DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Gold occurrences near Snowcap Mountain, Lime Hills B-2 quadrangle, Alaska

by

Bruce M. Gamble, Elizabeth A. Bailey, and Bruce. L. Reed[1]

Open-File Report 89-646

[1]Anchorage, Alaska

1989

DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Gold occurrences near Snowcap Mountain, Lime Hills B-2 quadrangle, Alaska

by

Bruce M. Gamble, Elizabeth A. Bailey, and Bruce. L. Reed[1]

Open-File Report 89-646

[1]Anchorage, Alaska

1989

Introduction

Sulfide-bearing float samples collected in 1987 in the Lime Hills B-2 (1:63,360) quadrangle have high contents of several metals, most notably gold, silver, arsenic, copper, and bismuth. In 1988, two mineral occurrences, informally referred to as the Nunatak and Breccia occurrences (figure 1) were briefly examined. The Nunatak occurrence is a likely source for the float collected in 1987. Chip samples of veins at the Nunatak occurrence contain up to 1.5 ppm gold, 150 ppm silver, and >2,000 ppm each of cobalt and arsenic. Sulfide-bearing float from this area contains up to 12 ppm gold and 700 ppm silver. Chip and grab samples from sulfide-bearing quartz-tourmaline veins at the Breccia occurrence contain up to 4.1 ppm gold. A composite of selected sulfide-rich samples from these veins contains 21 ppm gold. The purpose of this report is to present brief descriptions of these two mineral occurrences and to summarize the results of geochemical samples collected.

Field and Analytical Methods

Samples collected for geochemical analyses consist of composite chip samples, grab samples, and float samples. Float samples ranged between 5 and 15 cm in maximum dimension. Samples were also collected for thin and polished sections, and for hand sample (lithologic) specimens. Geochemical samples were crushed, split, pulverized with ceramic plates to minus 150 mesh, and analyzed by the semi-quantitative six-step direct-current emission spectrographic method of Grimes and Marranzino (1968) and Motooka and Grimes (1976). Gold, arsenic, bismuth, antimony, cadmium, and zinc were analyzed by atomic absorption (O'Leary and Viets, 1986; O'Leary and Meier, 1986). Hand samples collected from veins with high gold contents were submitted for additional gold determinations. These results are shown in table 2 as AA-Au*. In general, there is good agreement with the original results. Only those elements considered to be of economic or geochemical interest are given in table 2.

The lower limits of determination for the elements listed in table 1 are given below. Analyses are reported in parts-per-million (ppm) except for Fe, which is reported in weight percent. Analyses were performed in U.S.G.S. laboratories in Denver, Colorado and Anchorage, Alaska. Analysts were E. A. Bailey, L. A. Bradley, F. W. Brown, Z. A. Brown, M. J. Malcom, and R. M. O'Leary.

Element	Lower Determination Limit	Element	Lower Determination Limit
Ag	.5 ppm	Fe	.05 percent
As (AA)	10 ppm	Mo	5 ppm
Au (AA)	.05 ppm	Mn	10 ppm
B	10 ppm	Ni	5 ppm
Bi (AA)	1 ppm	Pb	10 ppm
Cd (AA)	.1 ppm	Sb (AA)	2 ppm
Co	10 ppm	Sn	10 ppm
Cu	5 ppm	Zn (AA)	5 ppm

Mineral species were identified by examination of hand samples, thin and polished sections, and by X-ray diffraction. Brief sample descriptions are given in table 2.

