TIN OCCURRENCES ASSOCIATED WITH THE OHIO CREEK PLUTON, CHULITNA REGION, SOUTH-CENTRAL ALASKA

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UNITS OF ABBREVIATIONS USED IN THIS REPORT

cm	centimeter
ft	feet
lb	pound(s)
mm	millimeter
m.y.	million year(s)
oz/st	troy ounces per short ton
pct	percent
pH	negative log10 of the hydrogen ion content
ppm	parts per million
wt pct	weight percent

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ABSTRACT

In 1984 and 1985, as part of its Alaskan critical and strategic minerals project, the Bureau of Mines mapped and sampled reported tin occurrences associated with the Ohio Creek pluton, in the central Alaska Range, south-central Alaska. The pluton is a composite intrusion with a core of moderately coarse-grained biotite granite and an outer zone of finer-grained leucocratic muscovite granite. Tin mineralization, associated with silver, base-metal, and tungsten values, occurs within the muscovite granite as cassiterite (SnO_2) within both quartz-muscovite greisen and arsenopyrite veins. Silver occurs within argentiferous galena and argentite (Ag_2S); tungsten is present in the Mn-rich wolframite mineral huebnerite ($MnWO_4$). Samples of arsenopyrite veins average 0.7 pct Sn over 0.5 ft, whereas samples of muscovite or quartz-muscovite greisen average 0.17 pct Sn over 1.0 ft. Metallurgical testing of three large samples of tin mineralized greisen showed tin recoveries of 27 to 64 pct in table concentrates: respective grades of concentrates range from 39.4 to 72.1 pct Sn. A low-grade (0.06 pct Sn) zone near the pluton's upper contact containing numerous relatively closely spaced greisen-bordered arsenopyrite veins is inferred to contain a resource of approximately 1,250,000 lb Sn.

INTRODUCTION

During portions of the summers of 1984 and 1985, the Bureau of Mines (Bureau) investigated several previously reported tin prospects and occurrences located in the Chulitna subdistrict of the Valdez Creek Mining District (1)[3/], south-central Alaska Range. Investigations comprised a portion of an ongoing Bureau project to evaluate Alaskan reserves and resources of certain critical and strategic minerals. Tin is considered a critical and strategic mineral because of its use in defense-related technologies and because of the United States' reliance on foreign sources for primary metal.

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3/Underlined numbers in parentheses refer to items in the list of references at the end of this report.

This report describes a portion of the Bureau investigations conducted at previously reported (2), but unstudied, tin occurrences associated with the Ohio Creek pluton on upper Ohio Creek. Numerous tin-mineralized zones were identified. One low-grade (0.06 pct) zone can be inferred to contain a resource of approximately 1,250,000 lb Sn, which represents slightly less than 1 pct of previously identified Alaskan tin reserves and resources (3).

ACKNOWLEDGMENTS

Field work was assisted by D. Southworth (in 1984), geological assistant, with the Bureau of Mines, and S. Masterman (in 1985), graduate student with the University of Alaska, Fairbanks. The final compilation of this report was performed by Roger Burleigh, geologist, formerly with the Bureau, subsequent to the lead author's leaving the Bureau.

LOCATION, ACCESS, AND PHYSIOGRAPHY

The Ohio Creek pluton is bisected by the toe of the Ohio Creek glacier in the northwestern portion of the Healy (A-6) Quadrangle, Alaska (fig. 1). This area is extremely precipitous, characterized by steep talus-covered mountainsides and broad, swift-flowing, glacially fed braided streams. Near the Ohio Creek pluton, elevations range from a low of 2,500 ft on Ohio Creek to greater than 6,000 ft on nearby mountaintops.

An all-weather road and rail route following the Chulitna and Susitna River valleys, is located 20 miles east of Ohio Creek. A short airstrip is also located on the left limit of Ohio Creek approximately 4 miles downstream of the Chulitna River. Otherwise, access is limited to helicopter. The Ohio Creek pluton lies within the boundaries of the Denali National Park and Preserve.

PREVIOUS WORK

The Ohio Creek pluton was initially recognized as tin-bearing by Hawley (2, 4, 5, and 6). Hawley reports tourmaline and muscovite greisen adjacent to a biotite-bearing inclusion and banded arsenopyrite-bearing veins and pegmatites near the pluton's upper contact. Hawley collected samples containing "more than 0.10 pct tin, at least partially in the form of cassiterite" (5, p. 103) and noted the area's potential for "fracture-filling type" tungsten deposits. Traces of the rare mineral wodginite $[(Ta,Cb,Sn,Mn,Fe)_{16}O_{32}]$ were identified at Ohio Creek by X-ray diffraction techniques by R. G. Wehr and reported by Hawley (2).

BUREAU OF MINES INVESTIGATIONS

The Ohio Creek pluton and associated tin occurrences were investigated in the field during a brief one-day reconnaissance in July, 1984, and over a six-day period in mid-August, 1985. Investigations consisted of 1:12,000-scale geologic mapping of the pluton with more detailed 1:480- to 1:1,200-scale mapping in several smaller areas, and systematic sampling of mineralization. During the

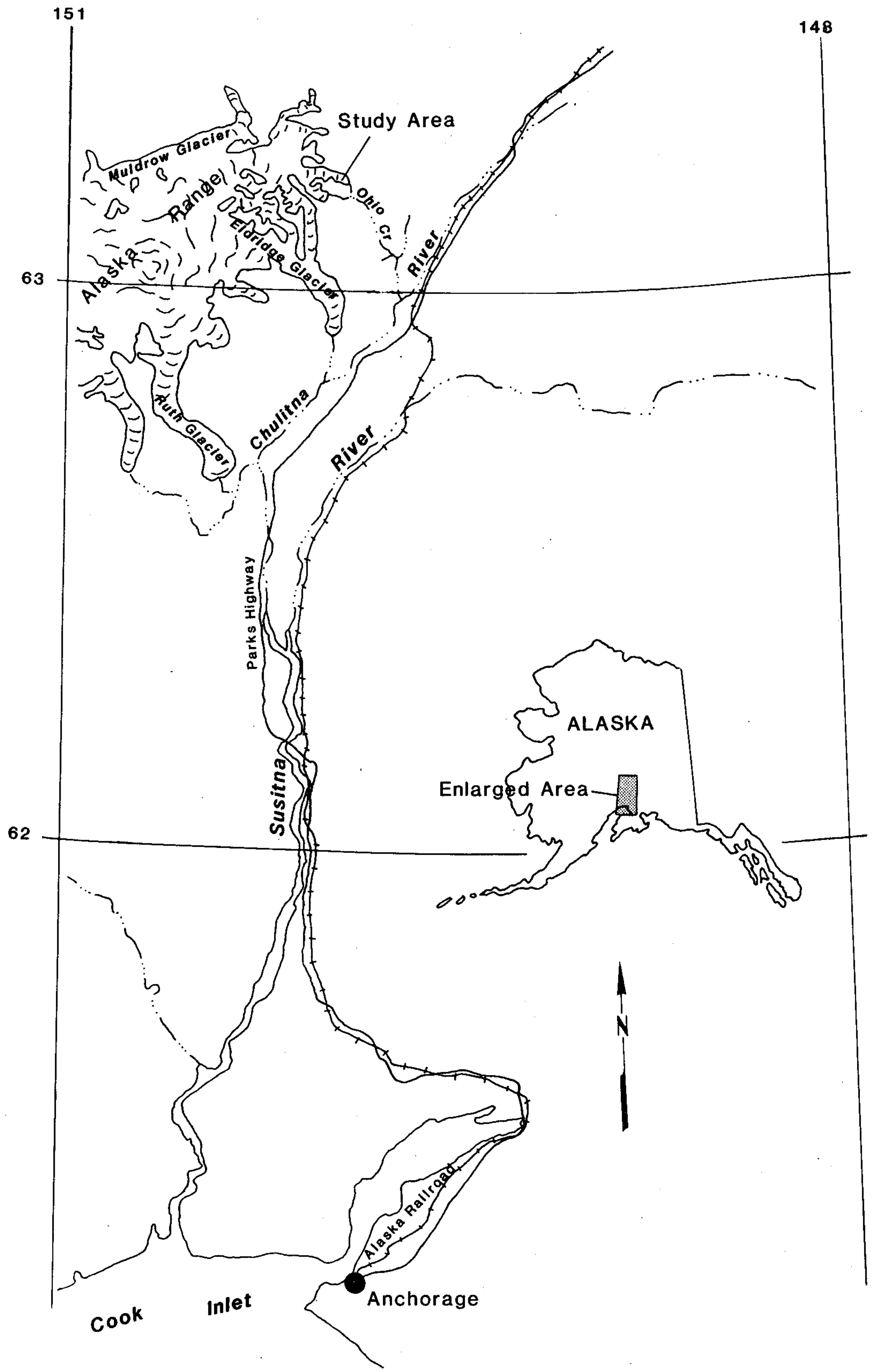

Figure 1. - Location of study area

course of field studies, 3 bulk samples of tin-mineralized rock were collected for more-detailed laboratory characterization of the occurrences. Laboratory studies included investigation of the beneficiation and mineralogic character of the potential ore.

