UNITED STATES DEPARTMENT OF INTERIOR
GEOLOGICAL SURVEY

Compilation of rock-chip and stream-sediment geochemical data for the American Flats Wilderness Study Area, Ouray and Hinsdale Counties, Colorado

by

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature

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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 the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and Congress. This report presents the results of a mineral survey of the region surrounding the American Flats Wilderness Study Area (CO-030-217), Ouray and Hinsdale Counties, Colorado.

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INTRODUCTION

Samples of unaltered and altered volcanic rock, vein material, and stream sediments were collected from sites within and immediately adjacent to the American Flats Wilderness Study Area (BLM) as part of the mineral resource assessment of the study area. These investigations were conducted jointly by the U.S. Geological Survey and U.S. Bureau of Mines during 1984 and 1985 (Hon and others, 1986; Hannigan, 1985; Hon and others, in press). Previous workers also collected rock and stream-sediment samples from this area during the course of BLM contract work (Weiland and others, 1980) and investigations of the adjacent Big Blue Wilderness Area (USFS) (Fischer and others, 1968). This report contains a compilation of all of the available geochemical data for the American Flats Wilderness Study Area and the immediately surrounding area (tables 1-4). Sample locations are shown on plate 1. A summary of the data and detailed interpretations are presented by Hon and others (in press) and Hon and others (1986).

METHODS

Details of sample preparation, analytical techniques, and results are listed in the original reports (Fischer and others, 1968; Weiland and others, 1980; Hannigan, 1985) and summarized briefly in tables 1 through 4. Most of the samples were analyzed by the direct-current arc and alternating-current spark emission spectrographic method described by Grimes and Marranzino (1968) in the laboratories of the U.S. Geological Survey, Denver, Colorado and the U.S. Bureau of Mines Metallurgy Research Center, Reno, Nevada (Hannigan, 1985). The 6 stream-sediment samples listed in table 4 were analyzed by a combination of induction-coupled argon plasma spectroscopic (ICP), atomic absorption, fluorimetric, and colorimetric techniques in the laboratories of Barringer Research, Inc. (Weiland and others, 1980). In addition, all of the samples collected by the Bureau of Mines in and adjacent to the study area (pl. 1) (Hannigan, 1985) were analyzed for gold and silver by fire assay-ICP, but were below the detection limits for these elements (Ag <0.3 ppm, Au <0.007 ppm). Similarly, the samples collected by Fischer and others (1968) (table 3, pl. 1) were analyzed for gold by atomic absorption spectroscopy, but none contained gold unequivocally above the reported detection limit (0.02 ppm Au).

The semiquantitative emission spectrographic values are reported to the nearest number in the series 10, 15, 20, 30, 50, 70, 100 and so forth, which are approximate geometric midpoints of the concentration ranges. The best precision to be expected is for replicate analyses to lie within two adjoining intervals 96 percent of the time (Motooka and Grimes, 1976). However, many of the reported values may not achieve this level of precision. Because the samples were collected at different times and analyzed by a variety of techniques at several laboratories, the results are not strictly comparable. The term anomalous is used only to describe values that exceed those commonly found in igneous rocks (Turekian and Wedepohl, 1961; Taylor, 1964; Levinson, 1980) and unaltered rocks in the region (table 5) by a margin greater than the two standard deviations from the mean. No analytical error was specified for the ICP and other data presented by Weiland and others (1980), however, the values they reported for Sn and B are spurious and were not evaluated or included in table 4. Similarly, the Sn and Te values reported by Hannigan (1985) were also found to be unreliable. In addition, comparison of selected arsenic values given by Hannigan (1985) that were analyzed by emission spectrography and the more reliable atomic absorption method, indicates that the arsenic data listed in table 2 are of questionable value.

Table 1. Semiquantitative analyses of rock-chip samples collected within and adjacent to the American Flats Wilderness Study Area by the U.S. Geological Survey during 1984.

[Semiquantitative emission spectrographic analyses were made by L. R. Layman and M. Malcolm at the laboratories of the U.S. Geological Survey in Denver, Colorado. All values given in parts per million unless otherwise noted. Asterisks denote samples within the boundaries of the study area.

