UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Analytical results and sample locality maps of soil, plant (douglas-fir, sagebrush, sedge, aquatic moss), stream-sediment, and heavy-mineral-concentrate samples from the Baker Creek Study Area, Blaine County, Idaho

By

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INTRODUCTION

A reconnaissance geochemical survey of an area just east of Baker Creek Blaine County, Idaho, was conducted by Erdman August 24-26, 1986, after a brief orientation tour of the area with D. McIntyre, formerly with the U.S. Geological Survey. McIntyre thought that conditions at Baker Creek were favorable for metallic mineral deposits of economic interest and suggested that the biogeochemical method might be more suitable than soil geochemistry because of the intense hydrothermal alteration (Hall and McIntyre, 1986) and attendent deep leaching at the surface.

The area, which we refer to as the Baker Creek study area, comprises about 12 mi^2 (~30 km^2) in the northwest corner of Blaine County, Idaho, and lies about 10 mi (16 km) northwest of Ketchum (see fig. 1). Access to the study area is provided by the unpaved Baker Creek road south of Idaho Highway 75 and by a logging road along the East Fork of Baker Creek.

The Baker Creek area is underlain by a thick section of mafic to intermediate lava flows and tuff breccias of the Challis Volcanics. Andesitic to dacitic volcanic units crop out as discontinuous units (figure 2), reflecting original deposition on an irregular topographic surface. Volcanic rocks have been intruded by a number of small intrusions, ranging from dacitic to alkali rhyolite in composition. These were emplaced at shallow levels as indicated by the Fox Peak rhyolite that vented to the surface to form a pyroclastic carapace.

Hydrothermal alteration associated with dacitic intrusions includes widespread propylitic alteration of volcanic rocks, argillic alteration of volcanic and intrusive rocks, and intense silicification of intrusive rocks. Mineralization occurs primarily in silicified breccia zones. Stockwork quartz veining occurs in zones in intense argillic alteration proximal to silicified zones. Sulfide minerals associated with stockwork and silicified zones include pyrite, chalcopyrite, and minor molybdenite.

The terrain in the study area is typically steep and ranges in elevation from about 6,600 ft (2,012 m) along the Big Wood River to 9,160 ft (~2,790 m) at Fox Peak on the southeastern border of the study area. The terrain consists of steep slopes cut by perennial and intermittent streams. The vegetation is a mosaic of douglas-fir (*Pseudotsuga menziesii* [Mirbel] Franco) forest and clearings dominated by mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana* [Rydberg] Beetle), a subspecies that is found throughout the upper foothill and mountain areas of much of the western interior of the United States. A common and easily recognized herbaceous plant in the area is elk sedge (*Carex geyeri* Boott.). The climate is temperate.

METHODS OF STUDY

Upland and Drainage-basin Surveys

One part of the study consisted of sampling soils, douglas-fir, mountain big sagebrush, and elk sedge from 10 upland or ridgetop localities (figure 3) mainly in the argillically altered zone. Douglas-fir was selected for its unusual ability to concentrate arsenic (Warren and others, 1968) and gold (Erdman and others, 1985); sagebrush was chosen because of its demonstrated response to gold (see, for example, Erdman and others, 1988) and base metals (Lovering and Hedal, 1983); and sedge was collected because of its ability to accumulate molybdenum (Erdman and others, 1985, p. 148). Gold and molybdenum were of particular interest because a rock sample from a stockwork-veined

