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SKARNS IN THE ISKUT RIVER – SCUD RIVER REGION, NORTHWEST BRITISH COLUMBIA (104B, G)

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KEYWORDS: Economic geology, skarn, gold, copper, magnetite, Iskut River, Scud River.

INTRODUCTION

This report describes a number of mineralized skarns in the Iskut River–Scud River region of northwest British Columbia. The study forms part of an on-going project to determine the distribution, controls and metallogeny of skarns in the province. It is hoped to establish genetic models for skarn formation and examine the distribution of skarns with regard to tectonic belts and lithostructural terranes.

Nearly all the skarn occurrences described in this paper are located along the upper reaches of McLymont and Forrest Kerr creeks and on the east and west sides of lower Snippaker Creek (Figure 2-10-1). Two skarns, the Devils Elbow (MINFILE 104G 012), situated 30 kilometres south of Telegraph Creek and another in the Scud River area, were investigated but are not shown on Figure 2-10-1. The details in this paper are based largely on field observations and on some preliminary trace element analyses (Table 2-10-1). Whole-rock analyses of the intrusions, and microprobe studies of skarn minerals will be completed at a later date.

GEOLOGICAL SETTING

The study area is situated in the Boundary Ranges of the Coast Mountains physiographic belt. It lies on the western edge of the Intermontane tectonic belt within the Stikine lithostructural terrane. The Quesnel Terrane in southern British Columbia has produced over 90 per cent of the province's gold derived from skarn (Ettlinger and Ray, 1989), as well as major amounts of copper. Since the Quesnel and Stikine terranes are believed to be correlative (Monger *et al.*, 1982) it suggests that the Iskut River – Scud River area has potential for gold and copper skarn mineralization.

The geology of the area has been outlined by Anderson (1989), Logan *et al.* (1990a and b), Britton *et al.* (1989; 1990), Brown and Greig (1990), and Webster and McMillan (1990). Anderson proposes a regional stratigraphy for the area comprising four tectono stratigraphic assemblages, each bounded by unconformities:

- Tertiary Coast plutonic complex
- Middle and Upper Jurassic Bowser overlap assemblage
- Triassic – Jurassic volcanic-plutonic arc complexes
- Paleozoic Stikine assemblage

The Paleozoic Stikine assemblage underlies most of the study area in the upper McLymont and Forrest Kerr creek area and is characterized by coralline reef limestone members intercalated with mafic to felsic volcanic rocks. In the upper Forrest Kerr Creek area, Mississippian rocks are distinguished from the Lower to Middle Devonian rocks by the presence of thick beds, local coarse bioclastic textures (large crinoidal columnals) and an association with pillowed basalt flows (Anderson, 1989).

Mesozoic strata underlie most of the area of study on the south side of the Iskut River. They comprises a 3-kilometre-thick sequence of volcanics and sediments that shows a decrease in its limestone content toward the top of the succession; it is distinguished from the Paleozoic rocks by an absence of macrofossils (Britton *et al.*, 1990).

At least four intrusive episodes, spanning Late Triassic to Quaternary time, cut this stratigraphy. These include synvolcanic plugs, stocks, dike and sill swarms, as well as the batholithic Coast plutonic complex (Britton *et al.*, 1990).

SKARN PROSPECTS

DIRK: MINFILE 104B 114 (KEN, CHANDI, W.D., DIRK 1-324, AU 1-2, BIZ AND NEZ)

Skarn mineralogy: pyrite, chalcopyrite, bornite, chalcocite, magnetite, hematite, garnet, epidote.

The Dirk skarn is located on the southeast side of a nunatak about 6.5 kilometres northwest of Newmont Lake (Figure 2-10-1), at an elevation of approximately 1700 to 1800 metres (5580 to 5900 feet). The area is underlain by Paleozoic limestone, ash and lapilli tuff, and tuff breccias that strike north-northeasterly and dip moderately to the northwest. The white to cream-coloured limestone is locally metamorphosed to a fine to medium-grained marble. Tectonically dismembered blocks of bedded limestone, up to 3 metres by 8 metres in size, occur in the tuff breccia. Some blocks are surrounded by zones of pyrrhotite mineralization 10 centimetres thick. Higher in the sequence, lapilli and ash tuffs predominate over the tuff breccia and limestone. These rocks are intruded by early syenites containing potassium feldspar megacrysts and later sill-like bodies of orange-coloured syenite. The early porphyries form sills, dikes and irregular plugs. The euhedral, platy feldspar megacrysts are up to 3 centimetres in length, and are often aligned parallel to intrusive contacts; hostrocks immediately adjacent to the porphyries are often brecciated. The later syenites are characterized by an aphanitic matrix with large, green biotite phenocrysts and rare crystals of hornblende and potassium feldspar.

Skarn mineralization is locally developed within the early porphyries as subcircular to irregular shaped zones of brown