Spectrographic analyses are reported to the nearest number in the series 1, 1.5, 2.0, 3.0, 5.0, 7.0, 10, and so forth, which represent approximate midpoints of group data on a geometric scale. The assigned group for semiquantitative results will include the quantitative value about 30 percent of the time. These data should not be quoted without stating these limitations. The symbol < indicates the value is less than the amount shown.]

TABLE 1--Semiquantitative analyses, American Flats Wilderness Study Area

No.	Ag	As	Au	B	Ba	Be	Ca%	Cd	Co	Cr
AF101*	<.5	<700	<15	<10	150	1.0	.05	<30	5	<10
AF102*	<.5	<700	<15	<10	1000	1.5	.15	<30	<5	<10
AF400	<.5	<700	<15	<10	150	<1.0	<.05	<30	<5	<10
AF401	<.5	<700	<15	<10	200	<1.0	.05	<30	<5	<10
AF404*	<.5	<700	<15	<10	1500	1.0	3.00	<30	15	<10

	Cu	Fe%	La	Mg%	Mn	Mo	Nb	Ni	Pb	Sb
AF101*	30	1.5	50	.05	200	50	<20	5	10	7
AF102*	5	1.0	70	.15	15	<5	<20	<5	15	5
AF400	7	.15	<30	<.02	70	<5	20	<5	<10	5
AF401	<5	.10	<30	<.02	30	<5	20	<5	<10	<5
AF404*	70	5.0	70	1.50	1500	<5	<20	15	20	15

	Sc	Sn	Sr	Th	Ti%	V	W	Y	Zn	Zr
AF101*	7	<10	<100	<200	.15	50	<50	15	<200	150
AF102*	5	<10	150	<200	.30	50	<50	15	<200	100
AF400	5	<10	200	<200	.30	20	<50	<10	<200	200
AF401	<5	<10	<100	<200	.30	<10	<50	10	<200	200
AF404*	15	<10	1000	<200	.30	200	<50	20	<200	150

Table 2. Semiquantitative spectrographic analyses of rock-chip and stream-sediment samples collected within and adjacent to the American Flats Wilderness Study Area during by the U.S. Bureau of Mines during 1984 (Hannigan, 1985).

[Semiquantitative emission spectrographic analyses were performed at the Reno Metallurgy Research Center of the U.S. Bureau of Mines. All values given in parts per million unless otherwise noted. Asterisks denote samples within the boundaries of the study area.

The symbol < indicates the value is less than the amount shown, > indicates the value is greater than the amount shown. Idealized detection limits are given by Hannigan (1985), but the actual upper and lower limits of the technique vary with the composition of the individual samples (Hannigan, 1985). Precision of the Bureau of Mines six-step spectrographic technique is presumed to be similar to that reported by the Geological Survey.]

