Creek, near the southwestern border of the study area (map A), quartz-pyrite-gold veins were mined in the past. The veins are localized along faults in granitic rocks; do not have anomalous concentrations of boron, contain anomalous concentrations of bismuth, molybdenum, and tin; are not associated with rhyolite dikes; and contain some uranium. Prospecting for uranium has recently been taking place in the vicinity of the Middle Fork of Salt Creek on the southeastern border of the study area (map A). The uranium is mostly in vuggy jasperoid deposits near the top of the Cambrian Sawatch Quartzite.

GEOCHEMICAL SAMPLING AND ANALYTICAL METHODS

Sampling density for streams was about one site per square mile. In addition, springs were sampled when encountered. Temperature, pH, and specific conductance were measured at the site. At each site, a 50-ml portion of water was filtered through a 0.45-micron membrane filter into an acid-washed polyethylene bottle and acidified to pH 1-2 with concentrated nitric acid. The filtered, acidified sample was later analyzed for the major elements calcium, magnesium, sodium, and potassium by flame atomic-absorption spectroscopy; for the trace elements iron, manganese, aluminum, silver, arsenic, cobalt, copper, molybdenum, nickel, lead, and zinc by flameless atomic-absorption spectroscopy; and for uranium by fluorimetry. A second untreated sample from each site was later analyzed for alkalinity by titration; for silica by flame atomic-absorption spectroscopy; and for sulfate, chloride, fluoride, nitrate, phosphate, and bromide by ion chromatography. References to methods of analysis are given by Ficklin and others (1984).

Alkalinity is assumed in this study to be due to bicarbonate ion and is reported as mg/L HCO_3^-. This assumption may not be strictly correct, but the reported values are probably within a few percent of the correct values; the most serious deviations resulting from the assumption would probably occur in ground water of much higher pH and a higher silica:bicarbonate ratio than any water sampled in this study (Hem, 1970, p. 153-154).

RESULTS

Table 1 is a statistical summary of the data. The samples were analyzed for bromide, nitrate, and phosphate, but the concentrations were generally less than the lower limit of determination (0.1 mg/L); therefore, these constituents are omitted from this report. Table 1 includes statistics for the raw data and for the data after any value less than the lower limit of determination was replaced by 0.7 of the lower limit.

Table 2 lists geometric means for stream samples and spring samples separately. On the basis of specific conductance measurements, total dissolved solids are higher in water that is in contact with carbonate-rich Paleozoic sedimentary rocks than in water elsewhere in the study area. Twelve of the 18 springs that were sampled are in or adjacent to areas underlain by Paleozoic sedimentary rocks; this partially explains why the geometric mean is higher for most constituents in spring water than in stream water. The similarities between stream and spring water are more important than the differences; therefore, the stream and spring water are not separated elsewhere in this report. In some cases, the classification of a source as a stream or a spring was very subjective.

Correlation coefficients are in table 3 and are based on logs of the replaced values. Histograms of the analyses for each constituent approximate a lognormal distribution. Replaced data were used in the correlation analysis because the correlation coefficients were used for R-mode factor analysis. R-mode factor analysis requires a correlation matrix derived from a set of data containing the same number of samples for all variables. Miesch (1976, p. 53) suggests that the use of replacement values will probably not bias the results of correlation analysis as long as approximately 80 percent of the values for any given variable are unqualified. Unqualified values are values from the lower to the upper limit of determination. Except for uranium, which has 75 percent unqualified values, the other variables are well above 80 percent unqualified.

Table 4 lists percentiles based on ranking the values for each constituent and determining the analytical value of the sample or samples that fall at selected percentile levels.

Geochemical patterns

Maps B through H show the distribution of some of the water constituents that show areal geochemical patterns. Symbols shown on the maps represent concentration ranges based on approximately the 50th, 75th, and 90th percentiles (table 4). We have defined concentrations at approximately the 90th percentile and greater as being anomalous. However, because the study area adjoins several mining districts, the coincidence of geochemical patterns and areas of known mineralization is more significant than an arbitrary decision of what is anomalous.