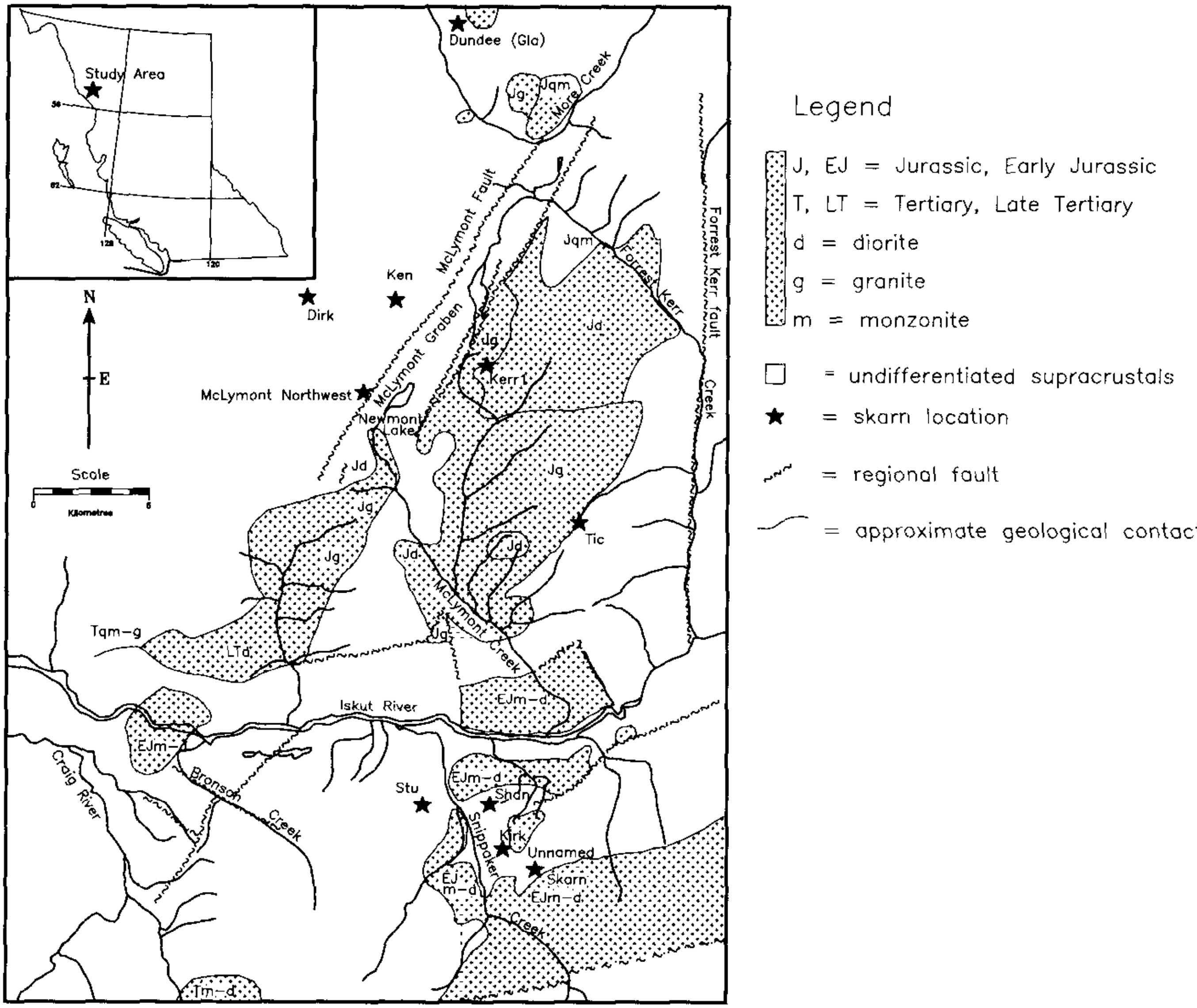

Figure 2-10-1. Generalized geological map of the study area with skarn locations. (Geology after Logan *et al.*, 1990b and Britton *et al.*, 1990)

garnet and epidote that carry pyrite, chalcopyrite, chalcocite, bornite, magnetite and hematite. These zones are generally less than 3 metres square in area and are heavily stained by malachite and azurite. Two diamond-drill holes put down by Newmont Corporation of Canada Limited gave assays of 0.3 per cent copper over 1.8 metres and 2.27 per cent over 6.0 metres. Channel samples from trenches returned assays of 0.8 per cent copper and 7.9 grams per tonne silver over 22 metres (Klesman and Ikona, 1988).

KEN: MINFILE 104B 027 (DIRK, GLACIER, ROPE, WARRIOR, GAB, CREVASSE, CONSOLIDATED AND SEA GOLD.)

Skarn mineralogy: magnetite, pyrite, chalcopyrite, gold, garnet, carbonate, epidote, wollastonite, (?)barite.

The Ken showing is exposed on several nunataks about 3.2 kilometres northwest of Newmont Lake (Figure 2-10-1) between elevations 1500 and 1585 metres (4920 to 5200 feet). Most of the property is underlain by bedded to massive, mafic andesitic ash and lapilli tuffs of probable Permian age. These rocks strike easterly and dip moderately to steeply south. Epidote alteration is locally pervasive and also occurs in veins with pink potassium feldspar and calcite. Magnetite, chalcopyrite and specular hematite also occur in some of these veins. The higher western flank of the largest nunatak is underlain by an intrusive quartz diorite and partly covered by a moraine consisting of 95 per cent pink granite to granodiorite boulders; some of these boulders are epidotized and cut by potassium feldspar veins, and may represent endoskarn.

A garnetite skarn zone, 5 metres wide, that trends northerly and dips steeply to the west, crosscuts the bedding in

TABLE 2-10-1
ASSAY RESULTS OF SKARN SAMPLES: ISKUT RIVER – SCUD RIVER AREA

Lab No.	Au	Ag	Cu	Pb	Zn	Co	Ni	Mo	As	Sb	Bi	Te	Se
041354	226	14	0.60%	3	233	9	<2	<8	6	<0.5	28	0.3	0.1
041356	412	57	3.83%	5	15.8%	69	9	13	2	3	<5	1.0	34.0
041357	18	1	515	3	270	20	<2	40	2	<0.5	<5	0.1	0.8
041358	5113	44	2.44%	3	660	91	6	405	7	2	<5	0.1	0.1
041359	16	4	0.17%	11	126	14	3	700	10	1	<5	0.1	0.4
041364	141	2	0.22%	6	38	238	5	<8	25	1	<5	0.8	0.2
041365	26	4	0.53%	29	445	360	19	<8	124	4	<5	1.0	3.0
041366	445	24	3.74%	33	175	402	38	<8	330	2	78	1.0	1.4
041367	23	0.7	27	3	21	55	11	14	4	2	<5	0.1	1.2
841368	23	<0.5	87	5	55	13	6	<8	10	3	<5	0.2	0.3
041369	64	3	62	<3	54	377	446	<8	22	2	<5	0.8	12.4
041370	14	3	478	11	307	47	6	<8	36	2	<5	0.2	2.2
041379	1335	106	17.5%	38	0.49%	243	10	<8	*<80	*<20	<5	0.5	0.5
041381	7	21	343	290	5.32%	32	4	8	20	1	0.16%	12.0	13.7
041383	7	28	18.2%	11	115	2	4	12	3	2	<5	0.5	0.5
041384	24	5	52	134	21.0%	101	3	8	16	2	144	15.1	25.4
041385	6	7	0.46%	9	84	118	17	19	30	1	44	2.1	0.3

