UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

GEOCHEMICAL ANALYSES OF ROCK AND STREAM-SEDIMENT SAMPLES FROM THE LONG SWAMP ROADLESS AREA, OKANOGAN COUNTY, WASHINGTON

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U.S. Geological Survey
Open-File Report 83-227
1983

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

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 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 Long Swamp Roadless Area (A6024) in Okanogan National Forest, Okanogan County, Washington. Long Swamp was classified as a further planning area during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

INTRODUCTION

The Long Swamp Roadless Area comprises 10,200 acres (15.9 mi^2) adjacent to the Pasayten Wilderness in the Okanogan Range of north-central Okanogan County, Wash. (fig. 1). The geology of the Long Swamp region has been studied by Daly (1912), Hawkins (1968, 1969), and Hibbard (1971), and regional geologic and geochemical studies have been published by Staatz and others (1971) and Rinehart (1981).

Most of the roadless area is underlain by coarse-grained leucocratic granite to trondhjemite of the Late Cretaceous Cathedral Peak batholith. In the study area, rocks of the batholith intrude the Tillman Mountain pluton, which underlies the easternmost part of the roadless area. The Tillman Mountain pluton is a highly variable body that typically possesses a gneissic texture and has an average composition of granodiorite. In many places the Cathedral Peak and Tillman Mountain bodies are separated by extremely complex, leucocratic, massive to foliated rocks that may be older metasedimentary rocks (Staatz and others, 1971) and (or) younger hybrid syntectonic intrusions (Hibbard, 1971).

SAMPLE COLLECTION

Samples for geochemical analysis were collected in July and September 1982. Stream-sediment samples were chosen as the primary medium for the geochemical reconnaissance of the Long Swamp area. In addition, panned concentrates from stream sediments were taken from all stream-sediment-sample sites on active stream channels, and rock samples were collected from outcrops showing evidence of mineralization or hydrothermal alteration. Fourteen stream-sediment and 11 panned-concentrate samples were collected from localities shown on figure 2. Tributaries in the recently glaciated Chewack River canyon in the western part of the area are not incised deeply enough to have established well-defined channels and drainage basins. Consequently, few of the tributaries shown on the topographic maps represent active streams. Localities LS-10, LS-12, and LS-14 were dry when sampled, and the latter two samples are composed of slope-wash debris rather than material from a discrete stream channel. All samples except LS-01 and LS-03 are from drainage basins entirely within the Cathedral Peak batholith, and the basin represented by LS-03 is underlain mainly by the Cathedral Peak unit. The predominant rock type in the drainage basin from which LS-01 was taken is the Tillman Mountain pluton.

SAMPLE PREPARATION

The stream-sediment samples were air dried, passed through an 80-mesh (177-micron) stainless steel sieve, and the minus-80-mesh fraction was pulverized for analysis. The panned-concentrate samples were dried and passed through a 30-mesh (590-micron) sieve. The most magnetic fraction, composed chiefly of magnetite and ilmenite, was removed using a Frantz Isodynamic Magnetic Separator[1] and discarded. Low-density mineral grains were separated from the heavy-mineral fraction by flotation in bromoform (sp grav 2.8) and discarded. The heavy-mineral fraction was then run through the Frantz separator again to produce a relatively magnetic fraction consisting primarily of mafic silicates and iron oxides. This fraction was not analyzed. The remaining relatively nonmagnetic fraction will contain the heavy minerals, if any, often associated with mineral deposits, such as native metals, sulfides, sulfates, sulfosalts, arsenates, vanadates, molybdates, tungstates, fluorides, and some oxides and carbonates as well as certain accessory minerals including tourmaline, zircon, apatite, sphene, rutile, monazite, corundum, topaz, and any rare uranium-, thorium-, or rare-earth-element-bearing minerals. This fraction was examined under a binocular microscope to identify the mineral constituents and estimate their relative proportions. A portion of each sample was then prepared for analysis by grinding under acetone in an agate mortar.

The rock samples were crushed and a 3-oz split was pulverized for analysis. Where appropriate, a thin section for petrographic examination was cut from the rock prior to crushing.

