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MINERALOGICAL INVESTIGATION OF SOME BASE METAL ORE DEPOSITS AND OCCURRENCES IN THE RED LAKE MINING DIVISION, ONTARIO

D. C. HARRIS

MINERAL SCIENCES DIVISION

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MINERALOGICAL INVESTIGATION OF SOME BASE METAL ORE DEPOSITS AND OCCURRENCES IN THE RED LAKE MINING DIVISION, ONTARIO

by

D. C. Harris*

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ABSTRACT

Three main types of base-metal sulphide mineralization are present in the Red Lake Mining Division:

(1) Small massive copper-lead-zinc deposits occurring mainly in drag folds or shear zones in sequences of metavolcanic and metasedimentary rocks, sometimes intruded by gabbroic sills and invariably surrounded by granitic rocks. Most of these deposits are located in the belt of volcanic rocks in the Confederation Lake area, 50 miles east of Red Lake, and are typified by the Fredart Lake and South Bay Mines deposits. In the Red Lake area, this type of deposit is represented by the Trout Bay sulphide prospect located on the western limb of the Red Lake basin-like volcanic complex.

(2) Low-grade disseminated nickel and copper mineralization as shown by the Trout Bay nickel prospect. The mineralization occurs in an antigorite-tremolite schist occurring along the stratigraphic top of a chert-magnetite iron formation. The schist represents the sheared and altered basal portion of a metagabbro sill.

(3) Massive to disseminated occurrences of galena in carbonate zones cut by numerous quartz stringers and veins. These shear zones are associated with metavolcanic rocks that have been intruded by quartz prophyry. The Galena Island and Middle Bay prospects are typical of this mode of mineralization.

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*Research Scientist, Mineralogy Section, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Direction des mines
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RECHERCHES MINÉRALOGIQUES SUR QUELQUES GISEMENTS MÉTALLIFÈRES DE MÉTAL COMMUN ET LEURS PRÉSENCES DANS LA DIVISION MINIÈRE DE "RED LAKE", ONTARIO

par

D. C. Harris*

RÉSUMÉ

Dans la Division minière de "Red Lake", on trouve trois sortes de métal commun sulfuré de minéralisation:

(1) Les petits gisements massifs de cuivre-plomb-zinc qui se trouvent surtout dans les plis d'étirement ou dans les zones de cisaillement en série de roches volcaniques et sédimentaires partiellement métamorphisées et quelques fois introduites par les seuils gabboriques et toujours entourés de roches granitiques. On peut trouver ces gisements dans la zone de roches volcaniques dans la région de "Confederation Lake", 50 miles à l'est de "Red Lake" et ils sont caractéristiques des gisements des mines de "Fredart Lake" et "South Bay". Dans la région de "Red Lake", cette sorte de gisements est représentée par la zone d'intérêt pour le sulfure de "Trout Bay" située dans la partie ouest du complexe volcanique genre bassin de "Red Lake".

(2) La minéralisation de nickel et de cuivre disséminés à faible teneur telle d'indiquée par la zone d'intérêt pour le nickel de "Trout Bay". La minéralisation se présente dans un schiste d'antigorite-tremolite se trouvant le long de la limite stratigraphique supérieure d'une formation de fer de chest-magnétite. Le schiste représente la base cisaillée et modifiée d'un seuil de métagabbro.

(3) L'occurrence de galène soit sous forme massive soit sous forme disséminée dans les zones de carbonate coupée par de nombreuses ficelles et veines de quartz. Ces zones de cisaillement sont associées aux roches volcaniques partiellement métamorphisées où le porphyre quartzifère s'est introduit. Les zones d'intérêt de l'Ile Galène et de "Middle Bay" sont typiques de ce mode de minéralisation.