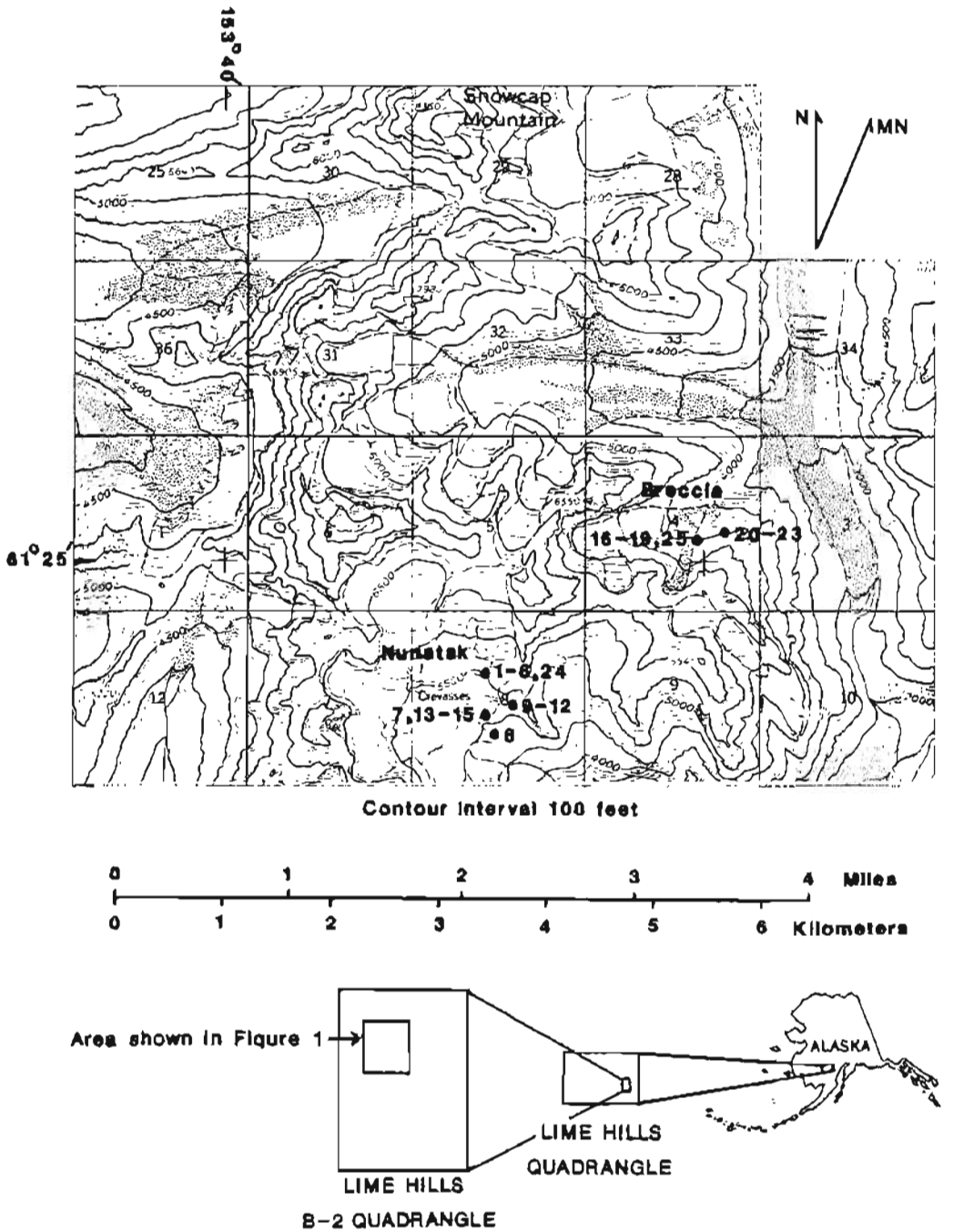

Figure 1. Sample locality map, Nunatak and Breccia mineralized areas, Lime Hills B-2 quadrangle, Alaska

Mineralization

Nunatak

Three types of veins are sporadically exposed over a distance of at least 600 m in the Nunatak area south of Snowcap Mountain (figure 1). The veins are apparently sparse, and consist of barren quartz veins, quartz-amphibole veins, and sulfide-bearing veins. They are localized along east-west trending sub-vertical fractures in a biotite-hornblende monzodiorite to quartz monzodiorite pluton. The quartz veins are apparently barren and are less than 5 cm wide. Quartz-amphibole veins (sample 1, table 1 and table 2) range from 2 mm to 15 cm wide. The amphibole (tremolite-actinolite) is medium brown and has colorless to pale brown pleochroism in thin section. The quartz-amphibole veins do not have high metal contents, although sample 1 contains 440 ppm arsenic. Sulfide-bearing veins contain variable amounts of metallic minerals, chiefly arsenopyrite, chalcopyrite, and magnetite. Gangue minerals consist chiefly of chlorite, amphibole, epidote, and plagioclase. Only the sulfide-bearing veins are discussed in the remainder of this section.