ANALYTICAL METHODS

Analytical data for 31 elements were obtained using a direct-current arc emission spectrographic technique (Grimes and Marranzino, 1968). The analytical values obtained from stream-sediment and rock samples were determined on 10-milligram splits whereas values obtained from the nonmagnetic panned-concentrate samples were determined on 5-milligram splits. Limits of analytical determination vary from element to element and are one reporting interval higher for the panned-concentrate samples than for the others. Limits of determination are given in table 1.

The analytical values were measured by visual comparison of spectra derived from the unknown sample against 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 are prepared in such a way that the range of concentrations normally found in naturally occuring sample is bracketed. When comparisons are made with sample films for semiquantitative use, reported values are rounded to 100, 50, 20, 10, and so forth. Those samples whose concentrations are estimated to fall between the above values are arbitrarily given values of 70, 30, 15, 7, and so forth. 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 (magnesium, calcium, iron,

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[1]Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

and titanium) are given in weight percent; all others are given in parts per million. The analyses were performed by G. W. Day, J. A. Domenico, and R. T. Hopkins of the U.S. Geological Survey in Denver, Colo.

ANALYTICAL DATA

The results of analyses of stream-sediment samples are given in table 2, data from the nonmagnetic fractions of panned concentrates are given in table 3, and data from rock samples are in table 4. Because of the small size of the study area and the correspondingly small number of samples collected, statistical analysis of the data was not attempted.

For comparative purposes, analyses of typical unaltered samples from the Cathedral Peak batholith are shown in table 5, along with calculated mean and threshold values. Three of the samples (LS-09R, LS-15RB, and LS-17R) were collected during this study; the other four samples (P10, P64, P77, P161) are from areas to the north and west of the Long Swamp Roadless Area in the Pasayten Wilderness (Staatz and others, 1971). Because of the limited data, conservative estimates of threshold (lowest anomalous) values, shown in table 5, were arbitrarily taken to be three times the mean values for the seven rock samples. For those elements which are present at concentrations less than the lower limits of analytical determination, meaningful threshold values cannot be calculated and all detectable values in tables 2 and 4 may be considered anomalous. A further complication is that the stated detection limits for the Pasayten samples of Staatz and others (1971) are different than those of the present study. However, some idea of the true threshold values for these elements may be obtained by taking 3 times their average abundances in granitic rocks as compiled by Krauskopf (1979, p. 544-545), also shown in table 5.

Comparison of the data in table 4 with the calculated threshold values of table 5 shows that the samples from sites LS-11R and LS-16R, which are from an area of intense hydrothermal alteration within the Cathedral Peak batholith, collectively contain anomalous concentrations of many elements commonly found in ore deposits related to felsic intrusive rocks, such as silver, arsenic, boron, copper, molybdenum, lead, antimony, and possibly zinc. This area also accounts for many of the anomalous values in stream-sediment and panned-concentrate samples shown in tables 2 and 3. The high tungsten value in the panned-concentrate sample from LS-11 may indicate that this element also is present in the area of altered bedrock, but at concentrations less than the spectrographic detection limit. Alternatively, and perhaps more likely, the tungsten may be derived from an area of tungsten mineralization in the Chewack River drainage several miles upstream from the sample site (Staatz and others, 1971). The other rock samples in table 4, LS-15RD and RE, showing high molybdenum and lead contents, are from a small isolated quartz-molybdenite vein in unaltered Cathedral Peak granite.

Among the stream-sediments samples, most or all show nominally anomalous concentrations of zirconium, yttrium, niobium, lanthanum, lead, manganese, and vanadium. All of these elements are typically concentrated in the common accessory minerals of granitic rocks, for example zircon, sphene, apatite, and magnetite, and the apparently anomalous values are probably due to crude hydraulic concentration of the relatively heavy accessory minerals in the stream sediments. Note that many of these same elements are very abundant in the nonmagnetic panned-concentrate samples as well (table 3). The high tin and thorium contents of many of the panned-concentrate samples are similarly attributable to accessory cassiterite and thorite, respectively, in the felsic igneous rocks of the area, and are probably not indicative of significant mineralization.