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CONTENTS

INTRODUCTION

The Red Lake Mining Division is well known as a gold producing area, but some of the gold mines have ceased operation. Occurrences of other minerals such as argentiferous galena, molybdenite, and nickeliferous pyrrhotite had been found but received little more than passing interest prior to 1966. In that year, however, an enormous deposit of iron ore at Bruce Lake, about 30 miles to the south of Red Lake was developed as the Griffith Mine. In 1968 the first viable base metal deposit was discovered in the Uchi-Confederation Lake area, which is 50 miles east of Red Lake. Production from this deposit, now known as the South Bay Mine, commenced in July 1971. The discovery of the South Bay Mine deposit renewed interest in base metal occurrences in the Red Lake Mining Division and has led to the discovery of several other deposits in both the Uchi-Confederation Lake and the Red Lake areas. One of the more promising deposits is the Trout Bay prospect of Cochenour Willans Gold Mines Ltd., about 20 miles west of Red Lake. Samples of diamond drill core from this deposit were submitted to the Mines Branch in December of 1968 for beneficiation tests. Mineralogical studies on these samples showed an unusual assemblage of antimony-bearing minerals which led to the identification of two new minerals (Cabri, Harris and Stewart, 1970). The increased interest in base-metal occurrences in the Red Lake district and of the identification of this unusual mineral assemblage indicated that more information should be obtained on the deposits in the area. A mineralogical study of these deposits was therefore undertaken as part of the Mines Branch program of studying the mineralogical characteristics of Canadian ore deposits. The author visited the area in July 1970 and collected drill core samples from the deposits of Trout Bay, Snakeweed Lake (Rexdale) and the South Bay

Mine. In addition, hand specimens were obtained from six other deposits in the Red Lake area and from four in the Uchi-Confederation Lake area. The locations of the properties sampled are shown in Figures 2 and 3.

LOCATION AND GENERAL GEOLOGY

The Red Lake area lies in northwestern Ontario in the Patricia portion of the district of Kenora, approximately 200 air miles northwest of Port Arthur - Fort William, recently renamed Thunder Bay (Figure 1). The town of Red Lake is reached via Highway 105 from Vermilion Bay. A new Ontario Resources Transportation road from Highway 105 at Ear Falls provides access to the mine site of South Bay Mine, Confederation Lake. The most convenient means of transportation to Red Lake is by air from Winnipeg, Manitoba.

The oldest known rock formations are lava flows and associated sedimentary rocks of Archean age, formerly referred to as Keewatin and Temiskaming types, respectively. These rocks are completely surrounded and intruded by later granitic rocks (Horwood, 1941; Ontario Department Mines Map 2175). Two broad remnants of folded structures of volcanic and sedimentary formations are present in the areas containing the mineral occurrences. The best known is the basin-like structure of Red Lake, and the second, approximately 50 miles east of Red Lake, extends from south of Uchi-Confederation Lake north-northeasterly beyond Birch Lake.

