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A COMPARISON BETWEEN THE GEOCHEMISTRY OF THE GOLD-RICH AND SILVER-RICH SKARNS IN THE TILLICUM MOUNTAIN AREA (82F/13, 82K/4)

By G. E. Ray
Ministry of Energy, Mines and Petroleum Resources
and
J. McClintock and W. Roberts
Esperanza Exploration Ltd.

INTRODUCTION

Gold and/or silver-bearing skarns are found in the Tillicum and Grey Wolf Mountains area, approximately 30 kilometres south of Nakusp in southeastern British Columbia (Fig. 3-1). The skarn mineralization is spatially and probably genetically associated with a suite of deformed, often schistose diorite sills that intrude a highly deformed, metamorphosed, volcano-sedimentary succession of uncertain age (*see* Ray and Spence, this volume). The skarns are divisible into gold-rich and silver-rich types (McClintock and Roberts, 1984; Ray, *et al.*, 1985). The former is best represented by auriferous mineralization at the Heino-Money zone, situated 150 metres northwest of Tillicum Mountain; while the mineralization at the defunct Silver Queen mine, situated 900 metres southwest of Grey Wolf Mountain (Fig. 3-1), is an example of a silver-rich skarn.

This report summarizes whole rock and trace element analytical results from two drill holes; one hole (TM 82-16) intersects the auriferous skarn at the Heino-Money zone; the other (hole SQ 84-10) intersects the silver-rich skarn at the Silver Queen mine.

GEOLOGY OF THE TILLICUM MOUNTAIN-GREY WOLF MOUNTAIN AREA

The supracrustal rocks hosting the skarn-related mineralization form an easterly trending, 5-kilometre-wide roof pendant which, to the north, west, and south, is intruded and hornfelsed by various granitoid stocks of Jurassic to Eocene age (Hyndman, 1968; Parrish, 1981). A synopsis of the regional geology is presented by Ray and Spence (this volume); other geological publications relevant to this area include those by Cairnes (1934), Little (1960), Kwong and Addie (1982), McClintock and Roberts (1984), Roberts and McClintock (1984), Kwong (1985), and Ray, *et al.* (1985). The sedimentary rocks are predominantly a metamorphosed succession of siltstone, calcareous siltstone, arkose, and wacke, with lesser amounts of basalts, tuff, and locally organic-rich argillite (Fig. 3-1). The volcanic-argillite suite at Tillicum Mountain is believed to be relatively older than the calcareous sedimentary succession around Grey Wolf Mountain; however, no evidence of either a structural break or an unconformity is evident (Ray, *et al.*, 1985; Ray and Spence, this volume). The country rocks are intruded by swarms of deformed, sill-like bodies of diorite that vary from 1 to over 100 metres in width (Fig. 3-1). These intrusive rocks are widely distributed throughout the district and are spatially, and probably genetically, related to gold and silver-rich skarn mineralization in the area. The sills are generally leucocratic, porphyritic diorites to quartz diorites that are characterized by abundant plagioclase phenocrysts up to 1 centimetre in diameter. Biotite, which forms less than 10 per cent by volume, is the commonest and most widespread mafic mineral; some rare, more mafic sills contain appreciable quantities of hornblende.

Igneous textures and euhedral feldspar phenocrysts are preserved in the central portions of the larger sills but the margins are generally schistose with highly flattened feldspar crystals. In thin section, margins of the oligoclase phenocrysts are frequently partially recrystallized, and rimmed with small crystals of fresh, untwinned plagioclase. In many areas this recrystallization process is complete, and phenocrysts are pseudomorphed by a mosaic of small plagioclase crystals, each less than 0.1 millimetre in diameter. The fine-grained matrix comprises mainly plagioclase, random to subaligned flakes of biotite, and minor to trace amounts of quartz, hornblende, chlorite, and sulphides. Country rocks immediately adjacent to feldspar porphyry sills are often weakly hornfelsed.

The diorite sills predate the large, massive, granotoid stocks of Jurassic age (Hyndman, 1968; Parrish, 1981), however, the precise age of their intrusion and the skarn mineralization is not known.

GEOLOGY AND MINERALIZATION AT THE HEINO-MONEY ZONE AND SILVER QUEEN MINE

At numerous localities throughout the Tillicum and Grey Wolf Mountains area, the margins of some diorite sills and country rock immediately adjacent to them are overprinted with skarn alteration that often carries geochemically anomalous quantities of gold and/or silver. These skarns are generally separable into gold-rich and silver-rich types, as represented respectively by the Heino-Money zone, and the Silver Queen mine mineralization.

At the Heino-Money zone gold-bearing, siliceous, calc-silicate skarn alteration is stratabound. It is mainly hosted in a thin, wedge-shaped package of basaltic tuff and tuffaceous sedimentary rocks which is bounded to the west by metabasalts and to the east by a large, altered, feldspar porphyritic diorite body (Fig. 3-1). The skarn is characterized by a pinkish green colour; it is generally well layered with subparallel thin quartz veins and variable amounts of sulphides. The skarn assemblage includes quartz, tremolite-actinolite, clinozoisite, plagioclase, diopside, biotite, garnet, and microcline, with minor amounts of sericite and carbonate. Free gold occurs as fine to coarse disseminations and fracture fillings within and along walls of the quartz sulphide veins; gold is generally associated with pyrrhotite, pyrite, galena, and sphalerite (Roberts and McClintock, 1984).

A polished section study of the Heino-Money mineralization (Northcote, 1983) showed that individual gold grains range from less than 2 microns to more than 3 millimetres in diameter. The gold occurs as plates and anhedral grains; they are generally free, but may also be intimately associated with pyrrhotite, arsenopyrite, sphalerite, and pyrite-marcasite. Some pyrrhotite grains are rimmed with colloform pyrite-marcasite, while others contain small masses of hematite and graphitic material. Northcote (1983) also reports minor to trace amounts of tetrahedrite, chalcopyrite, and possibly electrum.