The panned-concentrate sample LS-09 from Windy Creek contained visible gold, and analysis showed 500 ppm gold and 300 ppm silver (table 3). The tin in this sample probably reflects accessory cassiterite.

One of the panned-concentrate samples from the Basin Creek drainage, LS-06, contained 150 ppm lead, 50 ppm copper, and visible pyrite. However, other samples collected nearby do not show anomalous values, indicating that the source area for the lead and copper in the stream sediment at LS-06 is quite small.

Sample LS-01 (table 2) is from a drainage basin underlain by rocks of the Tillman Mountain pluton, which is significantly more mafic in composition than the Cathedral Peak batholith. All of the elements in this sample that are present in apparently anomalous amounts: nickel, scandium, strontium, copper, chromium, and cobalt, have higher average abundances in mafic than in granitic rocks. Thus the relatively high values for these elements reflect the nature of the local bedrock and do not indicate mineralization.

A few other stream-sediment samples contain anomalous contents of one or two elements which may reflect proximity to a mineralized area. For example samples LS-12 and LS-14 are marginally anomalous in cobalt, and sample LS-12 also has an anomalous copper content. Samples LS-12, LS-13, and LS-14 all show relatively high--though not anomalous--values for barium and manganese. Panned-concentrate samples LS-04, LS-09, LS-10, and LS-13 all show high concentrations of bismuth. These sample sites are all near LS-11 and LS-16R, and may be within a geochemical dispersion halo around the hydrothermally altered area.

REFERENCES CITED

Daly, R. A., 1912, Geology of the North American Cordillera at the forty-ninth parallel: Geological Society of Canada Memoir 38, 857 p.

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.

Hawkins, J. W., Jr., 1968, Regional metamorphism, metasomatism, and partial fusion in the southwestern part of the Okanogan Range, Washington: Geological Society of America Bulletin, v. 79, p. 1785-1820.

_____ 1969, Petrology of the Cathedral batholith, Okanogan Range, Washington, in Geological Society of America, Abstracts for 1968: Geological Society of America Special Paper 121, p. 511-512.

Hibbard, M. J., 1971, Evolution of a plutonic complex, Okanogan Range, Washington: Geological Society of America Bulletin, v. 82, p. 3013-3047.

Krauskopf, K. B., 1979, Introduction to geochemistry, 2d ed.: New York, McGraw Hill, 617 p.

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.

Rinehart, C. D., 1981, Reconnaissance geochemical survey of gully and stream sediments, and geologic summary, in part of the Okanogan Range, Okanogan County, Washington: Washington Division of Geology and Earth Resources Bulletin 74, 24 p.

Staatz, M. H., Weis, P. L., Tabor, R. W., Robertson, J. F., Van Noy, R. M., Pattee, E. C., and Holt, D. C., 1971, Mineral resources of the Pasayten Wilderness area, Washington: U.S. Geological Survey Bulletin 1325, 255 p.

Streckeisen, 1976, To each plutonic rock its proper name: Earth Science Reviews, v. 12, p. 1-33.