Several constituents show patterns of high concentrations that coincide with areas of known mineralization, especially with parts of the Granite-Two Bit mineralized area (map A, area B). Copper and fluoride (map C), silver (map D), and iron and manganese (not shown) show the most obvious areal relationship to the Granite-Two Bit mineralized area.

In contrast to stream-sediment and panned-concentrate samples (Nowlan and Gerstel, 1985), which did not show definite patterns related to specific bedrock units, water samples show some patterns that are quite clearly related to (1) the sequence of Paleozoic sedimentary rocks on the eastern side of the study area and (2) the Precambrian granitic rocks of the western side of the study area.

Map B shows that water having high concentrations of calcium occurs in areas underlain by carbonate-rich Paleozoic sedimentary rocks. Other constituents that are concentrated in water draining areas underlain by carbonate-rich Paleozoic sedimentary rocks are magnesium, manganese, potassium, bicarbonate, sulfate, chloride (not shown), copper (map C), arsenic (map E), cobalt and nickel (map F), and molybdenum and uranium (map G). The pH of water draining these sedimentary rocks is higher than elsewhere. Correlation analysis (table 3) shows a close association of calcium and many constituents.

Sodium (map B), fluoride (map C), and silica (not shown) are associated with areas of Precambrian granitic rocks; the highest concentrations are from samples collected at the lower elevations along the western boundary of the study area where the climate is warmer and more arid than the rest of the study area. This association of high concentrations and arid climate suggests some concentration is taking place because of evaporation.

Some constituents, such as copper (map C), appear to be part of both the lithologic and mineralization patterns, making the separation of significant and nonsignificant anomalies difficult. Factor analysis can often be utilized to group many geochemical variables into a few groups and to show the relative contribution of a variable such as copper to more than one group.

The same log data used to obtain correlation coefficients (table 3) were analyzed by an R-mode factor-analysis program developed by A. T. Miesch (unpub. computer program, 1980). Factor analysis is a multivariate statistical technique that is designed to reduce many variables in a data set to a few groupings of correlated variables. In R-mode factor analysis, the correlation matrix is the body of data that is mathematically manipulated (rotated) to produce the groupings of correlated variables. Many techniques exist for doing the mathematical rotations. The one most commonly used in geochemistry, and the one used here, is the varimax rotation. The mathematical manipulations can be performed rapidly by computers and so, generally, the investigator will perform the factor analysis several times, each time requesting a different number of factors to be calculated to give, for example, a 4-factor model or a 5-factor model. Commonly, in geochemical applications of R-mode factor analysis, a correlation analysis is made of the chemical analytical data and the resulting correlation matrix is used as input to a factor-analysis computer program. Interpretation of the results from factor analysis of geochemical data must be accompanied by good geochemical judgment. Discussions of the use of factor analysis and related techniques in geology and geochemistry are in Davis (1973, p. 473-533) and Howarth and Sinding-Larsen (1983, p. 232-254).

Table 5 shows correlations between the water constituents and the scores of a 6-factor varimax rotation. The results of the factor analysis for the first four factors were similar for four-, five-, six-, or seven-factor models. Models that had greater than six factors were dominated by a single constituent and thus negated one of the purposes of factor analysis, that is, to group variables; models that had less than six factors resulted in some constituents having very little influence on any factor. Therefore, the 6-factor model was chosen for presentation. A 6-factor model accounts for 78 percent of the variance in the data. Scores from factors 3 and 4 are plotted on maps D and E as symbols based on approximately the 50th, 75th, and 90th percentiles.

Factor 3 (table 5) is dominated by copper and silver, two elements that give excellent analytical results at low concentrations, but factor 3 also shows probable significant loadings for molybdenum, arsenic, and nickel. The map pattern of scores from factor 3 (map D) strongly emphasizes the Granite-Two Bit mineralized area and, to some extent, emphasizes the Weston Pass-Union Gulch mineralized area (map A, areas A and B). The grouping of constituents in factor 3 and the association of the map patterns of scores from factor 3 with areas of known mineralization suggest that factor 3 is indicative of the quartz-pyrite-gold vein-type mineralization of the Granite-Two Bit mineralized area. However, the vicinity of the Rough and Tumbling Creek rhyolite stock (map A, area F), where mineralization is unknown, also shows a pattern of high scores for factor 3.

