UNITED STATES DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

GEOCHEMICAL ANALYSES OF STREAM-SEDIMENT SAMPLES FROM THE PIT RIVER CANYON WILDERNESS STUDY AREA, LASSEN COUNTY, CALIFORNIA

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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 the Congress. This report presents the results of a geochemical study of the Pit River Canyon Wilderness Study Area (CA-020-103), Lassen County, California.

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PIT RIVER CANYON WILDERNESS STUDY AREA

INTRODUCTION

The Pit River Canyon Wilderness Study Area (CA-020-103) covers 5,400 acres in Lassen County, northeastern Calif. (fig. 1). The area covers about 11 linear mi of the steep, narrow canyon of the Pit River, where elevations range from 3,400 to 4,000 ft in the canyon and from 3,800 to 4,400 ft along the canyon rim. The canyon is 200 to 750 ft deep. Four-wheel drive roads and trails cross the plateau adjacent to the canyon and provide access to the canyon rim. The canyon bottom within the study area is relatively inaccessible; in places it is choked by talus composed of large boulders and contains rapids. No maintained trails lead into the canyon.

Mineral resources near the Pit River Canyon Wilderness Study Area include volcanic cinders, diatomite, gold, silver, sand, gravel, and stone. The study area contains no mines or prospects nor rock types that host precious-metal deposits. Rock types that contain industrial minerals are near the study area, but probably do no extend into it.

Geology

The Pit River Canyon Wilderness Study Area lies in the western part of the Modoc Plateau geomorphic province, which consists of a series of north-trending, block-faulted ranges, composed of flood basalts above which rise small shield volcanoes, composite andesitic cones, and cinder cones. Volcanic flows, lakebeds, and alluvium fill intervening basins. The Modoc Plateau region is part of the Basin and Range province which was flooded by volcanic flows of the Cascade volcanic province (Macdonald, 1966).

The U.S. Geological Survey mapped the study area in 1982 at a scale of 1:62,500 by photogeologic reconnaissance as part of a study of the Neogene Volcanic Rocks of the Cascade Range (J. G. Smith, written commun., 1985) and collected eight stream-sediment samples in June 1984 (fig. 2). The U.S. Bureau of Mines examined the area and collected one basalt sample for analysis in May 1984 (fig. 2). The only prior geologic study of the area is reconnaissance mapping by T. E. Gay, Jr. at a scale of 1:62,500 (Lydon and others, 1960).

Pliocene and late Miocene basalt flows (2 to 7 m.y., J. G. Smith, written commun., 1985) underlie the study area. They are vesicular to nonvesicular flows that are commonly 2 ft to 50 ft thick (Macdonald, 1966). A series of northwest-trending, high-angle normal faults cut the flows. Red soils, which are deepest on flat to gently dipping surfaces, cover much of the plateau. They are derived from deeply weathered basalt and contain subrounded boulders.

Neogene andesite of the same age as the basalt forms a shield volcano on Bald Mountain, about 5 mi southeast of the study area (fig 2.). Flows from this volcano extend to within 0.25 mi of the southeast border of the study area.

Although basaltic and andesitic flows dominate, lake beds and ash-flow tuffs are exposed locally. Colluvium, formed from the weathering of lava flows, commonly covers these less resistant rocks. Neither lake beds nor ash-flow tuffs extend into the study area.

Young volcanic cinder cones 120,000 to 730,000 years b.p. (J. G. Smith written commun., 1985) that are common in the region do not extend into the study area.