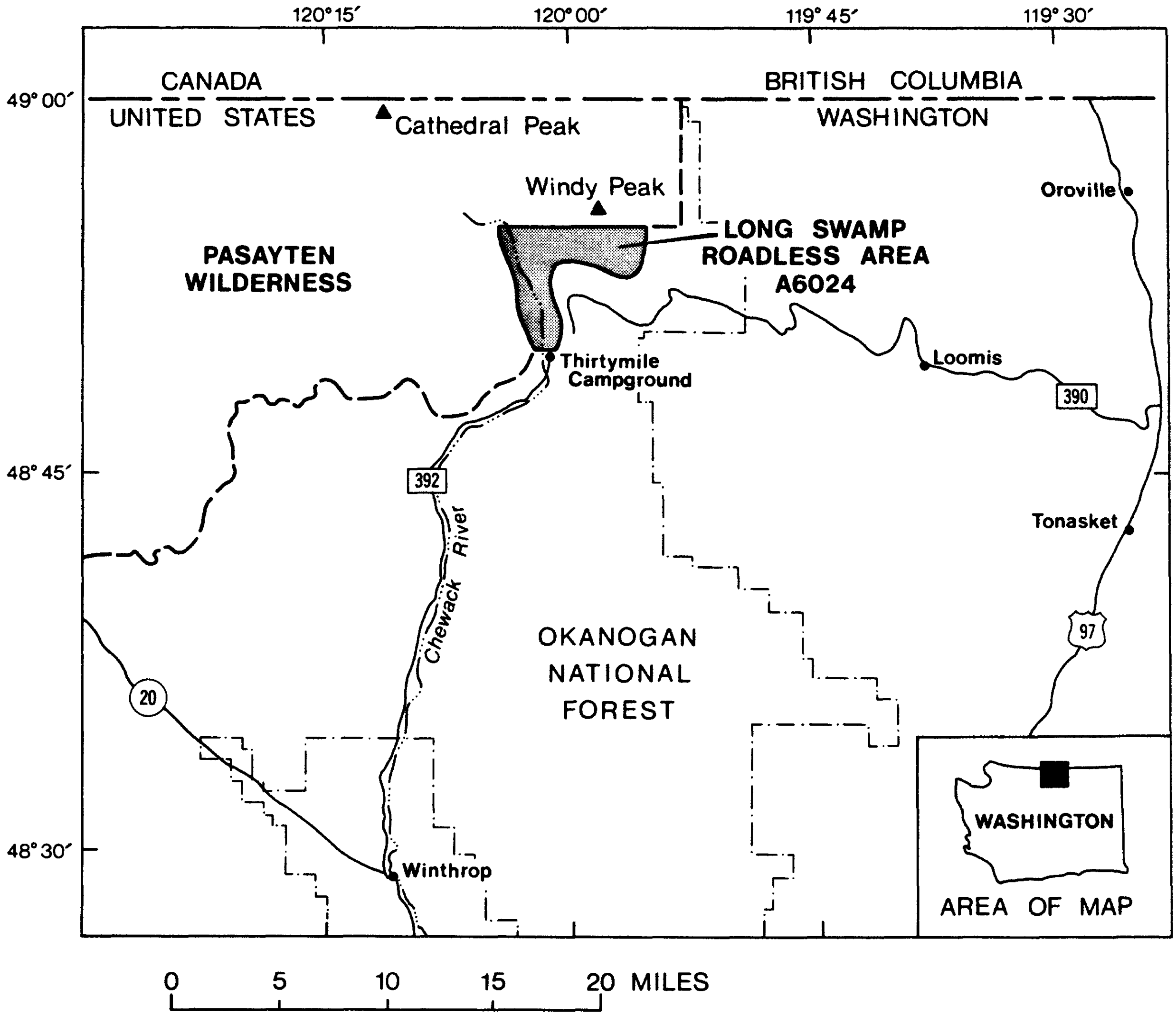

Figure 1.--Location of Long Swamp Roadless Area (A6024) in northern Washington.

