UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Geochemical sampling around the granodiorite of Hall Mountain, northeastern Washington and northern Idaho

By

Fred K. Miller[1] and James G. Frisken[2]

U.S. Geological Survey
Reston, Virginia 22092

Open-File Report 84-365

[1]U.S. Geological Survey
W920 Riverside, Rm 656
Spokane, WA 99201

[2]U.S. Geological Survey
Box 25046, Denver Federal Center
Mail Stop 955
Denver, CO 80225

1984

INTRODUCTION

During the course of geologic mapping in support of regional framework studies in northeastern Washington and northern Idaho (see figure 1), molybdenum- and tungsten-bearing minerals were found associated with a particular granitic rock type, the granodiorite of Hall Mountain. This association was reported in U.S. Geological Survey Open-File Report 82-295 (Miller and Theodore, 1982), in which it was noted that at least five plutons of this rock type had been identified. On the basis of that work, large areas around two of the plutons were staked, one property is currently being developed, and several others are being or have been explored.

Mapping during the summer of 1982 indicates that one of the plutons reported in OF-82-295 is actually two bodies separated by a narrow septa of metamorphic rock. Another pluton of the same rock type was discovered 23 km south of the area shown in Figure 2 in the Mill Creek drainage, but was mapped only in reconnaissance and is not covered by maps accompanying this report.

Extensive geochemical sampling, including stream-sediment, heavy-mineral concentrate (panned), and rock samples, was done during the summer of 1982 in and around all of the plutons of Hall Mountain granodiorite in Washington, except for the one near Mill Creek. Tungsten, molybdenum, gold, and (or) silver, occur in more than half of all heavy-mineral concentrate samples taken in the 155 km^2 area shown in figure 2. The results reported here, include not only the 1982 sampling, but some done in prior years and a few of the samples reported in OF-82-295. The analytical results are tabulated in Tables 1, 2, and 3, and the sample localities are shown in Figure 2.

GEOLOGIC SETTING

The granodiorite of Hall Mountain plutons are Cretaceous in age (100 m.y. potassium-argon concordant age on muscovite and biotite), and intrude all of the Proterozoic Y Belt Supergroup from the Prichard Formations at least through the Wallace Formation. These host rocks consist of phyllite or argillite, siltite, quartzite, dolomite, and dolomitic limestone. In addition, the plutons also intrude the lower part of the Proterozoic Z Windermere Group, including the Shedroof Conglomerate, Leola Volcanics, and possibly the Monk Formation.

Extensive remapping in the area covered by Figure 3 of OF-82-295 (Miller and Theodore, 1982), indicates that much of the section identified as Belt Supergroup in OF-82-295 is actually part of the Windermere Group. Because of time and space limitations, only Quaternary deposits and the granodiorite of Hall Mountain are differentiated on Figure 2 of this report. The reader is referred to OF-83-601 (Miller, 1983) and OF-83-600 (Burmester and Miller, 1983) for relatively detailed 1:48,000 scale geologic maps of the northern two-thirds of the area shown in figure 2. The Monumental Mountain and Orwig Hump 7.5′ quadrangles have been mapped geologically, and are currently being prepared for Open-File release.

The Proterozoic Y to Proterozoic Z section intruded by the various plutons of the granodiorite of Hall Mountain comprise a structurally complex assemblage. Most or all of the multiple deformation exhibited by these host rocks predate the emplacement of the plutons, with the exception of a possible fault cutting the pluton in the Monumental Mountain quadrangle (Fig. 2).

The granodiorite of Hall Mountain is described in moderate detail in OF-82-295, description of only the more general features are repeated here. The granodiorite is a medium- to fine-grained muscovite-biotite-granodiorite. The modal composition ranges from tonalite to calcic monzogranite, but at least 90 percent of the rock is granodiorite. The average color index is 9, and the biotite:(primary) muscovite ratio 10:1. (The name muscovite is used herein as a descriptive term only; it is not known that these white micas are chemically and structurally true muscovites. They may have a significant celadonite component). The apparently primary muscovite postdates crystallization of biotite, and probably is late stage. Biotite in most of the rock is brown or olive-green, but in mineralized rock containing abundant quartz veins, biotite is reddish-brown. Muscovite is spacially associated with biotite in the rock, and rarely occurs as solitary crystals that are not in contact with biotite. Plagioclase ranges from about an_{25} to an_{35}, but averages closer to the calcic end of that range. Potassium feldspar is microcline; crystals characteristically have numerous relatively large plagioclase, and less commonly biotite, crystals included in them. The large number of included minerals impart a poikolitic look to the microcline on a stained slab. Quartz occurs as irregular shaped crystals that average about 4mm in size and commonly are aggregates of smaller broken and rehealed fragments. Accessory minerals include epidote, clinozoisite, allanite, zircon, apatite, rutile and minor opaque mineral(s).

Texturally, the larger plutons are hypidiomorphic-granular in the interior parts, but lineate and (or) foliate in the outer parts. Development of the directional fabric is gradational, progressively more intense towards the outer margins. Systematic measurements of the fabric have not been made, but presumably it is primary, having developed during emplacement of the bodies.

Most of the plutons have noticably chilled margins of finer grained rock, particularly the smaller bodies, suggesting emplacement into a relatively cool host rock. This relatively low temperature environment also is reflected in narrow contact metamorphic aureoles in which megascopic recrystallization rarely extends more than 10 m to 20 m from the plutons. Locally, however, particularly in the carbonate-bearing host rocks, contact metamorphism extends farther, but contacts, or rocks within a hundred meters of contacts, rarely are seen because of generally incomplete exposure. A common assemblage developed within 20 m of the plutons in pelitic rocks include tourmaline-andalusite-plagioclase(?)-phlogopitic biotite-sericite-quartz; and in impure carbonate rocks, quartz-sericite-tremolite-clinozoisite-calcite; or tourmaline-sericite-tremolite-phlogopitic biotite-quartz-calcite. More than 100 m from most of the plutons, contact metamorphic effects are not separable from regional metamorphism.

Plutons of Hall Mountain-type granodiorite all appear to be shallower level equivalents of a much larger muscovite-biotite-intrusion, the granodiorite of Reeder Creek. This latter pluton underlies about 140 km^2, and centers on Priest Lake about 20 km southeast of the area of Figure 2. The granodiorite of Reeder Creek is petrographically, mineralogically, and modally the same as the Hall Mountain type, but is coarser grained and shows none of the shallower level characteristics of the latter rocks. None of the plutons have been studied systematically, but with the exception of the westernmost body, all are fairly well delineated. The configuration of the westernmost pluton is mapped in somewhat better than reconnaissance fashion, but the interior parts of all the plutons need additional study.

GEOCHEMISTRY

Sample Collection

Samples for geochemical analysis were collected from 1978 to 1982. Stream-sediment samples were selected as the primary sample medium. In addition, an initial heavy-mineral concentrate fraction was panned from stream sediment at each site with an active stream channel. Rock samples were collected from selected areas for background geochemistry, as well as from outcrops showing evidence of mineralization or hydrothermal alteration. Ninety nine stream-sediment, 93 panned-concentrate, and 25 rock samples were collected and analyzed from locations shown on Figure 2.