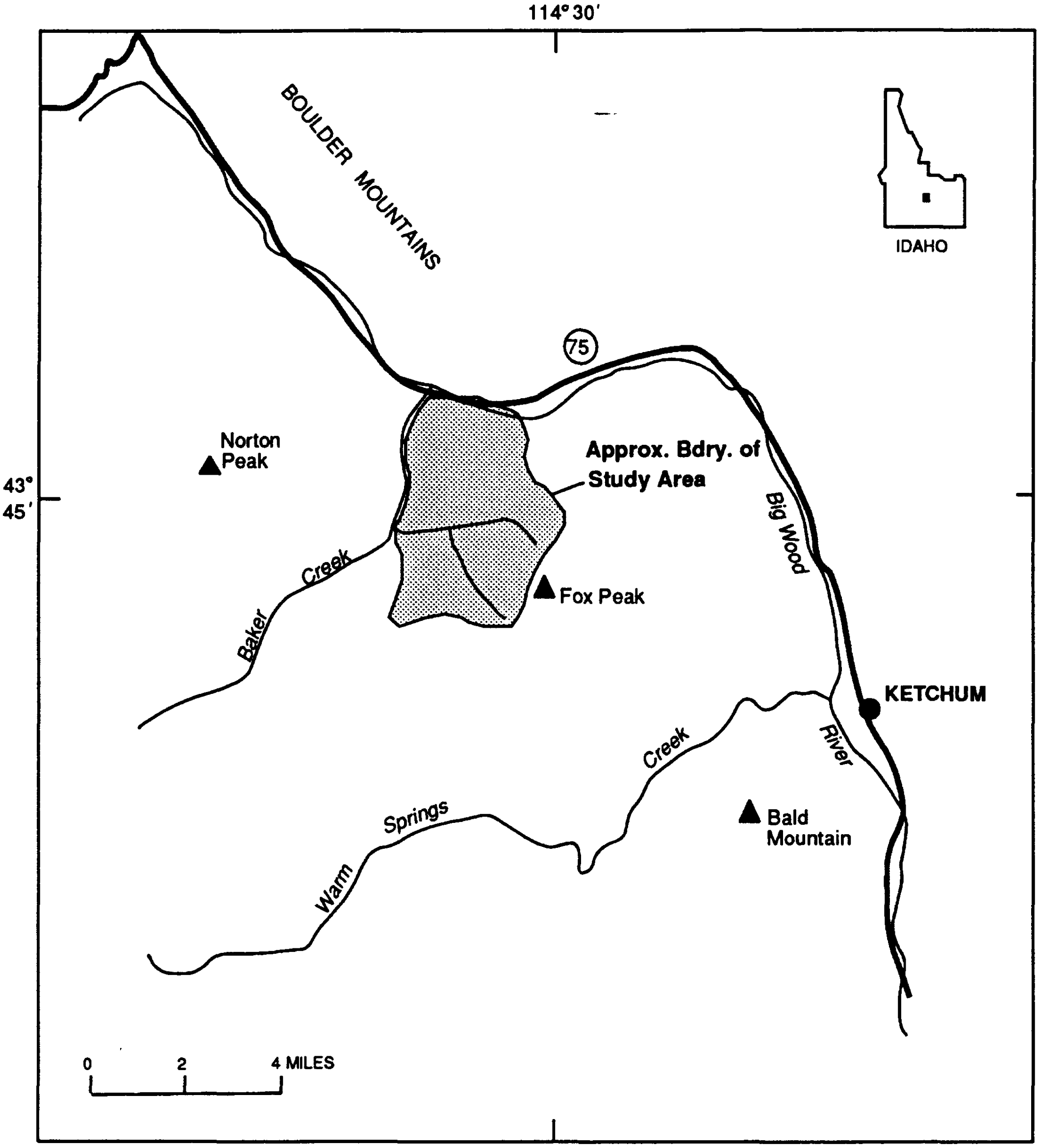

Figure 1. Index map showing the location of the Baker Creek study area, Blaine County, Idaho.