GEOLOGY OF THE OHIO CREEK PLUTON

The Ohio Creek pluton is exposed over an approximately 4,000-ft-long, 3,000-ft-wide area (fig. 2). It is elongate to the northeast and has sharp, although locally irregular contacts with hornfelsed argillite. The pluton's northeastern contact dips moderately northeast whereas the southwestern contact appears to dip southwest. The pluton's original shape may have been that of an elongated dome. Although undated, the pluton is assumed to be correlative to other early Tertiary-age (±56 m.y.) intrusions of the region referred to as the "McKinley Sequence", by Reed and Lanphere (7). Two mineralogically and chemically distinct phases of the granite were mapped (fig. 2 and table 1). The contact between the two was not observed, but is inferred to lie topographically and structurally below a zone containing several hornfelsed argillite inclusions.

Most outcrops of the topographically lower, inner portion of the pluton consist of a moderately coarse-grained biotite granite (Tgb) with minor amounts of muscovite and locally abundant tourmaline-filled miarolitic cavities. Major oxide analyses (table 1) indicate this phase is markedly peraluminous[4/], and has a silica-enriched but

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4/Molecular proportion of Al_2O_3 exceeds that of the sum of Na_2O, K_2O, and CaO.

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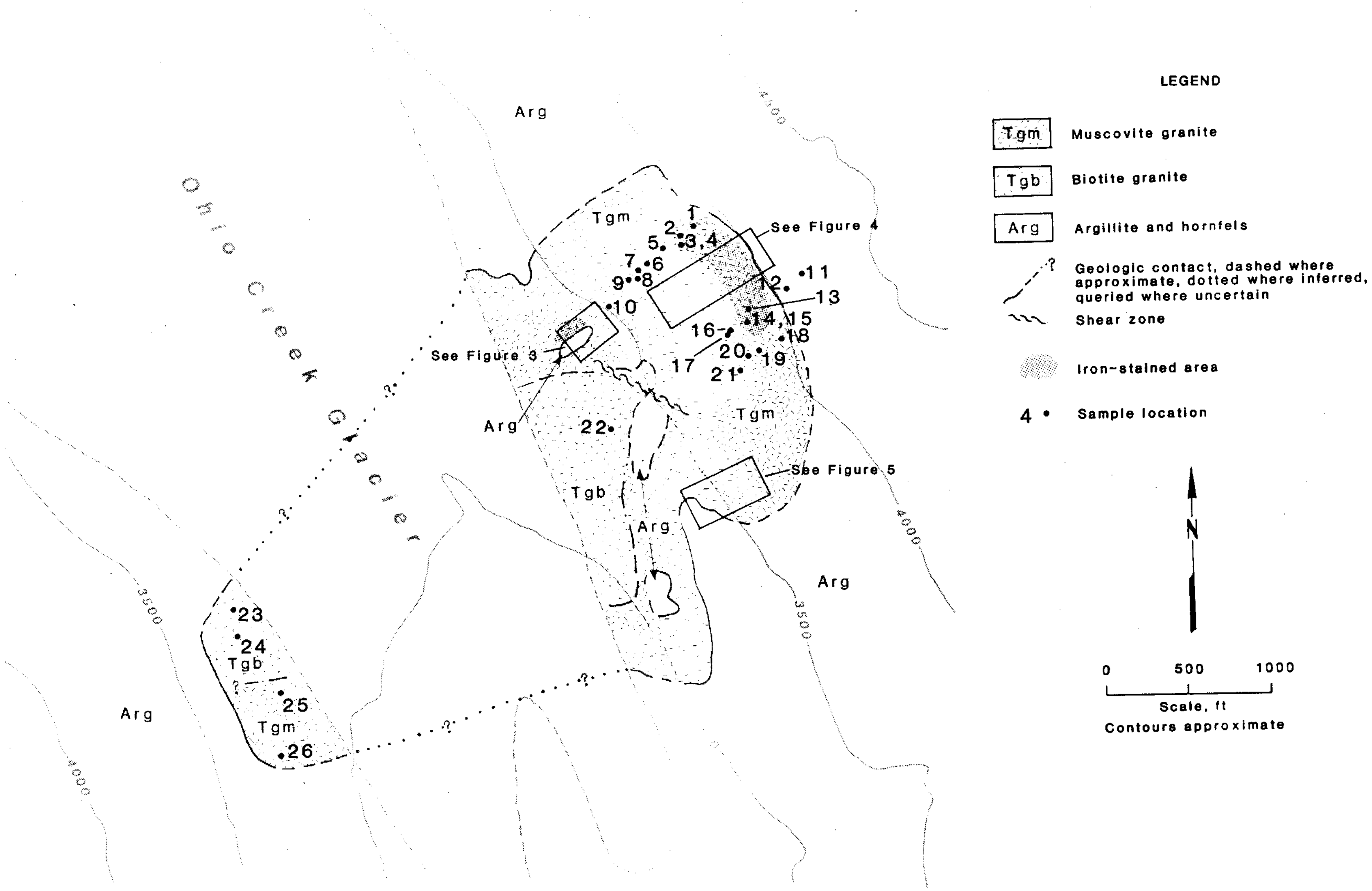
total-alkali- and titanium-depleted composition relative to average biotite alkali granite reported by Nockolds (8).

The outer portions of the pluton consist of medium- to fine-grained leucocratic muscovite granite (Tgm). Nearer to the pluton's core, this phase contains up to 0.2 cm crystals of slightly smokey quartz. Towards the pluton's margins, on the other hand, the quartz is not smokey and this phase contains trace amounts of green-tinted white micas, disseminated arsenopyrite, and less than an inch to several feet-wide pods of pegmatitic tourmaline. Abundant fluorite was also noted in this rock in exposures southwest of Ohio Creek. The upper 5 to 10 ft of the muscovite granite, adjacent to the hornfels, is an aphanitic rock probably representing a chilled margin.

Major oxide analyses of 5 samples indicate the leucocratic muscovite granite, like the biotite granite, is markedly peraluminous (4). The muscovite granite, however, is enriched in Al_2O_3 and Na_2O but depleted in SiO_2, K_2O, CaO, Fe_2O_3, and TiO_2 relative to both the biotite granite and to average biotite alkali granite (8).

Bulk compositions, especially the very high SiO_2 and low TiO_2, are indicative of great degrees of fractionation similar to that observed associated with major tin deposits worldwide. The high sodium/potassium ratios are similar to the "albite" trend observed for Seward Peninsula tin-related granites (9).



Base adapted from U.S.G.S. Healy (A-6) quadrangle

Figure 2. - Geologic and sample location map of the Ohio Creek pluton

TABLE 1. - Major oxide analyses[1/], of samples of the Ohio Creek pluton

Rock Type	Biotite Granite		Leucocratic Muscovite Granite				Granite[2/]
Sample	17	22	23	25	47	65	
Major Oxide Analyses (normalized), pct							
SiO_2	77.8	76.4	76.6	73.5	74.7	74.1	75.01
Al_2O_3	13.5	13.4	13.2	16.0	15.6	15.8	13.16
K_2O	3.2	3.4	4.2	3.0	3.0	3.3	5.11
Na_2O	4.2	3.8	4.0	4.7	5.3	5.2	3.48
CaO	0.17	0.42	0.44	0.19	0.30	0.29	0.58
MgO	.080	0.081	0.090	0.06[2/]	0.017	0.004	0.24
Fe_2O_3	0.63	1.3	1.3[3/]	0.33[3/]	0.62	0.51	0.94
FeO	0.24	1.0	N	N	0.18	0.40	5.88
MnO	0.033	0.063	N	N	0.080	0.062	N
P_2O_5	0.100	0.042	0.07	0.17	0.13	0.11	0.07
TiO_2	0.015	0.05	0.01	0.015	0.009	0.005	0.11
F	0.011	0.08	0.13	2.05	0.009	0.13	N

1/Analyses by X-ray fluorescence.
2/Average biotite alkali granite composition as reported by Nockolds (8).
3/Total iron reported as Fe_2O_3.
N - Not analyzed.

TIN OCCURRENCES

General Description

The Ohio Creek pluton contains tin-, silver-, and base-metal-bearing quartz-tourmaline and quartz-muscovite[5/] greisen[6/] occurrences

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5/Muscovite in this report refers to a generic pale mica of unknown composition.

6/An altered rock of generally granitic composition composed mostly of quartz, mica, chlorite, topaz, fluorite, or tourmaline and associated with ore minerals of tin, tungsten, and molybdenum.

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along the contact between an argillite inclusion and muscovite granite in the northwestern portion of the intrusion. Tin-mineralized quartz-muscovite greisen-bordered arsenopyrite veins are also present in the structurally higher portions of the pluton. Wolframite-[(Fe,Mn)WO_4] bearing quartz veins within both the argillite country rock and the muscovite granite area are also locally present.

Figure 3 is a detailed geologic sketch map of a hornfelsed argillite inclusion and associated greisen located in the northwestern portion of the Ohio Creek pluton (fig. 2). The inclusion is partially exposed along approximately 300 ft of creek length and dips steeply to gently northwest, subparallel to the orientation of original bedding in the argillite. Massive fine-grained to vein-like coarse-grained quartz-tourmaline and quartz-muscovite greisen are locally present in the muscovite granite along its contact with the argillite inclusion, and in granite dikes or sills within the inclusion. The inclusion is cut by unaltered, northwest-trending steeply north-dipping shear zones.