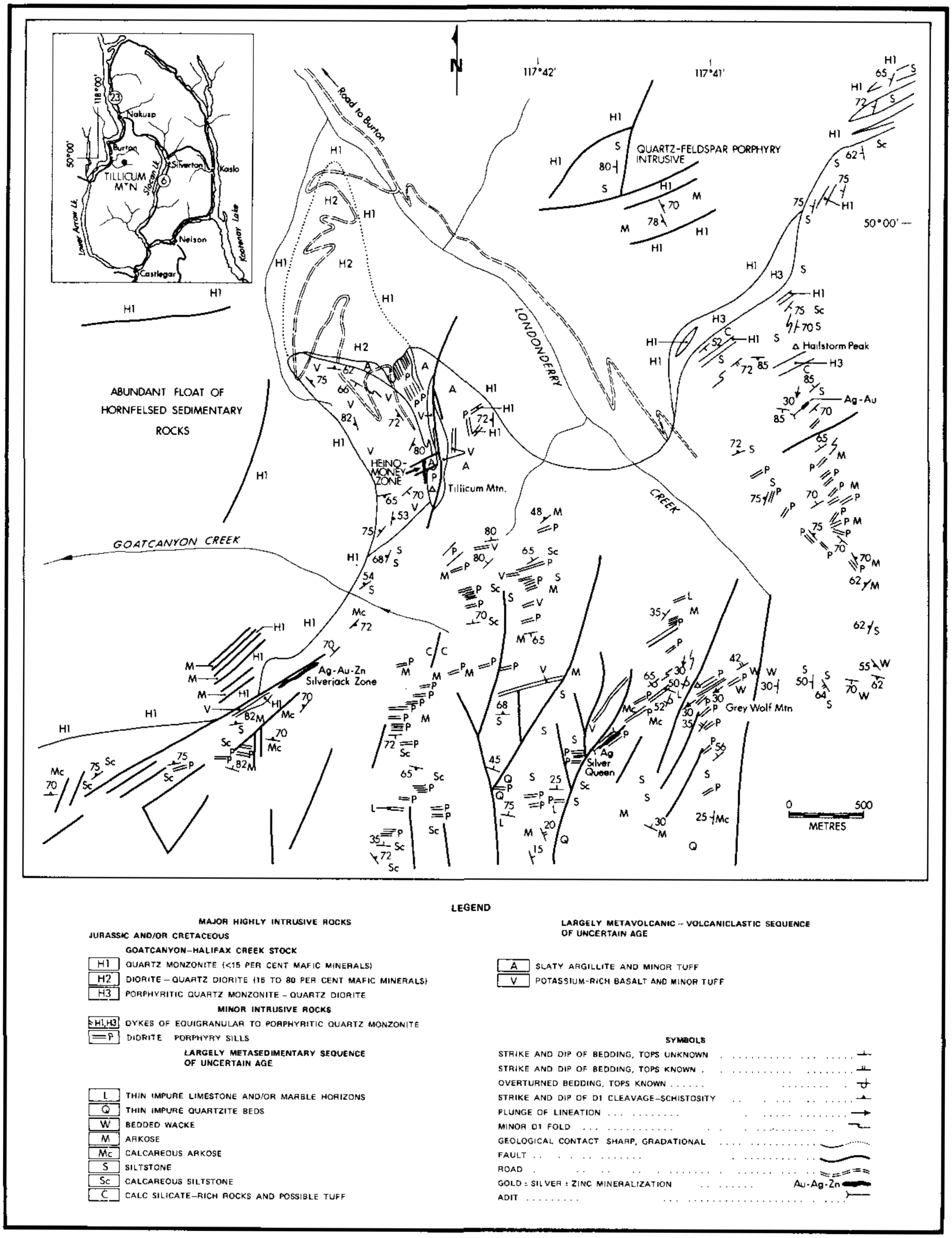

Figure 3-1. Simplified geology of the Tillicum-Grey Wolf Mountains area, showing the location of the Heino-Money zone and the Silver Queen mine. (Modified after Ray, *et al.*, 1985).

The Silver Queen mine property was active in the 1930's, but reportedly work terminated after a spring avalanche killed several miners. Intrusion of feldspar porphyritic diorite sills into a 30-metre-wide zone of impure calcareous quartzites, siltstones, and thin marble beds was accompanied by stratabound skarn development. Several mineralized horizons, each up to 20 metres thick are recognized; sulphide mineralization and skarn alteration are found in both the calcareous metasedimentary rocks and the adjacent feldspar porphyry sills. In contrast to the Heino-Money zone, mineralization is silver rich; gold is rare.

The skarn assemblage includes quartz, tremolite-actinolite, clinozoisite, garnet, biotite, and carbonate, with minor amounts of epidote and sphene. Anhedral garnet crystals up to 1 millimetre in diameter have clear margins but abundant inclusions in their cores. Some cores have overgrown and preserve a biotite schistosity that developed during the regional metamorphism. Mineralization extends for 300 metres along strike and grades from 3 to 240 grams silver per tonne. Associated sulphides include pyrite, pyrrhotite, tetrahedrite, sphalerite, galena, and pyrargyrite.