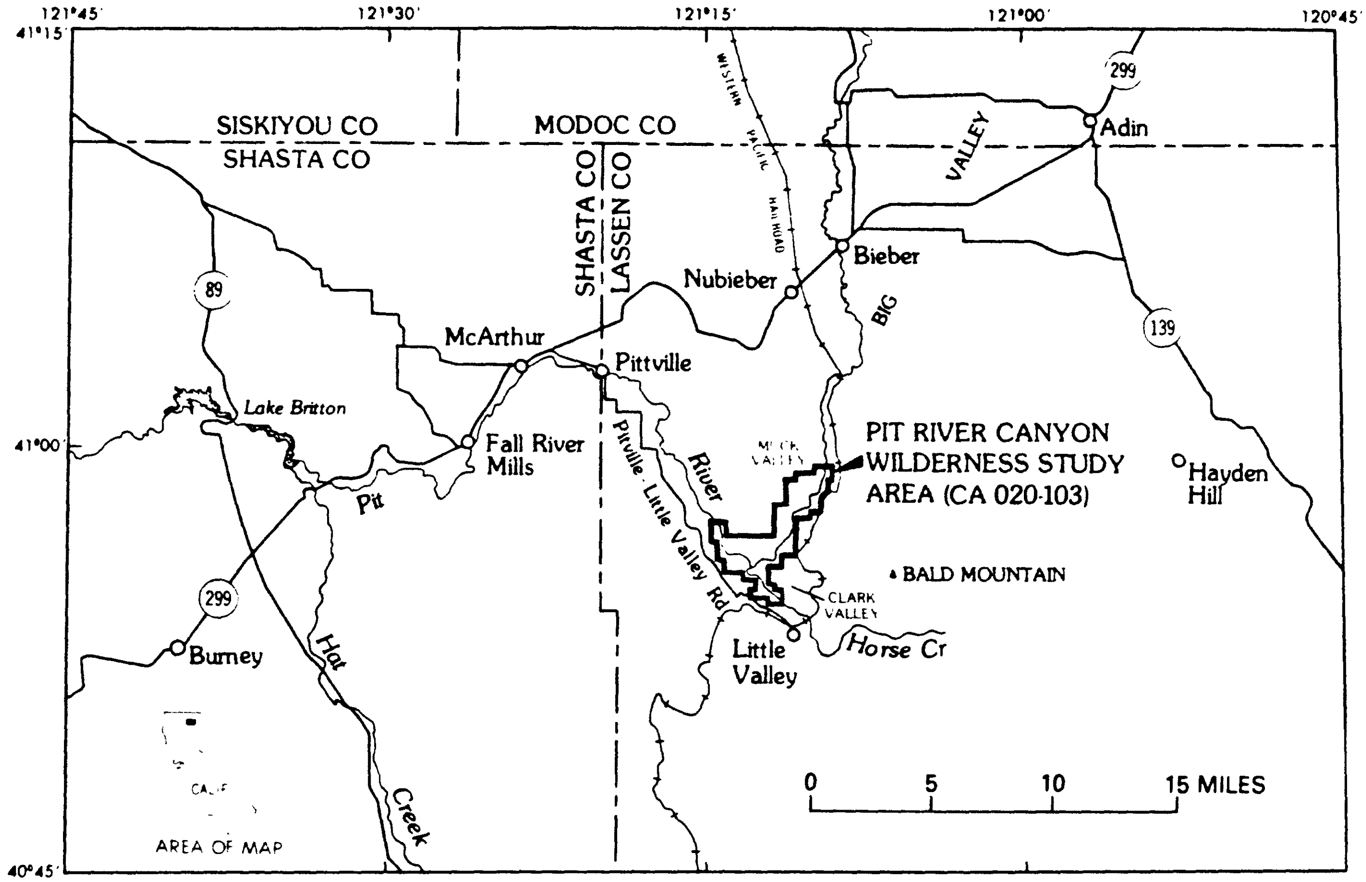


Figure 1. Index map showing the location of the Pit River Canyon Wilderness Study Area, Lassen County, Calif.