Cassiterite-bearing 0.1- to 1.3-ft-wide arsenopyrite-quartz veins are common within an approximately 1,000-ft-long and up to 50-ft-wide, iron-stained area near the upper contact of the pluton and are also locally present near the southeastern margin of the Ohio Creek pluton (figs. 2, 4, and 5). The veins strike north to northwest and dip moderately to steeply northeast, subparallel to the pluton's upper contact. Where most closely spaced, the veins occur at intervals of approximately 8 ft over a width of approximately 50 ft (fig. 4). In the upper portions of the pluton, the arsenopyrite-quartz veins have quartz-tourmaline and/or quartz-muscovite greisen selvages that are especially well-developed in the footwall. The width of the vein and selvage, together, ranges up to 2.5 ft, but averages approximately 1.5 ft. Trace to minor amounts of chalcopyrite, pyrite, sphalerite, and galena, as well as cassiterite, are locally present in the arsenopyrite veins or their greisen selvages. Cassiterite was observed associated with arsenopyrite and occurred as up to .5-cm dark brown euhedral grains in several veins.

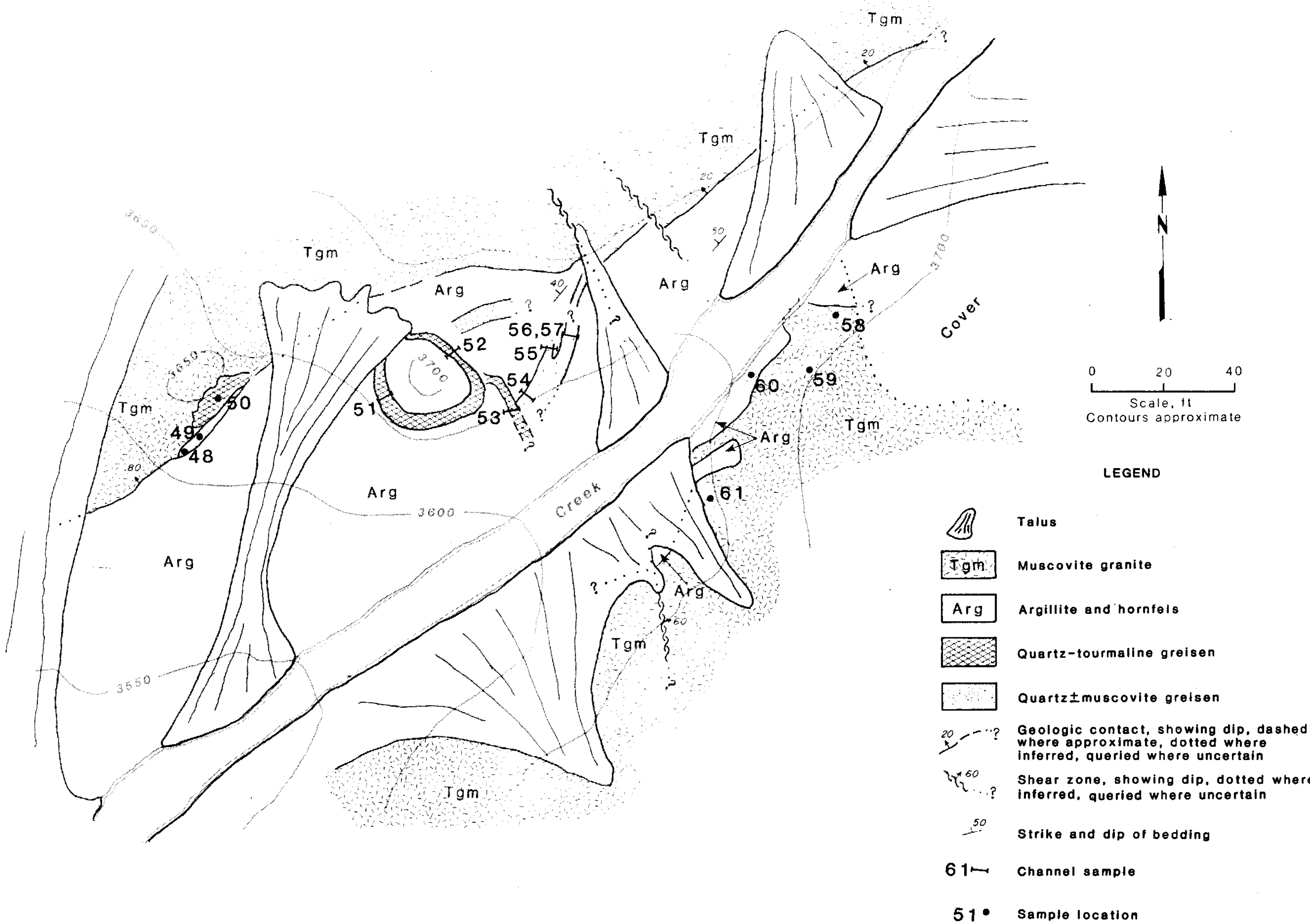

Figure 3. - Geologic sketch map of the hornfelsed argillite inclusion, northwestern Ohio Creek pluton

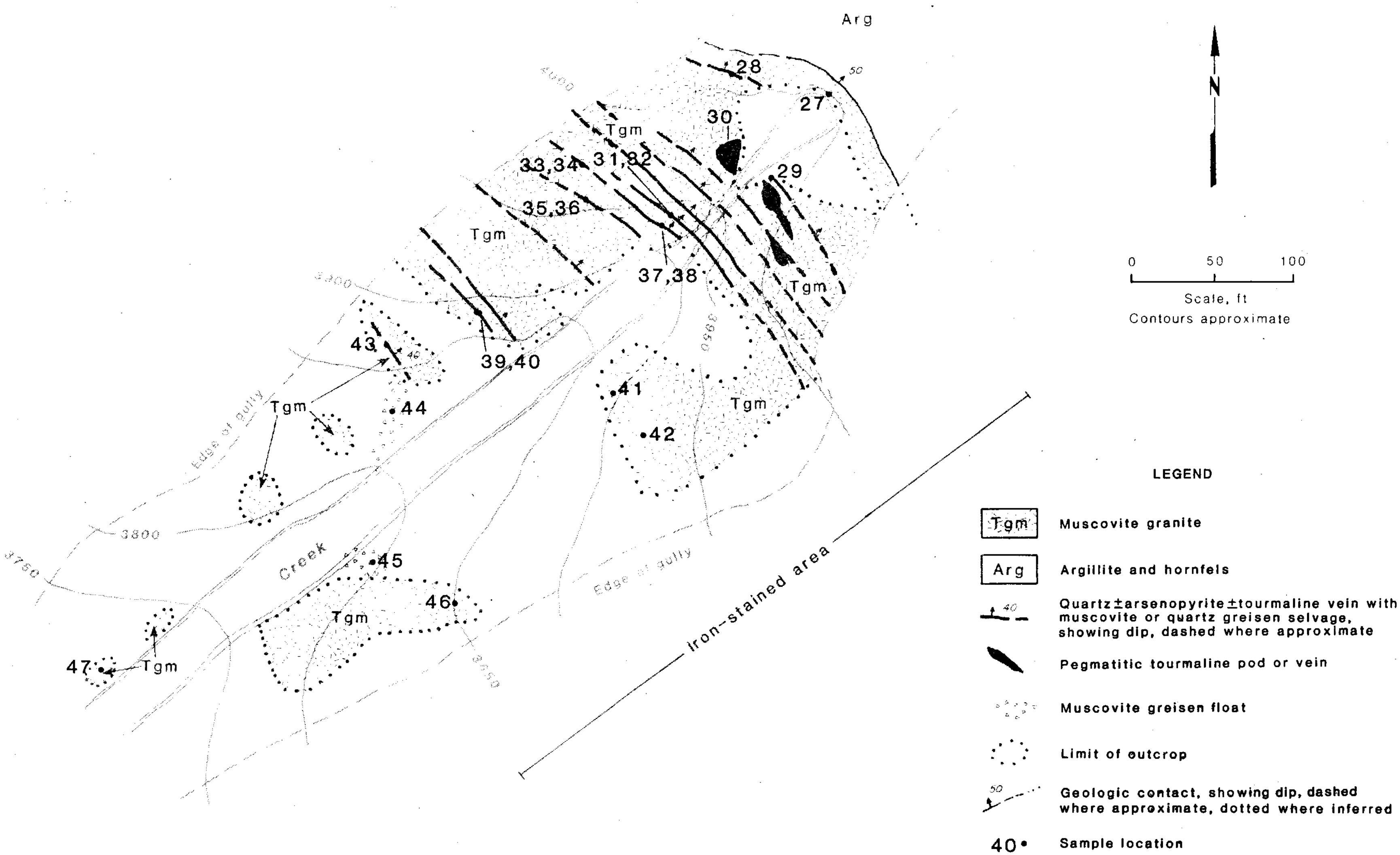

Figure 4. - Geologic sketch map of greisen occurrences near the roof of the Ohio Creek pluton