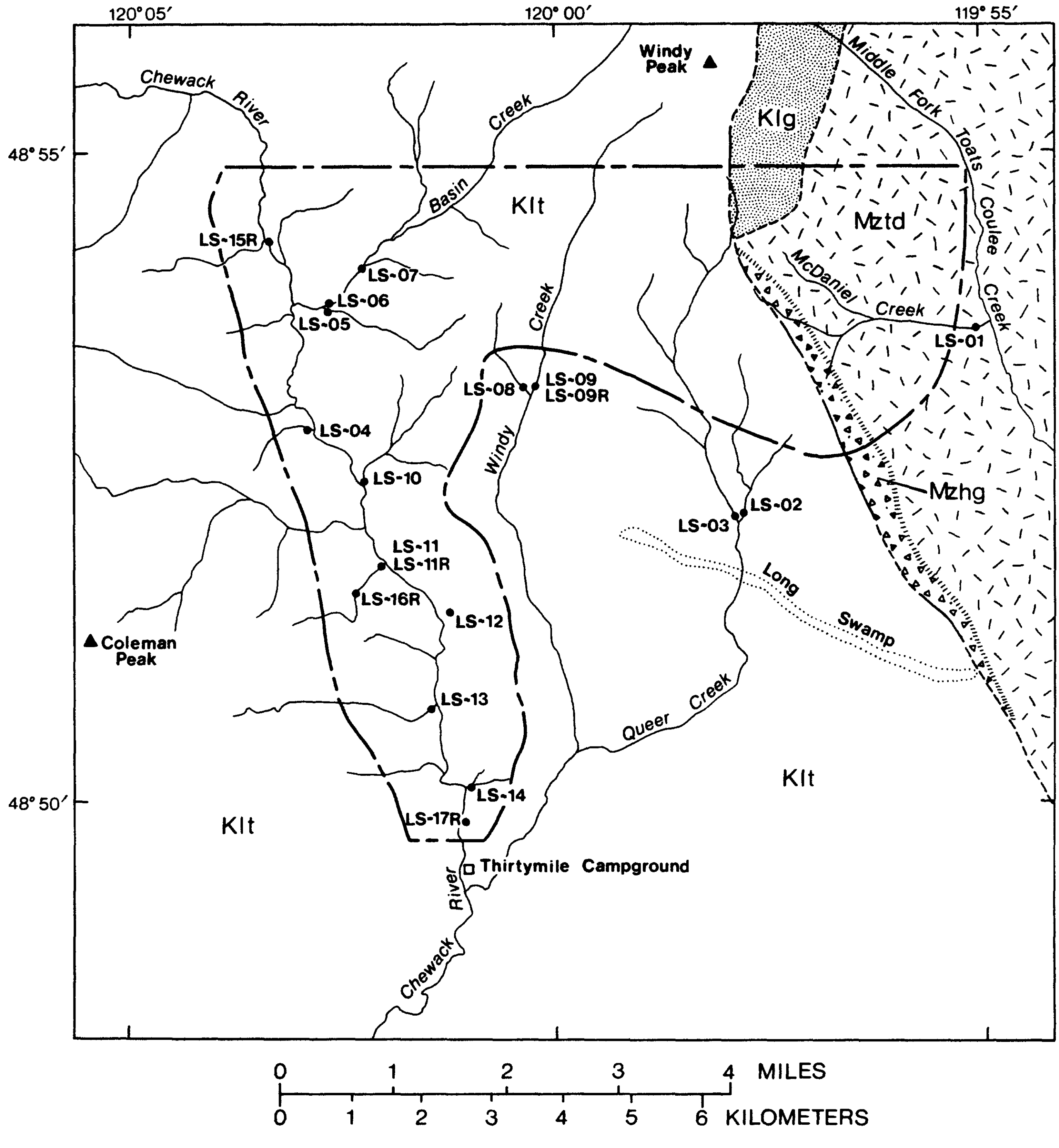

Figure 2.--Location of samples collected for geochemical analysis in Long Swamp Roadless Area. Sample numbers with "R" suffix are bedrock, all others are stream sediments.

EXPLANATION

APPROXIMATE BOUNDARY OF ROADLESS AREA

CORRELATION OF MAP UNITS

Klt
Klg
} CRETACEOUS

Mzhg
Mztd
} MESOZOIC

DESCRIPTION OF MAP UNITS[1]

Klt — BIOTITE LEUCOGRANITE TO TRONDHJEMITE (CRETACEOUS)--Homogeneous coarse-grained biotite lencogranite[1] to trondhjemite comprising the Cathedral Peak batholith

Klg — LEUCOCRATIC GNEISS (CRETACEOUS)--Medium-grained massive to gneissic hornblende-biotite trondhjemite to leucogranite (gneissic trondhjemite of Tiffany Mountain of (Rinehart 1981))

Mzhg — HYBRID GRANITOID ROCKS (MESOZOIC)--Heterogeneous fine- to coarse-grained massive to foliated biotite- and hornblende-bearing rocks of variable composition, chiefly granodiorite. Equivalent to North Fork Camp Hybrid Gneiss of Hibbard (1971)

Mztd — BIOTITE-HORNBLENDE TONALITE TO QUARTZ DIORITE (MESOZOIC)--Fine- to medium-grained typically gneissic biotite-hornblende tonalite to quartz diorite comprising the Tillman Mountain pluton

CONTACT--Dashed where approximately located, dotted where gradational

[1]Plutonic rock nomenclature according to I.U.G.S. system (Streckeisen, 1976).