TABLE 2—Semiquantitative analyses, American Flats Wilderness Study Area

No.	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	Ga	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Pd	Pt
														"Vein" material														
16	<40	>40,000	<300	<20	<70	200	4	<400	<1,000	<5	<30	20	<6	40,000	<10	<6000	<200	100	8	50	<1	<3000	<100	10	<7000	<20	<1	<6
17	<20	>40,000	300	<20	<30	300	<3	<300	<500	<5	<10	<3	<6	30,000	<2	<6000	<100	<40	100	40	<1	<3000	<70	<6	<7000	<20	<1	<6
														Altered Rock														
15	<3	>30,000	<400	<20	<70	500	5	<300	1,000	<5	<10	<3	<6	30,000	<6	<6000	<100	60	30	200	<1	<3000	<70	10	<7000	<20	<1	<6
18	<20	>40,000	300	<20	<40	300	<3	<400	<500	<5	<10	<3	<6	10,000	<2	<6000	<100	100	7	<20	<1	<3000	<80	<6	<7000	<20	<1	<6
19*	<10	>40,000	<200	<20	<70	800	<1	<100	<500	<5	<10	<3	<6	40,000	<2	100,000	<100	<20	5000	400	<1	<3000	<70	8	<7000	<20	<1	<6
20*	<9	>30,000	300	<20	90	300	<1	<100	40,000	<5	<10	10	<6	30,000	<2	<6000	<100	<20	9000	3000	<1	<3000	<70	<7	<7000	<20	<1	<6
25*	<10	>50,000	500	<40	100	2000	3	<300	30,000	<5	<10	<9	<6	40,000	<9	>100,000	<100	<20	5000	2000	<1	30,000	<200	20	<7000	<60	<1	<6
26*	<10	>40,000	<200	<20	<30	100	<1	<100	<500	<5	<10	20	<6	20,000	<2	<6000	<100	<20	200	600	<1	<3000	<70	<6	<7000	<20	<1	<6
29*	<30	>30,000	400	<20	100	900	<3	<200	10,000	<5	<10	<3	<6	40,000	<4	100,000	<100	60	10,000	4000	<1	<3000	<70	8	<7000	<40	<1	<6
30*	<40	>40,000	500	<30	100	100	<3	<100	30,000	<5	<10	<3	20	40,000	<4	100,000	<100	<20	20,000	3000	<1	<3000	<70	10	<7000	<50	<1	<6
31	<70	>40,000	400	<20	<80	1000	7	<500	40,000	<5	<10	<5	7	50,000	<10	80,000	<100	300	10,000	7000	<1	40,000	<300	30	<8000	<40	<1	<6
32	<40	>50,000	500	<40	100	3000	<1	<200	40,000	<5	<10	<3	10	50,000	<10	>100,000	<100	70	20,000	5000	<1	<10,000	<90	40	<7000	<80	<1	<6
49	<40	>40,000	400	<20	100	2000	7	<200	60,000	<5	<10	20	<6	50,000	<6	100,000	<100	<20	20,000	4000	<1	50,000	<200	30	<7000	<40	<1	<6
50	<50	>40,000	400	<30	100	2000	<1	<100	30,000	<5	<10	50	<6	50,000	<5	>100,000	<100	<20	20,000	4000	<1	20,000	<70	30	<7000	<50	<1	<6
51	<60	>40,000	600	<30	100	2000	7	<100	100,000	<5	<10	60	10	50,000	<6	>100,000	<100	<20	20,000	7000	<1	50,000	<70	30	<7000	<50	<1	<6
52	<90	>30,000	600	<30	100	1000	8	<300	50,000	<5	<10	40	<6	40,000	<9	90,000	<100	<50	20,000	3000	<1	50,000	<100	30	<9000	<50	<1	<6
53	<20	>50,000	400	<20	90	3000	5	<200	80,000	<5	<10	60	9	40,000	<8	40,000	<100	<20	10,000	5000	<1	50,000	<300	40	<7000	<30	<1	<6
66*	<50	>50,000	600	<30	100	3000	6	<400	20,000	<5	<10	<3	<6	30,000	<10	>100,000	<100	90	6000	2000	<1	20,000	<200	20	<7000	<50	<1	<6
67*	<20	>50,000	500	<30	100	3000	<1	<300	10,000	<5	<10	<3	<6	20,000	<10	>100,000	<100	<20	10,000	1000	<1	30,000	<70	10	<7000	<50	<1	<6
68	<5	>40,000	700	<50	200	100	10	<300	<800	<5	<10	<3	<6	20,000	<10	>100,000	<100	100	900	2000	<1	40,000	<90	<6	<7000	90	<1	<6