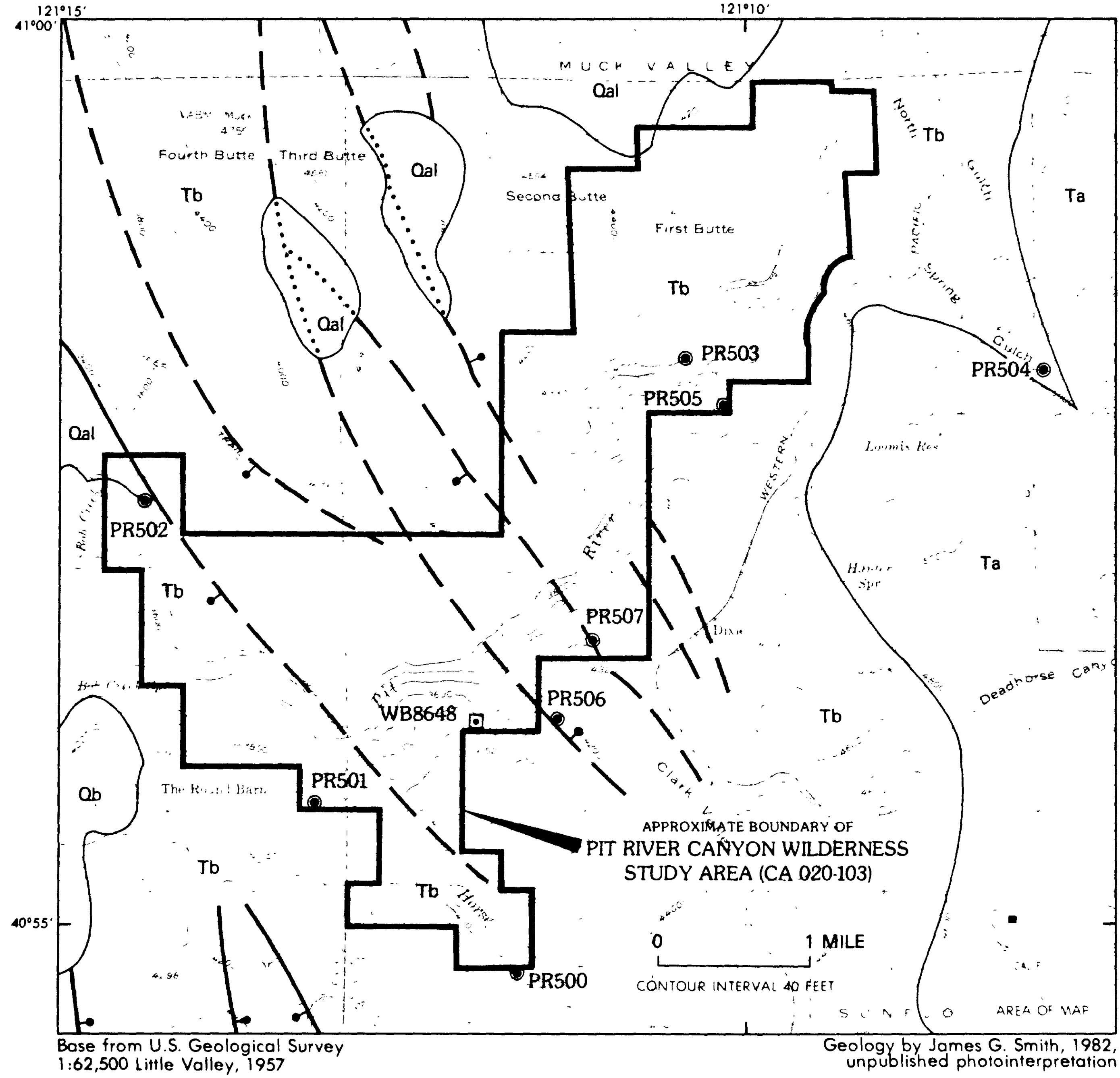
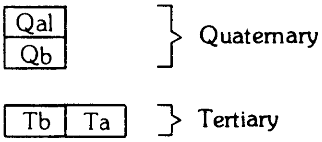


Figure 2. Map showing geology and sample locations of the Pit River Canyon Wilderness Study Area, Lassen County, California.