Table 1.--Lower limits of analytical determination for rock, stream-sediment and stream sediment concentrate samples from Long Swamp Roadless Area
[Limits of determination of elements are in parts per million (ppm) except where noted. All analyses are by spectrographic methods]

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

Table 2.--Results of spectrographic analyses of stream sediments from Long Swamp Roadless Area
[Qualifying codes in analytical data are defined as follows: N, not detected; <, detected, but below limit of analytical determination given in parentheses; >, greater than value given]

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
LS-01	48°53'40"	119°55'09"	5	5	3	1	N	N	N	30	700	1	N	N	20	70
LS-02	48°52'11"	119°57'49"	1	3	.5	1	N	N	N	10	700	2	N	N	5	N
LS-03	48°52'12"	119°57'56"	1	3	.7	.5	N	N	N	30	700	2	N	N	5	N
LS-04	48°52'53"	120°02'51"	2	3	1	.3	N	N	N	20	700	1	N	N	7	50
LS-05	48°53'47"	120°02'43"	1	5	1	.5	N	N	N	30	700	2	N	N	7	20
LS-06	48°53'49"	120°02'43"	1	5	1	.3	N	N	N	30	700	2	N	N	7	N
LS-07	48°54'07"	120°02'14"	1	2	.5	.2	N	N	N	10	700	2	N	N	5	N
LS-08	48°53'09"	120°00'18"	2	2	1	.5	N	N	N	10	700	2	N	N	7	N
LS-09	48°53'10"	120°00'16"	1	1	.7	.5	N	N	N	10	500	2	N	N	5	N
LS-10	48°52'28"	120°02'13"	1	3	.7	.3	N	N	N	30	700	2	N	N	5	N
LS-11	48°51'50"	120°01'58"	.5	5	.5	.5	3	N	N	200	2,000	1	N	N	15	N
LS-12	48°51'30"	120°01'15"	2	5	1	.5	N	N	N	30	1,000	1	N	N	10	N
LS-13	48°50'43"	120°01'28"	2	7	1	.5	N	N	N	30	1,000	1	N	N	7	50
LS-14	48°50'07"	120°00'58"	1	5	1	.5	N	N	N	30	1,000	1	N	N	10	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
LS-01	30	50	2,000	N	<(20)	15	50	N	15	N	700	N	200	N	30	N	500
LS-02	7	500	5,000	N	20	5	100	N	5	N	300	N	70	N	30	N	1,000
LS-03	7	200	2,000	N	20	5	70	N	5	N	300	N	70	N	50	N	1,000
LS-04	10	70	700	N	N	20	70	N	5	N	500	N	100	N	30	N	700
LS-05	10	100	1,000	N	<(20)	5	70	N	5	N	300	N	100	N	50	N	1,000
LS-06	10	100	1,500	N	<(20)	5	70	N	5	N	200	N	100	N	50	N	1,000
LS-07	5	100	1,000	N	<(20)	5	70	N	5	N	200	N	30	N	30	N	500
LS-08	10	100	1,000	N	<(20)	5	70	N	5	N	500	N	70	N	30	N	1,000
LS-09	5	200	1,000	N	20	5	70	N	5	N	200	N	50	N	70	N	1,000
LS-10	15	100	1,500	N	N	5	70	N	5	N	200	N	100	N	50	N	500
LS-11	700	100	1,500	10	N	5	100	N	5	N	200	N	100	N	30	N	1,000
LS-12	50	70	3,000	N	<(20)	5	70	N	5	N	300	N	100	N	30	N	500
LS-13	10	150	1,000	N	<(20)	10	70	N	5	N	500	N	200	N	50	N	>1,000
LS-14	10	100	3,000	N	<(20)	5	70	N	5	N	500	N	100	N	30	N	500

Table 3.--Results of spectrographic analyses of panned-concentrate samples from stream sediments, Long Swamp Roadless Area
[Qualifying codes in analytical data are as follows: N, not detected; <, detected, but below the limit of analytical determination given in parentheses; <, greater than value given]