70	<10	>50,000	500	<40	100	700	8	<300	20,000	<5	<10	<3	<6	30,000	<10	>100,000	<100	100	9000	2000	<1	30,000	<100	10	<7000	100	<1	<6
71	<5	>40,000	500	<20	<70	100	20	<400	5,000	<5	<10	<3	<6	10,000	<5	60,000	<100	<50	600	2000	<1	50,000	<100	<5	<7000	<20	<1	<6
														Stream Sediments														
22*	<40	>40,000	<200	<20	<80	900	9	<100	2,000	<5	<10	<3	<6	100,000	<6	100,000	<100	<20	1000	>20,000	<1	<8000	<200	70	<10,000	<20	<1	<6
24*	<7	>40,000	<200	<20	<70	1000	5	<200	10,000	<5	<10	<3	<6	60,000	<2	100,000	<100	<20	10,000	4000	<1	10,000	<100	20	<7000	<20	<1	<6
28*	<20	>40,000	300	<20	90	1000	4	<400	10,000	<5	<10	<3	<6	60,000	<10	>100,000	<100	<50	10,000	3000	<1	20,000	<200	20	<7000	<20	<1	<6
55	<5	>40,000	<200	<20	<70	2000	4	<100	40,000	<5	<10	<3	<6	50,000	<2	>100,000	<100	<20	10,000	4000	<1	30,000	<200	10	<7000	<20	<1	<6
57*	<10	>40,000	<200	<20	<70	2000	6	<200	30,000	<5	<10	<3	<6	50,000	<2	>100,000	<100	<20	20,000	4000	<1	<30,000	<200	10	<7000	<20	<1	<6
59*	<30	>40,000	<200	<20	<70	2000	5	<200	30,000	<5	<10	<3	<6	60,000	<5	100,000	<100	<30	10,000	5000	<1	20,000	<200	20	<7000	<20	<1	<6
61*	<40	>40,000	<300	<20	100	2000	9	<200	40,000	<5	<10	<3	<6	60,000	<2	>100,000	<100	<20	20,000	8000	<1	40,000	<90	20	<7000	<40	<1	<6
63*	50	>40,000	300	<20	90	2000	5	<300	40,000	<5	<10	10	6	70,000	<10	100,000	<100	<40	20,000	8000	<1	20,000	<300	40	<7000	<40	<1	<6
65*	<30	>40,000	<300	<20	90	1000	7	<400	40,000	<5	<10	<8	<6	90,000	<7	100,000	<100	<20	10,000	9000	<1	30,000	<200	30	<7000	<30	<1	<10
														Panned Concentrates														
21*	<500	10,000	<200	<30	<80	2000	20	<100	<3,000	<5	<20	30	6	>100,000	30	50,000	<100	<20	6000	>40,000	<2	<6000	<200	200	20,000	100	<1	<60
23*	<100	>40,000	<400	<20	<80	500	10	<200	10,000	<5	40	50	10	>100,000	40	<8000	<100	<20	5000	>50,000	<3	<3000	<300	200	<20,000	90	<1	<50
27*	<300	8,000	<100	<20	<30	100	6	<100	4,000	<5	<10	20	6	>100,000	<6	<6000	<100	<20	3000	>20,000	<1	<3000	<100	200	<8000	<70	<1	<20
54	<300	>40,000	<700	<40	<200	500	20	<2,000	40,000	<5	100	200	30	>100,000	100	30,000	<100	<40	10,000	>70,000	7	<20,000	<600	600	40,000	200	<2	<100
56*	<400	>40,000	<500	<50	<200	400	20	<100	20,000	<6	80	70	<6	>100,000	80	20,000	<100	<20	5000	>50,000	10	<10,000	<500	400	40,000	100	<3	<100
58*	<500	>30,000	<600	<40	<100	300	10	<100	<3,000	<5	60	70	20	>100,000	2000	20,000	<100	<20	5000	>40,000	<2	<4000	<300	500	20,000	90	<1	<80
60*	<100	>20,000	<200	<20	<30	200	6	<100	10,000	<5	<10	30	<6	>100,000	<10	30,000	<100	<20	20,000	>50,000	<1	<3000	<100	200	<10,000	<20	<1	<20
62*	<30	>30,000	<600	<20	<100	200	10	<100	9,000	<5	<60	400	80	70,000	<10	<6000	<100	<20	30,000	3,000	<1	<5000	<400	90	<10,000	<20	<1	<60
64*	<600	>40,000	<700	<40	<100	300	20	<100	30,000	<5	100	100	10	>100,000	90	30,000	<200	<30	9000	>60,000	7	<10,000	<400	400	30,000	100	<2	<100