Units and Methods:
Au, in ppb; all other elements in ppm except where noted in per cent (%).
Au, FA/ICP; Te and Se, AH/ICP; all other elements are by AAS.
* = interference due to high copper

Sample Descriptions and Property

041354: magnetite-pyrrhotite-chalcopyrite-garnet skarn boulder, Scud River
041356: pyrrhotite-pyrite-sphalerite-chalcopyrite-garnet skarn boulder, Scud River
041357: garnet-pyrrhotite-pyrite skarn boulder, Scud River
041358: chloritized, pyrite and chalcopyrite-rich boulder, Scud River
041359: pyrite-chalcopyrite-garnet skarn boulder, Scud River
041364: pyrite-chalcopyrite-garnet skarn boulder, Scud River
041365: pyrite-chalcopyrite-carbonate skarn, Stu skarn
041366: pyrite-chalcopyrite-actinolite skarn, Stu skarn
041367: pyrite-carbonate mineralization, Unnamed skarn
841368: magnetite-pyrite-epidote-pyroxene skarn, Unnamed skarn
041369: pyrite-magnetite-carbonate mineralization, Kirk magnetite skarn
041370: pyrite-carbonate-quartz mineralization, Kirk magnetite skarn
041379: chalcopyrite-pyrite mineralization, Dundee (Gla) skarn
041381: quartz-sphalerite vein, Shan skarn
041383: quartz-chalcopyrite breccia, Shan skarn
041384: quartz-actinolite-sphalerite mineralization, Shan skarn
041385: quartz-pyrite mineralization, Shan skarn

the lower part of the sequence. Alternating garnet-rich and epidote-rich layers trend approximately east and dip moderately south. The coarse, brown garnet-epidote-calcite skarn carries massive magnetite, chalcopyrite and coarse pyritohedrons and cubes of pyrite. The pyrite occurs as veins and as coarse crystals and blebs, up to 2 centimetres in diameter, which are intergrown with calcite and magnetite. Chalcopyrite forms veins subparallel to bedding and disseminations intergrown with coarse calcite.

DEVILS ELBOW: MINFILE 104G 012 (STIKINE, PEACH AND APRICOT)

Skarn mineralogy: magnetite, chalcopyrite, sphalerite, galena, pyrite, scheelite, pyrrhotite, garnet, quartz, epidote, wollastonite.

This scheelite-bearing skarn is located approximately 30 kilometres south of Telegraph Creek on the northwest side of Devils Elbow Mountain at an elevation of between 600 and 690 metres (1970 to 2260 feet). Three adits (two of which are now caved) and a number of open-cuts were opened during the early part of this century.

The area is underlain by Stikine assemblage limestone, argillites and minor tuffs, of possible Carboniferous age, that are intruded by Mid-Jurassic granodiorites and the Eocene Sawback granite (Brown and Greig, 1990; Brown *et al.*, 1990). Near the lowest adit (elevation 630 metres), biotite-hornfelsed tuffaceous argillites trend northeasterly and dip approximately 60° northwest. These are intruded by a hornblende-bearing granodiorite body as well as numerous sills up to 2 metres wide; these are probably related to the Mid-Jurassic granodiorite bodies that outcrop elsewhere on Devils Elbow Mountain. The 91-metre adit follows lenses rich in magnetite, pyrrhotite, sphalerite and copper minerals. The lenses reach 15 metres in length and 1.5 metres in width and generally occupy the contact between the intrusion and sediments, although some endoskarn mineralization is also reported in the granodiorite (Kerr, 1948). Skarn minerals include quartz, garnet, epidote and wollastonite. Mineralization in the two upper adits appears to be both lithologically and structurally controlled, and has an east-southeast strike and a steep northerly dip. It comprises galena and sphalerite with garnet, wollastonite and quartz.

Two other skarn occurrences are reported in the vicinity of the Devils Elbow prospect (Kerr, 1948). One of these, the Apex (MINFILE 104G 013), situated about 4 kilometres southeast of the Devils Elbow skarn, is hosted in limestone. The other, the Drapich (MINFILE 104G 011), situated on the west side of the Stikine River, lies along the contact between hornblende-bearing diorite and limestone. It contains lenses of chalcopyrite mineralization up to 1.5 metres thick.

SHAN: MINFILE 104B 023 (SHAN 1-6, SNIP, SNIP 5-6, JOSH AND MAY)

Skarn mineralogy: sphalerite, chalcopyrite, magnetite, pyrite, galena, tetrahedrite, epidote, actinolite, quartz, garnet, (?) bismuth tellurides.

The Shan skarn is situated 1 kilometre east of Snippaker Creek and 4 kilometres south of the Iskut River at an elevation of 1125 metres (3690 feet). The area is underlain by dark green to black andesitic tuffs which are intercalated with beds of tectonically dismembered limestone and siltstone. These strike easterly and dip moderately north. To the south these rocks are intruded by the Early Jurassic Lehto pluton, a potassium feldspar megacrystic pophyry of quartz monzonitic to dioritic composition (Britton *et al.*, 1990). The country rocks adjacent to the pluton are cut by numerous dikes and sills of quartz diorite. The Shan skarn is located close to the northern contact of the pluton; it includes abundant, coarse radiating actinolite crystals intergrown with lesser amounts of epidote, quartz and minor garnet. Metallic minerals include pods of sphalerite, pyrite, magnetite, galena and tetrahedrite. At one locality, angular fragments of strongly brecciated volcanic rocks are cemented by cockscomb quartz and chalcopyrite. Assays of chalcopyrite and sphalerite-bearing samples show no gold enrichment, although one sample contains anomalous bismuth and tellurium (Table 2-10-1).