Two sulfide-bearing veins (samples 2-6) are exposed at an elevation of 1680 m (5500 feet) along the base of a nunatak in the SE 1/4, NW 1/4, sec. 8, T15N, R24W (fig. 1). The northern vein (samples 2-4) is 20 to 35 cm wide and is exposed for at least 20 m in both horizontal and vertical directions. Due to the steepness of the cliff face, only a small part of this vein was sampled. Where observed, the vein contains 5 to 35 volume percent of arsenopyrite, chalcopyrite, and magnetite. Minor galena, pyrite, and sphalerite are also present. Erythrite (cobalt bloom) is locally present. Chip samples (samples 2-3) from this vein contain 0.5 to 1.5 ppm gold, 10 to 150 ppm silver, 300 to >20,000 ppm copper, and >2,000 ppm each arsenic and cobalt. Gangue minerals, in approximate decreasing order of abundance, are chlorite, amphibole, plagioclase, epidote, apatite, clinopyroxene, and quartz. Apatite is locally abundant, and samples 2 and 3 contain 0.7 and 1.0 percent phosphorus respectively.

A second vein (samples 5-6), exposed about 15 m to the south, has a maximum width of 50-60 cm and is exposed over a vertical distance of about 3 m. The upper part of this vein is truncated by a fault. The lower part is covered by talus. The vein contains 10 to 70 percent chalcopyrite and magnetite. Minor amounts of arsenopyrite and galena are also present. A composite chip sample (sample 5) of this vein contains 0.3 to 1.3 ppm gold (two determinations), 150 ppm silver, >20,000 ppm copper, and >2,000 ppm each arsenic and cobalt.

Two 10-15 cm wide veins, exposed approximately 400 meters (sample 7) and 600 meters (sample 8) south of the nunatak, contain less than 3 percent metallic minerals. One vein (sample 7) contains 50 ppm silver, and 5,000 ppm copper. The second vein (sample 8) contains 0.1 to 0.3 ppm gold (two determinations). Gangue mineralogy of these veins appears similar to the gangue in the veins exposed in the nunatak.

Sulfide-rich float (samples 9-15) in the area of samples 7 and 8 contains up to 80 volume percent of arsenopyrite, chalcopyrite, pyrrhotite, magnetite, and pyrite. Minor amounts of molybdenite, covellite, and malachite are also present. These samples contain up to 12 ppm gold, 700 ppm silver, 640 ppm bismuth, >20,000 ppm copper, and >2,000 ppm each arsenic and cobalt. The gangue in these float samples also appears similar to the gangue in the vein samples from this area.

Other than erythrite, a hydrous cobalt arsenate of secondary origin, specific cobalt or nickel minerals were not identified in either polished section or by X-ray diffraction. A sample of arsenopyrite(?) (sample 12x) from sample 12 contains >20,000 ppm arsenic, >5,000 ppm cobalt, and >10,000 ppm nickel, but only 7 percent iron, suggesting that this mineral may be glaucodot or alloclasite (nickel-bearing iron-cobalt-sulfarsenides). Both glaucodot and alloclasite exhibit X-ray patterns similar to arsenopyrite (Petruk and others, 1971).

A sample of pyrrhotite (sample 13x) from sample 13 has low arsenic, cobalt, and nickel contents. The high copper, silver, and relatively high tin contents of this sample are due to chalcopyrite and other impurities in the sample.

Erythrite-rich material (sample 2x) scraped from sample 2 has high concentrations of several metals. The high gold content (150 ppm) suggests that native gold may be present.

The gangue mineralogy of the Nunatak samples - particularly the pyroxene, amphibole, apatite and plagioclase - suggests that the veins may, in part, be mineralized mafic dikes.

Breccia

The Breccia occurrence (samples 16-19, 25) is located in a vertical north-facing cliff face of monzogranite in the NW 1/4, SE 1/4, sec. 4, T15N, R24W (fig. 1). An area of iron-stained tourmaline-rich breccia, 20 to 25 m wide and at least 15 m high, is present in the intrusive. The shape of the breccia is not known. The breccia is matrix-supported and consists of approximately 60 percent light-colored angular rock fragments in a black fine-grained tourmaline-rich matrix. Fragments of altered monzogranite and minor vein quartz range from a few cm to about 1 m and average about 5 cm in maximum dimension. The matrix consists chiefly of black tourmaline with lesser amounts of quartz, sericite, calcite, and chlorite.

Discontinuous quartz-tourmaline-sulfide veins cut the breccia. The veins are localized along vertical fractures that strike approximately north-south. The veins are difficult to discern but are usually more intensely iron-stained than the surrounding breccia. The veins examined are 5 to 20 cm wide. Some are limited to 1 to 3 m in vertical dimension. They contain up to 20% arsenopyrite, 10% chalcopyrite, 5% pyrrhotite, 1% pyrite, and minor amounts of sphalerite, and galena. Gangue minerals consist chiefly of quartz, tourmaline, chlorite, and epidote. Trace amounts of galena and arsenopyrite are locally present in the matrix of the breccia.