CORRELATION OF MAP UNITS



GEOLOGIC MAP UNITS

Qal	ALLUVIUM (HOLOCENE AND PLEISTOCENE)
Qb	BASALT (QUATERNARY)
Tb	BASALT (PLIOCENE AND MIOCENE)
Ta	ANDESITE (PLIOCENE AND MIOCENE)

MAP SYMBOLS

——— – – –	CONTACT – Dashed where approximately located
┸—— – – ··	NORMAL FAULT – Dashed where approximately located; dotted where concealed; ball and bar on downthrown side
━━━━	APPROXIMATE BOUNDARY OF WILDERNESS STUDY AREA
◉	GEOCHEMICAL STREAM-SEDIMENT SITE
⊡	GEOCHEMICAL ROCK SAMPLE SITE

An 8 m.y. old Tertiary dacite complex, comprised of ash-flow tuffs, ash beds, and associated glassy domes (J. G. Smith, written commun., 1985; Finn and Buchanan, 1984) occurs in the Hayden Hill mining district, 12 mi east of the study area. There, argentiferous gold, minor silver sulfides, and silver-bearing manganese oxides are disseminated in sulfide-rich breccias, and stockworks, and quartz-adularia veins (Finn and Buchanan, 1984). This is the closest precious-metal mining district to the study area within the Modoc Plateau (Albers and Fratcelli, 1985). No evidence suggests that similar mineralized rock may occur in the study area.

ANALYTICAL DATA

Stream-sediment samples and panned concentrates were analyzed by semi-quantitative emission spectrography and flame atomic absorption. Table 1 shows the lower limits of analytical determination using these techniques. Tables 2 and 3 show that for the results of these analyses the values for any of the detected elements do not differ significantly, such values are expected for rocks collected in unmineralized volcanic terrane.

Table 4 lists the results of an analysis of a typical basalt from the wilderness study area collected by H. W. Campbell, U.S. Bureau of Mines.

Sample collection

Eight stream-sediment samples were collected in and near the wilderness study area (fig. 2). Basalt contributed all the sediment to seven of the samples; andesite contributed much of the sediment for sample PR-504. One sample (PR-502) was collected from the main drainage of the Pit River and one sample (PR-500) from the main drainage of Horse Canyon. The other samples were collected from streams and dry gulches tributary to the Pit River. Sampling sites were selected for the availability of stream sediment, potential for panning onsite, and access. Stream sediments in basaltic terranes such as that of the study area typically consist of coarse pebbles and finer material that contains mostly heavy minerals. Consequently, the amount of stream sediment available at a sampling site is commonly small and only a small amount of light fraction is lost in panning. Sample PR-506 consists of mostly soil with little stream-sediment component because of the paucity of stream sediment at the site.

Sample preparation

The stream-sediment samples were dried, sieved to minus-80 mesh, split, and pulverized. The panned-concentrate samples were dried and sieved to minus 30-mesh. The magnetite and ilmenite were removed using a Frantz Isodynamic Magnetic Separator and discarded. Low-density minerals were removed by flotation in bromoform (sp grav 2.8) and discarded. The remaining heavy mineral fraction was then run through the Frantz separator to remove mafic silicate and iron oxide minerals. The remaining nonmagnetic fraction contains the heavy minerals, if any, associated with mineral deposits. These heavy minerals may include native metals, sulfides, sulfates, sulfosalts, arsenates, vanadates, molybdates, tungstates, fluorides, some oxides and carbonates, tourmaline, zircon, apatite, sphene, rutile, monazite, corundum, topaz, and any rare uranium-, thorium-, or rare-earth-element-bearing minerals. After examining this fraction under a binocular microscope to identify the mineral constituents and estimate their relative proportions, a portion of each sample was ground under acetone in an agate mortar.

Table 1. Lower limits of analytical determination for stream-sediment and nonmagnetic heavy-mineral-concentrate samples from Pit River Canyon Wilderness Study Area.

[Limits of determination of elements are in parts per million (ppm) except where noted. All analyses are by spectrographic methods. Numbers in parentheses are determination limits for nonstandard sample weights of 2.5 mg].