TABLE 2--Semiquantitative analyses, American Flats Wilderness Study Area

No.	Sb	Sc	Si	Sr	Ta	Ti	V	Y	Zn	Zr
				"Vein" material						
16	<600	<4	>100,000	1000	<200	5000	200	<9	20	100
17	<600	<4	>100,000	500	<200	2000	<90	<9	10	<30
				Altered Rock						
15	<600	<4	>100,000	600	<200	2000	<100	<9	10	60
18	<600	<4	>100,000	700	<200	900	<50	<9	20	30
19*	<600	<4	>100,000	5	<200	1000	<50	<9	40	<30
20*	<600	<4	>100,000	60	<200	<300	<50	<9	10	<30
25*	<600	<4	>100,0000	100	<200	3000	<60	<9	9	<30
26*	<600	<4	>100,000	<1	<200	1000	<100	<9	<1	30
29*	<600	<4	>100,000	8	<200	2000	<70	<9	10	<30
30*	<600	<4	>100,000	20	<200	2000	<50	<9	<2	<30
31	<600	<4	>100,000	300	<200	3000	200	<9	200	30
32	<600	<4	>100,000	100	<200	4000	200	<9	30	<30
49	<600	<4	>100,000	500	<200	3000	<90	<9	200	<30
50	<600	<4	>100,000	200	<200	2000	<70	<9	40	<30
51	<600	<4	>100,000	500	<200	2000	<60	<9	200	<30
52	<600	<4	>100,000	300	<200	2000	<100	<9	200	<30
53	<600	<4	>100,000	600	<200	3000	<100	<9	100	<30
66*	<600	<4	>100,000	40	<200	2000	<100	<9	40	<30
67*	<600	<4	>100,000	90	<200	1000	<60	<9	10	40
68	<600	<4	>100,000	2	<200	<500	<50	<9	9	<30
70	<600	<4	>100,000	60	<200	1000	<50	<9	50	<30
71	<600	<4	>100,000	5	<200	<500	<50	<9	70	<30
				Stream sediments						
22*	<1000	<4	>100,000	100	<200	7000	200	<9	1000	<30
24*	<600	<4	>100,000	100	<200	3000	<60	<9	300	<30
28*	<800	<4	>100,000	90	<200	4000	<100	<9	200	<60
55	<600	<4	>100,000	300	<200	1000	<50	<9	100	<30
57*	<600	<4	>100,000	300	<200	2000	<50	<9	200	<30
59*	<600	<4	>100,000	300	<200	4000	<90	<9	200	<30
61*	<600	<4	>100,000	400	<200	3000	<50	<9	300	<30
63*	<600	<4	>100,000	300	<200	7000	300	<9	400	60
65*	<600	<4	>100,000	300	<200	6000	200	<9	300	<30
				Panned concentrates						
21*	<600	<4	40,000	20	<1000	20,000	1000	<9	1000	200
23*	<5000	<6	>100,000	40	<1000	30,000	2000	<9	800	400
27*	<600	<4	30,000	3	<300	20,000	800	<9	500	300
54	<600	30	50,000	50	<2000	>100,000	5000	<9	900	400
56*	<1000	20	40,000	30	<2000	>100,000	4000	<10	900	700
58*	<600	<9	40,000	7	<1000	40,000	2000	<9	500	300
60*	<600	<4	>100,000	10	<300	20,000	1000	<9	800	100
62*	<600	<4	>20,000	<1	<200	>60,000	2000	<9	<1	<30
64*	<600	20	50,000	20	1000	>100,000	3000	<9	600	400

Table 3. Semiquantitative spectrographic analyses of rock-chip and stream-sediment samples collected within and adjacent to the American Flats Wilderness Study Area by the U.S. Geological Survey (Fischer and others, 1968).

[Semiquantitative emission spectrographic analyses were made by N. M. Conklin, K. J. Curry, C. L. Forn, D. J. Grimes, J. C. Hamilton, Jr., E. L. Mosier, J. M. Motooka, H. G. Neiman, T. A. Roemer, and A. L. Sutton, Jr. in the laboratories of the U.S. Geological Survey, Denver, Colorado. All values given in parts per million unless otherwise noted. Asterisks denote samples within the boundaries of the study area.

Spectrographic analyses are reported to the nearest number in the series 1, 1.5, 2.0, 3.0, 5.0, 7.0, 10, and so forth, which represent approximate midpoints of group data on a geometric scale. The assigned group for semiquantitative results will include the quantitative value about 30 percent of the time. These data should not be quoted without stating these limitations. The symbol < indicates the value is less than the amount shown, > indicates greater than the amount shown. Some elements are reported with more than one lower limit of detection because different analytical instruments or techniques were used.]