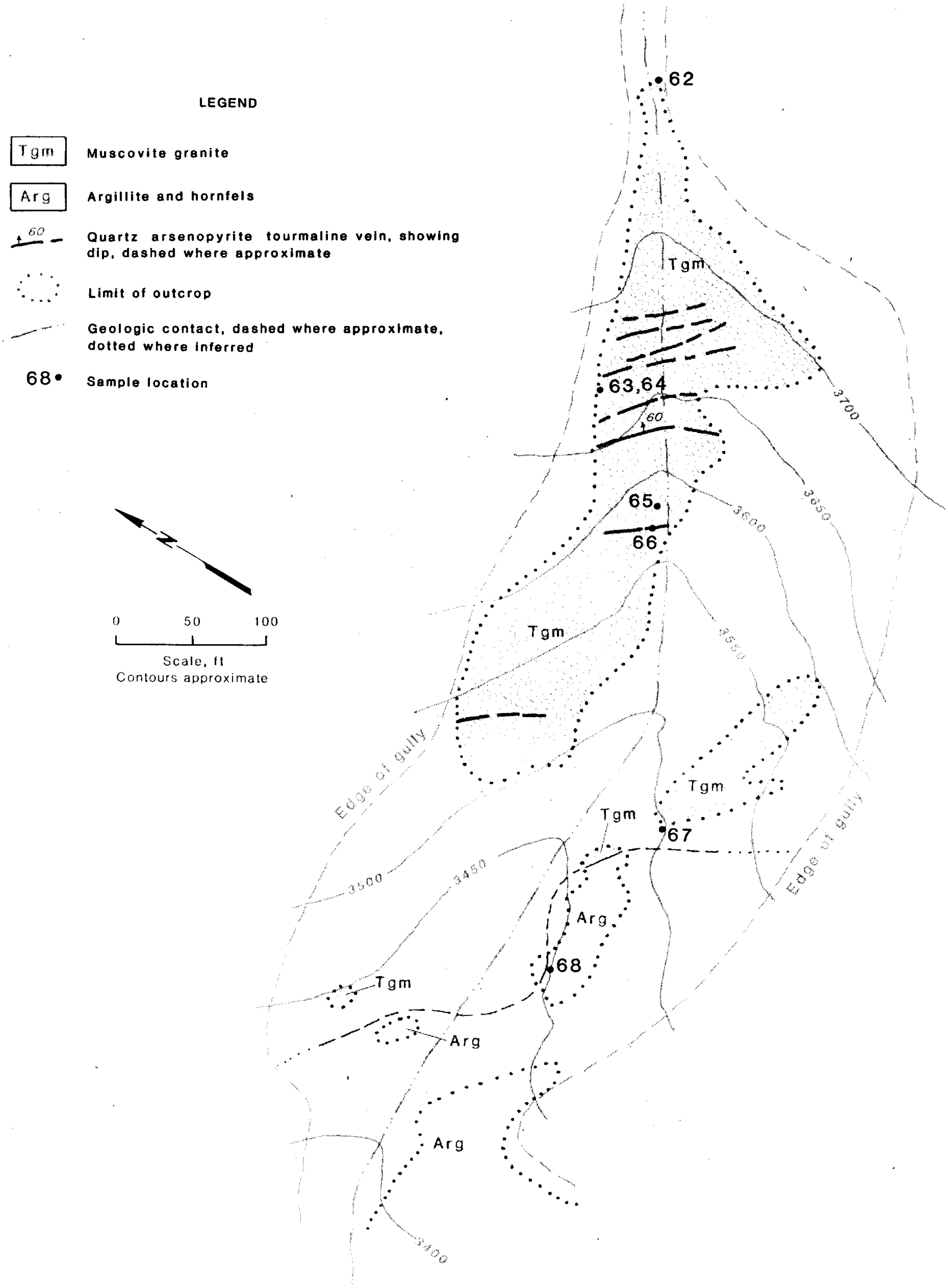

Figure 5. - Geologic sketch map of the greisen occurrences near the southeastern wallrock contact of the Ohio Creek pluton

Open-space filling quartz-tourmaline-muscovite-wolframite vein material occurs in float above and to the northeast of the intrusive contact and one quartz vein containing a pocket of coarsely crystalline wolframite was observed within the pluton (sample 21, appendix A). Although these occurrences were not investigated in detail, the lack of abundant float suggests that there is not a large volume of tungsten mineralization present in the area.

Sampling Methods and Results

Samples generally consisted of channels or continuous chips, however, some samples consisted of high-graded specimens, random grabs, or chips of mineralized rock collected from rubble or outcrop, respectively. Samples were sent to a commercial laboratory for preparation and forwarded to the Bureau Reno Research Center for analyses of tin, tantalum, and columbium by X-ray fluorescence, tungsten by colorimetry, gold and silver by fire assay, and a suite of 42 elements by emission spectrographic techniques.

Sampling indicates that greisen associated with the argillite inclusion is irregularly mineralized. Several samples of quartz-muscovite greisen (54, 59, 60, and 61), however, contain between 0.2 and 0.6 pct Sn as well as up to 1 pct combined base metals and 6.0 oz/st Ag over widths ranging from 3.0 to 6.0 ft (appendix A). Analyses of samples 59 and 60, in particular, indicate a 20-ft-long by 5 ft wide mineralized zone averaging 0.41 pct Sn and 4.0 oz/st Ag. Two larger, approximately 80-lb samples of quartz-muscovite greisen (samples 48 and 57) from this area also contained head analyses of 0.40 and 0.41 pct Sn (appendix A). A channel sample (52) of an 8-ft-wide quartz-tourmaline zone also contained 3.0 pct Sn; however, a sample (51) collected on strike 20 ft away contained only 33 ppm Sn over 12.0 ft.

Near the upper contact of the pluton, tin is concentrated largely in arsenopyrite veins with lesser quantities in muscovite, quartz-muscovite, or quartz-tourmaline greisen selvages. Eight representative samples comprising only arsenopyrite vein material average 0.70 pct Sn over 0.5 ft whereas 10 samples including only greisen selvage material average approximately 0.16 pct Sn over 1.0 ft. A large, approximately 80-lb sample of muscovite greisen (no. 45) from this area, however, had a head analysis of 0.32 pct Sn. Most samples consisting of only quartz-tourmaline greisen contained less than 100 ppm Sn, although some of these samples contain elevated concentrations of tungsten. Arsenopyrite-rich samples were also generally enriched in silver and base metals.

BULK SAMPLE CHARACTERIZATION

Three bulk samples (samples 45, 48, and 57) of tin- and silver-mineralized rock were collected from mineral occurrences associated with the Ohio Creek pluton. Concentration testing of the samples was performed at the Bureau's Albany (OR) Research Center and mineralogic and petrologic examinations were performed at both Albany and the Alaska Field Operations Center in Fairbanks. Each of the samples weighed between 60 and 100 lb. Sample 45 is a random chip sample of float boulders of muscovite-rich greisen whereas samples 48 and 57 are chip samples collected from outcrops of quartz-rich greisen (appendix A).

Concentration Testing

After separation of representative hand samples, each of the bulk samples was crushed to pass 1/4 in and split for chemical analyses and physical concentration tests. Analyses of the three head samples is presented along with rock sample analyses in the appendix; tin analyses ranged from 0.32 to 0.53 pct, and silver values ranged from 0.29 to 8.3 oz/st.

A combination of gravity concentration and bulk sulfide flotation was used to treat the samples. A flowsheet of the procedure is shown in figure 6. Each sample was stage-ground in rod mills to pass 48 mesh, the size at which good liberation was achieved. Because cassiterite is a brittle mineral, efforts were made to prevent overgrinding. The size distribution of each sample is shown in table 2. The ground sample was then tabled on a slime deck of a wet shaking table to produce a rougher concentrate, coarse table tailings (those that settled and banded on the table), and slime table tailings (those that washed off the table without settling). Recovery of concentrate was emphasized over concentrate grade. The rougher table concentrate was taken immediately to bulk sulfide flotation. Rougher and scavenger steps were done at natural pH with potassium amyl xanthate as sulfide collector and a polypropylene glycol methyl ether as frother. Reagent additions and flotation conditions for each sample are shown in table 3. The rougher and scavenger flotation concentrates from each sample were combined for chemical analysis and subsequent metallurgical balances. The scavenger flotation tailings were tabled again in a cleaner step to produce the final concentrate. In the cleaner step, the concentrate grade was emphasized over concentrate recovery. Metallurgical balances for the three samples are shown in tables 4-6. The cleaner table concentrate from sample 45 contained 64 pct of the tin at a grade of 71.2 pct Sn, and the sulfide flotation concentrate (combination of the rougher and two scavenger concentrates) contained 29 pct of the silver at a grade of 24.3 oz/st. The cleaner table concentration from sample 57 contained 27 pct of the tin at a grade of 61.0 pct Sn, and the sulfide flotation concentrate contained 51 pct of the silver at a grade of 78.5 oz/st. The corresponding samples from sample 48 contained 61 pct of the tin at a grade of 39.4 pct Sn and 38 pct of the silver at a grade of 77.4 oz/st.

The tin grade recovery numbers compare favorably to those obtained in commercial operations on lode ores. Although placer concentrates may be nearly pure cassiterite (70 to 75 pct Sn), concentrates from lode ores are substantially lower in grade and may contain only 15 to 20 pct Sn. Recoveries range from 50 to as much as 65 pct in sophisticated operations, but slime losses are a major problem (10).