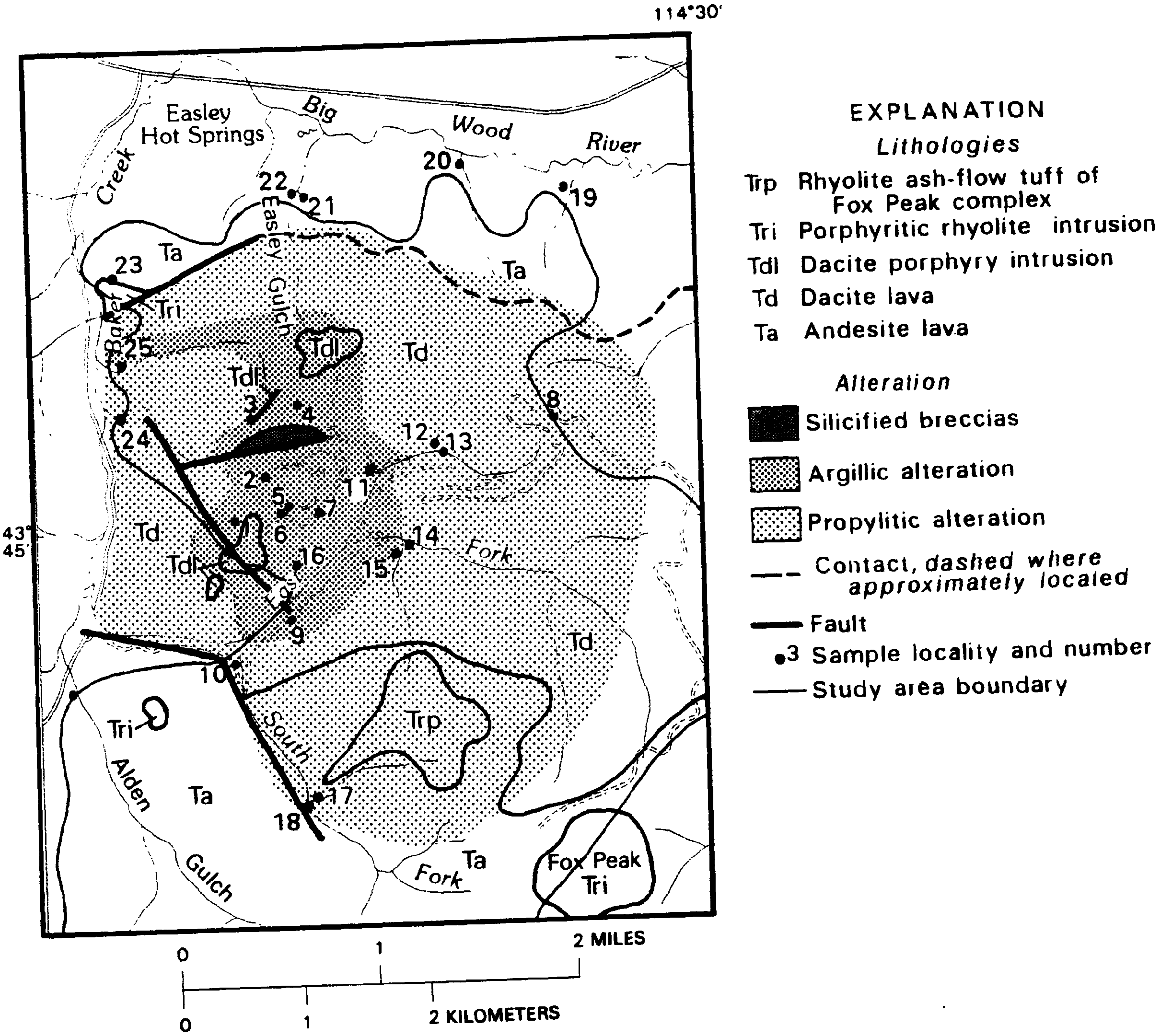

Figure 2. Geologic map of the Baker Creek study area, Blaine County, Idaho, including 26 sample localities.