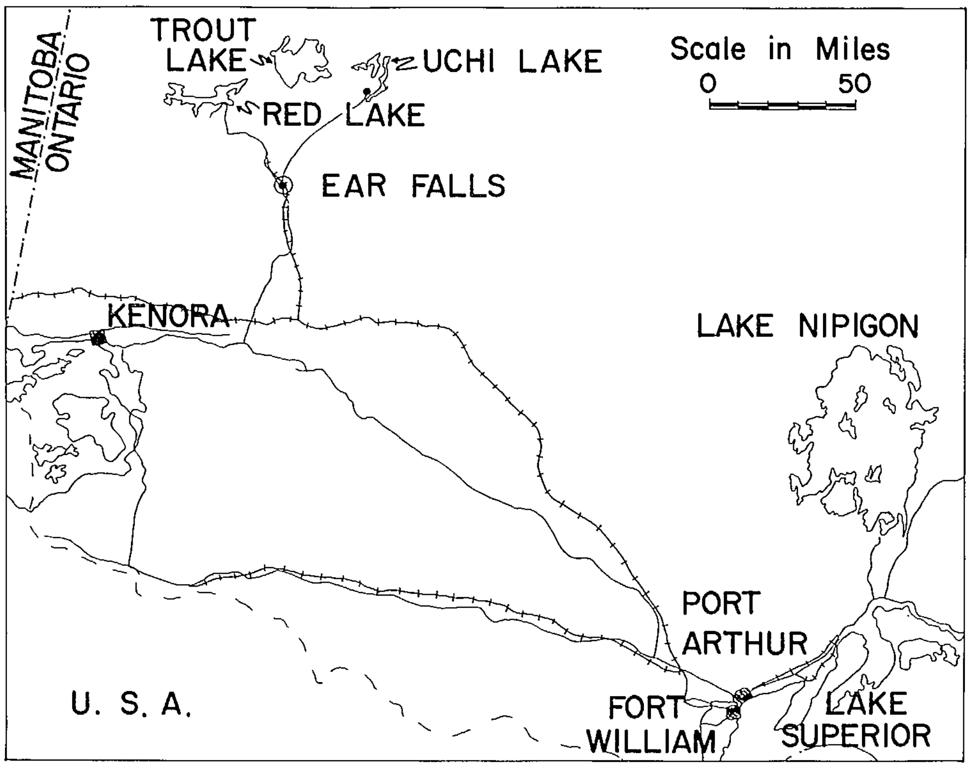

Figure 1. Location map of Red Lake area.

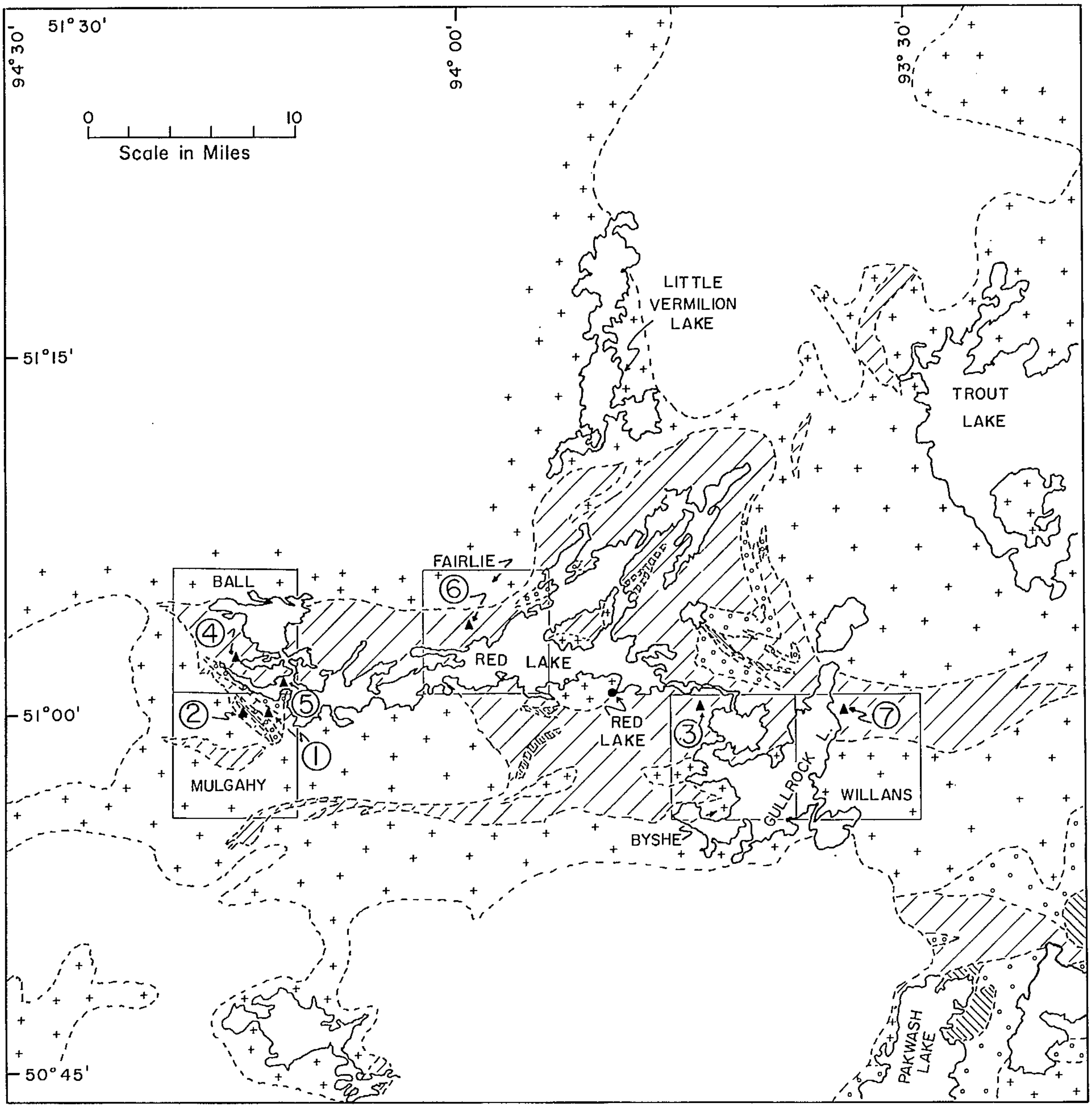

Figure 2. Geological sketch map of Red Lake area.