Factor 4 (table 5) is dominated by iron and manganese and may represent control of water chemistry by redox processes. A plot of scores from factor 4 (map E) is a composite of iron and manganese plots (not shown). Iron- and manganese-oxide solubilities are very sensitive to Eh-pH changes within the range of most natural water (Hem, 1970, p. 114-131). That factor 4 is indicative of mineralization should not be ruled out because of a pattern of high iron and manganese concentrations and high scores for factor 4 in the northern part of the Granite-Two Bit mineralized area (map A, area B); that same area shows high concentrations of manganese in nonmagnetic heavy-mineral-concentrate and stream-sediment samples (Nowlan and Gerstel, 1985).

Factors 1 and 2 (not shown) appear to represent the weathering of sedimentary and granitic rocks, respectively. A plot of scores from factor 1 is almost identical to a plot of calcium. A plot of scores from factor 2 is similar to a plot of sodium.

Factor 5 (table 5) is dominated by aluminum and has a map pattern similar to aluminum. A pattern of high concentrations of aluminum (not shown) and high scores for factor 5 (not shown) is found in the southern part of the study area. Factor 5 does not appear to be related to mineralization or lithology.

Factor 6 is dominated by zinc and to a lesser extent by low pH. Factor 6 and zinc concentrations in water (map H) do not have map patterns that are clearly related to mineralized areas or to lithology. Sample localities having high concentrations tend to cluster in the northern and southern parts of the study area.

In the 6-factor model, lead has the heaviest loading in factor 4, which is dominated by iron and manganese (table 5). Correlations of lead with other constituents are less than 0.20 (table 3) and thus do not appear to be significant (Snedecor and Cochran, 1967, p. 557). Nevertheless, a plot of lead concentrations (map H) is included because clusters of anomalous lead concentrations do appear adjacent to mineralized areas C and D (map A).

DISCUSSION

On the basis of water data, the Granite-Two Bit mineralized area (map A, area B) is geochemically the most anomalous area in the study area. Areas containing anomalous concentrations of sodium (map B), fluoride (map C), iron (not shown), manganese (not shown), silver (map D), and copper (map C) coincide with parts of area B. A cluster of anomalous scores for factor 3 plots in the Granite-Two Bit area (map D). Samples from Paleozoic sedimentary terrane have anomalous concentrations of many constituents, but the high concentrations generally appear to be related to the weathering of limestone, dolomite, and other sedimentary rocks except in the vicinity of the Rough and Tumbling Creek rhyolite stock (map A, area F).

The vicinity of the Rough and Tumbling Creek stock is a geochemically anomalous area on the basis of analyses of panned-concentrate and stream-sediment samples (Nowlan and Gerstel, 1985). Field mapping and geophysical data revealed no mineralization or geophysical anomaly in the vicinity of the stock (Hedlund and others, 1985). The water-sample data reinforce the existence of a geochemical anomaly in the vicinity of the stock. A small stream draining the east side of the stock contains 1,100 mg/L sulfate, 14 µg/L copper, 15 µg/L molybdenum, and 1,500 µg/L nickel.

Panned-concentrate samples from an area underlain by Paleozoic sedimentary rocks (map A, area E) contain anomalous amounts of barium (Nowlan and Gerstel, 1985). Water samples from that area have anomalous amounts of sulfate, manganese, arsenic, cobalt, molybdenum, nickel, and uranium. The significance of these anomalous water samples is diminished because of accompanying high amounts of calcium, magnesium, and bicarbonate that probably result from the weathering of limestone, dolomite, and gypsum. Nevertheless, the presence of mineralization in area E should not be completely ruled out on the basis of water chemistry; the weathering of mineralized sedimentary rocks could simultaneously release water constituents associated with mineralization as well as those associated with the common rock-forming minerals.