Most stream-sediment and panned-concentrate samples represent drainage basins from one to three km^2, but a few samples represent only local areas. A few others were taken on streams draining 5-10 km^2 areas or along major streams if tributary drainages were not adequate to geochemically evaluate areas of special interest. The stream sediment was scooped from active stream channels and passed through a 2 mm stainless steel sieve to fill a 35-cm-diameter steel "gold" pan. A 10x15 cm cloth bag was filled with sediment from the pan, and the bulk of the sediment was then panned down to the point at which heavy minerals were dominant in the pan. These concentrates were transfered to kraft paper sample envelopes. When possible, sediment was selectively collected from areas in the stream channel likely to normally concentrate heavy minerals, so that both the stream-sediment and panned-concentrate samples are somewhat biased toward representing mineralization as opposed to bedrock geochemistry.

Sample Preparation

All samples were air dried. The stream-sediment samples were passed through an 80-mesh (177-micron) stainless steel sieve and then pulverized. The panned-concentrate samples were passed through a 30-mesh (590-micron) sieve, and a Frantz Isodynamic Magnetic Separator was used to remove the most magnetic fraction, primarily magnetite and ilmentite, which was discarded. The low-density mineral grains in the non-magnetic fraction were floated off in bromoform (specific gravity 2.8) and discarded. The remaining heavy-mineral fraction was cleaned and dried and divided into a magnetic and nonmagnetic fraction on the Frantz Magnetic Separator. The relatively nonmagnetic fraction was chosen for analysis. Most -ore related minerals such as native metals, sulfides, sulfates, sulfosalts, arsenates, vanadates, molybdates, tungstates, fluorides, and some oxides and carbonates will be concentrated in this fraction along with several rock-forming accessory minerals such as tourmaline, epidote, zircon, apatite, sphene, rutile, monazite, thorite, chlorite, muscovite, low-iron-content pyroxenes and amphiboles, and several metamorphic silicates and oxides. This nonmagnetic 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.

Analytical Methods

The analytical data obtaind from stream-sediment samples are reported in Table 2, the data from nonmagnetic panned concentrates are reported in Table 1, and the data from rocks are reported in Table 3.

Spectrographic results for 31 elements were obtained by visual comparison of spectra derived from the unknown sample against spectra obtained from standards made from pure oxides or carbonates using a D. C. (direct current) arc emission spectrographic method (Grimes and Marranzino, 1968). Standard concentrations 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 occurring samples are bracketed. When comparisons are made with sample films for semiquantitive 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). All values are reported in parts per million (micrograms/gram).

Spectrographic gold values are of limited use due to the particle effect commonly observed with free gold, the small quantity of sample analyzed, and the high, lower limit of detection (10 ppm). The rock and panned-concentrate samples were therefore also analyzed by atomic absorption methods (Ward and others, 1969). The lower detection limits for gold in the panned concentrates varied according to sample weight analyzed, and detection limits are given for each sample in Table 1.

Discussion

Anomalous amounts of tungsten are found in samples from streams draining all plutons of granodiorite of Hall Mountain; anomalous molybdenum values are associated with all but one of the plutons. More than a few Km away from any pluton of the Hall Mountain granodiorite, detectable tungsten and molybdenum are extremely rare in geochemical samples. Therefore, anywhere in the region, either metal is considered to occur in anomalous amounts if it is found at or above detection limits. Tungsten values range from the limit of detection (100 ppm) to 2000 ppm in 51 of the 93 panned concentrate samples, and molybdenum from the limit of detection (10 ppm) to 200 ppm in 15 of the 93. Detection limits are lower in the bulk stream sediment samples, 50 ppm for tungsten and 5 ppm for molybdenum. Tungsten values ranged from 50 ppm to 70 ppm in 7 of the 99 stream sediment samples, and molybdenum values from 5 ppm to 50 ppm in 12 of the 99. Both tungsten and molybdenum concentrations drop off rapidly in samples from streams away from Hall Mountain plutons.

The highest tungsten values in panned concentrate samples are associated with the westernmost Hall Mountain pluton, referred to as the Paupac Creek body in OF-82-295, and with the pluton in the Monumental Mountain quadrangle, here referred to as the South Fork body after the South Fork of Granite Creek that flows through it (see fig. 2). All four samples from the Paupac Creek body have tungsten values equal to or greater than 1000 ppm in addition to gold and silver up to 62 ppm and 15 ppm respectively. Lead values are anomalously high in both heavy-mineral concentrate (700 ppm) and stream sediment (30 to 1000 ppm) samples from streams draining this pluton.

About a 1.5 km segment of contact along the northwest edge of the pluton was examined in moderate detail. Along this segment the granodiorite intrudes greenstone of the Leola Volcanics. The granodiorite is noticably finer grained than it is in the interior parts of the pluton, and is highly foliate and (or) lineate. Numerous close spaced quartz veins both parallel and oblique to the contact form a zone ranging from about 3 m to 20 m wide in the outermost part of the granodiorite along the entire 1.5 km segment. The zone could be present along the entire north border of the pluton, which is inferred along much of its length, but was not observed along the southern or eastern contacts. In addition to the quartz veins in this zone, numerous fine grained leucocratic dikes are present along with abundant pink potassium feldspar which appears to have flooded the rock during the latest stages of emplacement. The anomalous metal values in geochemical samples and the obvious mineralization along at least the northwest border, strongly recommend the pluton for more detailed exploration.

Six of the heavy-mineral concentrate samples from streams draining the South Fork body have tungsten values equal to, or greater than, 1000 ppm. In addition, small grains of scheelite are visible under black light in skarn developed in carbonate rocks of the Wallace Formation along the east edge of the pluton (rock sample R7b and R7c). The skarn, garnet-diopside-tremolite-clinozoisite-quartz-plagioclase-calcite-scapolite(?), is well developed over 300 m from the inferred contact in places. Higher grade metamorphic assemblages may be present closer to the granodiorite.

Numerous quartz veins are present in the granodiorite along much of this eastern contact and most of the granodiorite shows alteration and mineralization ranging from slight to extreme. Much of the granodiorite up to several hundred meters from the eastern contact in section 7, T. 37 N., R. 45 E., is hematite stained, locally vuggy with partial quartz and fluorite (rare) fillings. Pyrite is ubiquitous in the granodiorite and host rocks throughout this mineralized zone, and in places constitutes up to 20 percent of the rock. Quartz veins are locally numerous; very sparsely disseminated molybdenite was observed in only two of these veins even though it was carefully searched for. Lead values are anomalously high (1500 to 2000 ppm) in several heavy-mineral samples from streams draining this zone along the east side of the pluton, although silver was detected in only one sample (19), and gold and zinc in none. This area merits considerably more detailed attention than has been possible in the reconnaissance study reported here.

Five other heavy-mineral concentrate samples (28, 35, 36, 41, and 43) have tungsten values equal to or greater than 1000 ppm. The first three are from streams draining the pluton in the Orwig Hump quadrangle, referred to as the Orwig Hump body, and the other two are from streams draining the pluton that straddles the Washington-Idaho border, referred to as the Boulder Mountain body. Even though only three samples from the Orwig Hump body were equal to or higher than 1000 ppm in tungsten, almost every sample taken from streams draining this body had detectable tungsten. None of the samples, however, had detectable molybdenum. Two samples (32 and 34) from near the center of the body contained high gold values.