TABLE 3--Semiquantitative analyses, American Flats Wilderness Study Area

No.	Al%	Fe%	Si%	Ag	As	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Mg	Mn	Mo	Nb	Ni	Pb	Sb	Sn	Sr	Ti	V	Y	Zn
												"Vein" material														
715	>10	7	>10	<1	<2,000	1,000	1.5	<10	50,000	<50	30	30	100	30,000	1,000	<3	15	15	300	<100	<10	700	7,000	300	50	<200
862	3	.7	>10	<1	<2,000	100	3	<10	700	<50	<3	1.5	20	150	700	<3	<10	<3	<10	<100	<10	10	70	30	10	<200
902*	.1	.07	.2	<1	<2,000	10	<1	<10	>100,000	<50	<3	<5	3	700	1,500	<3	<10	<3	<10	<100	<10	100	30	<7	<10	<200
												Altered rock														
700*	>10	3	>10	<1	<200	1,000	1.5	<10	15,000	<20	15	30	70	10,000	300	<3	15	3	300	<100	<10	300	5,000	150	30	<200
701*	>10	2	>10	<1	<200	700	1.5	<10	3,000	<20	7	3	50	3,000	150	<3	15	2	50	<100	<10	150	3,000	30	30	<200
702*	>10	5	>10	<1	<200	500	<1	<10	1,500	<20	<3	20	50	300	20	10	10	<3	30	<100	<10	500	5,000	200	20	<200
703	5	1.5	>10	<1	<200	100	<1	<10	700	<20	<3	7	70	300	30	5	15	<3	30	<100	<10	200	3,000	30	15	<200
704	>10	3	>10	<1	<200	1,000	1.5	<10	10,000	<20	5	7	30	10,000	70	3	20	<3	30	<100	<10	300	5,000	150	50	<200
705	>10	5	>10	<1	<200	2,000	1.5	<10	20,000	<20	15	7	50	30,000	500	7	10	3	20	<100	<10	700	5,000	150	30	<200
707*	>10	7	>10	<1	<200	1,500	1.5	<10	70,000	<20	15	30	70	15,000	3,000	<3	10	15	30	<100	<10	500	7,000	300	70	<200
709	>10	7	>10	<1	<200	1,000	1.5	<10	50,000	<20	20	20	15	30,000	1,500	<3	10	3	15	<100	<10	700	7,000	300	30	<200
714*	>10	3	>10	<1	200	700	1.5	<10	3,000	<20	7	3	15	3,000	100	<3	15	3	15	<100	<10	100	3,000	50	30	<200
858	7	1	>10	<1	<200	500	1.5	<10	15,000	<20	<3	1.5	5	7,000	300	<3	15	<3	30	<100	<10	200	1,000	15	30	<200
859	>10	7	>10	<1	<200	700	1.5	<10	30,000	<20	15	30	700	15,000	1,000	<3	15	15	30	<100	15	300	7,000	300	70	<200
860	7	1.5	>10	<1	<200	2,000	2	<10	20,000	<20	<3	2	15	10,000	300	<3	15	<3	30	<100	<10	3,000	1,500	30	20	<200
861	>10	5	>10	<1	<200	1,500	1.5	<10	30,000	<20	15	15	70	15,000	700	<3	15	2	30	<100	<10	700	5,000	300	30	<200
863	7	1.5	>10	<1	<200	700	<1	<10	1,500	<20	<3	2	7	3,000	30	3	15	<3	30	<100	<10	100	1,500	50	20	<200
889	7	1.5	>10	<1	<200	1,500	1.5	<10	300	<20	<3	3	7	7,000	50	<3	10	<3	20	<100	<10	100	3,000	70	20	<200
898*	7	3	>10	<1	<200	700	<1	<10	15,000	<20	15	30	30	15,000	1,500	<3	15	7	30	<100	<10	500	5,000	150	30	<200
899*	7	3	>10	<1	<200	700	<1	<10	15,000	<20	15	10	70	30,000	1,500	<3	10	15	20	<100	<10	300	3,000	150	30	<200
900*	7	1.5	>10	<1	<200	1,000	1	<10	15,000	<20	3	1.5	7	7,000	300	<3	10	<3	30	<100	<10	700	1,500	30	30	<200
901*	7	3	>10	<1	<200	700	1	<10	3,000	<20	10	<1	15	3,000	300	<3	15	3	30	<100	<10	70	1,500	70	15	<200
904	7	1.5	>10	<1	<200	1,000	1.5	10	15,000	<20	3	3	15	7,000	150	<3	10	<3	30	<100	<10	700	1,500	20	20	<200
905*	>10	7	>10	<1	<200	700	1	<10	30,000	<20	20	30	70	30,000	700	<3	10	15	15	<100	<10	500	5,000	300	30	<200
												Unaltered rock														
706	>10	7	>10	<1	<200	1,000	1.5	<10	70,000	<20	15	15	50	15,000	1,500	<3	10	7	20	<100	<10	700	7,000	300	30	<200
708	>10	7	>10	<1	<200	1,000	1.5	<10	70,000	<20	30	20	20	30,000	3,000	<3	10	5	15	<100	<10	700	7,000	300	70	<200
713*	>10	3	>10	<1	<200	1,000	1.5	<10	15,000	<20	15	7	50	10,000	700	<3	15	7	30	<100	<10	700	5,000	150	70	<200
716	>10	7	>10	<1	<200	1,000	1.5	<10	50,000	<20	70	10	70	30,000	1,000	<3	10	15	20	<100	<10	1,000	7,000	300	70	<200
896*	>10	3	>10	<1	<200	700	<1	<10	3,000	<20	7	3	20	7,000	300	<3	10	3	20	<100	<10	150	2,000	70	15	<200
897*	>10	7	>10	<1	<200	700	<1	<10	30,000	<20	30	70	70	30,000	3,000	<3	10	30	30	<100	<10	700	5,000	300	50	<200
903*	7	7	>10	<1	<200	700	1	<10	30,000	<20	20	30	70	30,000	1,500	<3	10	15	30	<100	<10	300	5,000	150	30	<200
906*	>10	7	>10	<1	<200	700	1	<10	50,000	<20	30	30	150	30,000	1,500	<3	10	15	20	<100	<10	500	3,000	300	30	<200
907*	.3	7	>10	<1	<200	70	<1	<10	3,000	<20	<3	<1	7	1,500	70	<3	<10	2	<10	<100	<10	15	300	15	<10	<200
												Steam sediment														
908	>10	5	>10	<1	<2,000	1,000	1	<10	30,000	<50	20	20	50	20,000	1,000	<3	10	15	20	<200	<10	700	3,000	200	30	<200