Data from panned-concentrate and stream-sediment samples seem to delineate areas of known mineralization in the Buffalo Peaks Wilderness Study Area better than do data from water samples. However, the water-sample data reinforce two conclusions from studies of data from panned-concentrate and stream-sediment samples: (1) the northern part of the study area is geochemically the most anomalous of all of the known mineralized areas and (2) a geochemical anomaly is present in the vicinity of the Rough and Tumbling Creek rhyolite stock.

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Table 1.--Statistical summary of analytical data for samples of stream and spring water
[Leaders (--) indicate no data or not applicable; dash (-) indicates value of zero; L, element present in amount less than lower limit of determination; valid, number of unqualified values. See text for methods of analysis]

Constituent	Lower limit of determination	Raw data: Minimum	Maximum	Number of values L	valid	Replaced data: Geometric mean	Geometric deviation	Valid	Replacement values
Ca mg/L	0.1	0.5	440	-	102	8.5	3.2	102	--
Mg mg/L	0.1	<0.1	150	1	101	2.4	3.9	102	0.07
Na mg/L	0.1	0.1	15	-	102	2.8	2.0	102	--
K mg/L	0.1	0.2	3	-	102	0.64	1.9	102	--
HCO_3^- mg/L	1	<1	380	1	101	34	3.3	102	0.7
SO_4^{2-} mg/L	0.1	0.34	1100	-	102	6.8	3.6	102	--
Cl^- mg/L	0.05	0.13	3	-	102	0.42	2.1	102	--
F^- mg/L	0.01	0.02	1.2	-	102	0.20	2.2	102	--
SiO_2 mg/L	1	2.3	39	-	102	12	1.6	102	--
Fe µg/L	1	2.8	1900	-	102	39	4.1	102	--
Mn µg/L	0.1[a]	0.1	190	-	102	3.2	4.5	102	--
Al µg/L	1	1.4	720	-	102	19	2.9	102	--
Ag µg/L	0.1	<0.1	1.3	1	101	0.30	2.0	102	0.07
As µg/L	0.1[a]	0.1	4.2	-	102	0.34	2.4	102	--
Co µg/L	0.1[a]	<0.1	9.9	1	101	0.40	2.9	102	0.07
Cu µg/L	0.1[a]	0.2	14	-	102	1.7	2.5	102	--
Mo µg/L	0.3[a]	0.3	15	-	102	1.3	2.5	102	--
Ni µg/L	0.1[a]	<0.1	1500	2	100	0.62	3.8	102	0.07
Pb µg/L	0.1[a]	<0.1	2.0	9	93	0.37	2.3	102	0.07
U µg/L	0.1	<0.1	6.8	27	75	0.25	3.7	102	0.07
Zn µg/L	0.5	1.9	60	-	102	3.9	1.7	102	--
Specific conductance µS	--	8.2	1600	-	102	82	2.8	102	--
pH	--	6.57	8.63	-	102	7.53[b]	--	--	--
Temperature °C	--	2	15	-	102	7.3[b]	--	--	--

[a]Indicates that values below 1 µg/L are at or near the sensitivity limit of the instrument and, therefore, the analytical precision may be as high as 100 percent relative standard deviation.

[b]Mean

Table 2.--Comparison of geometric means of analytical data for 84 stream-water samples versus 18 spring-water samples from sites draining the Buffalo Peaks Wilderness Study Area, Colorado
[Based on replaced data]