Analyses of rock samples of both the host rock and granodiorite indicate scattered metal occurrences (Table 3). Sample R4 contains visible molybdenite and sample R7b and R7c visible scheelite. Several samples at locality R3 contained anomalous lead and zinc, but neither galena nor sphalerite were identified in the samples submitted for analyses. Gold and silver were not detectd in any of the rock samples.

Several rock samples of granodiorite of Hall Mountain from the pluton found in Mill Creek (mentioned in Introduction) were analysized but none contained any anomalous base or precious metals. These samples were collected in section 33, T., 35 N., R. 44 E., in road cuts along Le Clerc Road, just north of where it is intersected by the Mill Creek Road. The lack of anomalous metals was surprising because the granodiorite there is cut by numerous close spaced quartz veins and contains abundant pyrite. The same pluton crops out on the west side of the Pend Oreille River, but only a few quartz veins and sparse pyrite were observed there. Above the pluton, on the flanks of Ruby Mountain, however, rocks of the Belt Supergroup contain very abundant pyrite; locally it makes up to 25 percent of the rock. Detailed investigation of the pluton in Mill Creek, especially where it is in contact with Belt Supergroup rocks east of the Le Clerc Road is recommended despite the absence of any but iron sulfides in the rocks analyzed.

The small pluton in section 31, T., 38 N., R. 45 E., the Harvey Creek body, may show high gold and (or) silver values because it is so strongly mineralized, but it was not possible to obtain heavy-mineral concentrates at localities 13 and 14 along the stream (dry valley) that drains this body. Except for the Paupac Creek body, gold and silver do not show a consistant association with the plutons themselves. Gold and silver anomalies, however, appear to form a halo around the plutons, and in fact show a roughly antithetic relationship with the tungsten-molybdenum anomalies. Almost every sample containing detectable tungsten and (or) molybdenum from Table 1 clusters in or immediately adjacent to one of the granodiorite of Hall Mountain plutons. Gold and silver values, however, are rather uniformly scattered throughout the area north of plutons (Table 1); most of the samples in that area have detectable gold and (or) silver.

The area drained by streams with sediments containing anomalous gold and silver values is underlain almost entirely by rocks of the Windermere Group, chiefly the Shedroof Conglomerate. Although the antithetic relationship between gold-silver and tungsten-molybdenum suggests a metal zonation related to the granodiorite of Hall Mountain plutons, it is possible some or all of the gold-silver is of sedimenary origin, having been originally deposited with the conglomerates of the Windermere Group.

Regardless of the origin of the gold and silver, the consistent association of anomalous metal values with the granodiorite of Hall Mountain recommends the area underlain by, and surrounding, the plutons as an excellent exploration target. The consistent association pointed out in OF-82-295, of anomalous concentrations of metals with this plutonic type almost everywhere it occurs, is strongly re-emphasized here. Even though several specific areas of particularly anomalous metal values have been identified in this report, the granodioride of Hall Mountain as a plutonic type should be considered the primary exploration target in this area.

References

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.

Miller, F. K., 1983, Preliminary geologic map of the Gypsy Peak area: U.S. Geological Survey Open-File Report OF-83-601, 14 p., scale 1:48,000.

Miller, F. K., and Theodore, T. G., 1982, Molybdenum and tungsten mineralization associated with two stocks in the Harvey Creek area, northeastern Washington: U.S. Geological Survey Open-File Report OF-82-295, 31 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.

Ward, F. N., Nakagawa, H. M., Harms, T. M., and Van Sickle, G. H., 1969, Atomic-absorption methods of analysis useful in geochemical exploration: U.S. Geological Survey Bulletin 1289, 45 p.

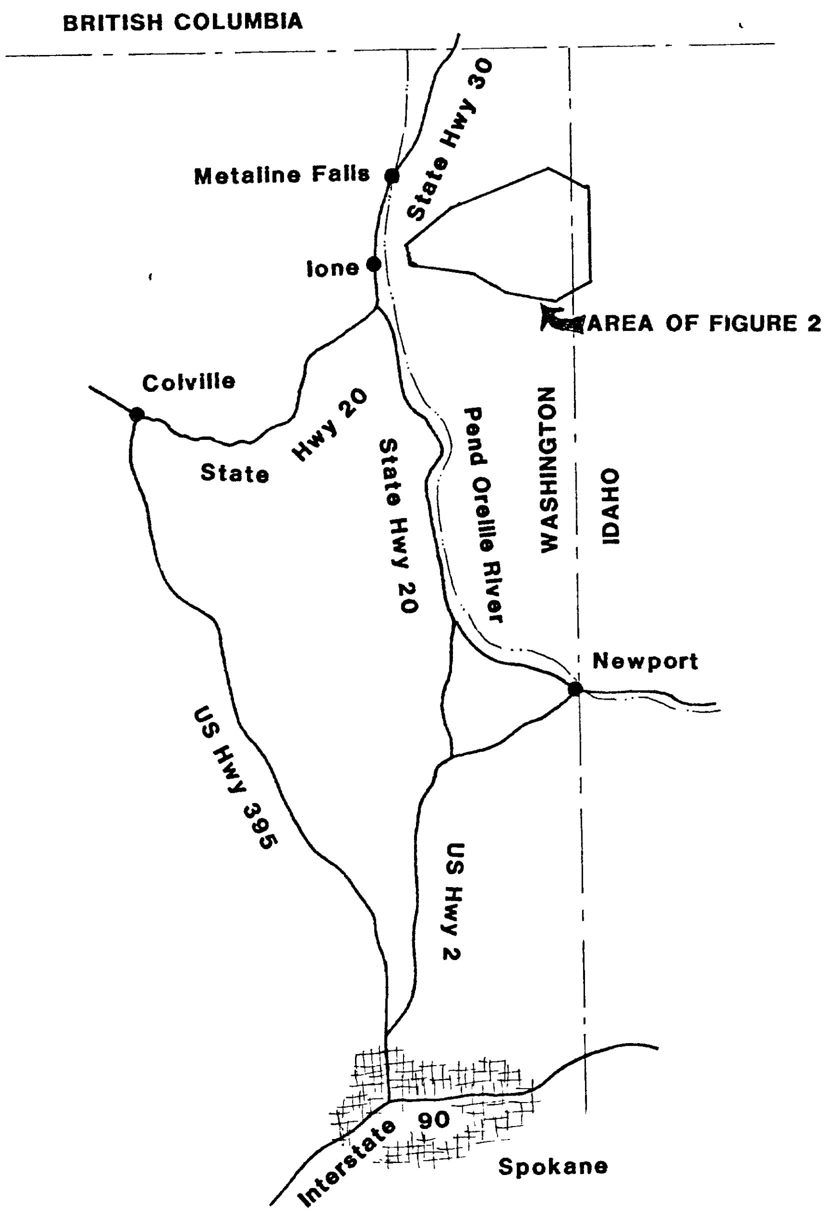

Figure 1. Index map showing locality of sampled area

Table 1. Analyses of panned concentrate stream-sediment samples. Sample localities shown in figure 2. Semiquantitative spectrographic analyses except as noted. Letters and symbols in table denote: N followed by number in parenthesis, not detected at lower limit indicated in parenthesis; L, detected but below lower limit indicated; NA, no analyses by method indicated; dash, not detected at lower limit indicated in table heading. Antimony (lower limit of detection, 200 ppm) and Cadmimum (lower limit of detection, 50 ppm) analyized for, but are not listed because they were not detected in any samples. Semiquantitative spectrographic analyses by D. E. Detra, E. L. Mosier, E. F. Cooley, and G. W. Day. Atomic absorption analyses by J. E. Gray, B. Arbogast, and J. D. Sharkey.