SCUD RIVER

Skarn mineralogy: pyrrhotite, pyrite, chalcopyrite, sphalerite, gold, garnet, potassium feldspar, epidote, lizardite.

A train of mineralized skarn boulders occurs in a southeast-trending tributary to the Scud River (between UTM coordinates 354400E, 6348750N and 353550E, 6349450N; Zone 9). These boulders, which are up to 1.5 metres in diameter, can be followed up the valley in a northwest direction for at least 1.5 kilometres to the toe of a receding glacier at an elevation of 1210 metres (3970 feet). The source of the mineralized boulders was not discovered, although a helicopter traverse revealed gossanous nunataks farther up the glacier to the north. The boulders may come from these nunataks or from beneath the glacier. Mineralization comprises massive pyrrhotite with lesser pyrite, chalcopyrite and sphalerite in a reddish brown garnetite matrix. Some boulders contain irregular, pale green masses of lizardite.

The bedrock geology and float at the toe of the glacier were examined in some detail. Besides large boulders of sulphide-bearing skarn, there are also numerous boulders of epidotized granodiorite which contain disseminated pyrite and pyrrhotite and some potassium feldspar and chloritic alteration. It is possible that this is endoskarn alteration. Bedrock is exposed in a large, semicircular cliff at the toe of the glacier. Thick-bedded, impure, brownish grey tuffaceous and crinoidal limestone strikes southeast and dips steeply northeast. These sediments are cut by several intrusives, including an early irregular body of granodiorite, and later dikes and sills of altered diorite to quartz diorite. A set of pre-dike tension gash fractures in the early granodiorite are filled with irregular, vuggy quartz-carbonate-chlorite veins up to 10 centimetres in thickness. The granodiorite adjacent to the veins is highly chloritized and weakly pyritic.

Assay results of samples collected from assorted mineralized skarn boulders are shown in Table 2-10-1. The pyrrhotite-rich skarn can contain high copper and zinc values but is low in gold. One boulder of intensely chloritized granodiorite with pyrite and chalcopyrite contained over 5 grams gold per tonne. This boulder was collected close to the toe of the glacier (UTM 353550E, 6349450N); it is uncertain whether it is skarn, or represents chloritic wallrock alteration similar to that adjacent to the quartz veins in the nearby granodiorite outcrops.

TIC

Skarn mineralogy: magnetite, pyrite, epidote, garnet, quartz, potassium feldspar, carbonate, quartz.

The Tic skarn is located approximately 11.5 kilometres southeast of Newmont Lake at an elevation of 1430 metres (4700 feet). The area is underlain by a steeply dipping, deformed package of andesitic ash and lapilli tuffs, bedded tuffaceous sediments and thin marble beds. These are locally epidotized and silicified, and are intruded by numerous sills and dikes of hornblende plagioclase-porphyritic quartz diorite and granodiorite. In places these intrusions contain elongate screens of the host tuffs.

The skarn is developed along the southeast margin of a steeply dipping and northeast-striking marble unit, 70 to 100 metres thick. The coarse-grained, recrystallized marble is strongly foliated and contains thin, deformed silty layers and pods of pink, crystalline calcite. A zone of massive magnetite, 5 to 7 metres wide, lies along the contact between the marble to the northwest and tuffs and mafic quartz diorite to the southeast. The contact between the magnetite zone and the marble is generally sharp but locally it is marked by either a 1-metre zone of orange-coloured ankeritic alteration or irregular pods of coarse crystalline pyrite up to 15 centimetres in diameter. Deformed pods of pyrite up to 30 centimetres wide, and thin pyrite veins, occur within the magnetite unit and the adjacent marble. Locally, the magnetite also contains some carbonate clots and small, euhedral quartz crystals.

A nearby sill of mafic hornblende quartz diorite is moderately to extensively altered to endoskarn; it contains widespread epidote, local pockets rich in brown-coloured garnet, and veins of pyrite and potassium feldspar. Farther from the skarn, the intrusions tend to be fresher. Local silicification and epidote-carbonate-pyrite alteration occurs in both the intrusions and country rocks up to 400 metres south and southwest of the Tic skarn, though no additional magnetite-rich skarn was seen. In places the rocks are overprinted by narrow, southeast-trending, fracture-controlled zones of orange to brown-coloured ankeritic alteration. At one locality southwest of the skarn, the altered tuffs are also cut by thin veins (<2 centimetres) that contain calcite, epidote and coarse, black tourmaline; X-ray diffraction analysis indicates the latter is dravite (M. Chowdry, personal communication, 1990).

KERR 1

Skarn mineralogy: magnetite, pyrite, chalcopyrite, hematite, epidote, garnet, quartz, calcite, potassium feldspar, pyroxene, (?)barite.

The Kerr 1 skarn is situated approximately 5.5 kilometres east-northeast of Newmont Lake (Figure 2-10-1) at an elevation of 1730 metres (5680 feet); it is on claims currently held by Pamicon Developments Limited. Only one magnetite-pyrite-chalcopyrite skarn occurrence was examined, but abundant and extensive skarn-altered float suggests that there are other occurrences in the area. The vicinity of the Kerr 1 skarn is underlain by highly altered mafic ash and crystal tuffs that are massive to weakly bedded. These rocks are cut by swarms of sills and dikes representing several generations of intrusion; early mafic, feldspar-porphyrytic diorite is cut by a phase of leucocratic, pink, granodiorite to quartz monzonite which is cut in turn by andesitic dikes with chilled margins. The granodiorite to quartz monzonite contains abundant rounded to subangular xenoliths of tuff and diorite as well as crosscutting veins of potassium feldspar and epidote.