SAMPLING AND ANALYTICAL METHODS IN HOLES TM 82-16 AND SQ 84-10

Twenty-four samples were collected from hole TM 82-16 which is 48 metres long, and 35 samples were taken from hole SQ 84-10 which is 79 metres long. The location of each sample in the holes is shown on Figures 3-2 to 3-5, and in Tables 3-1 and 3-3. Each sample was split; one part being submitted for thin section, the other for geochemical analysis. These were analysed for their major element contents, as well as for Au, Ag, Cu, Pb, Zn, Co, Ni, Mo, Cr, Hg, As, Sb, Ba, Sr, Bi, and CO_2. Analytical results are presented in Tables 3-1 to 3-4. The analytical methods for all samples are as follows: major elements by Flame AAS with a precision of 0.75 per cent RSD; Au by Fire Assay; Ag, Cu, Pb, Zn, Co, Ni, Cr, As, Ba, Sr, Mo, and Bi by Flame AAS; Sb by Hydride AAS; Hg by Cold Vapour AAS; CO_2 by Induction Furnace.

The major and trace element analytical results are plotted on Figures 3-2 to 3-5; these illustrate the relative changes in elemental weight per cent throughout each drill hole. Correlation coefficients have not yet been calculated for these data.

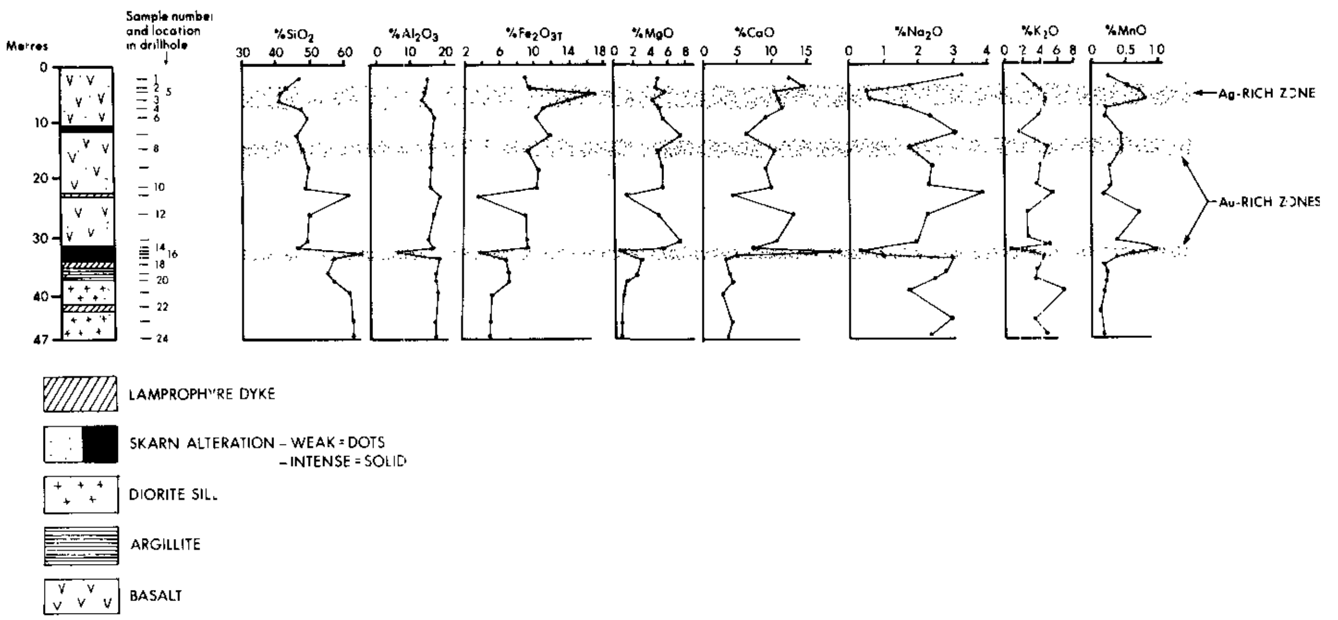

Figure 3-2. Geology and major element geochemistry of hole TM 82-16, Heino-Money zone, Tillicum Mountain.

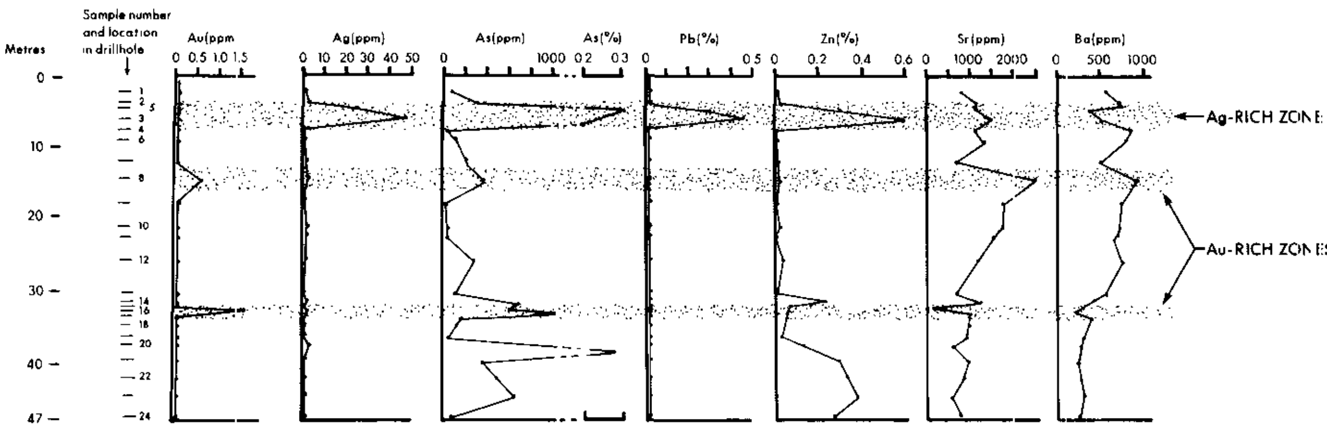

Figure 3-3. Trace element geochemistry of hole TM 82-16, Heino-Money zone, Tillicum Mountain.