Lower limit of detection (ppm) Sample No.	1 Ag	500 As	20 Au	Au1/	20 B	50 Ba	2 Be	20 Bi	10 Co	20 Cr	10 Cu	50 La	10 Mo	50 Nb	10 Ni	20 Pb	10 Sc	20 Sn	200 Sr	200 Th	20 V	100 W	20 Y	500 2/ Zn	20 Zr
1	5	-	-	L(.9)	150	500	-	2000	-	100	50	500	10	100	10	700	10	-	700	200	150	1500	1500	-	2000
3	15	-	-	62	70	700	20	2000	10	100	100	2000	30	70	10	700	70	-	500	1000	100	1500	1500	-	2000
4	7	-	-	N(2.8)	50	200	-	2000	10	200	30	2000	10	50	20	700	20	-	500	300	150	1500	1000	-	2000
5	-	-	-	25	300	300	2	2000	10	100	70	700	L(5)	L(50)	10	300	10	-	700	L(200)	150	1000	700	-	2000
6	-	-	-	N(.45)	200	700	-	100	20	50	150	150	-	-	10	200	10	-	200	-	150	500	70	-	1000
7	-	-	-	N(.5)	20	100	-	50	10	-	10	100	-	-	10	500	10	-	200	-	100	100	50	-	1500
8	-	-	-	NA	1500	5000	2	200	10	70	10	500	-	L(50)	10	-	10	-	200	-	200	L(100)	100	-	1000
9	-	-	-	NA	300	1000	2	200	10	70	10	300	20	50	10	-	10	-	200	-	200	500	100	-	1000
10	-	-	-	N(.1)	1000	1000	L(2)	30	20	200	100	200	-	50	20	50	30	-	200	-	500	200	100	-	1000
11	-	-	-	N(.05)	1000	300	5	50	20	70	100	200	-	L(50)	10	100	-	-	200	-	200	100	150	-	1500
15	-	-	-	N(.85)	1500	300	2	2000	10	150	100	300	70	150	10	700	10	50	200	-	200	2000	200	-	2000
16	-	-	-	N(.55)	1500	500	2	1000	10	100	50	300	-	100	10	300	10	50	200	-	200	1000	150	-	2000
17	-	-	-	N(.60)	2000	300	-	2000	15	100	150	300	150	150	10	500	50	50	500	-	300	2000	200	-	2000
18	-	-	-	N(13)	200	700	30	2000	15	-	50	300	15	200	10	200	10	-	700	-	200	1000	200	-	2000
19	5	-	-	N(12)	150	300	5	2000	15	-	300	1000	200	300	20	2000	10	50	700	200	150	500	500	-	2000
20	-	-	-	N(5.6)	150	300	5	2000	30	20	200	2000	30	300	10	1500	10	200	700	300	150	1000	500	-	2000
21	-	-	-	N(3.1)	2000	300	2	70	10	70	30	300	-	100	10	150	10	-	200	-	300	300	150	-	2000
22	-	-	-	N(1.9)	3000	200	2	2000	20	50	50	700	-	150	10	500	10	-	500	L(200)	300	150	150	-	700
24	-	-	-	N(2.9)	2000	300	2	700	10	50	30	300	-	150	10	200	10	-	500	-	200	100	200	-	2000
25	-	-	-	N(4.2)	1000	300	5	70	10	50	30	700	-	150	10	150	10	30	500	-	150	L(100)	500	-	2000
26	-	-	-	L(.75)	150	200	5	2000	10	20	30	300	-	100	10	150	10	-	200	200	150	1500	200	-	2000
27	-	-	-	N(.30)	20	50	-	-	10	-	50	1000	-	200	10	50	20	150	200	500	500	L(100)	2000	-	2000
28	-	-	-	N(.60)	20	150	-	2000	10	-	50	1000	-	200	10	150	20	200	200	200	500	1000	2000	-	2000
29	-	-	-	N(.50)	20	100	-	200	10	-	30	1500	-	500	10	50	20	200	200	200	300	L(100)	2000	-	2000
30	-	-	-	0.1	70	500	-	200	10	-	10	2000	-	150	10	100	20	70	700	500	200	L(100)	500	-	2000
31	-	-	-	N(2.1)	1000	500	5	30	10	150	150	200	-	150	10	50	10	30	200	-	150	700	200	-	2000
32	-	-	-	4.5	300	200	-	-	20	100	200	2000	-	100	10	150	200	30	1500	1500	200	-	2000	-	2000
33	-	-	-	N(2.3)	200	300	-	150	10	50	20	1500	-	150	10	150	20	20	1500	200	200	100	700	-	2000
34	-	-	-	3.6	200	200	-	500	10	20	10	1500	-	150	10	150	20	200	1500	200	150	200	700	-	2000
35	-	-	-	N(.90)	1000	200	5	1000	10	150	50	1000	-	150	10	150	10	50	500	200	200	1000	500	-	2000
36	-	-	-	N(.60)	200	1500	5	700	10	20	30	150	-	50	10	150	10	-	200	-	150	1500	150	-	1000
37	-	-	-	N(.30)	200	10000	5	70	10	50	30	200	-	70	10	70	10	-	500	-	100	200	100	-	700
38	-	-	-	N(.25)	200	10000	5	-	10	-	20	50	-	-	10	150	10	-	1500	-	100	200	70	500	300
39	-	-	-	N(.90)	1000	300	5	20	10	150	30	300	-	100	10	150	10	-	200	-	200	500	200	-	2000
40	-	-	-	N(1.6)	500	300	5	150	10	150	20	300	-	150	10	70	10	20	500	-	200	500	200	-	2000
41	-	-	-	N(3.6)	1000	300	5	2000	20	700	100	700	-	300	10	300	20	200	500	500	200	1500	1000	-	2000
43	-	-	-	N(2.3)	200	300	-	200	20	30	150	1000	30	100	20	150	30	150	1500	200	200	1500	500	-	2000
45	-	-	-	L(.50)	200	300	5	-	10	100	10	70	-	70	20	20	10	-	200	-	100	L(100)	70	-	200
46	-	-	-	N(1.2)	500	200	5	150	10	100	30	700	-	1000	10	150	10	50	500	200	150	100	100	-	2000
47	-	-	-	N(.80)	1000	700	-	70	70	100	150	700	-	70	10	150	10	-	500	-	200	-	200	-	2000
48	-	-	-	N(.90)	700	1000	-	-	50	150	200	1000	-	70	10	70	10	-	200	-	500	500	150	-	2000
49	-	-	-	N(1.9)	700	500	-	150	20	150	200	1000	-	100	10	150	10	-	200	-	500	500	150	-	2000
50	-	-	-	L(1.1)	700	500	-	-	10	100	150	700	-	70	10	70	10	-	200	-	500	500	200	-	2000
51	-	-	-	N(.45)	700	500	-	-	20	200	200	1500	-	50	10	70	20	-	500	-	300	-	500	-	2000
52	1	-	-	0.3	200	500	1	-	150	70	200	700	-	-	150	70	20	-	200	-	150	-	100	200	200