The skarn occurrence examined is hosted by epidotized mafic tuffs; no intrusive rocks were identified in the immediate vicinity. A zone of magnetite and epidote skarn, 1 to 2 metres thick, strikes northeast and dips 45° northwest. This zone, which is irregular and discontinuous, includes large pods of massive pyrite and trace chalcopyrite. It is structurally overlain by a zone of massive brown garnetite 2 to 3 metres thick, which in turn passes upward into epidote-rich skarn. The latter contains small, irregular pods of garnetite as well as massive blebs of hematite surrounded by dark green pyroxene. Contacts between the magnetite, garnet and epidote-pyroxene-rich zones are sharp. The occurrence is crosscut by several weakly mineralized veins up to 7 centimetres wide. One set strikes southeast to east-southeast and is steeply dipping; these veins contain calcite, dolomite, quartz, barite and trace pyrite and chalcopyrite. The vein barite seen in outcrop did not exceed 1.5 centimetres in width, but float containing pods of barite up to 9 centimetres wide occurs in the area. Irregular, discontinuous veins with quartz, carbonate, magnetite and specular hematite also cut the garnetite skarn. The quartz forms euhedral, elongate crystals intergrown with carbonate, while the magnetite is coarse and bladed. Another set of ankeritic veins is associated with a minor, northeast-trending, southwest-dipping fault zone.

KIRK MAGNETITE: MINFILE 104B 362

Skarn mineralogy: magnetite, pyrite, chalcopyrite, azurite, epidote, garnet, pyroxene, chlorite, potassium feldspar, lizardite, carbonate, (?)barite.

The Kirk skarn is situated east of Snippaker Creek (Figure 2-10-1), about 5.5 kilometres north-northwest of Snippaker airstrip, at an elevation of 1465 metres (4800 feet). It lies close to the toe of a receding glacier and appears to have been uncovered relatively recently. The area is underlain by a package of altered siltstone, bedded to massive mafic tuff and marble, and lies close to the northern margin of the Early Jurassic Lehto pluton. Farther south, the pluton mainly comprises a fresh, pink, coarse-grained quartz monzonite that is rich in potassium feldspar and contains hornblende phenocrysts. Approximately 200 metres south of the Kirk magnetite skarn, however, the pluton becomes green coloured and pervasively altered; it contains chlorite, epidote and veins of carbonate. Nearby, the tuffs and sediments strike southeast to north-northeast and dip between 30° and 55° easterly. They are cut by potassium feldspar rich granitic dikes that are presumed to be derived from the adjacent Lehto pluton.

The mineralized stratiform skarn is developed along the lower contact of a major unit of grey to white, foliated and banded marble that is estimated to be at least 150 metres thick. A zone of massive magnetite, 2 to 8 metres thick, outcrops over a 150-metre strike length; like the structurally overlying marble it dips northeastwards into the hillside at about 45°. The marble close to the magnetite contains thin stringers of magnetite orientated parallel to the banding. In the main magnetite zone, magnetite is intergrown with white calcite, minor epidote and chlorite, as well as with irregular masses and veins of a massive yellow-green mineral which X-ray diffraction studies indicate to be lizardite (M. Chowdry, personal communication, 1990). Locally, the magnetite zone contains thin, discontinuous interlayers of marble up to 0.6 metre thick which contain coarse masses of crystalline, amber-coloured garnet that reach 9 centimetres in diameter. The lower part of the zone contains some sulphides and the magnetite is intergrown with pods and stringers of pyrite up to 7 centimetres wide. Traces of chalcopyrite and azurite also occur together with malachite staining. Assay results of two mineralized samples from the Kirk skarn are shown in Table 2-10-1. Gold and silver values are very low.

Immediately beneath the magnetite-rich zone is a thin, discontinuous unit of bleached, massive and siliceous rock that contains disseminations and veinlets of pyrite and carbonate with traces of chalcopyrite. Locally, these veinlets penetrate the overlying magnetite.

Structurally underlying the mineralized skarn is a zone of pyroxene-garnet-epidote skarn that is at least 100 metres thick. The protolith of this unit comprises interbanded layers of feldspar crystal tuff and bedded tuffaceous sediment. The sediments are overprinted by abundant pyroxene-garnet-epidote alteration that has preferentially replaced certain beds to produce banded skarn; the brown garnet forms discontinuous bands up to 0.3 metre thick. This skarn contains patches of black to dark green chlorite, as well as some white carbonate clots that are rimmed by bands of pyrite and epidote. The massive, mafic crystal tuffs in this unit, particularly those close to the magnetite skarn, are less strongly altered to garnet-pyroxene skarn. Instead, they are partially to completely replaced by a dense vein network of bleached, siliceous alteration.

The magnetite skarn is cut by a closely spaced set of steeply dipping, east-northeast-trending faults that are downthrown to the north. Where these faults displace the marble they are often marked by orange-weathering ankeritic zones up to 1 metre wide. Locally, the skarn is also cut by thin veins of dolomite and white barite; float of Lehto pluton cut by carbonate-barite veins was also observed at the occurrence.

Stu

Skarn mineralogy: magnetite, pyrite, chalcopyrite, pyrrhotite, galena, sphalerite, tremolite-actinolite, epidote, quartz, garnet, chlorite, ferrocarbonate.

The Stu skarn occurrence is situated approximately 5 kilometres south of the confluence of Snippaker Creek and the Iskut River (Figure 2-10-1), at an elevation of 1390 metres (4560 feet). In 1988 the property was trenched and sampled by Kestrel Resources Ltd., (Blanchflower, 1988). The area is underlain by a steeply dipping, east-northeast to northeast-trending package of massive to bedded tuffs, thin andesitic flows, flow breccias, and occasional bands of white to grey marble up to 20 metres thick. The volcaniclastic rocks include ash and lapilli tuffs as well as some tuff brecccias with clasts up to 0.3 metre across. Some rare, fresh-looking dioritic sills, less than 1.5 metres thick, intrude the sequence.