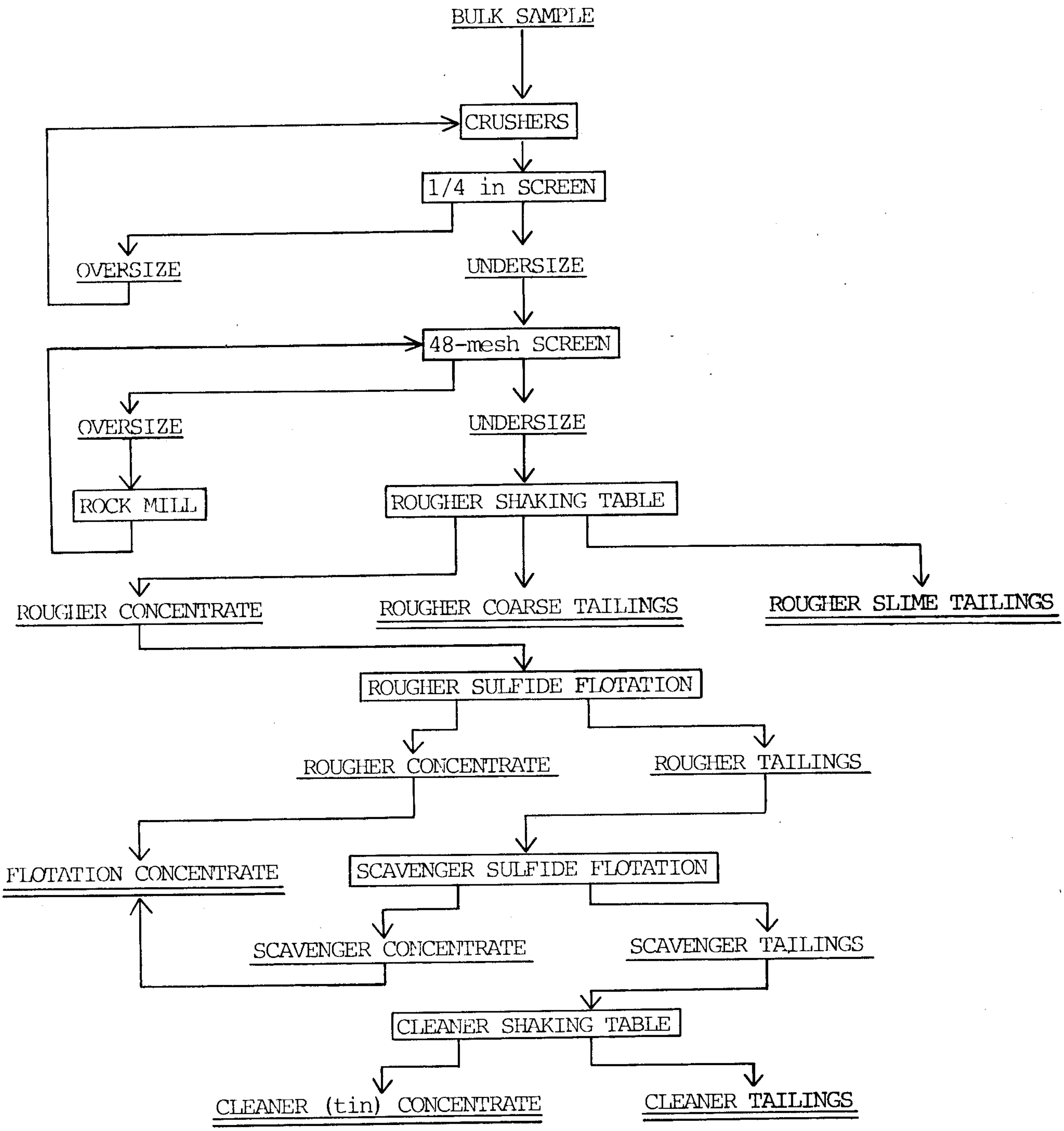

Figure 6. - Procedures used to concentrate the bulk samples

TABLE 2. - Size distribution of the rougher table feed for the three bulk samples

Sample No.	45		48		57	
Size, Mesh	Wt Pct	Cumulative Wt Pct	Wt Pct	Cumulative Wt Pct	Wt Pct	Cumulative Wt Pct
Plus 65....	36.1	36.1	27.0	27.0	27.0	27.0
65 by 100..	32.8	68.9	21.4	48.4	21.1	48.1
100 by 150.	8.7	77.6	16.0	64.4	15.5	63.6
150 by 200.	5.9	83.5	9.3	73.7	9.3	72.9
200 by 270.	3.4	86.9	5.1	78.8	5.3	78.2
270 by 400.	5.4	92.3	7.8	86.6	8.0	86.2
400 by 500.	1.6	93.9	6.0	92.6	5.9	92.1
Minus 500..	6.1	100.0	7.4	100.0	7.9	100.0

TABLE 3. Reagent additions and conditions for bulk sulfide flotation of the three bulk samples from Ohio Creek, Alaska

Sample Number	Reagent addition, lb/st feed		pH	Time, Min.
	Potassium amylxanthate	Frother		
45				
Conditioning[1/]	0.07	0.014	5.9	1
Rougher flotation.......	0	0	NM	5
Conditioning...........	0.04	0.014	5.9	1
1st scavenger flotation.	0	0	NM	5
Conditioning...........	0.04	0	6.0	1
2nd scavenger flotation.			NM	5
48				
Conditioning[2/]	0.08	0.026	4.6	1
Rougher flotation.......	0	0.013	NM	8
Conditioning...........	0.04	0.013	4.8	1
Scavenger flotation.....	0	0	NM	4.5
57				
Conditioning[3/]	0.09	0.026	5.7	1
Rougher flotation.......	0	0	NM	6.5
Conditioning...........	0.05	0.013	5.6	1.5
Scavenger flotation.....	0	0	NM	4

NM - Not measured.

1/ Natural pH = 5.9
2/ Natural pH = 4.8
3/ Natural pH = 5.7

TABLE 4. - Metallurgical balance for sample 45

Product	Wt pct	Analysis		Distribution, pct	
		Sn, pct	Ag, oz/st	Sn	Ag
Rougher table concentrate:					
Sulfide flotation concentrate 1/.	0.6	0.14	24.3	0.2	28.7
Sulfide flotation tailings:					
Cleaner table concentrate 2/...	.3	71.2	3/ NA	63.8	NAp
Cleaner table tailings......	10.3	.60	.7	18.5	14.2
Rougher table coarse tailings...	74.7	.05	.2	11.2	29.3
Rougher table slime tailings....	14.1	.15	1.0	6.3	27.8
Composite or total	100.0	.33	.5	100.0	100.0

NA - Not analyzed.
NAp - Not applicable.
1/Combination of rougher and two scavenger concentrates. Additional analyses in pct: 36.8 As, 28.1 Fe, 16.6 S, 2.91 Cu, 0.14 Zn; in oz/st: 0.002 Au, <0.0003 Pd, <0.0003 Pt.
2/Additional analyses in pct: 2.09 Fe, 0.92 W, 0.74 SiO_2, 0.36 S, 0.14 Al_2O_3,; in oz/st: 0.001 Au, <0.0003 Pd, <0.0003 Pt.
3/Ag analysis failed. Insufficient sample for repeat analysis.

TABLE 5. - Metallurgical balance for sample 57

Product	Wt pct	Analysis		Distribution, pct	
		Sn, pct	Ag, oz/st	Sn	Ag
Rougher table concentrate:					
Sulfide flotation concentrate 1/.	5.2	2.84	78.5	32.0	51.3
Sulfide flotation tailings:					
Cleaner table concentrate 2/...	.2	61.0	NA	26.5	NAp
Cleaner table tailings......	6.3	1.04	2.0	14.2	1.6
Rougher table coarse tailings...	74.5	.10	1.4	16.2	13.1
Rougher table slime tailings....	13.8	.37	19.6	11.1	34.0
Composite or total	100.0	.46	8.0	100.0	100.0

NA - Not analyzed.
NAp - Not applicable.
1/Combination of rougher and two scavenger concentrates. Additional analyses in pct: 27.0 As, 25.4 Fe, 22.9 S, 4.44 Cu, 7.87 Zn; in oz/st: 0.001 Au, <0.0003 Pd, <0.0003 Pt.
2/Additional analyses in pct: 5.36 Fe, 0.52 W, 3.38 SiO_2, 0.33 S, 0.98 Al_2O_3. Insufficient material for precious metals analysis.

TABLE 6. - Metallurgical balance for sample 48

Product	Wt pct	Analysis		Distribution, pct	
		Sn, pct	Ag, oz/st	Sn	Ag
Rougher table concentrate:					
Sulfide flotation concentrate[1/].	2.4	3.49	77.4	16.2	37.6
Sulfide flotation tailings:					
Cleaner table concentrate[2/]...	.8	39.4	11.0	60.8	1.8
Cleaner table tailings......	8.4	.37	2.2	6.0	3.7
Rougher table coarse tailings...	73.9	.07	1.5	10.0	22.5
Rougher table slime tailings....	14.5	.25	11.7	7.0	34.4
Composite or total	100.0	.52	4.9	100.0	100.0

1/Combination of rougher and two scavenger concentrates. Additional analyses in pct: 20.0 As, 25.3 Fe, 25.5 S, 4.35 Cu, 9.21 Zn; in oz/st: 0.007 Au, <0.0003 Pd, <0.0003 Pt.

2/Additional analyses in pct: 7.77 Fe, 3.15 W, 7.99 SiO_2, 0.66 S, 2.07 Al_2O_3; in oz/st: 0.003 Au, <0.0003 Pd, <0.0003 Pt.

The distribution of the tin and silver in the concentrate tailings products suggests that a more elaborate flowsheet could improve recovery of these values. Precise control of the grinding could conceivably improve liberation and still prevent excessive generation of fines.

The use of equipment more suitable to fine-particle separation than wet shaking tables could enhance recovery from the slimes. The rougher table coarse and slime tailings were not treated by sulfide flotation, and a significant amount of silver (47 to 57 pct) was lost to these fractions. The results show that the silver is strongly concentrated by sulfide flotation, and a significant amount of the silver in the tailings could probably be recovered by flotation.