Table 1 (Continued)

Lower limit of detection (ppm)	1	500	20		20	50	2	20	10	20	10	50	10	50	10	20	10	20	200	200	20	100	20	500[2/]	20
Sample No.	Ag	As	Au	Au[1/]	B	Ba	Be	Bi	Co	Cr	Cu	La	Mo	Nb	Ni	Pb	Sc	Sn	Sr	Th	V	W	Y	Zn	Zr
53	1.5	-	-	L(.05)	70	500	3	-	150	100	200	1500	-	-	100	100	15	-	L(200)	-	100	-	100	-	200
54	-	-	-	0.05	100	300	3	-	100	150	150	1000	-	-	100	150	20	-	200	-	100	-	100	-	300
55	5	200	-	0.15	200	300	-	-	150	70	200	700	-	-	150	200	30	-	200	-	150	-	150	200	300
56	-	-	-	2.25	150	500	3	-	150	150	150	1500	-	-	200	150	20	-	200	-	100	-	200	-	200
57	2	-	-	N(.10)	200	1000	5	-	200	300	150	1000	-	L(50)	150	150	30	-	300	-	200	-	150	-	1000
58	-	-	-	N(.65)	200	700	3	-	100	150	200	1000	-	L(50)	150	100	20	-	200	-	200	-	200	-	300
59	1.5	-	-	N(.15)	300	700	5	-	150	300	500	300	-	L(50)	200	500	20	-	300	-	200	-	100	-	700
60	1	-	-	N(.5)	200	700	L(2)	-	200	70	300	500	-	L(50)	200	100	20	-	200	-	150	-	100	200	700
61	7	200	-	1.0	200	700	L(2)	-	500	70	500	700	-	-	300	200	20	-	200	-	150	-	150	200	1000
62	3	-	-	N(.15)	200	700	2	-	150	150	300	10000	-	L(50)	100	100	20	-	200	-	200	-	150	-	2000
63	2	-	-	N(.30)	500	700	2	-	150	150	300	1000	-	50	150	150	20	-	200	-	200	-	300	-	2000
64	1	-	-	N(.30)	700	300	3	-	500	100	200	1000	-	L(50)	200	300	20	-	-	-	100	-	100	-	2000
65	7	-	-	0.5	500	200	-	-	700	100	500	500	-	L(50)	300	300	50	-	200	-	150	-	200	L(200)	1000
66	-	-	-	L(.05)	200	500	3	-	100	100	200	700	-	-	200	150	15	-	-	-	200	-	100	-	300
66A	2	-	-	N(.25)	200	700	3	-	150	150	100	500	-	L(50)	100	70	20	-	200	-	150	-	70	-	1500
67	-	-	-	10	500	500	-	-	150	100	100	2000	-	50	50	100	30	-	200	-	200	-	150	-	2000
68	2	-	-	N(.50)	300	200	L(1)	-	300	100	200	300	-	L(20)	100	150	50	-	300	-	200	-	200	-	1000
69	1.5	-	-	0.1	200	100	L(1)	-	200	150	200	200	-	L(20)	150	150	20	-	200	-	100	-	200	L(200)	700
70	-	-	-	N(.10)	200	700	5	-	70	300	50	200	-	-	100	50	30	-	500	-	150	-	70	-	500
71	-	-	-	N(.50)	500	700	5	L(20)	300	200	500	2000	-	50	200	200	20	-	L(200)	-	200	-	200	-	1500
72	-	-	-	N(.60)	1000	500	2	-	150	150	100	2000	-	70	100	100	30	-	300	-	200	-	200	-	1500
73	-	-	-	0.45	200	700	5	-	150	200	100	1000	-	L(50)	200	100	15	-	200	-	150	-	150	-	2000
74	-	-	-	N(.15)	300	700	3	-	100	200	70	1000	-	-	100	70	20	-	200	-	150	-	100	-	2000
75	-	-	-	N(.7)	500	700	5	-	150	200	100	700	-	-	100	70	20	-	300	-	100	-	150	-	1000
76	-	-	-	0.5	300	300	L(1)	-	300	150	200	500	-	L(20)	200	150	20	-	200	-	100	-	500	L(200)	700
77	-	-	-	N(.25)	150	700	2	-	500	200	500	2000	-	-	500	500	15	-	200	200	100	-	1000	-	700
78	-	-	-	0.6	700	1000	3	-	150	200	150	1000	-	50	70	200	15	-	-	-	150	-	200	-	2000
79	-	-	-	1.7	1500	500	-	50	70	200	200	1500	-	50	10	1000	70	20	200	-	200	-	1000	-	2000
80	-	-	-	N(1.9)	1500	700	-	-	50	200	150	1000	-	100	10	200	30	-	700	-	200	-	500	-	2000
81	-	-	-	N(3.1)	1500	1500	-	-	70	150	200	1500	-	70	10	300	20	-	700	-	200	-	500	-	2000
82	-	-	-	L(.15)	300	500	5	-	70	150	150	2000	-	-	100	100	20	-	L(200)	-	200	-	150	-	200
83	-	-	-	13	2000	2000	-	-	50	150	200	1000	-	150	10	150	10	-	500	-	200	-	200	-	2000
84	-	-	-	N(2.1)	1000	1000	-	70	20	150	150	500	-	150	10	150	10	20	200	-	200	-	150	-	2000
85	5	-	-	L(.10)	500	1000	-	70	300	100	500	200	-	-	200	200	10	-	-	-	200	-	70	-	700
86	5	-	-	N(.65)	2000	10000	-	70	70	100	150	150	-	50	10	2000	10	-	1000	-	100	L(50)	200	-	2000
87	-	-	-	N(.60)	1000	1500	-	500	100	150	300	300	-	L(50)	10	500	10	-	1000	-	200	L(50)	100	-	2000
88	3	-	-	N(.30)	700	1000	3	300	300	200	500	500	-	-	200	150	30	-	200	-	300	-	150	-	2000
89	1.5	-	-	N(.15)	1000	700	5	500	200	200	150	1000	-	-	150	100	20	-	500	-	200	500	300	-	1500
90	70	-	1000	130	1500	300	-	200	-	150	150	700	-	50	10	200	50	-	500	-	200	-	1500	-	2000
91	-	-	-	L(.60)	500	2000	-	150	20	50	150	200	-	L(50)	10	L(20)	10	-	200	-	200	500	70	-	2000
92	5	-	-	N(1.3)	2000	2000	-	2000	200	150	300	1000	-	70	10	300	20	-	700	-	150	-	500	-	2000
93	-	-	-	N(.80)	2000	700	-	1000	10	70	30	1000	-	70	10	100	10	-	500	-	150	-	500	-	2000
94	7	-	-	L(1.9)	1500	700	-	2000	30	100	150	2000	-	150	10	150	20	30	500	300	200	200	500	-	2000
95	-	L(500)	-	NA	1000	500	2	1500	20	150	20	1000	15	50	15	200	10	50	200	-	300	300	200	-	2000
96	-	-	-	NA	2000	500	2	1500	30	100	20	1000	10	70	20	150	10	30	200	-	200	200	200	-	2000
97	50	-	-	NA	1000	500	2	500	50	150	50	1000	50	70	20	500	30	50	200	-	300	200	300	-	2000
98	-	-	-	N(.05)	500	5000	5	200	20	50	30	100	L(10)	L(50)	L(10)	50	-	L(20)	-	-	100	700	100	-	2000
99	-	-	-	N(1.9)	1500	700	-	2000	30	150	150	1500	-	150	10	200	20	20	500	200	200	300	500	-	2000