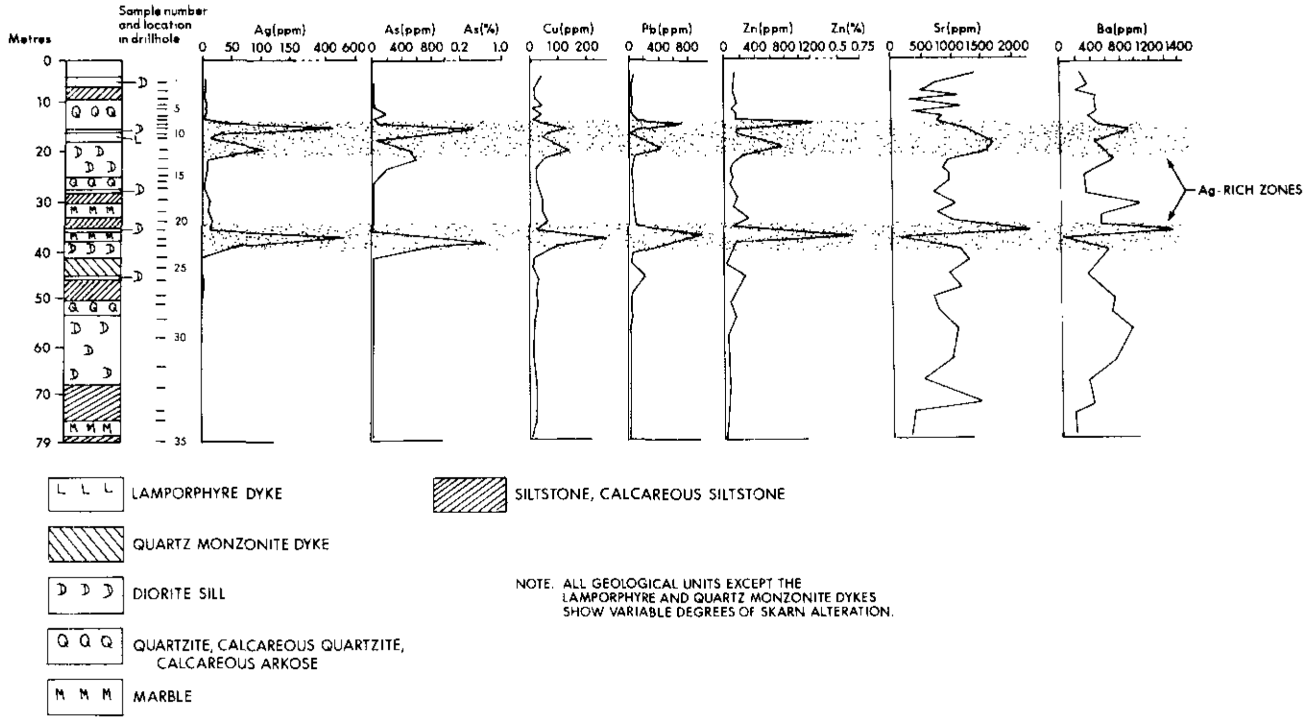

Figure 3-4. Geology and trace element geochemistry of hole SQ 84-10, Silver Queen mine.

TABLE 3-1
MAJOR ELEMENT ANALYSES OF SAMPLES TAKEN FROM HOLE TM 82-16 (HEINO-MONEY ZONE)
(Analytical values in per cent)

Sample No.	Depth of Sample (metres)	SiO_2	Al_2O_3	Fe_2O_{3T}*	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	MnO	CO_2	Total**
TM 82-16-1	2.4	46.59	14.87	8.99	7.39	5.01	12.53	3.30	2.16	0.78	0.27	4.50	90.0
TM 82-16-2	4.0	43.32	14.57	9.59	7.87	4.73	14.82	1.81	3.45	0.79	0.54	4.54	98.1
TM 82-16-3	6.0	41.83	13.28	14.06	11.08	4.25	11.15	0.61	4.44	0.77	0.81	3.97	97.8
TM 82-16-4	7.6	47.43	15.27	11.10	8.73	5.13	11.53	1.60	4.29	0.99	0.23	2.46	100.8
TM 82-16-5	4.5	41.49	14.06	17.18	12.50	5.91	10.52	0.54	4.19	0.83	0.71	1.47	100.8
TM 82-16-6	9.1	49.25	16.39	10.39	8.62	5.71	9.24	2.36	3.89	0.90	0.20	1.01	99.8
TM 82-16-7	12.1	46.05	15.98	11.84	9.51	7.49	6.72	3.13	1.44	0.98	0.44	2.37	99.7
TM 82-16-8	14.6	48.48	15.60	9.69	7.74	4.98	10.50	1.73	4.85	0.92	0.44	1.04	99.7
TM 82-16-9	17.9	49.43	15.52	10.41	8.32	5.68	9.25	2.41	4.12	0.89	0.25	0.21	100.5
TM 82-16-10	21.3	48.41	15.35	10.20	7.25	5.51	10.07	2.32	3.77	0.89	0.30	1.18	99.6
TM 82-16-11	22.5	60.78	17.77	3.75	2.78	1.39	4.51	3.83	5.23	0.57	0.19	0.35	99.4
TM 82-16-12	25.9	48.75	15.70	9.04	6.99	5.15	13.56	2.27	2.47	0.94	0.72	0.69	101.1
TM 82-16-13	30.4	48.44	14.76	9.88	7.93	7.45	10.95	1.97	2.61	0.80	0.38	1.38	100.1
TM 82-16-14	31.6	45.99	15.92	9.72	6.38	4.66	7.50	0.90	5.12	0.89	0.80	4.28	98.6
TM 82-16-15	32.3	56.02	5.90	3.39	2.07	0.96	19.06	0.28	0.65	0.21	0.93	11.10	98.2
TM 82-16-16	32.9	66.00	11.68	5.27	3.57	2.10	4.99	0.80	3.37	0.59	0.58	1.49	99.0
TM 82-16-17	33.5	55.79	17.81	6.75	5.04	3.20	3.59	3.05	4.60	0.71	0.35	1.37	99.6
TM 82-16-18***	34.7	44.82	11.66	9.49	6.49	11.64	9.65	2.31	1.69	0.94	0.19	3.13	99.9
TM 82-16-19	36.2	54.00	16.62	7.16	5.76	2.69	4.38	2.75	3.79	0.76	0.24	2.32	96.2
TM 82-16-20	37.4	55.96	16.24	7.19	4.76	1.72	4.47	2.44	3.88	0.67	0.23	1.27	96.7
TM 82-16-21	39.6	60.75	16.91	4.92	3.99	1.24	3.12	1.70	6.92	0.52	0.20	0.48	99.3
TM 82-16-22***	42.0	50.06	14.05	8.07	5.78	7.22	6.48	2.17	2.91	1.03	0.14	3.75	99.8
TM 82-16-23	44.5	60.58	16.37	4.96	4.74	1.17	4.65	2.94	3.85	0.48	0.16	1.36	98.8
TM 82-16-24	47.5	61.17	16.69	5.09	3.99	1.27	3.76	2.24	5.09	0.51	0.18	0.24	98.3