An elongate zone of tremolite-actinolite-quartz-carbonate skarn follows the contact between tuffs and a 20-metre-thick marble unit. The skarn lies along the southeastern margin of the marble; it reaches 20 metres in thickness and is traceable along strike to the southeast for at least 600 metres. It largely comprises veins, rounded pods and irregular masses of tremolite-actinolite-epidote-quartz skarn that cut the marble. Locally, the skarn encloses subrounded to angular masses of marble several metres in diameter. The contacts between the skarn and marble are sharp, except where they are separated by narrow zones of ferrocarbonate alteration. The tremolite-actinolite generally occurs as elongate, radiating crystals up to 10 centimetres long. The quartz forms coarse crystals intergrown with the tremolite-actinolite; where quartz grows adjacent to calcite it develops good, euhedral faces. The skarn is also cut by massive to vuggy quartz veins up to 0.3 metre wide that can contain abundant pyrrhotite and lesser pyrite and carbonate. Locally the tremolite-actinolite-quartz skarn includes minor amounts of massive brown garnet and disseminated epidote.

Mineralization is characterized by magnetite with lesser pyrite and pyrrhotite and trace chalcopyrite. Blanchflower (1988) reports trace galena, sphalerite and possible scheelite. Metallic minerals occur as disseminations or lensoid masses in the skarn, as magnetite-sulphide veins up to 10 centimetres wide, or in quartz veins that cut the tremolite-actinolite skarn. Some quartz veins contain large blebs of pyrrhotite with minor pyrite, tremolite, chlorite and traces of chalcopyrite. Pyrite is often concentrated along the margins of the quartz veins. Assay results on two mineralized grab samples are listed in Table 2-10-1. The samples contain high copper and silver values, are weakly anomalous in arsenic, but contain only low quantities of gold.

Late, orange-coloured ferrocarbonate alteration is extensive. It occurs in a vein network cutting the marble adjacent to the skarn and as veins that postdate the tremolite-actinolite, the magnetite and the sulphides. The sequence of crystallization at the Stu skarn was as follows: 1) tremolite-actinolite, 2) magnetite, 3) pyrite and chalcopyrite, followed by 4) ferrocarbonate.

Dundee (Gla)

Skarn mineralogy: magnetite, pyrrhotite, pyrite, chalcopyrite, sphalerite, gold, garnet, epidote, pyroxene, wollastonite, quartz, carbonate, potassium feldspar, (?) barite.

The Dundee (Gla) property, currently held by Kestrel Resources Ltd., straddles the south fork of More Creek between elevations 730 metres (2400 feet) and 1500 metres (5000 feet) (Figure 2-10-1). The area is largely underlain by a deformed, highly altered package of tuffs, tuffaceous sediments, siltstones and argillites with lesser volcanics and rare limestone beds (Figure 2-10-2). Many of the tuffs and volcanics are massive; poorly preserved bedding is seen locally. The strike and dip of the bedding is highly variable throughout the area. The sedimentary and volcanic package is intruded by a body that varies compositionally from quartz monzonite to quartz diorite. The margins of this intrusion are irregular, but it reaches at least 500 metres in width in its southern section, and could be much wider to the north (Figure 2-10-2). The sediments and volcanics close to the intrusion are commonly hornfelsed and silicified, making it difficult to recognize their origin. Mineralized skarns are preferentially developed where the intrusion crosscuts limestone sequences.

Numerous andesitic dikes cut both the volcanic-sedimentary package and the major intrusion. Dikes are particularly common close to the margin of the intrusion; they form densely packed, highly irregular, crosscutting swarms that disrupt bedding in the sediments. They include massive equigranular forms, and coarsely feldspar-porphyritic phases that display flow fabrics. These dikes postdate the main intrusive body, but may represent a late phase of the same magmatic event. However, their relationship to skarn alteration is uncertain. Two narrow dikes of fresh potassium feldspar megacrystic syenite are seen in the area. These resemble the intrusion associated with the Dirk skarn elsewhere in the district.

Three fault sets are seen on the Dundee property. An early north-striking set trends parallel to the More Creek valley. A later east-trending set displaces the major intrusive body and cuts some skarn zones. Slickensides on this set indicate subhorizontal dextral movement. The latest, northeast-trending set apparently displaces the east-striking faults (Figure 2-10-2).

Three types of mineralization are recognized. Thin, irregular veins of quartz, carbonate and pyrite, with sporadic chalcopyrite, cut both the intrusions and the volcanic-