1/Atomic absorption analyses; limits of detection for each sample in parentheses. Detection limit high in many cases due to instrument "noise" resulting from small sample weight available for analyses.

2/Lower limit of detection for most samples is as indicated, but for a few, lower limit is 200 ppm.

Table 2. Analyses of bulk stream-sediment samples. Sample localities shown in figure 2. Semiquantitative spectrographic analyses. Letters and symbols in table denote: L, detected but below lower limit indicated; dash, not detected at lower limit indicated. Antimony (lower limit of detection, 100 ppm), cadimum (lower limit of detection, 20 ppm), and gold (lower limit of detection, 10 ppm), analyzed for, but are not listed because they were not detected in any samples. Semiquantitative spectrographic analyses by J. Domenico, D. E. Detra, E. F. Cooley, E. L. Mosier, and G. W. Day.

Lower limit of detection (ppm)	0.5	200	10	20	1	10	5	10	5	20	5	20	5	10	5	10	100	100	10	50	10	200	10
Sample No.	Ag	As	B	Ba	Be	Bi	Co	Cr	Cu	La	Mo	Nb	Ni	Pb	Sc	Sn	Sr	Th	V	W	Y	Zn	Zr
1	-	-	50	500	3	30	5	-	15	200	-	-	5	30	5	-	500	-	70	-	70	-	150
2	2	-	100	500	5	-	10	30	50	70	-	-	20	1000	10	-	300	-	100	-	50	2000	200
3	-	-	10	500	3	10	5	-	5	300	-	-	5	300	5	-	500	100	50	-	100	500	150
4	-	-	20	500	3	L(10)	5	15	7	300	-	-	10	70	5	-	500	-	70	-	70	-	200
5	-	-	50	500	3	-	10	20	20	70	-	-	15	70	5	-	500	-	100	-	70	L(200)	100
6	-	-	100	200	2	-	20	50	70	30	-	L(20)	50	30	15	-	100	-	200	-	30	L(200)	300
7	-	-	L(10)	50	-	-	10	-	10	-	-	-	5	200	-	-	100	-	30	-	L(10)	-	100
8	-	-	150	1500	1.5	-	7	50	20	70	-	L(20)	15	15	15	-	100	-	100	-	30	-	200
9	-	-	70	700	1.5	-	7	50	20	70	5	L(20)	20	15	15	-	300	-	150	L(50)	50	-	200
10	-	-	100	700	1.5	-	20	70	50	70	-	L(20)	20	20	10	-	100	-	100	-	20	-	100
11	-	-	100	500	1.5	-	20	70	50	50	5	L(20)	20	20	15	-	100	-	100	-	20	-	100
13	-	-	100	500	2	-	10	30	70	30	15	-	20	300	5	-	200	-	100	-	20	300	100
14	-	-	L(10)	100	1	-	-	-	5	-	-	-	-	L(10)	5	-	100	-	30	-	10	L(200)	50
15	-	-	150	300	2	-	15	30	50	50	-	L(20)	20	70	10	-	150	-	100	L(50)	30	L(200)	300
16	-	-	200	300	1	-	15	50	50	70	-	L(20)	20	70	10	-	150	-	100	-	50	L(200)	300
17	-	-	200	500	1	20	20	30	70	30	-	L(20)	20	70	5	-	100	-	200	L(50)	30	L(200)	300
18	-	-	10	150	7	20	-	-	30	50	5	-	10	15	5	-	500	-	30	-	70	L(200)	30
19	-	-	50	500	10	70	10	-	50	70	50	L(20)	20	70	5	-	500	-	100	-	50	500	150
20	-	-	50	500	10	15	10	-	70	70	10	20	10	50	5	-	500	-	100	-	70	500	150
21	-	-	200	500	2	-	20	50	50	50	7	L(20)	20	70	5	-	200	-	100	-	50	L(200)	300
22	-	-	200	300	2	-	20	20	30	50	5	L(20)	20	50	5	-	200	-	100	-	30	L(200)	200
23	-	-	20	200	5	-	5	-	15	100	-	-	5	10	5	-	300	-	50	-	20	300	70
24	-	-	100	500	5	-	15	10	20	70	5	L(20)	10	20	5	-	500	-	100	-	30	L(200)	200
25	-	-	70	500	5	-	5	-	5	-	-	-	5	30	5	-	300	-	20	-	20	-	100
26	-	-	50	500	5	-	7	10	15	70	-	L(20)	10	50	5	-	500	-	100	-	50	200	200
27	-	-	20	500	3	-	15	20	10	150	-	30	7	20	30	-	500	-	200	-	100	-	700
28	-	-	50	500	2	-	5	-	10	150	-	L(20)	5	30	5	-	500	-	100	-	70	-	500
29	-	-	20	500	2	-	5	20	10	300	-	30	5	50	5	-	500	-	200	-	70	-	500
30	-	-	30	500	2	-	10	20	10	700	-	30	5	50	5	-	500	150	300	-	100	-	500
31	-	-	150	300	3	-	10	30	20	150	-	70	15	30	5	-	200	-	70	70	70	-	500
32	-	-	30	700	5	-	5	-	15	300	-	L(20)	5	50	5	-	1000	-	70	-	50	-	300
33	-	-	50	700	5	-	5	-	15	100	-	L(20)	10	50	5	-	1000	-	70	-	30	-	300
34	-	-	30	700	3	-	5	-	5	300	-	L(20)	5	30	5	-	1000	100	70	-	70	-	300
35	-	-	200	300	2	-	7	50	30	50	-	L(20)	15	20	5	-	100	-	70	-	50	-	300
36	-	-	300	700	2	-	10	30	30	200	-	L(20)	15	70	5	-	200	-	100	L(50)	50	200	300
37	-	-	200	1000	2	-	15	20	30	50	-	L(20)	15	100	5	-	150	-	70	-	30	L(200)	300
38	-	-	300	2000	2	-	10	30	50	30	-	L(20)	15	100	5	-	100	-	70	-	30	700	200
39	-	-	300	500	3	-	10	20	20	20	-	-	7	50	5	-	200	-	70	-	50	-	300
40	-	-	200	500	3	-	5	20	10	50	-	L(20)	10	30	5	-	200	-	70	-	50	-	300
41	-	-	150	300	3	-	5	30	5	50	-	L(20)	5	20	5	-	100	-	70	-	50	-	300
42	1	-	70	300	20	-	10	30	70	70	7	L(20)	5	20	5	-	100	-	70	-	50	-	300
43	-	-	30	500	10	-	10	10	70	50	5	L(20)	10	50	5	-	500	-	100	50	70	L(200)	300
44	-	-	70	300	7	-	7	-	15	20	-	L(20)	7	70	5	-	100	-	50	-	20	-	300
45	-	-	300	500	7	-	15	30	30	70	L(5)	50	50	70	5	-	100	-	100	-	70	200	200
46	-	-	200	200	7	-	7	20	20	70	-	500	10	70	5	10	100	-	100	70	150	-	200
47	-	-	200	300	1	-	15	50	70	30	-	L(20)	30	30	5	-	100	-	100	-	30	L(200)	200
48	-	-	200	300	1	-	30	70	100	100	-	L(20)	30	30	20	-	100	-	200	-	50	L(200)	300
49	-	-	200	500	1	-	20	100	70	70	-	L(20)	30	30	15	-	100	-	200	-	50	-	300
50	-	-	300	300	2	-	30	50	50	70	-	L(20)	50	20	20	-	100	-	200	-	50	L(200)	300
51	-	-	200	300	2	-	30	100	70	150	-	L(20)	50	50	20	-	100	-	200	-	50	L(200)	300