Table 4. Semiquantitative analyses of stream-sediment samples collected adjacent to the American Flats Wilderness Study Area by Barringer Research, Inc. (Weiland and others, 1980).

[Analyses were done in the laboratories of Barringer Research, Inc., Denver, Colorado and Toronto, Canada. Most of the reported elements were analyzed by semiquantitative induction-coupled argon plasma spectroscopy. Copper, lead, molybdenum, and zinc were analyzed by atomic absorption spectroscopy. Tungsten was analyzed colorimetrically and uranium determined by fluorimetry. All values in parts per million unless otherwise noted. All samples lie outside of the American Flats Wilderness Study Area boundaries shown on plate 1.

No relative errors were listed by Weiland and others (1980) for any of the analytical methods. The symbol < indicates the value is less than the amount shown, -- indicates no data.]

TABLE 4--Semiquantitative analyses, American Flats Wilderness Study Area

No.	Ag	Al_2O_3%	As	Ba	Be	CaO%	Cd	Co	Cr	Cu
2323	<5	12.8	3	1447	1.6	.66	<7	15	33.5	19
2324	<5	14.6	5	1568	1.9	.89	<7	10	25.6	21
2325	<5	14.9	5	1704	1.5	.97	<7	20	38.6	37
2326	<5	13.5	4	1344	1.6	.62	<7	10	20.9	16
2327	<5	15.7	5	1817	1.6	2.84	<7	26	38.1	34
2328	<5	15.5	6	2100	1.5	3.24	<7	28	45.5	41

	Fe_2O_3%	K_2O%	MgO%	MnO_2%	Mo	Na_2O%	Ni	Pb	P_2O_5%	Sr
2323	6.8	2.53	.98	.1	1	1.50	11	20	.20	190
2324	5.4	2.64	1.07	.1	1	1.76	9	25	.24	222
2325	8.3	2.41	2.12	.1	2	1.81	16	90	.28	206
2326	4.6	2.80	.92	.0	1	1.46	8	20	.19	191
2327	7.7	2.52	2.25	.2	2	2.45	16	25	.27	620
2328	8.3	2.87	2.54	.2	1	2.84	20	25	.26	790

	TiO_2%	U	V	W	Zn	Zr
2323	.99	.2	158	<4	95	127
2324	.70	.6	105	--	109	104
2325	1.12	.2	198	<4	138	159
2326	.70	.4	96	--	74	114
2327	1.06	1.2	177	<4	118	171
2328	1.08	.9	215	--	116	158

Table 5. Average major and minor element content of 51 samples of Oligocene volcanic and intrusive rocks from the western San Juan Mountains, Colorado.