* Total iron expressed as Fe_2O_3
** Total = major oxides and LOI
*** Post-ore lamprophyre dyke

GEOLOGY AND GEOCHEMISTRY OF HOLE TM 82-16 (HEINO-MONEY ZONE)

The geology of hole TM 82-16 is shown on Figure 3-2; it totals 47 metres in length and was drilled vertically to intersect part of the Heino-Money zone. With the exception of some late lamprophyre dykes, the entire hole shows varying degrees of skarn development, marked by garnetiferous calc-silicate alteration. The first 30 metres of the hole comprise massive to schistose metabasalts that are locally amygdaloidal. The lower portion of the hole, from 37 to 47 metres (Fig. 3-2) is a skarn-altered porphyritic diorite sill. Between the metabasalt and the diorite unit (30 to 37 metres) is a zone of intense skarn development and sulphide mineralization which contains some highly altered, sheared, and schistose remnants of argillite. This prominent altered zone and the diorite sill are cut by lamprophyre dykes that postdate both the skarn development and the sulphide mineralization. Minor amounts of disseminated pyrite and pyrrhotite, which occur throughout the hole, are more abundant at a depth of 6 metres in the metabasalts and again at a depth of 32 metres, close to the intensely altered contact between the argillite and the metabasalt. In addition to pyrite and pyrrhotite, these two sulphide-rich zones contain minor amounts of arsenopyrite, chalcopyrite, and sphalerite; the upper zone also carries traces of galena. Disseminated arsenopyrite is common throughout the hole, but is noticeably more abundant as veins and stringers at depths of 6, 32, and 38 metres.

The whole rock and trace element analytical results for the 24 samples analysed from hole TM 82-16 are listed in Tables 3-1 and 3-2, and plotted on Figures 3-2 and 3-3. These show that gold is confined mainly to the narrow, intensely skarn-altered contact zone between the metabasalt and the sheared argillites. This zone had been previously sampled and entirely removed by Esperanza Exploration Ltd. and returned assay values up to of 90 ppm gold; remnant chips collected during this study assayed 1.7 ppm gold. Silver, which shows no spatial association with the gold, appears to be related to disseminated galena mineralization at the 6-metre depth. The element plots on Figures 3-2 and 3-3 suggest that gold has a positive but sporadic correlation with As, SiO_2, CaO, and MnO, and a negative but sporadic correlation with Al_2O_3, MgO, Na_2O, K_2O, total iron, Sr, and Ba. Gold appears to have no significant correlation with Ag, Pb, and Zn. Silver has a positive but sporadic correlation with total iron, K_2O, MnO, As, Pb, and Zn, and a weak to moderate negative correlation with MgO, CaO, and Sr. It appears to be unrelated to Al_2O_3, SiO_2, Na_2O, and Ba.

GEOLOGY AND GEOCHEMISTRY OF HOLE SQ 84-10 (SILVER QUEEN MINE)

The geology of hole SQ 84-10 is shown on Figure 3-4. It was drilled to intersect silver-bearing skarn mineralization at the defunct Silver Queen mine (Fig. 3-1). The hole cuts a thinly interbedded sequence of calcareous metasedimentary rocks that includes quartzite, siltstone, arkose, and marble; some beds are graphitic. Schistosity increases toward the bottom of the hole; this makes it difficult to identify the original nature of the metasedimentary rocks. The sedimentary sequence is intruded by six diorite sills that vary from fine grained and equigranular to coarsely porphyritic and weakly schistose. All the sedimentary and dioritic rocks in the hole are variably skarn altered; however, skarn development is most intense close to the margins of the diorite sills. Sporadic pyrite, pyrrhotite, sphalerite, galena, tetrahedrite, and pyrargyrite occur as disseminations and blebs between 9 and 45 metres depth. The skarn-sulphide mineralization is postdated by a dyke of fresh quartz monzonite at 44 metres depth, and by several late lamprophyre

TABLE 3-2
TRACE ELEMENT ANALYSES OF SAMPLES TAKEN FROM HOLE TM 82-16 (HEINO-MONEY ZONE)
(Analytical values in ppm)