Table 2 (Continued)

Lower limit of detection (ppm) Sample No.	0.5 Ag	200 As	10 B	20 Ba	1 Be	10 Bi	5 Co	10 Cr	5 Cu	20 La	5 Mo	20 Nb	5 Ni	10 Pb	5 Sc	10 Sn	100 Sr	100 Th	10 V	50 W	10 Y	200 Zn	10 Zr
52	-	-	100	500	1	-	15	70	30	70	-	L(20)	30	20	10	-	100	-	70	-	30	-	200
53	-	-	100	500	1.5	-	20	50	30	150	-	L(20)	30	20	10	-	L(100)	-	70	-	50	-	150
54	-	-	100	500	1.5	-	20	70	20	70	-	L(20)	30	20	10	-	100	-	70	-	20	-	150
55	-	-	100	700	2	-	20	70	50	70	-	L(20)	30	30	15	-	200	-	100	-	30	L(200)	200
56	-	-	70	300	1.5	-	70	500	50	70	-	20	70	50	15	10	L(100)	-	150	-	50	-	500
57	-	-	50	500	1.5	-	100	200	50	200	-	-	100	50	10	-	100	-	100	-	150	-	500
58	-	-	50	300	2	-	50	100	30	500	-	L(20)	70	30	10	-	L(100)	-	100	-	70	-	1000
59	L(.5)	-	50	300	1.5	-	100	200	50	200	-	L(20)	100	50	10	-	100	-	150	-	100	-	1000
60	-	-	100	500	1	-	20	70	50	100	-	L(20)	30	20	15	-	100	-	100	-	30	-	200
61	-	-	100	700	1	-	10	50	30	50	-	L(20)	20	20	10	-	L(100)	-	50	-	30	-	200
62	-	-	50	300	1	-	70	100	50	200	-	L(20)	70	30	7	-	L(100)	-	150	-	100	-	1000
63	-	-	50	200	-	-	70	70	50	200	-	L(20)	50	30	5	-	-	-	100	-	70	-	1000
64	-	200	70	150	-	-	200	700	100	1000	-	20	200	100	-	10	-	150	150	-	200	-	1000
65	-	-	100	500	1	-	10	30	20	50	-	-	15	20	10	-	-	-	50	-	20	-	200
66	1	-	50	300	1	-	70	150	50	150	-	-	70	50	7	-	-	-	-	-	100	-	1000
66A	-	-	50	300	1	-	50	100	20	150	-	L(20)	30	15	10	-	100	-	-	-	50	-	500
67	-	-	70	200	-	-	70	150	30	300	-	20	50	20	7	-	L(100)	-	100	-	100	-	1000
68	-	-	70	500	1	-	10	50	20	70	-	-	20	20	15	-	L(100)	-	70	-	20	L(200)	200
69	-	-	100	300	1	-	15	50	20	50	-	L(20)	20	20	7	-	100	-	50	-	10	-	100
70	-	-	50	300	1	-	50	150	15	100	-	L(20)	50	20	10	-	150	-	100	-	5	-	200
71	-	-	50	500	1	-	50	100	30	200	-	L(20)	30	15	10	-	-	-	150	-	70	-	1000
72	-	-	70	300	1	-	50	50	15	200	-	L(20)	30	20	10	-	L(100)	-	100	-	50	-	1000
73	-	-	50	200	1.5	-	50	50	30	150	-	L(20)	50	50	5	-	-	-	100	-	100	-	1000
74	-	-	50	300	1.5	-	50	100	20	200	-	L(20)	70	20	7	-	100	-	150	-	100	-	1000
75	-	-	50	300	1.5	-	50	100	20	200	-	L(20)	70	30	10	-	100	-	100	-	100	-	500
76	-	-	100	300	1	-	20	70	20	100	-	L(20)	50	20	10	-	200	-	50	-	20	-	200
77	0.5	-	50	500	1	-	70	200	70	300	-	-	100	70	10	-	100	-	70	-	70	-	500
78	-	-	70	200	1	-	50	70	30	200	-	L(20)	30	30	5	-	-	-	70	-	50	-	1000
79	-	-	300	300	1	-	20	30	30	200	-	L(20)	20	30	5	-	-	-	100	-	70	-	1000
80	-	-	200	300	2	-	20	70	30	100	-	L(20)	50	30	5	-	100	-	70	-	50	-	500
81	-	-	200	500	1	-	20	70	50	50	-	L(20)	50	30	5	-	100	-	100	-	50	L(200)	300
82	-	-	50	700	2	-	30	100	30	300	-	20	30	20	10	-	L(100)	-	100	-	100	-	150
83	-	-	200	500	2	-	20	30	50	100	-	L(20)	30	30	5	-	100	-	100	-	50	L(200)	300
84	-	-	200	700	1	-	20	50	70	30	-	L(20)	30	30	5	-	100	-	150	-	30	L(200)	300
85	1	200	20	300	1.5	10	150	200	70	30	-	20	100	100	10	-	-	-	200	-	50	-	200
86	-	-	200	1000	1	-	20	70	70	20	-	-	30	30	5	-	100	-	100	-	20	L(200)	200
87	-	-	70	500	1	-	20	50	70	20	-	-	30	30	5	-	100	-	200	-	20	L(200)	150
88	L(.5)	-	50	500	1	-	70	70	50	20	-	L(20)	30	20	10	-	L(100)	-	150	-	20	-	300
89	-	-	70	300	1.5	-	100	150	20	200	-	L(20)	70	20	10	-	100	-	100	-	100	-	700
90	-	-	200	300	1	-	15	50	30	70	-	L(20)	20	30	5	-	100	-	70	-	50	-	1000
91	-	-	200	1000	1	-	20	50	50	70	-	-	30	30	5	-	100	-	100	-	30	-	300
92	-	-	200	1000	1	-	20	70	30	70	-	-	30	30	5	-	100	-	100	-	30	-	500
93	-	-	200	500	2	-	7	15	15	150	-	L(20)	10	50	5	-	500	-	70	-	50	-	300
94	-	-	100	500	2	-	10	10	20	100	-	L(20)	15	50	5	-	500	-	100	-	50	L(200)	300
95	0.5	-	30	300	1	15	5	50	20	50	-	-	20	30	7	-	-	-	70	-	30	-	150
96	0.5	-	70	500	2	-	7	50	30	70	-	L(20)	30	30	15	-	150	-	100	-	70	L(200)	150
97	-	-	100	700	5	-	10	70	50	70	5	L(20)	30	20	15	-	100	-	200	-	50	-	200
98	-	-	100	700	1.5	-	15	70	30	20	-	-	20	20	15	-	100	-	100	-	20	-	150
99	-	-	100	700	2	-	20	50	20	100	-	-	20	30	5	-	500	-	150	-	30	L(200)	200