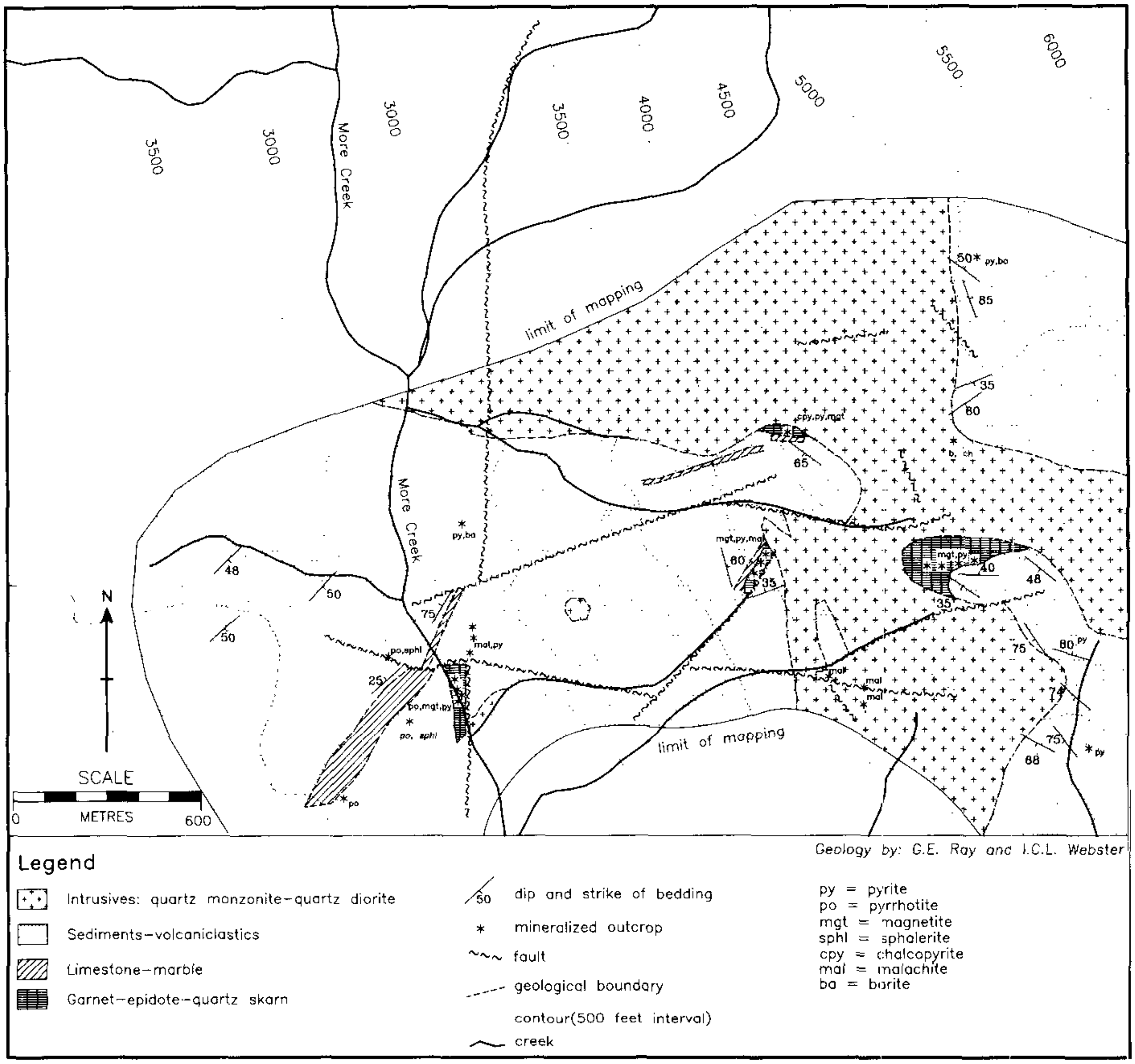

Figure 2-10-2. Geological map of the Dundee (Gla) skarn, showing areas of mineralization.

sedimentary package; these are locally weakly stained with malachite. In at least two localities, narrow veins also carry dolomite, chalcopyrite and barite.

In addition to the veins, pervasive silicification with disseminated pyrite mineralization overprints the quartz monzonite and the country rocks. It appears to be related to the nearby intrusion and it is locally associated with structurally controlled zones of intense pyritic alteration, up to 4 metres thick, that crosscut bedding.

The third type of mineralization is related to skarns, and appears to be the only type with economic potential. Four major areas of skarn alteration are seen (Figure 2-10-2), although numerous minor skarn zones are present on the property. The northernmost skarn, exposed at an elevation of 1375 metres (4520 feet) lies close to the contact between quartz monzonite, to the north, and an east-southeast-trending marble unit 30 to 35 metres thick. The skarn is largely covered by talus, but above the scree slope, chalcopyrite-pyrite mineralization occurs along the sheared contact between the monzonite and a feldspar-porphyritic andesite dike. Immediately to the east of the scree, outcrops of steeply dipping marble pass gradationally into massive garnetite skarn that is cut by veins and lenses of magnetite and pyrite. At this locality, the sulphide and magnetite-rich zone tends to separate garnetite skarn from sheared and hornfelsed metasediments and plagioclase porphyry sills and dikes. Assay results on a chalcopyrite-bearing sample collected from this skarn locality are shown in Table 2-10-1. The sample is enriched in gold, silver, copper and zinc, and contains anomalous antimony.

The second area of extensive skarn alteration crops out about 600 metres farther east-southeast. Massive garnetite-epidote skarn is exposed over a 200-metre width. This skarn is cut by numerous epidotized monzonite-diorite dikes. Veins and masses of magnetite contain white clots of quartz and carbonate that are often rimmed with brown garnet. Both brown and yellowish green garnets are seen in this skarn, and several generations of garnet are recognized; late veins of garnetite cut earlier, banded garnet-epidote skarn.

The third extensive garnet-epidote skarn on the property lies about 600 metres farther west at an elevation of 1250 metres (4100 feet). It is developed at the contact between marble and the quartz monzonite intrusion. Skarn assemblages include coarse brownish green euhedral garnet, up to 3 centimetres across, with variable amounts of epidote, and carbonate. Metallic minerals include magnetite, pyrite, minor pyrrhotite and chalcopyrite.

The fourth major skarn is located close to More Creek at the 760-metre elevation (2500 feet). It lies along a northerly trending fault and differs from the other three major skarns in that it does not lie close to the major quartz monzonite to quartz diorite intrusion. It includes two types of mineralization. One of these forms semimassive pods and lenses of pyrrhotite. The hostrock is a silicified and epidotized, green andesitic ash and lapilli tuff that is locally cut by quartz and carbonate veins. At least eight of the pyrrhotite lenses have been mapped. They are up to 5 metres long and 2 metres wide, outcrop on both sides of More Creek and trend approximately north-northeast and dip 30 to 35° west. The other type of mineralization, associated with pale, reddish brown garnetite skarn, includes coarse, radiating magnetite crystals intergrown with minor pyrite, as well as irregular pods of pyrite, up to 20 centimetres wide.