Sample No.	Au	Ag	Cu	Pb	Zn	Co	Ni	Cr	As	Ba	Sr
TM 82-16-1	<0.3	1.5	101	51	145	31	32	90	75	580	810
TM 82-16-2	<0.3	3.0	162	110	190	43	36	110	342	720	1 160
TM 82-16-3	0.3	49.0	650	4 600	6 200	37	27	50	2 000	510	1 480
TM 82-16-4	0.3	1.0	164	24	100	43	37	60	22	850	1 150
TM 82-16-5	<0.3	26.0	600	2 500	3 100	58	31	80	2 900	370	1 170
TM 82-16-6	<0.3	1.3	158	60	127	42	26	70	138	770	1 370
TM 82-16-7	<0.3	1.8	212	73	203	43	39	140	221	500	670
TM 82-16-8	0.7	2.6	164	173	290	43	28	70	395	930	2 530
TM 82-16-9	<0.3	0.9	162	58	148	35	29	90	25	750	1 810
TM 82-16-10	<0.3	2.2	140	67	274	39	32	100	22	700	1 740
TM 82-16-11	<0.3	1.6	65	87	102	22	10	10	56	660	1 550
TM 82-16-12	<0.3	1.9	124	77	418	58	63	350	310	740	1 170
TM 82-16-13	<0.3	0.8	87	41	150	42	45	180	131	550	700
TM 82-16-14	<0.3	2.7	145	95	2 300	31	34	130	733	320	1 230
TM 82-16-15	<0.3	1.1	56	61	590	15	7	10	606	310	190
TM 82-16-16	1.7	2.0	56	112	501	26	17	30	1 100	200	930
TM 82-16-17	<0.3	1.0	51	25	540	24	17	40	194	390	1 020
TM 82-16-18*	<0.3	<0.3	36	8	90	43	168	910	<10	910	780
TM 82-16-19	<0.3	0.5	53	20	250	23	17	40	43	320	890
TM 82-16-20	<0.3	2.7	68	41	1 200	34	18	10	2 800	250	600
TM 82-16-21	<0.3	1.3	64	98	3 000	23	9	<10	369	230	970
TM 82-16-22*	<0.3	<0.3	23	18	129	31	72	360	<10	620	850
TM 82-16-23	<0.3	0.8	60	84	3 800	22	5	10	690	320	580
TM 82-16-24	<0.3	0.5	68	86	2 500	22	6	<10	38	260	820

* Post-ore lamprophyre dykes
All samples recorded <4 ppm Mo, <10 ppm Sb, <10 ppb Hg, and <5 ppm Bi

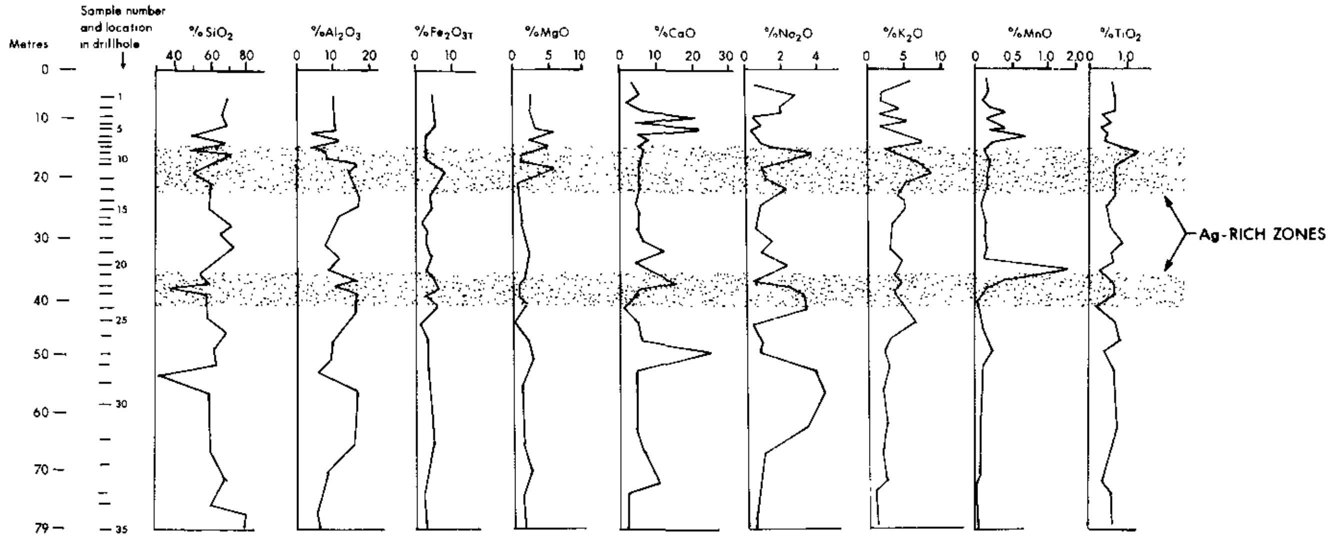

Figure 3-5. Major element geochemistry of hole SQ 84-10. Silver Queen mine.

TABLE 3-3
MAJOR ELEMENT ANALYSES OF SAMPLES TAKEN FROM HOLE SQ 84-10 (SILVER QUEEN MINE)
(Analytical values in per cent)