Table 3. Analyses of selected rock samples. Sample localities shown in figure 2. Semiquantitative spectrographic analyses. Letters and symbols in table denote: L, detected but below lower limit indicated; dash, not detected at lower limit indicated. Silver (lower limit of detection, 0.5 ppm), arsenic (lower limit of detection, 200 ppm), gold (lower limit of detection, 10 ppm), antimony (lower limit of detection, 100 ppm), tin (lower limit of detection, 100 ppm) analyzed for, but not listed because they were not detected in any samples. Gold also analyzed for by atomic absorption (lower limit of detection, 0.05 ppm) but was not detected in any samples Semiquantitative spectrographic analyses by E. F. Cooley. Atomic absorption analyses by J. E. Gray.

Lower limit of detection (ppm)	10	20	1	10	20	5	10	5	20	10	5	20	5	10	5	100	10	50	10	200	10
Sample No.	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mn	Mo	Nb	Ni	Pb	Sc	Sr	V	W	Y	Zn	Zr
R1a	30	1000	1	-	-	-	-	5	200	500	-	20	-	100	30	1000	10	-	70	-	2[illegible]
b	20	150	1	-	-	-	-	15	L(20)	200	-	L(20)	-	20	5	-	10	-	L(10)	-	2[illegible]
c	70	1000	2	100	-	-	-	15	70	300	-	L(20)	-	50	5	1000	20	-	50	-	20[illegible]
d	150	700	5	-	-	-	-	5	70	1000	-	L(20)	-	100	10	1000	50	-	50	-	20[illegible]
e	10	1500	2	10	-	-	-	5	50	500	20	L(20)	-	70	7	2000	30	-	50	-	30[illegible]
f	20	1000	5	-	-	-	-	7	70	700	-	L(20)	-	50	10	1500	20	-	50	-	30[illegible]
g	50	500	1	-	-	-	150	50	100	200	10	20	-	50	30	L(100)	50	-	70	-	30[illegible]
R2a	10	2000	5	-	-	-	-	L(5)	50	500	20	L(20)	-	70	10	2000	50	50	20	-	20[illegible]
b	50	1000	5	-	-	-	-	10	50	1000	-	L(20)	-	20	10	1000	50	50	50	-	20[illegible]
R3a	10	1500	L(1)	20	-	-	20	L(5)	50	1000	-	-	-	700	5	300	10	-	20	-	20
b	10	1000	-	10	30	5	50	15	20	1000	-	-	7	1000	5	100	70	-	20	1000	20
c	10	1500	-	-	-	10	100	20	L(20)	3000	-	-	5	10	7	200	30	-	30	-	100
d	-	1000	1	-	20	-	30	10	20	700	-	-	-	500	7	L(100)	20	-	15	500	50
R4	10	2000	1	-	-	5	150	30	100	500	100	20	10	100	30	300	70	-	70	-	300
R5a	10	1500	1	-	-	10	20	10	100	1000	L(5)	20	L(5)	50	30	1500	100	-	70	-	300
b	10	1000	2	-	-	L(5)	150	100	70	5000	10	L(20)	5	100	20	500	50	-	50	L(200)	200
c	10	700	1	-	-	L(5)	70	30	50	1500	-	L(20)	5	100	20	300	50	-	50	-	100
R6	50	1000	1	-	-	20	150	20	50	700	L(5)	L(20)	20	100	20	100	100	-	70	-	500
R7a	10	300	2	-	-	L(5)	100	5	50	5000	L(5)	L(20)	10	70	20	100	50	-	50	-	100
b	20	100	1	-	-	15	100	L(5)	50	5000	L(5)	L(20)	10	50	20	100	70	100	70	-	200
c	30	20	1.5	-	L(20)	30	150	L(5)	50	5000	-	L(20)	20	50	20	100	100	100	70	500	200
R8	10	200	L(1)	-	-	-	20	100	L(20)	50	5	-	-	20	L(5)	L(100)	10	-	10	-	20
R9	50	300	1	-	-	-	30	5	70	100	-	L(20)	-	20	5	200	20	-	50	-	200
R10a	20	500	-	-	-	-	100	L(5)	100	100	L(5)	L(20)	-	20	20	200	50	L(50)	50	-	300
b	L(10)	700	L(1)	-	-	-	50	L(5)	70	150	-	L(20)	-	20	10	300	30	-	70	-	300

R1a—White aphanitic dike rock with microphenocrysts of feldspar; appears unaltered.
b—Quartz vein, heavily hematite stained. Cube-shaped vugs from altered pyrite.
c—Granodiorite of Hall Mountain. Highly altered, sericitic
d—Similar to R1c
e—Similar to R1c
f—Similar to R1c, but less altered
g—Similar to R1c, but heavily hematite stained
R2a—Granodiorite of Hall Mountain. Contains abundant quartz veins with minor amount of pink flourite
b—Same as R2a, but with no visable flourite
R3a—Dolomitic limestone, contains minor tremolite and clinozoisite. Pale green.
b—Dolomitic limestone, altered, vuggy and punky; white to pale tan.
c—Tremolitic marble, contains abundant clinozoisite and pyrite; may contain garnet.
d—Dolomitic limestone, contains minor tremolite; white.
R4 —Siltite cut by thin quartz veinlet; miner finely disseminated molybdenite.
R5a—Granodiorite of Hall Mountain. Thick (10 mt) dike, fine-grained, no apparent mineralization.
b—Calc-silicate rock, contains abundant pyrite
c—Similar to R5b
R6 —Chloritic siltite, contains one thin quartz veinlet.
R7a—Calc-silicate hornfels, contains abundant garnet and clinozoisite.
b—Same as R7a, but with specks of scheelite under UV light
c—Same as R7b
R8—Thin quartz veinlets in Revett Quartzite; abundant altered pyrite.
R9—Quartz veinlet in siltite
R10a—Gray siltite with abundant quartz veinlets; contains bladed metallic mineral, probably magnetite.
b—Same as R10a