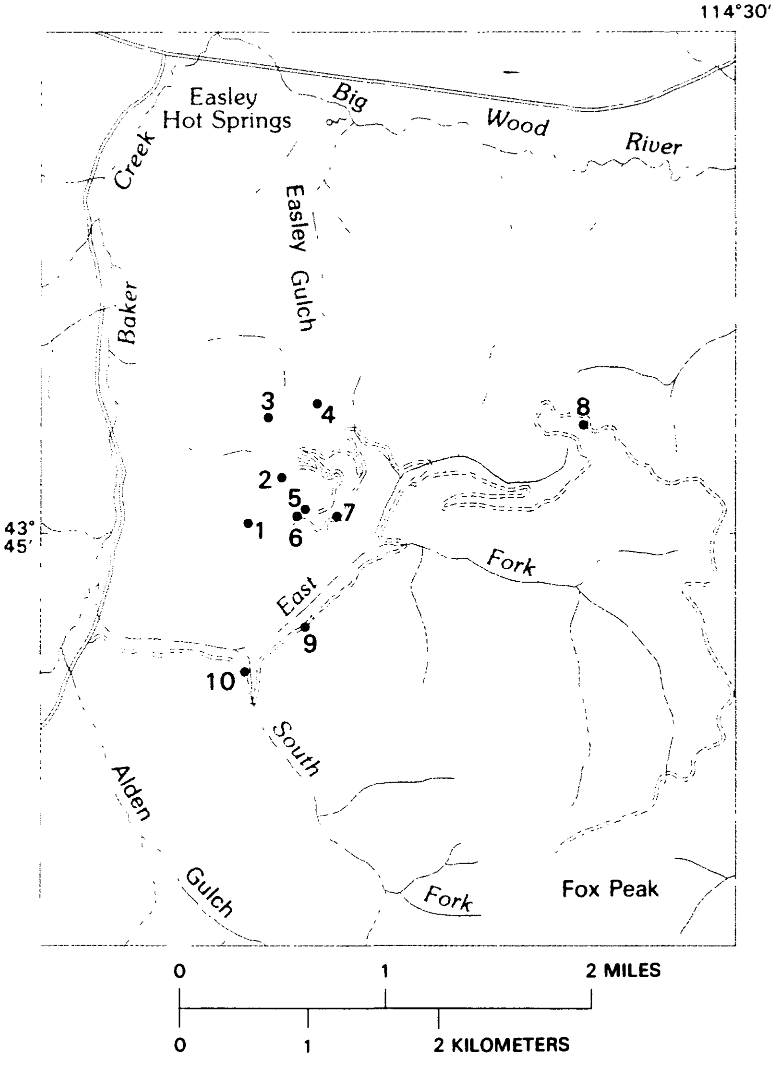

Figure 3. Localities of soil and plant samples from the upland sampling of the Baker Creek study area, Blaine County, Idaho.

outcrop contained 50 ppb (parts per billion) Au, 1.5 ppm Ag, and 50 ppm (parts per million) Mo.

In a second part of the study, stream sediments, panned concentrates, and aquatic mosses were sampled from 16 drainage basins (figure 4) that were generally within the zones of propyllitic and argillic alteration. Heavy rain and sleet at the time of collecting these samples made sampling very difficult.

Sample Media and Collection

Plants. At most of the 10 upland localities, plant samples were collected from two sites about 10 m (33 ft) apart, because of high local chemical variability commonly encountered with plants. The outer branches of a single douglas-fir tree were collected at each site and the twigs and needles were placed in cloth HUBCO bags. Samples of big sagebrush consisted of new growth, including the inflorescence, composited from several adjacent shrubs. The above-ground portion of several clumps of sedge were combined into a composite sample, as with the sagebrush. Locality 5 consisted of a small stand of douglas-fir at the base of a silicified outcrop, so only a single set of samples was collected. Locality 6 was selected because of an incrustation of manganese and iron oxides from an apparent spring; only a sample of elk sedge was taken here.

Soils. Soil samples were collected from shallow pits located at the plant-sampling sites at each upland locality. These samples were taken from a depth just below 2 in (5 cm), sieved to a minus 10-mesh fraction and composited. This fraction was later sieved into two size fractions: <30- to >80-mesh and <80-mesh.

Stream sediments. Stream-sediment samples represent the rock material eroded from the drainage basin upstream from each sample site. Analysis of such material is useful in identifying those basins which contain concentrations of elements that may be related to mineral deposits. The stream-sediment samples consisted of active alluvium collected, with few exceptions, from first-order (unbranched) streams as shown on USGS topographic maps (scale = 1:24,000). Each sample was composited from several sites at the locality plotted on the map.

Heavy-mineral concentrates. 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 be ore related, permits determination of some elements that are not easily detected in stream-sediment 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 in the field until most of the quartz, feldspar, organic material, and clay-sized material were removed.

Aquatic mosses. Aquatic mosses are an ideal alternative sampling medium where steep terrain and the attendant high flow rate of streams make it difficult to obtain adequate sediment samples (Erdman and Modreski 1984). Boyle (1979, p. 472) reports that where moss abounds along stream courses and spring flooding occurs it is often useful to obtain samples of the moss; this plant tends to mechanically collect fine (skim) gold, which can be determined chemically on the ash. Mosses were generally abundant and easily collected. No attempt was made to identify the moss species because previous studies indicate that the element content between different species collected at the