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
LS-01	48°53'40"	119°55'09"	20	1	.2	>2	N	N	N	<(20)	150	N	150	N	N	N
LS-02	48°52'11"	119°57'49"	1	1	.5	>2	N	N	N	<(20)	200	N	N	N	N	20
LS-03	48°52'12"	119°57'56"	.5	.5	.1	>2	N	N	N	<(20)	150	N	N	N	N	N
LS-04	48°52'53"	120°02'51"	5	.5	.2	>2	N	N	N	<(20)	2,000	N	300	N	N	50
LS-05	48°53'47"	120°02'43"	.5	1.5	.5	>2	N	N	N	<(20)	200	N	N	N	N	50
LS-06	48°53'49"	120°02'43"	.5	1.5	.5	2	N	N	N	<(20)	1,000	N	N	N	N	50
LS-07	48°54'07"	120°02'14"	.5	1	.5	2	N	N	N	<(20)	200	N	N	N	N	N
LS-08	48°53'09"	120°00'18"	.5	.5	.2	>2	N	N	N	<(20)	200	N	N	N	N	N
LS-09	48°53'10"	120°00'16"	.5	.5	.2	>2	300	N	500	<(20)	150	N	70	N	N	N
LS-11	48°51'50"	120°01'58"	.5	3	.05	>2	N	N	N	20	>10,000	N	70	N	N	N
LS-13	48°50'43"	120°01'28"	5	1	.07	>2	N	N	N	>(20)	7,000	N	200	N	N	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
LS-01	20	1,000	1,000	N	<(50)	N	20	N	30	150	200	N	200	N	700	N	>2,000
LS-02	20	>2,000	1,000	N	<(50)	N	20	N	150	50	200	700	150	N	5,000	N	>2,000
LS-03	10	>2,000	500	N	<(50)	N	20	N	150	300	200	700	150	N	5,000	N	>2,000
LS-04	20	1,000	700	N	<(50)	N	50	N	70	70	200	N	300	N	1,000	N	>2,000
LS-05	10	1,500	700	N	N	N	20	N	150	70	200	300	200	N	5,000	N	>2,000
LS-06	50	>2,000	1,000	N	<(50)	N	150	N	70	20	200	700	150	N	2,000	N	>2,000
LS-07	10	>2,000	1,000	N	N	N	20	N	150	70	200	700	100	N	5,000	N	>2,000
LS-08	10	1,500	500	N	<(50)	N	20	N	150	20	200	500	100	N	5,000	N	>2,000
LS-09	10	>2,000	300	N	<(50)	N	20	N	150	150	200	500	70	N	5,000	N	>2,000
LS-11	200	700	200	N	<(50)	N	50	N	50	N	1,500	N	150	100	500	N	>2,000
LS-13	30	700	500	N	N	N	N	N	100	N	500	N	150	N	1,500	N	>2,000

Table 4.--Results of spectrographic analyses of altered rock samples from Long Swamp Roadless Area
[Qualifying codes in analytical data are defined as follows: N, not detected; <, detected, but below the lower limit of analytical determination given in parentheses]