[Geochemical data were retrieved from the Rock Analysis Storage System (RASS) of the U.S. Geological Survey for 75 samples of Oligocene volcanic and intrusive rocks collected by R. G. Luedke and P. W. Lipman from the western San Juan Mountains. Original rock descriptions and major element data were used to discriminate between relatively fresh and altered rock samples. The resultant data set contains 51 samples of unaltered igneous rocks, which have been analyzed for major element oxides by the rapid method of Shapiro and Brannock (1962) and for minor elements by several semiquantitative spectrographic techniques. These data are only meant to provide an estimate of the concentrations of minor elements in relatively unaltered volcanic rocks surrounding the American Flats area and do not represent a meaningful average composition of volcanic or intrusive rocks from the western San Juan Mountains.

Most of the minor elements were analyzed by emission spectrographic techniques and the detection limits for this method are listed for samples with qualified values (Grimes and Marranzino, 1968; U.S. Geological Survey, unpublished data). Precision is similar to that reported for the analytical data in Appendices 1 and 3. However, some of the samples were analyzed by more sensitive spectrographic methods, which resulted in the presence of valid values less than the listed detection limits for certain elements. Elements looked for but not detected in 44 of the 51 samples (these elements were not analyzed for in 7 of the samples) are: Ag (<.5), As (<200), Au (<10), B (<10), Bi (<10), Cd (<20), Ge (<10), Hf (<100), In (<10), Li (<100), Pd (<2), Pt (<50), Sb (<100), Sn (<10), Ta (<200), Te (<2000), Th (<200), W (<50), Zn (<200) (detection limits in parantheses, in ppm).]

Table 5.--Average major and minor element content of 51 samples of Oligocene volcanic and intrusive rocks from the western San Juan Mountains.

	Average Value	Std. Dev.	Minimum Value	Maximum Value	Number of Samples			
					Valid Values	Less Than Detection Limit[1]		Not Analyzed
Major element oxides (weight percent)								
SiO2	61.08	4.49	52.10	72.80	51			
Al2O3	16.13	1.06	13.00	17.90	51			
Fe2O3	3.48	1.31	1.10	7.20	51			
FeO	2.11	1.09	0.24	4.20	51			
MgO	1.90	0.90	0.34	5.00	51			
CaO	4.53	1.52	1.30	7.70	51			
Na2O	3.38	0.55	1.80	4.50	51			
K2O	3.62	0.87	2.00	5.60	51			
H2O+	1.35	0.58	0.40	3.80	51			
H2O-	0.53	0.60	0.02	2.40	49	2	(<.02)	
TiO2	0.69	0.19	0.34	1.00	51			
P2O5	0.36	0.14	0.07	0.69	51			
MnO	0.11	0.05	0.02	0.26	51			
CO2	1.16	0.85	0.04	3.30	36	15	(<.05)	
Semiquantitative minor element analyses (ppm)								
Ba	1277	584	670	3000	51		(<5)	
Be	1	.5	1	3	28	16	(<1)	7
Ce	285	100	100	500	33	10	(<100)	7
Co	15	6	7	30	46	5	(<5)	
Cr	40	55	5	300	50	1	(<5)	
Cu	29	22	2	100	51		(<2)	
Ga	15	3	10	20	44		(<10)	7
La	89	27	50	150	44	7	(<20)	
Mo	5	3	2	20	34	10	(<5)	7
Nb	13	12	3	70	38	6	(<10)	7
Ni	27	40	2	150	25	26	(<2)	
Pb	18	10	5	50	41	10	(<10)	
Sc	15	8	5	50	46	5	(<5)	
Sr	1154	479	350	2000	50		(<50)	1
V	100	57	30	300	51		(<10)	
Y	39	15	9	70	44		(<10)	7
Yb	4	1.3	1	7	44		(<1)	7
Zr	219	115	100	700	46	5	(<20)	

[1] Detection limits are given in parentheses.

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