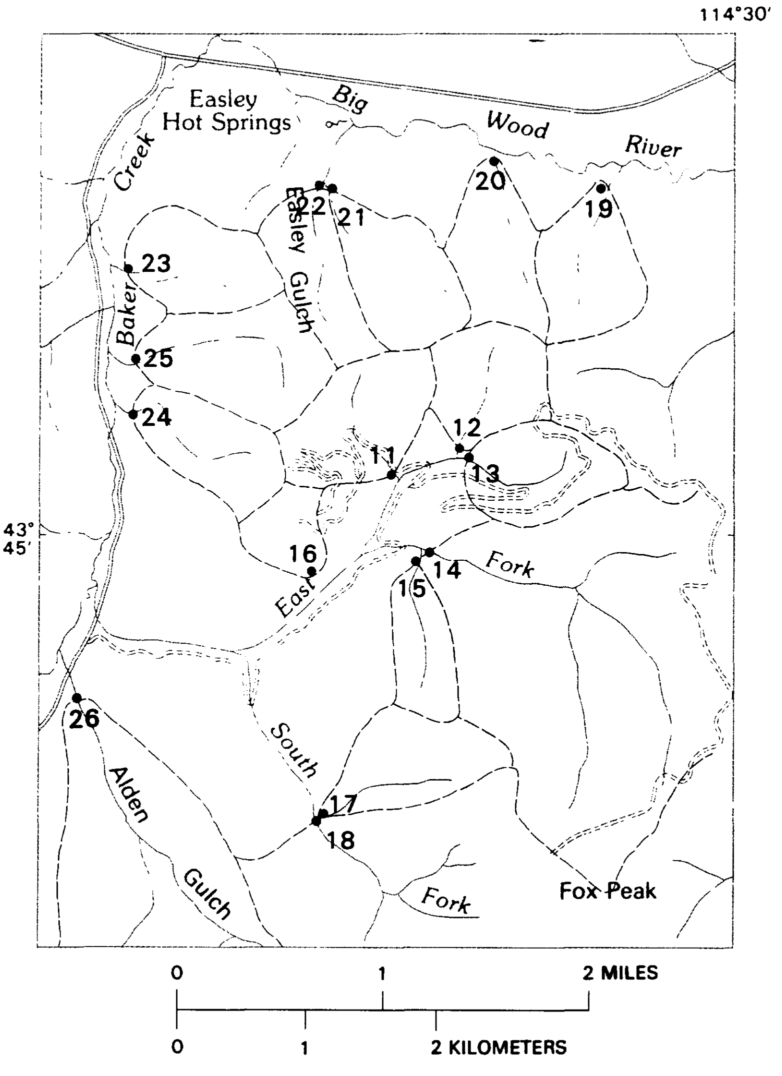

Figure 4. Localities of stream-sediment, heavy-mineral concentrate, and aquatic moss samples from the drainage basin sampling of the Baker Creek study area, Blaine County, Idaho.

same site is minimal (Erdman and Modreski, 1984). The samples were rinsed in the stream water, squeezed to remove most of the water, and placed in ziploc bags.

Sample Preparation and Analysis

Plant samples were washed, dried to brittleness at ~40 degrees C, then pulverized in a mill to pass a 2-mm screen. Aliquots of the homogenized ground material were then ashed by dry ignition in an electric muffle furnace at 450 degrees C for 24 h.

Gold analyses were made on 500-mg samples of ash (250-mg samples for moss) by a modified graphite furnace atomic absorption method of Meier (1980), detailed in Erdman and others (1988). Nine ore-related elements--Ag, As, Bi, Cu, Cd, Mo, Pb, Sb, and Zn--were determined in 250-mg aliquots for douglas-fir, sedge and moss (500-mg aliquots for sagebrush) by flame atomic absortion (O'Leary and Viets, 1986). Bismuth was not detected in any of the plant samples at a lower limit of determination of 4 ppm (2 ppm for sagebrush).

The soil and stream-sediment samples were air dried, then sieved using 30- and 80-mesh stainless-steel sieves. The portion of the sediment passing through the sieves was saved for analysis; two size fractions (<30 to >80; <80) of the soils were analyzed, whereas only the finer fraction of the sediments was retained.

After air drying and sieving to -35 mesh, bromoform (specific gravity 2.85) 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) by placing the sample in contact with the face of the magnet. The most magnetic material (removed at a setting of 0.25 ampere), primarily magnetite, was not analyzed. The second fraction (removed at a setting of 1.75 ampere) largely ferromagnesian silicates and iron oxides, was saved for analysis/archival storage. The third fraction (the nonmagnetic material which may include the nonmagnetic ore minerals, zircon, sphene, etc.) was split using a Jones splitter for analysis. One split was hand ground for spectrographic analysis; the other split was saved for mineralogical analysis.

The soil, stream-sediment, and heavy-mineral-concentrate samples were analyzed for 31 elements using semiquantitative, direct-current arc emission spectrographic methods. The analyses of heavy-mineral-concentrate samples were performed in the Branch of Geochemistry using the method of Grimes and Marranzino (1968). Gold analyses were conducted by flameless atomic absorption spectrophotometry on 10-g aliquots of soil samples only.