Constituent	Stream water	Spring water
Ca mg/L	7.4	17
Mg mg/L	2.1	5.2
Na mg/L	2.7	3.1
K mg/L	0.6	0.83
HCO_3^- mg/L	29	67
SO_4^{2-} mg/L	6.1	11
Cl^- mg/L	0.38	0.63
F^- mg/L	0.20	0.20
SiO_2 mg/L	12	14
Fe µg/L	42	26
Mn µg/L	3.4	2.8
Al µg/L	20	18
Ag µg/L	0.30	0.28
As µg/L	0.32	0.46
Co µg/L	0.37	0.55
Cu µg/L	1.7	1.9
Mo µg/L	1.2	1.8
Ni µg/L	0.57	0.94
Pb[a] µg/L	0.38	0.33
U[b] µg/L	0.21	0.56
Zn µg/L	3.7	4.8
Cond[c] µS	72	150
pH	7.54[d]	7.44[d]

[a]Lead values were replaced for eight stream samples and one spring sample. Median values are 0.4 µg/L for streams and 0.35 µg/L for springs.

[b]Uranium values were replaced for 26 stream samples and one spring sample. Median values are 0.15 µg/L for streams and 0.52 µg/L for springs.

[c]Specific conductance

[d]Mean

Table 3.--Correlation coefficients for analytical data from samples of stream and spring water collected at 102 sites draining the Buffalo Peaks Wilderness Study Area, Colorado [Based on logs of replaced data. Cond, specific conductance]