Legend

Precambrian

- Granitic rocks
- Mafic and ultramafic rocks
- Metasediments
- Metavolcanics

Mineral Occurrences

1. Trout Bay Sulphide Deposit
2. Trout Bay Nickel Deposit
3. Peterson Red Lake Mines
4. Middle Bay
5. Galena Island Showing
6. Alcourt Mines Ltd.
7. Fox Farm Showing

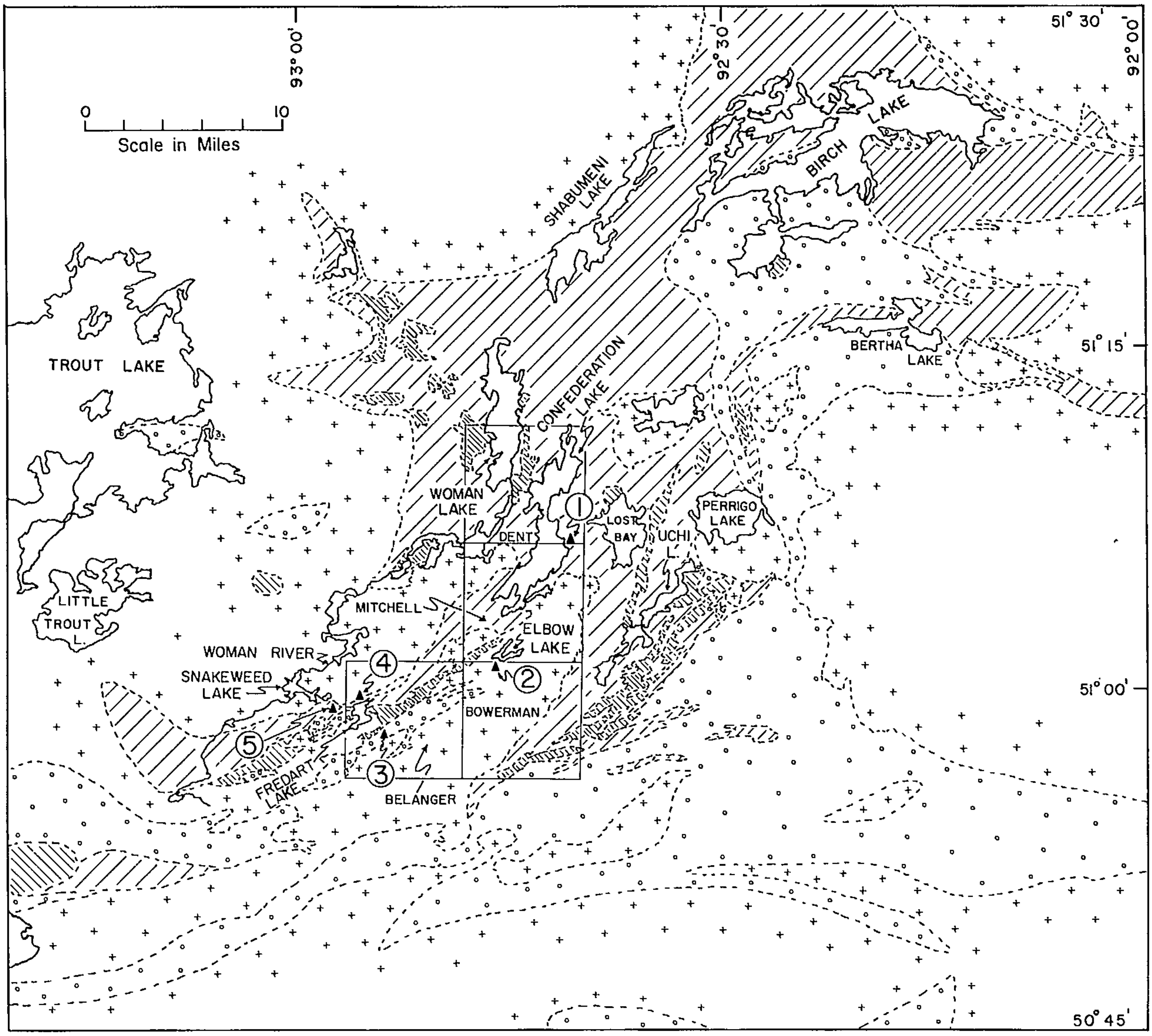

Figure 3. Geological sketch map of the Uchi-Confederation Lake area.