Element	Determination limits stream sediment	Determinations limits stream sediment concentrates
Ca	0.05 percent	0.1 percent
Fe	.05 percent	.1 percent
Mg	.02 percent	.05 percent
Ti	.002 percent	.005 percent
Ag	.5	1 (2)
As	200	500 (1,000)
Au	10	20 (50)
B	10	20
Ba	20	50
Be	1	2 (5)
Bi	10	20 (50)
Cd	20	50 (100)
Co	5	10 (20)
Cr	10	20 (50)
Cu	5	10 (20)
La	20	50 (100)
Mn	10	20
Mo	5	10 (20)
Nb	20	50 (100)
Ni	5	10 (20)
Pb	10	20 (50)
Sb	100	200 (500)
Sc	5	10 (20)
Sn	10	20 (50)
Sr	100	200
Th	100	200 (500)
V	10	20
W	50	100 (200)
Y	10	20 (50)
Zn	200	500 (1,000)
Zr	10	20

Table 2.--Results of semiquantitative spectrographic analyses of stream-sediment samples from Pit River Canyon Wilderness Study Area

[Qualifying codes in analytical data are defined as follows: N, not detected at the lower limit of determination; L, detected, but below lower limit of determination; G, present in an amount greater than the upper limit of determination shown.]

Analysed by James G. Frisken and Betty Adrian

Sample	Latitude	Longitude	Ca-pct	Fe-pct	Mg-pct	Ti-pct	Ag-ppm	As-ppm	Au-ppm	B-ppm	Ba-ppm	Be-ppm	Bi-ppm	Cd-ppm	Co-ppm	Cr-ppm
PR-500	40°54'44"	121°11'39"	2	5	3	.5	N	N	N	10	500	N	N	N	30	150
PR-501	40°55'39"	121°13'07"	5	7	2	G(1)	N	N	N	10	300	L	N	N	30	200
PR-502	40°57'18"	121°14'22"	3	7	5	1	N	N	N	10	700	N	N	N	30	200
PR-503	40°58'07"	121°10'25"	5	10	5	1	N	N	N	20	700	N	N	N	70	200
PR-504	40°58 04"	121°07'49"	1	10	2	1	N	N	N	15	500	L	N	N	50	200
PR-505	40°57'40"	121°10'06"	2	15	5	G(1)	N	N	N	10	300	N	N	N	50	200
PR-506	40°56'06"	121°11'21"	1	5	1	.5	N	N	N	50	300	L	N	N	15	100
PR-507	40°56'32"	121°11'06"	1.5	7	2	1	N	N	N	20	500	N	N	N	30	150

Sample	Cu-ppm	La-ppm	Mn-ppm	Mo-ppm	Nb-ppm	Ni-ppm	Pb-ppm	Sb-ppm	Sc-ppm	Sn-ppm	Sr-ppm	Th-ppm	V-ppm	W-ppm	Y-ppm	Zn-ppm	Zr-ppm
PR-500	30	N	700	N	N	70	15	N	20	20	500	N	100	N	20	N	70
PR-501	15	N	1000	N	N	50	15	N	30	N	500	N	150	N	15	N	150
PR-502	10	N	1500	N	N	50	15	N	20	N	500	N	200	N	20	N	100
PR-503	100	N	2000	N	N	150	15	N	30	N	300	N	200	N	30	N	100
PR-504	100	N	1500	N	N	100	10	N	20	N	200	N	200	N	20	N	100
PR-505	100	N	1500	N	N	100	10	N	30	N	300	N	200	N	20	N	150
PR-506	70	L	300	N	N	50	15	N	10	N	200	N	100	N	30	N	150
PR-507	50	N	1000	N	N	70	15	N	20	N	300	N	200	N	20	N	100

Table 3.--Results of semiquantitative spectrographic analyses of panned concentrate samples from stream sediments from Pit River Canyon Wilderness Study Area

Qualifying codes in analytical data are defined as follows: N, not detected at the lower limit of determination; N ( ), not detected at the limit of determination shown in parentheses; L, detected, but below the lower limit of determination; G, present in an amount greater than the upper limit of determination shown.]