Analytical results for upland soils, drainage-basin stream sediments, and heavy-mineral-concentrates are listed in tables 1, 5, and 6, respectively. Analytical results for upland plants and drainage-basin aquatic mosses are listed in tables 2-4 and 7, respectively. Only those elements that we judged to be of interest to the study area are given in the tables; concentrations of those elements not reported were generally uniform among samples.

ACKNOWLEDGMENTS

R. H. Hill, assisted by J. G. Frisken, analyzed the soil samples for Au.

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TABLE 1.--Analytical results for selected elements in soils from the upland localities in the Baker Creek study area west of Ketchum, Idaho

[Suffixes C and F in sample numbers indicate powdered coarse (<30- to <80-mesh) and fine (<80-mesh) fractions of soils, respectively; analyses for Ag, Mo, Pb, and Zn by optical emission spectroscopy and for Au by graphite furnace atomic absorption; <, indicates trace but less than the lower limit of determination given in parentheses; N, not detected.]

Sample #	Au ppb (2)	Ag ppm (0.5)	Mo ppm (5)	Pb ppm (10)	Zn ppm (200)
H01-C	N	<	7	30	N
H01-F	N	N	<	20	N
H02-C	N	N	N	10	N
H02-F	N	N	N	<	N
H03-C	N	2	<	30	N
H03-F	2	2	5	30	N
H04-C	2	1	7	30	N
H04-F	N	1.5	10	50	N
H05-C	N	<	N	70	200
H05-F	N	N	N	50	200
H07-C	N	<	15	150	200
H07-F	N	<	15	150	200
H08-C	2	N	N	10	N
H08-F	N	N	N	10	N
H09-C	N	N	N	30	N
H09-F	2	N	N	20	N
H10-C	N	N	N	15	N
H10-F	N	N	<	10	N

TABLE 2.--Analytical results for elements in the ash of douglas-fir branches (stems and needles combined) from the upland localities in the Baker Creek area west of Ketchum, Idaho

[Concentrations are in ppm, except for Au where levels are in ppb (parts per billion); <, indicates trace but less than the lower limit of determination given in parentheses; N, not detected; Mo analyses were on an acid digestion of the ash from 30-g samples of dry material by inductively coupled plasma emission spectroscopy at the laboratory of Geochemical Services, Inc., Rocklin, CA 95677.]

Sample #	Au (8)	Ag (0.2)	As (40)	Cd (0.2)	Cu (20)	Mo	Pb (20)	Zn (20)
H01-P1	<	N	N	2.8	60	0.67	<	600
H01-P2	N	0.8	N	2.0	40	.57	<	480
H02-P1	<	.2	N	2.4	40	.57	<	360
H02-P2	8	N	N	.8	40	.61	20	240
H03-P1	<	.6	N	.4	40	.52	<	400
H03-P2	8	.2	<	.8	80	.90	20	480
H04-P1	N	N	N	2.4	40	.55	<	400
H04-P2	16	.4	N	1.2	60	.74	<	440
H05-P	<	.2	N	3.6	60	1.10	20	1,000
H07-P1	8	3.2	N	5.6	60	1.80	<	1,000
H07-P2	<	3.8	N	2.4	60	4.00	<	800
H08-P1	16	N	N	2.4	80	.76	<	440
H08-P2	N	.6	N	1.6	40	.51	<	360
H09-P1	8	.4	200	.8	60	.97	<	520
H09-P2	<	<	400	.8	60	.68	<	640
H10-P1	<	N	160	2.0	60	.67	N	680
H10-P2	<	.4	240	2.8	60	.83	N	800

TABLE 3.--Analytical results for elements in the ash of big sagebrush new growth (stems and leaves combined) from the upland localities in the Baker Creek area west of Ketchum, Idaho

[Concentrations are in ppm, except for Au where levels are in ppb (parts per billion); <, indicates trace but less than the lower limit of determination given in parentheses; N, not detected.]