Two of the samples, 57 and 48, produced sulfide flotation concentrates that contained 32 and 16 pct of the tin at grades of 2.84 pct Sn and 3.49 pct Sn, respectively, while in the third sample, 45, the sulfide flotation concentrate contained only 0.2 pct of the tin at a grade of 0.14 pct Sn. This suggests that some of the tin exists as cassiterite locked with or included in the sulfides, that it exists as floatable tin-sulfide mineral such as stannite (Cu_2FeSnS_4), or that cassiterite was mechanically entrained in the sulfide froth.

Mineralogic Characterization

Several thin sections cut from mineralized specimens and polished grain mounts prepared from bulk sample cleaner table or flotation concentrates were observed by petrologic or SEM methods in order to characterize the tin mineralization found at Ohio Creek. Cassiterite occurs in both macroscopically visible grains ranging up to 0.5 cm in width within arsenopyrite veins and in microscopic grains disseminated throughout the quartz-muscovite greisen. The disseminated cassiterite has a pale-yellow pleochroism and occurs as irregular 0.1 to 0.2 mm grains associated with blebs of arsenopyrite and sphalerite (fig. 7c) and as larger, up to 0.8 mm-long anhedral grains that fill voids rimmed by crystals of quartz or muscovite (fig. 7a and b). No tin-sulfide mineral was observed and it is likely that high tin values in sulfide flotation concentrates result from the intimate association of fine-grained cassiterite grains with sulfide minerals.

Other minerals identified by SEM in polished grain mounts include the Mn-rich wolframite end-member mineral huebnerite ($MnWO_4$), argentiferous galena, and the silver mineral argentite (Ag_2S). The argentite was observed to be intergrown with chalcopyrite.

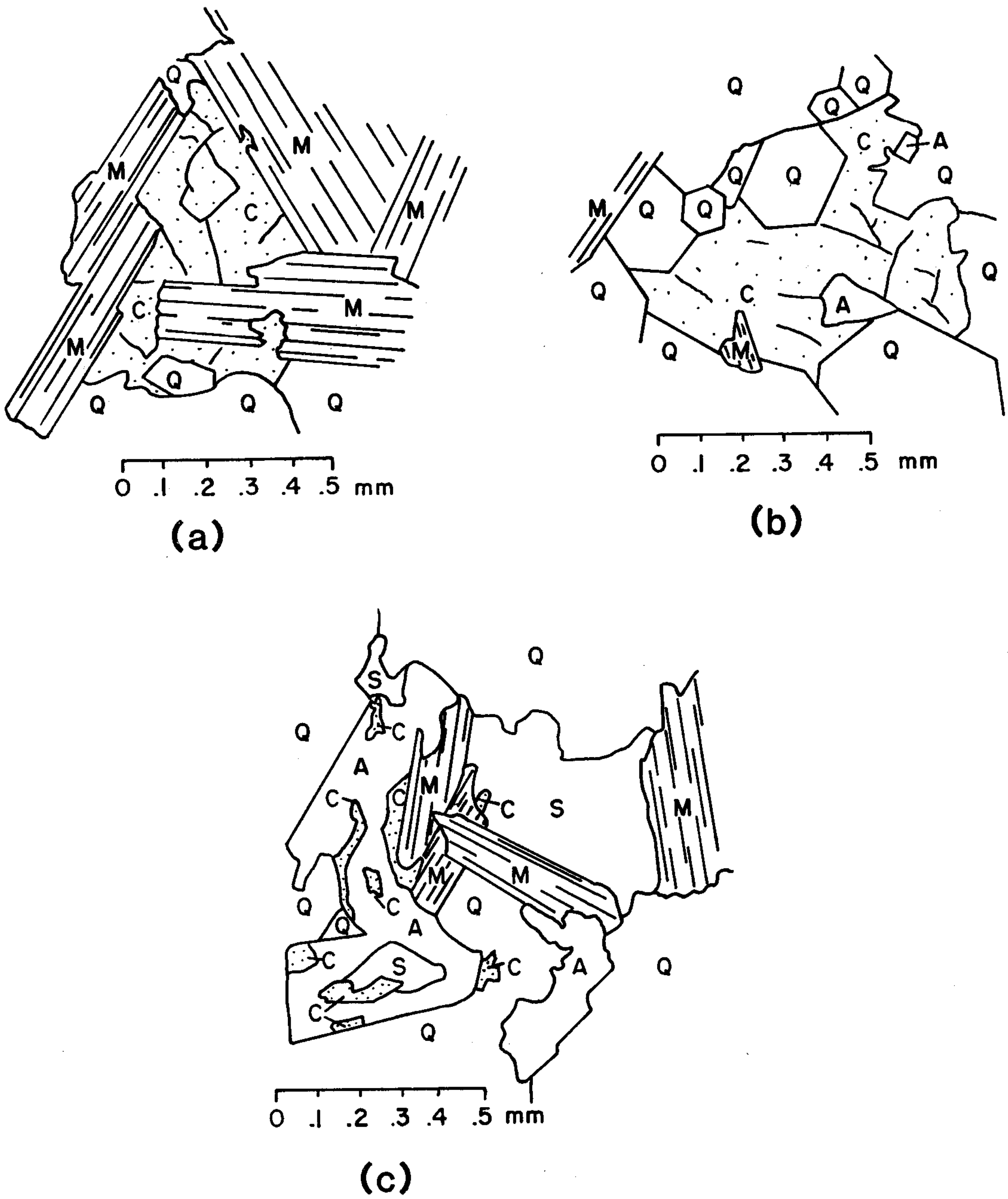

Figure 7. - Sketches from thin sections showing modes of cassiterite (C) occurrence: (a) and (b) open space filling between grains of muscovite (M), quartz (Q), and arsenopyrite (A): (c) partial replacement and associated with grains of arsenopyrite and sphalerite (S).

TIN RESOURCES

Sampling indicates that locally high concentrations of tin are associated with the Ohio Creek pluton but that most of the better values are restricted to relatively narrow vein zones averaging approximately 0.34 pct Sn over 1.5 ft. These veins are present over a lateral distance of approximately 1,000 ft and are most abundant near the roof of the pluton, shown in figure 4, where 6 veins occur over a true width of 50 ft. Assuming a pod-like mineralized zone 1,000 ft long and up to 50 ft wide that extends for 500 ft depth and averages 0.06 pct Sn ([6 x 1.5 ft/50 ft] x .34 pct Sn) and an estimated tonnage factor of 12 ft^3/st, approximately 1,000,000 st of mineralized rock containing 1,250,000 lb Sn can be inferred. This zone includes several smaller moderately to steeply dipping zones of relatively higher grade material averaging approximately 0.17 pct Sn over a mining width of 3.0 ft and also contains silver and base-metal resources.

DISCUSSION

The Ohio Creek pluton is one of several identified tin occurrences in the Upper Chulitna subdistrict. Other occurrences include prospects at Canyon Creek, Long Creek, and Coal Creek. Location and brief description of the prospects are given by Hawley (2, 4, and 5). Although differing in geologic detail, the occurrences show many similarities. Each occurrence is associated with early Tertiary-age biotite or muscovite granite or felsic dikes and plugs. Each occurrence has an associated restricted hornfelsed aureole that in most cases forms a resistant knoll surrounding the occurrence. Each of the occurrences is also characterized by arsenopyrite-rich veins containing elevated base-metal and silver as well as tin concentrations. The similarities imply that the occurrences represent similar mineralizing systems exposed at different erosional levels. The Ohio Creek pluton likely represents the most deeply eroded of the occurrences. At Ohio Creek, the pluton's upper (cupola) portion, which in most greisen systems contains the richest concentrations of tin, has likely been removed by erosion.

CONCLUSIONS

Tin-bearing quartz-tourmaline and quartz-muscovite greisen and arsenopyrite-rich veins are associated with the Ohio Creek pluton, a composite intrusion of probably early Tertiary age. Tin mineralization is associated with a leucocratic, peraluminous, muscovite granite that forms an outer zone of the pluton. The leucocratic granite is separated from biotite granite in the core of the intrusion by a zone containing several hornfelsed argillite inclusions, however, the actual contact relationship is not known.

Greisen that has developed adjacent to, and within dikes cutting an argillite inclusion in the northwestern portion of the pluton contains irregularly distributed tin mineralization. A channel sample of quartz-tourmaline greisen contained as much as 3.0 pct Sn, however, a channel sample of the same material collected 20 ft away contained only 33 ppm Sn. Samples of the quartz-muscovite greisen also show a wide range of tin values. Several of the samples and two larger bulk samples contained between 0.2 and 0.6 pct Sn. Trace to major concentrations of silver and base metal minerals are also locally present.

Thin and polished section studies indicate that tin occurs as cassiterite in small, 0.1-0.2 mm grains associated with sulfide minerals, as larger, up to 0.8 mm grains that fill open spaces rimmed by quartz or muscovite crystals, and as up to 0.5 cm grains in arsenopyrite veins. Silver occurs in argentiferous galena and argentite, which is intergrown with chalcopyrite.

Concentration testing of three 60-100 lb samples of tin-mineralized rock produced cleaner table concentrates containing 27 to 64 pct of the contained tin at grades ranging from 39.4 pct to 71.2 pct Sn. The tin grade and recovery numbers compare favorably to those obtained in commercial operations on lode ores.