Analysed by James G. Frisken and Betty Adrian

Sample	Latitude	Longitude	Ca-pct	Fe-pct	Mg-pct	Ti-pct	Ag-ppm	As-ppm	Au-ppm	B-ppm	Ba-ppm	Be-ppm	Bi-ppm	Cd-ppm	Co-ppm	Cr-ppm
PR-500	40°54'44"	121°11'39"	5	1.5	2	.5	N	N	N	20	300	N	N	N	10	N
PR-501	40°55'39"	121°13'07"	3	1	1	.3	N	N	N	20	300	N	N	N	10	70
PR-502	40°57'18"	121°14'22"	5	.5	.1	.07	N	N	N	20	500	N	N	N	L	N
PR-504	40°58'04"	121°07'49"	3	3	2	.7	N	N	N	20	500	N	N	N	30	70
PR-505	40°57'40"	121°10'06"	2	3	.7	.3	N	N	N	20	300	N	N	N	10	100
PR-506	40°56'06"	121°11'21"	5	3	.5	.2	N(2)	N(1000)	N(50)	50	500	N(5)	N(50)	N(100)	L(20)	N(50)
PR-507	40°56'32"	121°11'06"	3	1.5	.5	.15	N	N	N	20	500	N	N	N	L	N

Sample	Cu-ppm	La-ppm	Mn-ppm	Mo-ppm	Nb-ppm	Ni-ppm	Pb-ppm	Sb-ppm	Sc-ppm	Sn-ppm	Sr-ppm	Th-ppm	V-ppm	W-ppm	Y-ppm	Zn-ppm	Zr-ppm
PR-500	N	N	300	N	N	50	N	N	N	N	700	N	20	N	L	N	2000
PR-501	N	N	200	N	N	L	N	N	N	N	700	N	30	N	70	N	G(2000)
PR-502	N	N	100	N	N	N	N	N	20	N	1000	N	N	N	20	N	G(2000)
PR-504	N	N	300	N	N	70	N	N	N	N	700	N	100	N	30	N	G(2000)
PR-505	L	N	150	N	N	20	N	N	N	N	500	N	70	N	100	N	G(2000)
PR-506	N(20)	N(100)	200	N(20)	N(100)	N(20)	N(50)	N(500)	N(20)	N(50)	1000	N(500)	60	N(200)	N(50)	N(1000)	700
PR-507	N	N	200	N	N	10	N	N	N	N	700	N	L	N	50	N	G(2000)

Table 4.--Results of fire assay-inductively coupled plasma emission spectrometry and semiquantitative optical-emission spectroscopy from basalt (sample WB-8648)from the Pit River Canyon Wilderness Study Area.

[Analyses in percent, except as indicated by parts per million (ppm). s, in element column indicates spectrographic analysis; f, in element column indicates fire-assay analysis; <, concentration less than value shown; >, concentration greater than value shown.] Analyzed by the U.S. Bureau of Mines, Reno Research Center.

Element	Concentration	Element	Concentration
Ag-f	0.430 ppm[1]	Mn-s	.4
Ag-s	<.0005	Mo-s	<.0001
Al-s	>4.	Na-s	2.
As-s	<.009	Nb-s	<.02
Au-f	0.018 ppm[1]	Ni-s	.005
Au-s	<.002	P-s	<.7
B-s	<.005	Pb-s	<.002
Ba-s	.02	Pd-s	<.0001
Be-s	<.0001	Pt-s	<.0006
Bi-s	<.02	Sb-s	<.06
Ca-s	7.	Sc-s	<.0004
Cd-s	<.0005	Si-s	>10.
Co-s	<.001	Sn-s	<.003
Cr-s	.004	Sr-s	.007
Cu-s	<.0006	Ta-s	<.02
Fe-s	5.	Te-s	<.04
Ga-s	<.0002	Ti-s	.2
K-s	<.6	V-s	<.005
La-s	<.01	Y-s	<.0009
Li-s	<.002	Zn-s	.01
Mg-s	2.	Zr-s	<.003

1/ Result is near the detection limit and must be interpreted accordingly.

Analytical methods

The samples were analyzed for 31 elements (table 1) by direct-current arc emission spectrographic technique (Grimes and Marranzino, 1968). The analytical values were determined on 10-milligram stream-sediment splits and on 5-milligram nonmagnetic panned-concentrate splits. Two exceptions are made for these samples: the nonmagnetic heavy fraction of sample (PR-503) was too small for analysis. Sample PR-506 yielded only sufficient nonmagnetic heavy fraction for analysis of a 2.5-milligram split. Limits of analytical determination for each element are one reporting interval higher for the panned-concentrate samples than for the stream-sediment samples (table 1).