Sample #	Au (8)	Ag (0.1)	As (20)	Cd (0.2)	Cu (10)	Mo (2)	Pb (10)	Zn (10)
H01-A1	16	.1	N	2.6	160	8	N	480
H01-A2	<	N	N	3.0	380	6	N	360
H02-A1	8	N	N	1.0	340	6	N	300
H02-A2	24	N	N	1.0	340	12	N	320
H03-A1	8	.1	N	1.6	320	8	N	380
H03-A2	8	N	N	1.2	380	6	N	360
H04-A1	<	N	N	4.2	460	10	N	400
H04-A2	48	N	N	2.8	400	4	N	420
H05-A	<	N	N	5.0	440	20	N	520
H07-A1	<	.1	N	26	520	20	20	620
H07-A2	8	<	N	40	520	72	10	720
H08-A1	<	N	N	3.6	360	6	N	360
H08-A2	8	N	N	1.8	360	10	N	400
H10-A1	<	N	N	3.2	310	8	<	380
H10-A2	<	N	N	.4	440	8	<	320

TABLE 4.--Analytical results for elements in the ash of elk sedge (above-ground parts) from the upland localities in the Baker Creek area west of Ketchum, Idaho

[Concentrations are in ppm, except for Au where levels are in ppb (parts per billion); <, indicates trace but less than the lower limit of determination given in parentheses; N, not detected.]

Sample #	Au (8)	Ag (0.2)	As (40)	Cd (0.2)	Cu (20)	Mo (4)	Pb (20)	Zn (20)
H01-C1	<	.2	N	2.0	60	12	N	480
H01-C2	24	.4	N	1.6	80	12	N	480
H02-C1	<	.4	N	1.6	40	4	N	360
H02-C2	N	.4	N	1.6	40	20	N	400
H03-C1	8	1.4	N	.8	60	16	N	360
H03-C2	N	.4	N	1.2	40	12	N	360
H04-C1	N	2.0	N	3.2	60	20	N	600
H04-C2	<	.4	N	2.4	80	8	N	560
H05-C	<	N	N	1.6	40	28	N	880
H06-C	20	1.2	N	5.2	100	8	N	2,000
H07-C1	N	N	N	5.2	100	24	N	1,200
H07-C2	<	.8	N	7.6	60	56	N	1,400
H08-C1	N	N	N	1.2	40	8	N	280
H08-C2	8	N	N	1.2	60	8	N	560
H09-C1	16	N	N	.8	20	4	N	160
H09-C2	8	.2	N	.8	20	4	N	180
H10-C1	N	.4	N	2.0	60	12	N	400
H10-C2	N	.8	N	1.2	40	8	N	300

TABLE 5.--Analytical results of selected elements in stream sediments from drainage-basin localities in the Baker Creek area west of Ketchum, Idaho

[Analyses made on <80-mesh (<180-m) fraction by optical emission spectroscopy for Ag, Mn, Mo, and Zn, and by graphite furnace atomic absorption for Au; <, indicates trace but less than the lower limit of determination given in parentheses; N, not detected]

Sample #	Ag ppm (0.5)	Mn ppm (10)	Mo ppm (5)	Pb ppm (10)	Zn ppm (200)
H11-SS	1.5	>5,000	10	50	<
H12-SS	N	700	N	20	N
H13-SS	<	500	<	30	N
H14-SS	N	500	N	30	N
H15-SS	.5	>5,000	<	30	200
H16-SS	.5	2,000	5	150	700
H17-SS	N	500	N	20	N
H18-SS	N	300	N	30	N
H19-SS	N	150	N	10	N
H20-SS	N	100	N	<	N
H21-SS	N	150	N	15	N
H22-SS	N	500	N	<	N
H23-SS	N	1,000	N	10	N
H24-SS	.5	300	7	30	N
H25-SS	N	300	7	20	N
H26-SS	N	150	N	15	N

TABLE 6.--Analytical results of selected elements in the non-magnetic and weakly magnetic fractions of heavy-mineral concentrates collected from drainage-basin localities in the Baker Creek study area west of Ketchum, Idaho

[Analyses of powdered <80-mesh fractions by optical emission spectroscopy; < indicates trace but less than the lower limit of determination given in parentheses; N, not detected.]