	Ca	Mg	Na	K	HCO_3^-	SO_4^{2-}	Cl^-	F^-	SiO_2	Fe	Mn	Al	Ag	As	Co	Cu	Mo	Ni	Pb	U	Zn	Cond	pH
Ca	1.00	0.92	0.44	0.78	0.89	0.88	0.82	0.13	0.36	-0.25	0.20	-0.24	0.17	0.51	0.66	0.35	0.73	0.81	0.04	0.72	-0.10	0.98	0.58
Mg	0.92	1.00	0.33	0.74	0.87	0.80	0.72	0.06	0.26	-0.30	0.13	-0.31	0.04	0.45	0.59	0.23	0.61	0.68	0.03	0.70	-0.15	0.93	0.65
Na	0.44	0.33	1.00	0.38	0.35	0.60	0.63	0.72	0.73	0.22	0.26	0.18	0.23	0.02	0.45	0.24	0.59	0.52	0.09	0.32	0.05	0.52	0.08
K	0.78	0.74	0.38	1.00	0.75	0.66	0.71	0.02	0.56	-0.22	0.13	-0.03	0.05	0.30	0.62	0.09	0.54	0.62	-0.09	0.54	-0.11	0.78	0.59
HCO_3	0.89	0.87	0.35	0.75	1.00	0.69	0.70	0.06	0.33	-0.32	0.20	-0.37	0.13	0.44	0.46	0.30	0.58	0.61	0.01	0.57	-0.12	0.90	0.60
SO_4^{2-}	0.88	0.80	0.60	0.66	0.69	1.00	0.78	0.25	0.36	-0.12	0.23	-0.08	0.17	0.54	0.71	0.35	0.78	0.85	0.06	0.72	-0.04	0.89	0.43
Cl^-	0.82	0.72	0.63	0.71	0.70	0.78	1.00	0.32	0.58	-0.17	0.10	-0.09	0.17	0.36	0.65	0.22	0.71	0.67	0.02	0.66	-0.13	0.83	0.44
F^-	0.13	0.06	0.72	0.02	0.06	0.25	0.32	1.00	0.46	0.20	0.10	0.16	0.12	-0.26	0.12	0.12	0.26	0.17	0.18	0.09	0.12	0.19	-0.07
SiO_2	0.36	0.26	0.73	0.56	0.33	0.36	0.58	0.46	1.00	0.13	0.07	0.20	0.14	-0.11	0.42	0.02	0.34	0.38	0.07	0.12	0.03	0.41	0.16
Fe	-0.25	-0.30	0.22	-0.22	-0.32	-0.12	-0.17	0.20	0.13	1.00	0.56	0.33	0.07	-0.20	-0.03	0.11	-0.06	0.01	0.13	-0.27	0.08	-0.24	-0.36
Mn	0.20	0.13	0.26	0.13	0.20	0.23	0.10	0.10	0.07	0.56	1.00	-0.03	0.14	0.14	0.17	0.17	0.23	0.29	0.04	0.06	0.11	0.19	-0.06
Al	-0.24	-0.31	0.18	-0.03	-0.37	-0.08	-0.09	0.16	0.20	0.33	-0.03	1.00	-0.06	-0.15	0.06	-0.15	0.03	-0.09	-0.09	-0.11	-0.01	-0.23	-0.21
Ag	0.17	0.04	0.23	0.05	0.13	0.17	0.17	0.12	0.14	0.07	0.14	-0.06	1.00	0.11	0.06	0.27	0.34	0.26	-0.07	-0.04	0.02	0.15	-0.03
As	0.51	0.45	0.02	0.30	0.44	0.54	0.36	-0.26	-0.11	-0.20	0.14	-0.15	0.11	1.00	0.29	0.39	0.44	0.48	0.03	0.51	-0.12	0.46	0.17
Co	0.66	0.59	0.45	0.62	0.46	0.71	0.65	0.12	0.42	-0.03	0.17	0.06	0.06	0.29	1.00	0.03	0.69	0.70	0.00	0.61	-0.05	0.64	0.39
Cu	0.35	0.23	0.24	0.09	0.30	0.35	0.22	0.12	0.02	0.11	0.17	-0.15	0.27	0.39	0.03	1.00	0.35	0.44	-0.12	0.20	-0.05	0.33	0.08
Mo	0.73	0.61	0.59	0.54	0.58	0.78	0.71	0.26	0.34	-0.06	0.23	0.03	0.34	0.44	0.69	0.35	1.00	0.71	-0.00	0.66	-0.08	0.72	0.37
Ni	0.81	0.68	0.52	0.62	0.61	0.85	0.67	0.17	0.38	0.01	0.29	-0.09	0.26	0.48	0.70	0.44	0.71	1.00	0.04	0.60	0.01	0.78	0.38
Pb	0.04	0.03	0.09	-0.09	0.01	0.06	0.02	0.18	0.07	0.13	0.04	-0.09	-0.07	0.03	0.00	-0.12	-0.00	0.04	1.00	0.04	-0.03	0.04	-0.02
U	0.72	0.70	0.32	0.54	0.57	0.72	0.66	0.09	0.12	-0.27	0.06	-0.11	-0.04	0.51	0.61	0.20	0.66	0.60	0.04	1.00	-0.14	0.71	0.47
Zn	-0.10	-0.15	0.05	-0.11	-0.12	-0.04	-0.13	0.12	0.03	0.08	0.11	-0.01	0.02	-0.12	-0.05	-0.05	-0.08	0.01	-0.03	-0.14	1.00	-0.11	-0.41
Cond	0.98	0.93	0.52	0.78	0.90	0.89	0.83	0.19	0.41	-0.24	0.19	-0.23	0.15	0.46	0.64	0.33	0.72	0.78	0.04	0.71	-0.11	1.00	0.61
pH	0.58	0.65	0.08	0.59	0.60	0.43	0.44	-0.07	0.16	-0.36	-0.06	-0.21	-0.03	0.17	0.39	0.08	0.37	0.38	-0.02	0.47	-0.41	0.61	1.00

Table 4.--Percentiles of analytical data for samples of stream and spring water collected at 102 sites draining the Buffalo Peaks Wilderness Study Area, Colorado

Constituent	Percentiles: 50	75	90
Ca mg/L	6.2	16	47
Mg mg/L	2.0	5.0	19
Na mg/L	2.8	3.7	6.8
K mg/L	0.6	1.0	1.8
HCO_3^- mg/L	28	71	200
SO_4^{2-} mg/L	5.3	9.5	41
Cl^- mg/L	0.35	0.73	1.3
F^- mg/L	0.22	0.35	0.51
SiO_2 mg/L	12	16	22
Fe µg/L	28	120	230
Mn µg/L	2.2	9.1	28
Al µg/L	17	36	62
Ag µg/L	0.3	0.5	0.8
As µg/L	0.3	0.5	1.3
Co µg/L	0.3	1.0	1.8
Cu µg/L	1.6	3.5	5.8
Mo µg/L	1.0	2.1	4.2
Ni µg/L	0.5	1.1	3.2
Pb µg/L	0.4	0.7	0.9
U µg/L	0.16	0.52	1.6
Zn µg/L	3.5	4.6	6.8
Cond[a] µS	64	160	360
pH	7.55	7.76	8.13