Analytical values of spectrographic analysis are measured by visual comparison of spectra derived from the sample and spectra obtained from standards made from pure oxides or carbonates. The concentrations of standard samples are geometrically spaced over any given order of magnitude of concentration and the standards are prepared so that concentrations bracket the range of concentrations normally found in naturally occurring samples. Sample comparisons are made with standard films for semiquantitative use, and reported values are rounded to 100, 50, 20, 10, and so forth. Samples whose spectra fall between the spectra of the standards are given values of 70, 30, 15, 7, and so forth whichever is appropriate for the concentration of the standards. The precision of the method is approximately plus or minus one reporting unit at the 83-percent confidence level and plus or minus two reporting units at the 96-percent confidence level (Motooka and Grimes, 1976). Values determined for the major elements (calcium, iron, magnesium, and titanium) are reported in weight percent; all others are given in parts per million. Betty Adrian and J. G. Frisken of the U.S. Geological Survey in Denver, Colo., analyzed the samples.

Basalt sample WB-8648 was crushed and pulverized to minus 100 mesh at the Western Field Operations Center, Spokane, Wash. A split was sent for analysis to the U.S. Bureau of Mines Metallurgy Research Center, Reno, Nev. The sample was analyzed for gold and silver by standard fire-assay methods combined with inductively coupled plasma-atomic emission spectrometry measurement of the dore bead, utilizing a Jarrell-Ash Plasma AtomComp 0.75 meter computer-controlled spectrometer with direct printout and digital microphotometer. The detection limits by this method are 0.007 ppm for gold and 0.3 ppm for silver. The sample was also analyzed for 40 elements[1] by semiquantitative optical emission spectroscopy, with a Jarrell-Ash 3.4 meter Wadsworth spectometer.

INTERPRETATION OF THE DATA

We did not statistically evaluate the stream-sediment and panned-concentrate data because of the small number of samples. Data for the stream-sediment heavy-mineral concentrate samples do not indicate mineralization. The values are typical of a basaltic terrane, that may have, in some samples,

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[1] Aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, gallium, gold, iron, lanthanum, lead, lithium, magnesium, manganese, molybdenum, nickel, niobium, palladium, phosphorus, potassium, platinum, scandium, silicon, silver, sodium, strontium, tantalum, tellurium, tin, titanium, vanadium, yttrium, zinc, and zirconium.

been diluted by gravels, eolian silt, or non-mafic additions. The panned concentrate for sample PR-501 contained two tarnished sulfide grains (pyrite?) seen under the microscope, but the sample shows no anomalous analytical values. The geochemistry reflects an unmineralized basaltic terrane in the Pit River Canyon Wilderness Study Area.

The values obtained from the analysis of basalt are typical of unmineralized basalt.

REFERENCES CITED

Albers, J. P., and Fraticelli, L. A., 1985, Preliminary mineral resource assessment map of California: U.S. Geological Survey Mineral Investigations Map MR-88, scale 1:1,000,000.

Finn, D. R., and Buchanan, L. J., 1984, Hayden Hill, California: Epithermal Au-Ag mineralization associated with Cascade volcanism [abs.]: Geological Society of America Abstracts with Programs, v. 16, no. 6, p. 509.

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

Lydon, P. A., Gay, T. E., Jr., and Jennings, C. W., 1960, Geologic map of California-Westwood (Susanville) sheet: California Division of Mines and Geology, scale 1:250,000.

Macdonald, G. A., 1966, Geology of the Cascade Range and Modoc Plateau <u>in</u> Bailey, E. H., ed., Geology of northern California: California Division of Mines and Geology Bulletin 190, p. 65-96.

Motooka, J. M., and Grimes, D. J., 1976, Analytical precision of one-sixth order semiquantitative spectrographic analysis: U.S. Geological Survey Circular 738, 25 p.