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
LS-11RA	48°51"50"	120°01'58"	<(.05)	.5	.2	.1	.7	N	N	70	700	1	N	N	N	N
LS-11RB	48°51'50"	120°01'58"	<(.05)	.3	.3	.1	.5	N	N	70	300	1.5	N	N	N	N
LS-11RC	48°51'50"	120°01'58"	<(.05)	3	.1	.1	.5	200	N	30	500	1	N	N	N	N
LS-11RD	48°51'50"	120°01'58"	2	1.5	2	.3	N	N	N	10	150	N	N	N	30	300
LS-11RE	48°51'50"	120°01'58"	<(.05)	.7	.15	.15	N	N	N	70	700	1.5	N	N	<(5)	<(10)
LS-11RF	48°51'50"	120°01'58"	7	1	.3	.2	1	N	N	150	1,000	1.5	N	N	7	<(10)
LS-11RG	48°51'50"	120°01'58"	<(.05)	.7	.15	.2	N	N	N	100	1,500	1	N	N	<(5)	<(10)
LS-15RD	48°53'48"	120°03'21"	.2	.3	.05	.03	N	N	N	10	50	2	N	N	<(5)	N
LS-15RE	48°53'48"	120°03'21"	.1	.15	.03	.03	N	N	N	10	30	2	N	N	<(5)	N
LS-16R	48°51'38"	120°02'18"	<(.05)	.3	.1	.1	5	N	N	150	700	<(1)	N	N	<(5)	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
LS-11RA	20	50	20	20	N	<(5)	N	<(100)	N	N	N	N	15	N	N	<(200)	30
LS-11RB	15	50	500	N	N	5	N	N	N	N	N	N	20	N	N	N	30
LS-11RC	1,000	50	30	N	N	<(5)	15	100	5	N	N	N	30	N	N	<(200)	70
LS-11RD	30	N	150	N	N	100	<(10)	N	5	N	500	N	200	N	10	N	20
LS-11RE	15	20	20	N	<(20)	5	50	N	<(5)	N	N	N	20	<(50)	<(10)	N	70
LS-11RF	200	30	500	N	<(20)	5	15	N	5	N	N	N	30	<(50)	15	N	70
LS-11RG	15	30	15	<(5)	<(20)	5	50	N	<(5)	N	N	N	20	<(50)	<(10)	N	50
LS-15RD	<(5)	<(20)	200	150	N	<(5)	70	N	5	N	N	N	<(10)	N	15	N	15
LS-15RE	<(5)	N	100	30	N	5	50	N	<(5)	N	N	N	<(10)	N	15	N	10
LS-16R	70	20	10	N	N	<(5)	30	<(100)	N	N	N	N	15	N	N	N	30

Table 5.--Spectrographic analyses of seven unaltered rock samples from the Cathedral Peak batholith, means, and calculated threshold values
[Qualifying codes in analytical data are defined as follows: N, not detected; <, less than value given; --, not analyzed for]

Sample	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
LS-15RB	.2	0.3	.05	.03	N	N	N	10	200	2	N	N	N	N
LS-17R	2	2	.5	.3	N	N	N	10	1,000	<1	N	N	7	<10
LS-09R	.15	.3	.15	.05	N	N	N	N	200	<1	N	N	N	N
P10	.5	1	.2	.1	<.1	<100	--	<30	1,500	1	--	--	<1	10
P64	1.5	1.5	.2	.1	<.1	<100	--	<30	500	<1	--	--	<1	3
P77	1	.5	.07	.03	<.1	<100	--	<30	700	1	--	--	<1	<3
P161	1.5	1	.15	.07	<.1	<100	--	<30	1,500	<1	--	--	<1	<3
Mean	1	.9	.2	.1	N	N	N	10	800	1	N	N	N	N
Threshold 1 (3 x mean)	3	2.7	.6	.3	<.5	<200	<10	30	2,400	3	<10	<20	<10	<20
Threshold 2 (3 x avg. granite)	5	7	1.5	.7	.1	5	.007	50	2,000	15	.7	.3	10	60

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
LS-15RB	5	N	150	N	N	5	70	N	5	N	N	N	<10	N	15	N	15
LS-17R	<5	20	500	N	<20	5	20	N	5	N	500	N	50	N	15	N	50
LS-09	<5	N	200	N	N	<5	20	N	N	N	N	N	10	N	<10	N	10
P10	70	50	500	<3	--	<30	7	<100	3	<3	70	--	10	--	15	<100	150
P64	<3	<30	300	<3	--	<30	5	<100	<1	<3	500	--	15	--	7	<100	100
P77	1	<30	200	<3	--	<30	10	<100	<1	<3	200	--	<1	--	10	<100	30
P161	<.3	<30	300	<3	--	<30	7	<100	<1	<3	300	--	10	--	5	<100	70
Mean	10	20	310	N	N	5	20	N	<5	N	240	N	14	N	10	N	60
Threshold 1 (3 x mean)	30	60	930	<5	<20	15	60	<100	10	<10	720	<100	42	<50	30	<200	180
Threshold 2 (3 x avg granite)	30	200	1,500	5	70	3	70	.7	30	10	1,000	70	150	5	100	150	200