Cassiterite-bearing arsenopyrite-rich veins in the upper portions of the pluton contain an average of 0.70 pct Sn over 0.5 ft width (8 samples). Muscovite and quart-muscovite greisen selvages to the veins, generally best developed in the footwall, also contain elevated tin concentrations, averaging 0.16 pct over 1.0 ft width. Samples of quartz-tourmaline greisen collected in this area generally contain only traces of tin. In the upper portions of the pluton a pod-like, approximately 1,000-ft-long, 50-ft-wide zone containing numerous greisen-bordered arsenopyrite veins is inferred to contain approximately 1,250,000 lb Sn resources at an average grade of 0.06 pct Sn. Higher grade, lower tonnage tin-mineralized zones are contained within the larger zone and resources of silver and base metals are also present.

The Ohio Creek pluton is one of several tin occurrences in the upper Chulitna subdistrict. These occurrences likely represent similar mineralizing systems exposed at different erosional levels. The Ohio Creek pluton is the most deeply eroded of the systems and probably has had its richest tin mineralization removed. Given the variable pluton levels exposed in the area, however, there is a high probability for significant tin resources elsewhere in the area (i.e. Coal Creek).

REFERENCES

1. Ransome, A. L. and W. H. Kerns. Names and Definitions of Regions, Districts, and Subdistricts in Alaska. BuMines IC 7679, 1954, 99 pp.

2. Hawley, C. C. and A. L. Clark. Geology and Mineral Deposits of the Upper Chulitna District, Alaska. U.S. Geol. Surv. Prof. Paper 758-B, 1974, 47 pp.

3. Warner, J. Dean. Critical and Strategic Minerals in Alaska: Tin, Tantalum, and Columbium. BuMines IC 9037, 1985, 19 pp.

4. Hawley, C. C. and A. L. Clark. Geology and Mineral Deposits of the Chulitna-Yentna Mineral Belt, Alaska. U.S. Geol. Surv. Prof. Paper 758-A, 1973, 10 pp.

5. C. C. Hawley and Associates, Inc. Mineral Appraisals of Lands Adjacent to Mt. McKinley National Park, Alaska. Prepared for BuMines, AFOC, under contact J0166107. BuMines OFR 24-78, 1978, 274 pp.

6. Hawley, C. C., A. L. Clark, M. A. Hendrick, and Sandra H. B. Clark. Results of Geological and Geochemical Investigations in an Area Northwest of the Chulitna River, Central Alaska Range. U.S. Geol. Surv. Circ. 617, 1969, 19 pp.

7. Reed, B. L. and M. A. Lanphere. Alaska-Aleutian Range Batholith: Geochronology, Chemistry, and Relation to Circum-Pacific Plutonism. Geol. Soc. Am. Bull., v. 84, 1973, pp. 2583-2610.

8. Nockolds, S. R. Average Chemical Compositions of some Igneous Rocks. Geol. Soc. Am. Bull., v. 65, 1954, pp. 91-108.

9. Hudson, T. and J. G. Arth. Tin Granites of Seward Peninsula, Alaska; G.S.A. Bull., vol 94, pp. 768-790.

10. Aplan, F. F. Tin Sec. in SME Mineral Processing Handbook, ed. by N. L. Weiss. Soc. Min. Eng. AIME, 1985, pp. 27-10 to 27-14.

APPENDIX A - Results of sample analyses1/

Sample	Type	Width, ft	Sn, pct	W, ppm	Cb, ppm	Au, oz/st	Ag, oz/st	Cu, pct	Pb, pct	Zn, pct	Descriptions
1.....	C...	1.5	0.231	360	70	LD	0.3	0.01	LD	.02	Arsenopyrite-rich vein bordered by muscovite-quartz greisen.
2.....	CR..	0.7	0.063	2/	LD	0.004	0.43	0.1	LD	.003	Arsenopyrite-rich vein.
3.....	CR..	0.5	0.010	16	LD	LD	0.18	0.01	LD	.004	Quartz-muscovite greisen in footwall of sample 2.
4.....	CR..	1.3	0.63	2/	LD	LD	0.64	0.1	LD	.05	Arsenopyrite vein bordered by muscovite greisen, minor tourmaline present.
5.....	CR..	0.7	0.045	2/	LD	LD	0.21	0.02	LD	.05	Quartz-arsenopyrite vein bordered by quartz-muscovite-tourmaline greisen.
6.....	C...	0.5	0.039	200	LD	LD	0.34	0.001	.01	.09	Massive tourmaline vein with minor scorodite.
7.....	C...	1.3	0.138	2/	LD	0.006	2.7	0.2	LD	.008	Arsenopyrite-quartz vein and arsenopyrite-bearing quartz-muscovite-tourmaline greisen. Arsenopyrite content variable, sample represents more arsenopyrite-rich portion.
8.....	C...	1.0	0.039	36	LD	LD	0.27	0.004	LD	.02	Vein with quartz core and tourmaline margin, minor chalcopyrite.
9.....	C...	2.5	0.203	240	50	LD	0.90	0.04	LD	.01	Arsenopyrite-bearing vein and alteration zone, very weathered.
10....	CR..	NA	0.027	14	70	LD	0.18	0.005	LD	.02	Pink weathered granite with disseminated arsenopyrite. Sulfides mostly oxidized. Minor muscovite.
11....	C...	5.0	20ppm	400	70	LD	0.14	0.001	LD	.1	Massive tourmaline (hanging wall) and tourmaline-quartz vein cut by quartz veins.
12....	H...	NA	10ppm	1,400	LD	LD	0.12	LD	LD	.01	Quartz-muscovite-tourmaline-wolframite vein material from float.
13....	G...	NA	0.97	300	LD	LD	6.7	0.1	3.0	.07	Near-massive arsenopyrite-pyrite-chalcopyrite-quartz vein and arsenopyrite-cemented quartz vein breccia. Sample of float.
14....	Ch..	0.8	0.91	2/	LD	LD	8.7	0.04	.2	.04	Arsenopyrite vein. Vein traceable for 20 ft.

See footnotes at end of Appendix A.

APPENDIX A - Results of sample analyses 1/ - Continued

Sample	Type	Width, ft	Sn, pct	W, ppm	Cb, ppm	Au, oz/st	Ag, oz/st	Cu, pct	Pb, pct	Zn, pct	Descriptions
15....	C...	1.5	0.215	80	LD	LD	0.09	0.006	LD	.08	Muscovite-quartz greisen with trace arsenopyrite in hanging wall of sample 14.
16....	C...	1.5	LD	LD	LD	LD	0.05	0.004	LD	.009	Quartz vein with up to 1 pct arsenopyrite.
3/ 17....	CR..	1.5	0.049	8	60	LD	0.23	0.02	LD	.05	Muscovite greisen in hanging wall of sample 16. Trace arsenopyrite.
18....	CR..	0.7	25ppm	100	LD	LD	0.30	0.001	LD	.06	Composite of two quartz-tourmaline veins, each 0.7-ft-wide.
19....	C...	1.2	0.059	60	LD	0.007	1.7	0.02	LD	.09	Vein zone with two 0.3-ft-wide quartz±arsenopyrite veins with muscovite greisen between.
20....	C...	0.4	1.11	2/	LD	LD	0.51	LD	LD	.05	Arsenopyrite-rich, footwall portion of 1.5-ft-wide quartz vein.
21....	H...	NA	0.071	47pct	800	LD	0.46	0.04	.03	.02	Wolframite pocket in 0.8-ft-wide quartz vein, contains 800 ppm Ta.
3/ 22....	CR..	NA	LD	8	LD	LD	LD	LD	LD	.007	Biotite (muscovite) granite with trace tourmaline. Moderately coarse grained.
3/ 23....	CR..	NA	N	N	N	N	N	N	N	N	Coarsely crystalline biotite-muscovite granite.
24....	CR..	NA	92ppm	12	LD	LD	LD	LD	LD	.05	Quartz-tourmaline-feldspar pegmatite pod.
3/ 25....	CR..	NA	N	N	N	N	N	N	N	N	Fluorite-rich muscovite granite.
26....	CR..	NA	56ppm	LD	LD	LD	0.41	0.001	LD	.02	Muscovite granite. Medium grained. Slightly smoky quartz, trace fluorite, locally up to 5 pct tourmaline in outcrop.
27....	CR..	NA	7ppm	70	80	LD	0.04	LD	LD	.01	Leucocratic granite with minor fine muscovite, 1 pct disseminated tourmaline, and trace arsenopyrite. Medium grained.
28....	G...	NA	0.58	360	80	LD	0.24	0.009	LD	.1	Massive quartz-tourmaline vein material with trace arsenopyrite in rubble.
29....	C...	0.4	0.72	2/	LD	LD	0.48	0.3	LD	.01	Quartz-arsenopyrite vein.
30....	CR..	10.0	15ppm	240	LD	LD	0.05	0.006	LD	.2	Tourmaline-quartz-muscovite pegmatite pod. Tourmaline is coarsest where muscovite is absent.
31....	C...	0.6	2.13	2/	LD	0.001	0.53	0.08	LD	.009	Arsenopyrite-chalcopyrite-cassiterite vein bordered by muscovite greisen (border not included).

See footnotes at end of Appendix A.