Sample No.	Depth of Sample (metres)	SiO_2	Al_2O_3	Fe_2O_{3T}*	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	MnO	CO_2	Total**
SQ 84-10-1	5.4	68.91	10.49	3.39	1.89	2.54	3.28	0.51	5.74	0.60	0.41	1.69	99.3
SQ 84-10-2	7.0	67.05	11.89	4.26	2.88	2.32	5.35	2.63	1.89	0.70	0.18	1.68	99.3
SQ 84-10-3	8.8	70.00	11.41	4.98	4.00	3.11	1.86	1.79	1.47	0.73	0.09	0.83	99.6
SQ 84-10-4	10.0	62.02	12.19	4.20	3.08	3.24	5.92	1.92	3.83	0.65	0.18	3.21	99.6
SQ 84-10-5	10.6	49.72	3.94	2.00	1.55	5.92	22.19	0.31	1.28	0.25	0.42	11.50	99.6
SQ 84-10-6	12.1	69.42	10.75	2.31	1.65	2.24	3.84	0.94	5.24	0.58	0.13	2.53	99.7
SQ 84-10-7	12.9	49.16	4.42	2.34	1.82	5.27	22.46	0.33	1.58	0.29	0.41	12.20	99.8
SQ 84-10-8	14.0	71.43	8.63	2.51	1.69	2.62	4.91	0.62	4.35	0.49	0.18	2.82	99.3
SQ 84-10-9	14.9	66.68	8.35	2.63	1.90	1.34	7.98	0.66	4.60	0.42	0.70	5.53	99.7
SQ 84-10-10	15.8	60.10	16.65	4.40	3.15	1.26	4.83	1.29	7.49	0.61	0.23	1.13	99.9
SQ 84-10-11***	16.7	49.17	14.78	7.64	5.35	6.25	6.90	3.69	2.30	1.43	0.14	3.24	99.4
SQ 84-10-12	19.5	61.15	16.12	5.56	4.58	0.97	4.87	0.93	7.16	0.66	0.22	0.88	99.7
SQ 84-10-13	21.3	59.02	17.74	3.48	2.69	1.03	5.15	1.06	8.51	0.74	0.17	1.23	99.6
SQ 84-10-14	23.1	59.45	17.14	4.59	3.52	1.25	5.08	2.28	5.32	0.71	0.21	0.89	99.1
SQ 84-10-15	24.6	68.31	12.82	3.27	3.03	1.55	4.69	1.73	4.45	0.65	0.13	1.58	99.7
SQ 84-10-16	25.9	72.11	10.86	1.68	1.46	1.56	4.45	0.91	5.43	0.47	0.09	1.53	99.9
SQ 84-10-17	27.4	68.28	10.52	3.12	2.47	1.87	5.46	0.70	5.16	0.47	0.10	2.82	99.7
SQ 84-10-18	29.8	74.04	8.85	3.01	2.00	2.39	4.42	0.49	3.71	0.58	0.14	2.63	100.2
SQ 84-10-19	32.0	64.17	12.11	4.09	3.29	2.40	7.14	1.55	3.36	0.86	0.14	2.86	99.6
SQ 84-10-20	34.1	56.32	8.93	3.20	2.05	2.08	12.38	0.87	3.24	0.55	0.20	12.60	96.8
SQ 84-10-21	35.9	59.05	17.28	5.31	3.42	1.72	4.51	2.39	5.12	0.68	0.11	1.62	100.1
SQ 84-10-22	37.8	38.01	9.21	8.67	4.25	1.04	17.41	0.40	4.05	0.30	2.17	12.90	94.2
SQ 84-10-23	39.0	59.19	17.44	3.74	2.96	1.22	5.26	2.23	5.35	0.60	0.43	1.22	98.0
SQ 84-10-24	41.4	59.95	17.33	4.75	3.61	1.56	5.11	3.38	3.96	0.70	0.15	1.09	99.5
SQ 84-10-25	43.5	69.93	14.79	1.77	1.26	0.41	1.50	3.51	5.27	0.24	0.04	0.37	99.3
SQ 84-10-26	46.3	63.29	11.28	3.40	2.15	2.49	5.81	0.52	7.02	0.69	0.10	3.51	99.1
SQ 84-10-27	49.3	65.74	10.22	3.79	2.90	3.23	6.52	0.96	3.43	0.79	0.19	1.74	99.8
SQ 84-10-28	51.2	28.35	7.07	3.40	2.65	2.51	26.04	0.94	2.76	0.37	0.29	21.50	93.2
SQ 84-10-29	54.2	60.66	17.48	4.81	3.73	1.53	5.05	4.12	3.31	0.72	0.15	1.22	100.0
SQ 84-10-30	57.9	60.57	17.37	4.88	3.98	1.54	4.86	4.56	2.21	0.76	0.16	0.95	99.5
SQ 84-10-31	64.0	61.36	17.11	5.14	4.61	1.76	5.07	3.64	3.11	0.75	0.14	0.68	99.9
SQ 84-10-32	68.2	69.77	9.48	3.72	2.72	3.16	7.56	1.22	2.58	0.60	0.12	0.95	100.0
SQ 84-10-33	73.1	61.55	7.97	2.92	2.20	1.75	12.03	0.98	3.24	0.44	0.12	7.85	99.9
SQ 84-10-34	74.9	81.37	7.43	2.33	1.86	1.84	2.39	1.05	1.59	0.73	0.05	1.78	100.4
SQ 84-10-35	79.2	79.34	7.91	3.53	2.73	2.57	2.82	0.76	1.72	0.66	0.07	0.45	100.9

* Total iron expressed as Fe_2O_3
** Total = major oxides and LOI
*** Post-ore lamprophyre dyke

dykes. The quartz monzonite dyke is cut by thin fractures that carry pyrite, pyrrhotite, and sphalerite, but the lamprophyre dykes are barren.

Plots of the major and trace element geochemistry in hole SQ 84-10 are shown on Figures 3-4 and 3-5. No gold mineralization was encountered, but silver enrichment occurs between 4 and 24 metres depth. The plots demonstrate that silver has a positive correlation with MnO, Cu, Pb, As, and Zn, and a negative correlation with Na_2O, Al_2O_3, and total iron. Sharp fluctuations in Sr, Ba, MgO, SiO_2, and K_2O values occur within the silver-rich zones; enhanced CaO values are recorded at the margins of the silver-bearing horizons.