[a]Specific conductance

Table 5.--Loadings for a 6-factor R-mode factor analysis of analytical data from samples of stream and spring water collected at 102 sites draining the Buffalo Peaks Wilderness Study Area, Colorado
[Significant loadings are enclosed in solid boxes. Probable significant loadings are enclosed in dashed boxes. Cond, specific conductance; H, negative pH, the log of hydrogen ion concentration]

Factor 1 variable	Factor 1 loading	Factor 2 variable	Factor 2 loading	Factor 3 variable	Factor 3 loading	Factor 4 variable	Factor 4 loading	Factor 5 variable	Factor 5 loading	Factor 6 variable	Factor 6 loading
Ca	0.94	F^-	0.83	Cu	0.76	Fe	0.82	Al	0.77	Zn	0.94
Cond	0.93	Na	0.78	Ag	0.73	Mn	0.77	Co	0.26	H	0.52
SO_4^{2-}	0.90	SiO_2	0.77	Mo	0.31	Pb	0.37	Fe	0.17	Mn	0.09
Mg	0.90	Cl^-	0.37	As	0.30	H	0.28	SiO_2	0.16	F^-	0.08
K	0.82	Al	0.24	Ni	0.27	Ni	0.22	Mo	0.16	Ni	0.07
HCO_3^-	0.82	Fe	0.23	Na	0.19	Al	0.21	H	0.15	Na	0.05
Cl^-	0.81	Pb	0.21	SO_4^{2-}	0.18	Na	0.21	K	0.10	SO_4^{2-}	0.05
U	0.81	Ag	0.20	Ca	0.17	Cu	0.18	Na	0.09	Co	0.02
Ni	0.81	Mo	0.20	HCO_3^-	0.16	As	0.16	Ag	0.04	As	0.02
Co	0.78	K	0.16	Cond	0.15	Mo	0.14	Ni	0.03	Ag	0.01
Mo	0.75	Cond	0.16	Mn	0.13	SO_4^{2-}	0.13	U	0.01	Mo	-0.02
As	0.57	SO_4^{2-}	0.16	F^-	0.11	Co	0.13	Cl^-	-0.00	Fe	-0.03
Na	0.43	Co	0.15	Cl^-	0.11	F^-	0.11	As	-0.01	SiO_2	-0.03
SiO_2	0.36	Ni	0.12	H	0.07	Zn	0.03	SO_4^{2-}	-0.01	U	-0.04
Cu	0.23	Zn	0.10	Fe	0.04	Ag	0.00	Zn	-0.03	Cu	-0.05
Mn	0.19	Ca	0.08	Mg	0.04	U	-0.00	Cu	-0.08	Ca	-0.05
F^-	0.05	HCO_3^-	0.05	U	-0.03	Ca	-0.02	Mn	-0.08	Cond	-0.07
Ag	0.04	H	0.04	Zn	-0.04	SiO_2	0.03	F^-	-0.10	Cl^-	-0.08
Pb	-0.01	Mn	0.01	SiO_2	-0.05	Cond	-0.04	Ca	-0.16	HNO_3^-	-0.10
Zn	-0.07	Mg	-0.00	K	-0.09	Cl	-0.07	Cond	-0.18	Al	-0.10
Al	-0.14	Cu	-0.05	Co	-0.14	Mg	-0.10	Mg	-0.24	Mg	-0.11
Fe	-0.26	U	-0.08	Al	-0.19	HCO_3^-	-0.13	HCO_3^-	-0.32	Pb	-0.11
H	-0.59	As	-0.47	Pb	-0.31	K	-0.14	Pb	-0.58	K	-0.11

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