APPENDIX A - Results of sample analyses[1] - Continued

Sample	Type	Width, ft	Sn, pct	W, ppm	Cb, ppm	Au, oz/st	Ag, oz/st	Cu, pct	Pb, pct	Zn, pct	Descriptions
32....	H...	NA	1.98	2/	LD	0.006	4.3	0.2	LD	.02	High grade of sample 31 with several brown 1-2 mm cassiterite grains.
33....	C...	NA	0.01	8	60	LD	0.08	0.04	LD	.04	Pervasively weathered hematite-stained clayey granite.
34....	CR..	0.2	0.30	2/	150	LD	4.2	0.03	LD	.02	Muscovite greisen with 2 pct arsenopyrite and trace chalcopyrite.
35....	Ch..	2.5	0.26	2/	LD	LD	2.6	0.2	LD	.08	Greisen zone including 1.5-ft-wide and 0.1-ft-wide quartz-arsenopyrite veins and muscovite and tourmaline-quartz greisen zones.
36....	Ch..	0.4	0.158	12	90	LD	0.38	0.008	LD	.02	Footwall to sample 35. Siliceous muscovite greisen with 0.5 pct disseminated arsenopyrite and trace chalcopyrite.
37....	Ch..	0.3	10ppm	10	100	LD	0.03	0.002	LD	.07	Quartz-tourmaline vein. Has hanging wall of arsenopyrite and muscovite greisen (not sampled).
38....	C...	0.8	0.36	8	LD	LD	0.11	0.02	LD	.02	Footwall to sample 37. Siliceous greisen with minor muscovite, 1 pct disseminated arsenopyrite and trace chalcopyrite.
39....	C...	0.4	0.191	2/	LD	LD	0.35	0.03	LD	.2	Quartz-tourmaline-arsenopyrite vein. Hanging wall of sample 40. Similar vein (not sampled) occurs below sample 40.
40....	C...	2.0	30ppm	10	70	LD	0.32	0.06	LD	.1	5-ft-long "pod" of muscovite greisen with trace disseminated arsenopyrite. Footwall and hanging wall are quartz-tourmaline-arsenopyrite veins.
41....	C...	0.6	0.86	≥120	130	LD	10.2	0.1	LD	.1	Greisen zone. Lower 0.33-ft-wide zone with quartz-tourmaline-limonite-malachite. Upper zone in muscovite greisen.
42....	CR..	NA	.017	12	50	LD	0.15	0.002	LD	.001	Leucocratic muscovite granite with disseminated arsenopyrite.
43....	C...	0.1	.112	2/	LD	0.004	1.2	0.1	LD	.01	Arsenopyrite-quartz vein with trace cassiterite. Footwall is muscovite greisen, hanging wall is fault.

See footnotes at end of Appendix A.

APPENDIX A - Results of sample analyses[1] - Continued

Sample	Type	Width, ft	Sn, pct	W, ppm	Cb, ppm	Au, oz/st	Ag, oz/st	Cu, pct	Pb, pct	Zn, pct	Descriptions
44....	G...	NA	0.141	[2]	50	LD	0.58	0.04	LD	.04	Quartz-muscovite greisen with minor arsenopyrite. Very abundant in float.
45....[4]	C...	2.0	.32	LD	LD	LD	0.29	0.043	N	.037	Float boulder of muscovite-quartz-arsenopyrite greisen.
46....	CR..	NA	.036	6	50	LD	0.23	.0006	LD	.08	Muscovite granite with disseminated arsenopyrite.
47....[3]	CR..	NA	30ppm	28	50	LD	0.06	LD	LD	.002	Leucocratic granite with smoky quartz and a dusting of green-tinted mica. Trace disseminated arsenopyrite and local clots of tourmaline.
48....[4]	CR..	NA	.40	500	LD	LD	5.0	0.17	N	.31	Quartz greisen with disseminated arsenopyrite, chalcopyrite, and sphalerite.
49....	C...	10.0	18ppm	LD	LD	.0003	8.2	0.006	LD	.2	Massive coarse tourmaline-quartz with local muscovite and chalcopyrite.
50....	CR..	3.0	0.021	200	LD	LD	0.59	0.1	0.04	.03	Adjacent to sample 49. Quartz-muscovite greisen with minor arsenopyrite and chalcopyrite.
51....	C...	12.0	33ppm	LD	LD	LD	0.07	LD	LD	0.2	Massive tourmaline-quartz. Two stages of tourmaline: early finer and later coarse.
52....	C...	8.0	3.0	1400	50	LD	12.9	LD	LD	0.2	Massive tourmaline-quartz. Two stages of tourmaline: early finer and later coarse.
53....	C...	2.0	0.214	60	LD	LD	LD	0.005	LD	0.1	Massive tourmaline-quartz-(muscovite) greisen between sample 54 and hornfels.
54....	C...	3.0	0.30	[2]	LD	LD	0.03	0.4	LD	0.1	Quartz-arsenopyrite-muscovite greisen zone.
55....	C...	2.0	71ppm	[2]	LD	LD	0.06	0.001	LD	.009	Muscovite and quartz-muscovite greisen with minor arsenopyrite and tourmaline developed in dike cutting hornfels.
56....	C...	1.5	.042	[2]	LD	LD	0.23	0.1	0.04	0.5	Quartz and quartz-muscovite greisen. More siliceous greisen with minor disseminated arsenopyrite and chalcopyrite adjacent to hornfels.
57....[4]	C...	1.5	.41	LD	N	LD	8.3	0.4	N	.64	Quartz-muscovite greisen, with disseminated arsenopyrite, chalcopyrite, and sphalerite.

See footnotes at end of Appendix A.

APPENDIX A - Results of sample analyses1/ - Continued

Sample	Type	Width, ft	Sn, pct	W, ppm	Cb, ppm	Au, oz/st	Ag, oz/st	Cu, pct	Pb, pct	Zn, pct	Descriptions
58....	CR..	6.0	0.253	60	LD	LD	0.12	0.02	LD	0.2	Hanging wall of altered argillite. Consists of 50 pct quartz-muscovite greisen and 40 pct hornfels.
59....	CR..	4.0	0.242	2/	LD	LD	6.0	0.006	LD	0.2	Quartz-muscovite and tourmaline greisen zone.
60....	C...	6.0	0.58	1200	LD	LD	2.0	0.05	0.003	0.2	Quartz-muscovite greisen with minor arsenopyrite and trace chalcopyrite.
61....	CR..	10.0	0.214	2/	LD	LD	1.2	0.004	LD	0.02	Variably greisenized granite. Ranges from near massive arsenopyrite to arsenopyrite-rich granite.
62....	CR..	2.0	6ppm	6	100	LD	0.25	.0007	LD	0.02	Muscovite-rich granite (greisen?).
63....	CR..	2.0	45ppm	2/	LD	LD	0.19	0.1	LD	0.03	Quartz-tourmaline vein.
64....	H...	NA	43ppm	2/	LD	.031	3.8	0.02	LD	LD	Pod of arsenopyrite in sample 63.
3/ 65....	CR..	NA	7 ppm	16	70	LD	0.4	LD	LD	LD	Leucocratic granite with minor muscovite. Medium grained. Local pods of tourmaline.
66....	Ch..	0.4	0.01	2/	LD	LD	8.4	0.02	LD	.005	Quartz-arsenopyrite vein with a few 1- to 3-mm-wide cassiterite (?) crystals.
67....	CR..	0.2	0.074	N	LD	0.02	3.3	0.2	0.3	0.09	Quartz-arsenopyrite vein.
68....	G...	NA	7ppm	6	LD	0.002	0.01	LD	LD	0.1	Quartz-tourmaline-muscovite-arsenopyrite pod developed on granite-hornfels contact.

C - Continous chip sample; CR - Random chip sample; NA - Not applicable; Ch - Channel sample; H - High grade sample; N - Not analyzed; G - Grab sample; LD - Less than detection limit.

1/Analytical methods: Sn, Cb, Ta, X-ray fluorecence (Ta detected in sample 21 only), W-colorimetry or x-ray fluorecence, Au, Ag-fire assay/inductively coupled plasma analyses, Cu, Pb, Zn-emission spectrography.

2/Interference due to arsenic.

3/Sample analyzed for major oxides, see table in text.

4/Bulk sample weighing 60-100 lb. See characterization section of text for results of metallurgical testing. Additional analyses, sample 45: .37 pct As, .59 pct F, <.0002 oz/t Au; sample 48: .32 pct As, .45 pct F, <.0002 oz/t Au; sample 57: .48 pct As, .68 pct F, <.0002 oz/t Au.

APPENDIX B- Sample map numbers vs. field number cross-reference

Sample	Field number	Sample	Field number	Sample	Field number	Sample	Field number
1	AS24049	18	AS24015	35	AS24035	52	AS24043
2	AS24050	19	AS24010	36	AS24036	53	AS24042
3	AS24051	20	AS24009	37	AS24037	54	AS24041
4	AS24052	21	AS24000	38	AS24038	55	AS24040
5	AS24053	22	AS23978	39	AS24034	56	AS24039
6	AS24054	23	AS20792	40	AS24033	57	AS24174
7	AS24055	24	AS20791	41	AS24011	58	AS24171
8	AS24056	25	AS20565	42	AS24017	59	AS24047
9	AS24057	26	AS20789	43	AS24032	60	AS24173
10	AS24191	27	AS24005	44	AS24031	61	AS24172
11	AS24001	28	AS24004	45	AS24030	62	AS23972
12	AS24002	29	AS24006	46	AS24016	63	AS23973
13	AS23981	30	AS24007	47	AS24014	64	AS23974
14	AS23982	31	AS24018	48	AS24192	65	AS23976
15	AS23983	32	AS24012	49	AS24046	66	AS23975
16	AS23979	33	AS24019	50	AS24045	67	AS20800
17	AS23980	34	AS24013	51	AS24044	68	AS23977