A composite of grab samples from 5 veins in the breccia (sample 16) contains 1 to 4.1 ppm gold (two determinations), 7 ppm silver, and >2,000 ppm arsenic. Selected sulfide-rich material (sample 17) from these same veins contains 18 to 21 ppm gold (two determinations), 150 ppm silver, >2,000 ppm arsenic, 10,000 ppm copper, and >1,000 ppm bismuth. A chip sample (sample 18) across a 20-cm-wide vein contains .05 to .45 ppm gold (two determinations), 70 ppm silver, and comparatively high contents of copper, lead, and zinc. A grab sample of breccia (sample 19) contains .15 ppm gold and 1900 ppm arsenic.

A second, 20-m-wide, iron-stained breccia is exposed approximately 250 m to the east (samples 19-23). Veins were not observed at this location. Minor amounts of disseminated arsenopyrite, pyrite, and galena occur locally within the matrix of the breccia. Malachite is locally present. Gold was not detected in the breccia (sample 23).

Most intervening ground between these two breccia zones is covered by talus. However, three small exposures crop out above the talus; two are unaltered monzogranite and the third is brecciated, but unmineralized, monzogranite.

The monzogranite breccia and veins may be related to the monzodiorite, which is thought to intrude the monzogranite, or to a light colored intrusive that crops out along the valley walls at the west end of the glacier in section 4. Owing to difficult access, the light colored intrusive was not examined. Intrusive rocks that form the near-vertical walls at the head of the glacier are locally copper-stained, and appear to be intruded by the light-colored intrusive. The relatively uniform tin content of 100-300 ppm for the breccia samples, as well as for the float samples at the Nunatak occurrence, suggest that the mineralization in this area could also be related to felsic magmatism.

References

Grimes, D.J., and Maranzino, 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.

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

Petruk, W., Harris, D.C., and Stewart, J.M., 1971, Characteristics of the arsenides, sulpharsenides, and antimonides in Berry, L.G., ed, The silver-arsenide deposits of the Cobalt-Gowgands region, Ontario: The Canadian Mineralogist, v. 11, n. 1, p. 150-186.

O'Leary, J.M., and Meier, 1986, Analytical methods used in geochemical exploration, 1984: U.S. Geological Survey Circular 948, p. 23-25.

O'Leary, R.M., and Viets, J.G., 1986, Determination of antimony, arsenic, bismuth, cadmium, copper, lead, molybdenum, silver, and zinc in geologic materials by atomic absorption spectrometry using a hydrochloric acid-hydrogen peroxide digestion: Atomic Spectroscopy, v. 7, no. 1, p. 4-14.

Table 1. Geochemical analyses of rock samples.

[S = semiquantative spectrographic analysis; A = atomic absorption analysis; * = second analysis; N = not detected at value shown; H = interference; < = detected, but below the lower limit of determination shown; > = greater than the value shown; - = not analyzed. All values in ppm unless otherwise noted. Latitude and longitude are in degrees-minutes-seconds;