To summarize, the Dundee (Gla) skarns include garnet, epidote, quartz, potassium feldspar, carbonate with rare pyroxene and wollastonite. Mineralization comprises massive and veined magnetite with variable amounts of pyrite, pyrrhotite, chalcopyrite, sphalerite and gold. The westernmost skarn is characterized by semimassive lenses of pyrrhotite. Most of the Dundee skarns are garnet-rich exoskarns that replace limestone; they differ from many other skarns in the district in being locally pyrrhotite-rich.

McLymont Northwest Zone: Minfile 104B 281 (McLymont 3, Warrior 4, Dirk and Ken)

Skarn mineralogy: Magnetite, pyrite, chalcopyrite, gold, galena, sphalerite, tetrahedrite, chlorite, quartz, calcite, dolomite, siderite, jasper, potassium feldspar, (?) barite.

This property lies about 2 kilometres southwest of Newmont Lake (Figure 2-10-1) and is currently being explored by Gulf International Minerals Ltd. The mineralogy and morphology of this gold deposit, which is described by Ray *et al.*, (this volume), is distinct from most of the other skarns in the district. It is tentatively classified as a retrograde-altered gold-rich skarn that contains chimney and manto-type ore zones.

Unnamed Skarn

Skarn mineralogy: magnetite, pyrite, chalcopyrite, garnet, epidote, tremolite-actinolite, potassium feldspar, lizardite, (?) barite.

This skarn is situated east of Snippaker Creek (Figure 1-10-1), about 4.5 kilometres north of the Snippaker airstrip, at an elevation of between 1575 and 1725 metres (5180 to 5660 feet). The area is underlain by a package of altered, massive to bedded ash tuffs, tuffaceous sediments and massive limestones that strike east-southeast and dip steeply north. These are intruded by early sills and dikes of altered, porphyritic quartz monzonite, as well as thin, late sills of epidotized mafic andesite. The quartz monzonite contains variable amounts of megacrystic potassium feldspar, up to 2.5 centimetres long, together with some coarse hornblende phenocrysts. These intrusions, which locally contain xenoliths, are sporadically epidotized and cut by veinlets of potassium feldspar and pyrite. Both the tuff-sediment package and the intrusions are cut by numerous northeast to north-northeast-striking faults.

The extensive gossanous skarn visited in this survey occurs on a steep, west-facing slope at an elevation of 1725 metres. Farther upslope to the east, the mountaintop appears to be largely underlain by carbonate and there are numerous gossans that could mark other skarns. The visited skarn is hosted by bedded tuff close to its faulted contact with a quartz monzonite intrusion. The banded skarn is characterized by an assemblage of epidote, potassium feldspar, tremolite-actinolite, quartz, carbonate and minor pyroxene cut by veinlets of epidote and potassium feldspar. Metallic minerals include magnetite, with moderate amounts of pyrite and traces of chalcopyrite. Pyrite veins ranging up to 4 centimetres in width also occur. No garnet was seen in outcrop, but mafic hornblende diorite and marble float at the toe of the glacier below the skarn outcrop contain veins of brown garnet rimmed with epidote. Boulders of magnetite-pyrite-bearing marble with yellow-green lizardite were also seen at this locality.

Assay results on two mineralized samples collected from this skarn are shown in Table 2-10-1; they show only low values of gold, silver and base metals.

CONCLUSIONS

The Iskut River–Scud River area contains numerous mineralized skarns that have only recently received serious exploration attention. Many of the occurrences, based on their predominant economic commodity, appear to represent copper or iron-copper skarns, some of which are sporadically enriched in gold. The McLymont Northwest zone, however, may represent a retrograde-altered gold-rich skarn. The occurrence of lizardite at the Scud River and Kirk skarns, together with the presence of dolomites in the region, suggests that some occurrences may have magnesian skarn affinities.

This preliminary field investigation suggests the following conclusions with respect to skarns in the Iskut River–Scud River area:

- They are commonly associated with monzonite, quartz monzonite or quartz monzodiorite intrusions rich in potassium feldspar. Skarn-related diorites and gabbros are rare.
- They are commonly hosted in carbonate-rich sediments and tuffs where these rocks are intruded by either large plutons or small dikes and sills. In some cases, however, (*e.g.* McLymont) no intrusions have been identified immediately adjacent to the skarn.
- The skarn morphology varies from stratiform (Kirk magnetite) to irregular (Dirk) to chimney and manto-like (McLymont).
- Most skarns have high garnet/pyroxene ratios and low pyrrhotite/pyrite ratios. Pyroxene-rich assemblages are seen only in the footwall of the Kirk magnetite skarn. Some skarns, such as the Stu and Shan, contain coarse tremolite-actinolite.
- Many skarns are characterized by abundant magnetite, and minor amounts of hematite. Pyrite and chalcopyrite are the most abundant sulphides; no arsenopyrite was positively identified, although trace amounts may exist in the Mclymont Northwest zone (Ray *et al.*, this volume), and at the Stu.
- Preliminary trace element analyses indicate some skarns such as the Dundee, and possibly the Scud River, are sporadically enriched in gold. The anomalous bismuth and tellurium at the Shan skarn suggests the presence of bismuth tellurides.
- Late barite-carbonate veining is seen at many skarns, but it is uncertain whether this is associated with the skarn or to some later, unrelated mineralizing event.
- The most common skarn silicates are garnet and epidote. Potassium feldspar is also a common minor constituent. The McLymont mineralization is associated with intense silicification and carbonate alteration of the wallrocks.
- The low pyrrhotite/pyrite ratios, abundance of garnet and the presence of hematite suggest most skarns in the Iskut River area formed in a relatively oxidized environment. The Scud River skarn and some of the Dundee (Gla) skarns are unusual in being pyrrhotite-rich.

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NOTES