Sample #	Ag ppm (1)	B ppm (20)	Ba ppm (50)	Be ppm (2)	Bi ppm (20)
			Non-magnetic (C3) fraction		
H11-H	N	20	>10,000	N	70
H12-H	N	20	>10,000	N	N
H13-H	N	<	>10,000	N	N
H14-H	N	20	>10,000	N	N
H15-H	2	500	10,000	N	N
H16-H	N	20	>10,000	N	20
H17-H	N	20	>10,000	N	N
H18-H	N	<	7,000	2	N
H19-H	N	20	700	N	N
H20-H	N	20	3,000	N	N
H21-H	N	50	>10,000	<	N
H22-H	N	20	>10,000	N	N
H23-H	N	50	7,000	<	N
H24-H	N	50	2,000	N	100
H25-H	N	50	>10,000	N	1,000
H26-H	N	30	2,000	<	30
			Weakly magnetic (C2) fraction		
H11-H	2	<	3,000	5	N
H12-H	N	<	700	<	N
H13-H	<	<	500	<	N
H14-H	<	<	1,000	<	N
H15-H	1	<	1,000	3	N
H16-H	1	<	1,000	15	N
H17-H	N	<	200	N	N
H18-H	N	<	200	N	N
H19-H	N	<	200	N	N
H20-H	N	<	200	N	N
H21-H	<	<	150	2	N
H22-H	N	<	500	2	N
H23-H	N	<	150	<	N
H24-H	<	<	150	2	N
H25-H	N	<	700	3	N
H26-H	N	<	200	N	N

TABLE 6.--(Continued)

Sample #	Cu (10)	Mo (10)	Pb (20)	Sr (200)	Zn (500)
			Non-magnetic (C3) fraction		
H11-H	<	N	<	<3,000	N
H12-H	<	N	N	3,000	N
H13-H	<	N	N	5,000	N
H14-H	<	N	20	3,000	N
H15-H	<	N	50	500	N
H16-H	<	70	3,000	2,000	N
H17-H	N	N	50	700	N
H18-H	<	N	<	<	N
H19-H	N	N	N	<	N
H20-H	<	N	30	200	N
H21-H	<	N	700	500	N
H22-H	300	N	300	1,000	N
H23-H	10	N	30	500	N
H24-H	<	N	30	N	N
H25-H	<	N	20	1,500	N
H26-H	N	N	30	200	N
			Weakly magnetic (C2) fraction		
H11-H	100	15	30	<	500
H12-H	70	N	<	<	<
H13-H	100	N	50	<	<
H14-H	70	10	70	<	<
H15-H	100	15	100	<	500
H16-H	100	<	200	200	1,000
H17-H	70	N	50	N	N
H18-H	10	N	<	N	N
H19-H	20	N	50	<	N
H20-H	70	N	50	<	N
H21-H	100	10	50	N	N
H22-H	70	N	20	200	<
H23-H	10	N	20	300	N
H24-H	20	N	100	500	N
H25-H	70	20	70	300	<
H26-H	15	N	30	N	N

TABLE 7.--Analytical results, including ash yield, in aquatic mosses from drainage-basin localities in the Baker Creek study area west of Ketchum, Idaho

[< = detected, but below the limit of determination given in parentheses; N = not detected; --, no data]

Sample #	Au ppb (16)	Ag ppm (0.2)	As ppm (40)	Sb ppm (8)	Mo ppm (4)
H11-M	64	3.2	<	72	8
H12-M	insufficient sample, no data				
H13-M	48	N	N	N	8
H14-M	16	N	N	N	4
H15-M	64	5.2	N	N	8
H16-M	16	1.6	40	N	8
H17-M	--	N	N	N	8
H18-M	16	N	N	N	N
H19-M	<	N	N	N	N
H20-M	<	N	N	N	4
H21-M	insufficient sample, no data				
H22-M	<	.40	N	N	4
H23-M	<	.60	40	N	4
H24-M	--	2.2	N	N	20
H25-M	16	.60	N	N	16
H26-M	--	N	N	N	4

Sample #	Cu ppm (20)	Pb ppm (20)	Zn ppm (20)	Cd ppm (0.2)	Ash %
H11-M	100	60	720	2.8	15.5
H12-M	insufficient sample, no data				
H13-M	60	20	380	1.2	16.8
H14-M	40	20	240	.8	32.0
H15-M	140	40	1,500	5.6	16.1
H16-M	120	160	>2,000	20	21.4
H17-M	60	<	380	1.6	12.6
H18-M	20	<	360	.4	56.5
H19-M	80	40	180	1.2	32.3
H20-M	40	<	160	.8	17.8
H21-M	insufficient sample, no data				
H22-M	80	20	300	1.6	17.5
H23-M	80	20	320	1.6	14.3
H24-M	100	100	360	4.4	23.3
H25-M	60	100	180	2.4	38.2
H26-M	60	<	260	.8	20.2