Map No.	Sample	Latitude	Longitude	Fe%-S	Ag-S	Au-A	Au*-A	As-A	Co-S	Ni-S
1	88GE018C	61 24 27	153 37 21	5	1.5	<.05	-	440	300	200
2	88GE018A	61 24 27	153 37 20	7	10.0	.50	1.40	>2,000	>2,000	150
2x	88GE018A	61 24 27	153 37 20	2	15.0	150.00[1]	-	>20,000[1]	>5,000	>10,000
3	88GE018B	61 24 27	153 37 20	20	150.0	1.50	1.50	>2,000	>2,000	3,000
4	88GE018G	61 24 27	153 37 20	10	20.0	3.00	-	>2,000	>2,000	5,000
5	88GE018D	61 24 27	153 37 20	20	150.0	.30	1.30	>2,000	>2,000	500
6	88GE018E	61 24 27	153 37 20	>20	200.0	.55	-	1,800	>2,000	500
7	88GE019A	61 24 14	153 37 13	15	50.0	N.05	N.05	1,300	300	300
8	88GE020	61 24 09	153 37 13	7	15.0	.30	.10	360	15	10
9	87R018A	61 24 15	153 36 58	15	200.0	.10	-	600	10	70
10	87R018B	61 24 15	153 36 58	>20	700.0	.15	-	1,000	70	70
11	87R018C	61 24 15	153 36 58	20	30.0	.10	-	>2,000	30	30
12	87R018D	61 24 15	153 36 58	>20	15.0	12.00	-	>2,000	>2,000	1,000
12x	87R018D	61 24 15	153 36 58	7	20.0	N10[1]	-	>20,000[1]	>5,000	>10,000
13	88GE019B	61 24 14	153 37 13	>20	200.0	N.05	N.05	60	150	70
13x	88GE019B	61 24 14	153 37 13	20	200.0	N10[1]	-	N200[1]	70	100
14	88GE019C	61 24 14	153 37 13	15	15.0	5.50	5.30	>2,000	>2,000	700
15	88GE019D	61 24 14	153 37 13	20	200.0	.35	.15	>2,000	700	100
16	88GE026B	61 25 07	153 35 05	5	7.0	1.00	4.10	>2,000	70	30
17	88GE026C	61 25 07	153 35 05	15	150.0	21.00	18.00	>2,000	300	150
18	88GE026D	61 25 07	153 35 05	10	70.0	.45	.05	>2,000	20	20
19	88GE026E	61 25 07	153 35 05	3	10.0	.15	-	1,900	10	15
20	88GE027A	61 25 08	153 34 47	3	5.0	N.05	-	1,300	15	50
21	88GE027B	61 25 08	153 34 47	3	1.5	N.05	-	190	N10	10
22	88GE027C	61 25 08	153 34 47	3	2.0	.40	N.05	>2,000	50	300
23	88GE027D	61 25 08	153 34 47	3	15.0	N.05	-	1,100	N10	70
24	88GE018F	61 24 27	153 37 20	7	1.5	N.05	-	20	15	15
25	88GE026A	61 25 07	153 35 05	3	.7	N.05	-	150	15	50

Table 1 (continued)

Map No.	Cu-S	Pb-S	Zn-A	Bi-A	Cd-A	Sb-A	Sn-S	B-S	Mn-S	Mo-S
1	200	15	15	N1	.4	N2	N10	300	1,500	10
2	300	1,500	230	12	90.0	2	20	1,500	1,500	300
2x	500	15,000	-	-	-	-	N10	150	1,000	500
3	>20,000	70	500	40	40.0	12	30	H	2,000	1,000
4	150	300	130	46	16.0	36	20	N10	1,000	50
5	>20,000	300	60	20	8.6	6	30	H	1,000	100
6	>20,000	15	45	43	15.0	8	70	H	1,000	300
7	5,000	1,500	450	3	8.0	22	30	N10	5,000	15
8	500	2,000	900	2	69.0	6	200	>2,000	1,500	N5
9	15,000	1,500	400	1	20.0	180	300	>2,000	1,500	N5
10	20,000	700	150	640	9.0	30	100	700	1,500	30
11	2,000	70	100	32	1.7	34	100	>2,000	1,500	N5
12	2,000	30	50	500	.5	12	100	300	1,500	300
12x	1,000	N10	-	-	-	-	N10	<10	200	700
13	>20,000	50	800	1	28.0	44	150	2,000	200	N5
13x	15,000	30	-	-	-	-	150	N10	150	N5
14	3,000	15	35	180	.7	360	20	200	500	50
15	>20,000	700	800	18	32.0	70	300	2,000	1,500	15
16	300	300	320	39	2.2	100	200	2,000	300	50
17	10,000	1,500	65	>1,000	2.1	410	200	>2,000	700	N5
18	2,000	10,000	>2,000	14	6.2	70	300	>2,000	3,000	N5
19	100	1,500	1,100	5	5.7	9	200	>2,000	1,000	N5
20	30	300	95	5	.5	6	100	1,000	1,000	N5
21	200	70	60	<1	.5	2	100	1,500	1,500	N5
22	30	200	110	5	1.7	60	150	700	1,000	N5
23	1,500	30	160	2	3.8	110	200	>2,000	1,000	N5
24	150	15	55	N1	.2	N2	N10	N10	1,000	N5
25	70	20	30	1	.3	<1	15	10	500	N5

[1]Spectrographic analysis

Table 2. Sample Descriptions

1: Composite chip sample of quartz-amphibole veins. Chiefly brown fine- to medium-grained amphibole.

2: Chip sample across 35 cm wide north vein. Chiefly dark green, fine- to medium-grained rock with up to 5% aspy and minor cpy, sph, eryth, and an unidentified gray metallic mineral. Non-metallics = chl, plag, amph, apt, ep.

2x: Erythrite scraped from sample 2; about 90% eryth.