CONCLUSIONS

These preliminary results indicate that geochemical differences and similarities exist between the silver-rich and the gold-rich skarns in the Tillicum Mountain-Grey Wolf Mountain area. Gold and silver-bearing horizons are present in the skarns at the Heino-Money zone but they do not occur together. Gold mineralization is marked by an increase in SiO_2, CaO, MnO, and As, and a decrease in Al_2O_3, MgO, Na_2O, K_2O, total iron, Sr, and Ba. The horizons of highest arsenic enrichment, however, do not carry gold. Silver in the Heino-Money zone skarn is probably carried in galena; its presence is marked by increases in total iron, K_2O, MnO, As, Pb, and Zn, and a decrease in MgO, CaO, and Sr.

Polished section studies (Northcote, 1983) and this geochemical study suggest that the mineralizing process at the Heino-Money zone involved two phases of precious metal deposition. The first phase included the introduction of gold, arsenopyrite, and possibly sphalerite, accompanied by the crystallization of quartz, carbonate, and calc-silicate minerals. This was followed by the deposition of argentiferous galena and the continued introduction of arsenopyrite and sphalerite.

At the Silver Queen mine, the skarn contains a 20-metre-wide silver-rich zone which is associated with enhanced values of K_2O, MnO, Cu, Pb, As, and Zn, and a depletion in Na_2O, Al_2O_3, and total iron. Mineralization is associated with sporadic Sb enrichment, which probably reflects the relative abundance of tetrahedrite at the Silver Queen mine. Neither the Heino-Money zone nor the Silver

TABLE 3-4
TRACE ELEMENT ANALYSES OF SAMPLES TAKEN FROM HOLE SQ 84-10 (SILVER QUEEN MINE)
(Analytical values in ppm)

Sample No.	Ag	Cu	Pb	Zn	Co	Ni	Cr	As	Sb	Ba	Sr
SQ 84-10-1	1.0	35	41	140	21	22	30	10	<10	270	1 280
SQ 84-10-2	1.1	17	26	110	19	8	20	<10	<10	370	710
SQ 84-10-3	0.5	20	20	107	19	13	<10	<10	<10	180	460
SQ 84-10-4	7.6	44	40	148	20	21	30	<10	<10	480	1 120
SQ 84-10-5	3.3	5	44	182	9	16	<10	<10	<10	460	270
SQ 84-10-6	4.8	44	26	95	22	26	70	201	<10	450	1 150
SQ 84-10-7	1.4	12	39	150	11	15	30	<10	10	460	300
SQ 84-10-8	35	48	77	138	22	29	40	95	12	380	360
SQ 84-10-9	455	132	740	1 200	22	25	<10	1 000	168	420	760
SQ 84-10-10	35	59	110	167	24	13	20	2 600	<10	510	1 070
SQ 84-10-11*	11	42	25	123	34	129	410	<10	<10	930	1 310
SQ 84-10-12	112	143	456	780	24	8	20	568	45	450	1 710
SQ 84-10-13	11	50	60	250	19	8	40	608	<10	550	1 530
SQ 84-10-14	12	20	39	83	17	7	20	199	<10	700	940
SQ 84-10-15	7	18	36	76	10	11	40	110	<10	470	870
SQ 84-10-16	6	16	54	91	15	13	40	<10	<10	310	970
SQ 84-10-17	4	28	57	73	16	10	40	<10	<10	310	940
SQ 84-10-18	15	44	62	167	23	54	100	<10	<10	350	700
SQ 84-10-19	10	39	68	110	25	24	50	17	<10	1 070	1 070
SQ 84-10-20	18	58	97	297	18	64	160	11	<10	540	780
SQ 84-10-21	16	23	104	100	22	11	20	30	<10	540	1 000
SQ 84-10-22	603	271	1 000	7 500	10	2	30	7 000	171	1 500	2 370
SQ 84-10-23	68	94	617	143	24	5	<10	1 700	12	<20	80
SQ 84-10-24	1	15	47	103	22	5	10	<10	<10	670	1 130
SQ 84-10-25	0.8	10	34	36	19	4	<10	<10	<10	500	1 310
SQ 84-10-26	4	33	206	259	16	48	90	<10	<10	370	940
SQ 84-10-27	2.5	24	50	140	18	12	30	<10	<10	530	1 160
SQ 84-10-28	2.6	27	35	85	7	7	20	<10	<10	700	720
SQ 84-10-29	1.4	19	49	189	17	10	10	<10	<10	660	770
SQ 84-10-30	1.1	15	19	70	19	8	30	<10	<10	920	1 110
SQ 84-10-31	1.3	15	26	86	20	5	30	<10	<10	750	980
SQ 84-10-32	1.1	28	20	109	21	30	80	<10	<10	390	490
SQ 84-10-33	1.2	24	21	51	17	21	30	<10	<10	460	1 510
SQ 84-10-34	0.3	26	5	45	29	29	50	<10	<10	280	350
SQ 84-10-35	1.3	11	22	40	31	21	30	<10	<10	200	280

* Post-ore lamprophyre dyke
All samples recorded <4 ppm Mo and <5 ppm Bi
All samples recorded <10 ppb Hg except sample Nos. SQ 84-10-22 and SQ 84-10-29 which recorded 25 ppb Hg

Queen mine skarns contain Hg, Mo, or Bi enhancement, but the silver and gold-bearing zones at both properties are marked by an increase in MnO. Since silver and gold-rich horizons in the Heino-Money zone show notable geochemical differences, and are not spatially related, the cause of the positive correlation between the precious metals and MnO in the district is puzzling. It may reflect the presence of manganese-rich garnet (spessartine), carbonate (rhodochrosite), or pyroxene [Johannsenite, Ca(Mn, Fe)(Si_2O_6)]. While calcareous-rich rocks are apparently important to skarn development, the presence of organic carbon may also play a signficant role in localizing the precipitation of precious metals, since graphite occurs in the metasedimentary rocks at both the Heino-Money zone and the Silver Queen mine.

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