3: Chip sample across 25 cm wide north vein. Dark green, fine- to coarse-grained rock with 5 to 10% combined aspy, cpy, py, gal, and mol. Non-metallics = ep, chl, amph, px, apt, qtz, plag, tour(?).

4: Selected sample of erythrite-rich portion of sample 2; about 10% eryth.

5: Chip sample across 30 cm wide south vein. Dark green rock with 10-15% mag, 3-5% cpy, trace gal. Non-metallics = chl, px, ep.

6: Selected samples of sulfide-rich portions of south vein. Same rock as sample 5 but with approximately 70% mag and cpy, and minor aspy.

7: Chip sample across 15 cm wide vein. Dark green rock with <1% cpy, prominant mal stain.

8: Chip sample across 15 cm wide vein. Light (qtz-rich) to dark (green silicate minerals) fine-grained rock with 2-3% metallic minerals, chiefly po, with minor aspy.

9: Float. Dark green to black, fine-grained banded rock with minor disseminated py and mag. Non-metallic minerals = chl, plag, apt, ep, ser, and tour.

10: Float. Highly oxidized, green to brown, fine- to coarse- grained rock with 1-2% disseminated cpy, py, aspy, cov, mag(?), and mal. Non-metallic minerals = chl, qtz, amph(?).

11: Float. White to dark green, fine- to coarse-grained rock with 3-5% disseminated to massive aspy, mag, cpy, and py. Non-metallic minerals include qtz, chl, px and (or) amph, ep, apt(?).

12: Float. Dark greenish gray, fine- to very fine-grained rock with 15-20% mag, aspy, cpy, and mol. Non-metallic minerals = px, amph, apt.

12x: Arsenopyrite(?) separate from sample 12.

13: Float. Approximately 50-60% po, 25-30% cpy, and trace mag(?). Non-metallics = qtz, chl, other silicate minerals.

13x: Pyrrhotite separate from sample 13.

14: Float. Gray rock with up to 25% aspy and minor cpy.

15: Float. Dark green rock with 15% aspy, 10% cpy, 3% po, and an unidentified gray metallic mineral.

16: Grab samples from several veins within a 25 m^2 area of breccia. White to dark green, fine- to coarse-grained rock with 1-20% aspy and py. Non-metallics = qtz, tour, chl, and unidentified silicate minerals.

17: Selected sulfide-rich material from same veins as sample 16. Light gray to dark green rock with 10-20% aspy, minor sph and gal. Non-metallics = qtz, tour, chl, other silicate minerals.

18: Chip sample across 20 cm wide vein. Dark green, medium-grained rock with 3-7% cpy, 2-4% po, trace sph + gal. Nonmetallics = qtz, tour, chl.

19: Grab sample of breccia. Breccia with angular clasts <1 to 6 cm in maximum dimension. Clasts (chiefly altered monzogranite) are light colored, fine-to medium grained qtz (85%) and ser (15%). Matrix is a dark colored, fine-grained mixture of 85% tour, 10% qtz, and 5% ser + cc + chl, and contains minor py, aspy and rare gal.

20: Grab sample of breccia clasts. Light to medium gray, quartz-rich rock with lesser amounts of ser, tour, and chl. Minor aspy.

21: Similar to sample 20, minor aspy.

22: Similar to sample 20; 3-5% aspy.

23: Grab sample of breccia. Breccia with light colored angular clasts ranging from a few mm to 8 cm in maximum dimension. Clasts are very fine- to medium grained and contain 80% qtz and 20% ep + ser. Matrix is black, fine-grained, tour (80%) and qtz (20%). Contains minor py and aspy.

24: Grab sample of unaltered monzodiorite from the Nunatak area. Fine- to medium-grained seriate rock with 51 volume percent plagioclase, 25% hornblende and biotite, 21% alkali feldspar, and 3% quartz.

25: Grab sample of unaltered monzogranite from the Breccia area. Fine- to medium-grained, almost equigranular rock with 34 volume percent plagioclase, 25% alkali feldspar, 24% quartz, and 17% hornblende and biotite.

Abbreviations

amph = amphibole
apt = apatite
aspy = arsenopyrite
chl = chlorite
cov = covellite
cpy = chalcopyrite
ep = epidote
eryth = erythrite
gal = galena
mag = magnetite
mal = malachite
mol = molybdenite
plag = plagioclase
po = pyrrhotite
px = pyroxene
py = pyrite
qtz = quartz
sph = sphalerite
tour = tourmaline