Legend		Mineral Occurrences
	Precambrian	1. South Bay Mines
+₊+	Granitic rocks	2. Horseshoe (Elbow) Lake
	Mafic and ultramafic rocks	3. Copper Lode
	Metasediments	4. Fredart Lake
	Metavolcanics	5. Snakeweed Lake (Rexdale)

CHARACTERISTICS OF THE DEPOSITS

The base metal sulphide deposits and occurrences of the Red Lake district occur in a wide variety of geological environments and contain different types of sulphide minerals. In spite of their differences, a broad grouping seemed desirable; a summary of their mineralogical characteristics is given in Table 1.

MASSIVE SULPHIDE DEPOSITS

Trout Bay Sulphide Deposit No. 1 (Figure 2)

The Troup Bay sulphide deposit is located in Mulcahy township, approximately 4,000 ft southwest of the southeast end of Trout Bay, or about twenty miles west of the town of Red Lake.

The deposit consists of two small bodies of massive sulphides which are located about 800 ft apart on either side of an east-trending fault (Shklanka, 1969, p. 154 and Pye, 1968, p. 10-12). The blocked-out ore as of December 1969 was 125,000 tons averaging 7.86% Zn, 1.50% Cu, 0.24% Pb, and 1.70% oz. Ag/ton (Can. Mines Handbook 1970-71). Preliminary mineralogical studies (Cabri, 1969) and beneficiation tests (Stemerowicz and Bruce, 1969) were done at the Mines Branch in 1969 on behalf of Cochenour Willans Gold Mines Ltd. The shipment of ore was received on December 6, 1968, and consisted of 267 lb of split diamond drill core. Chemical and semi-quantitative spectrographic analyses of the head sample of this ore are given in Table 2. During a visit to the area in July 1970, samples were taken at one-foot intervals from two diamond drill holes designated as Hole 179 and 105. Mineralogical data obtained from all the material examined is incorporated in this report.

TABLE 1

Characteristics of the Deposits

Deposit (Type and Name)	Geological Environment	Principal Ore Minerals	Minor to Trace Ore Minerals
	MASSIVE SULPHIDE DEPOSITS		
Trout Bay Sulphide	Drag folds in metasediments cut by metagabbro	pyrrhotite, sphalerite, chalcopyrite	
South Bay Mine	Complex series of porphyritic felsic metavolcanics	pyrite, sphalerite, chalcopyrite, cassiterite	arsenopyrite, galena, tetrahedrite, pyrrhotite, marcasite, scheelite, wolframite, native bismuth
Horseshoe (Elbow) Lake	Shear zone in paragneiss surrounded by granitic rocks	pyrite, sphalerite	chalcopyrite, galena, cassiterite, stannite, pyrrhotite
Copper Lode	Coarse-grained garnetiferous amphibolite and metasediments	pyrrhotite, chalcopyrite, sphalerite	pyrite, galena, ilmenite
Fredard Lake	Metasediments	sphalerite	pyrite, pyrrhotite, galena, chalcopyrite, marcasite, ilmenite
Snakeweed Lake	Coarse-grained garnetiferous-biotite schist and amphibolites	pyrrhotite, chalcopyrite, sphalerite	galena, pyrite, cubanite, ilmenite, cassiterite, stannite, bismuthinite, native bismuth, native silver, silver telluride, mackinawite
	LOW-GRADE DISSEMINATED SULPHIDES		
Trout Bay Nickel	Antigorite-tremolite schist	magnetite, chalcopyrite, pyrite, violarite	

(Con't)

Table 1 - continued

Deposit (Type and Name)	Geological Environment	Principal Ore Minerals	Minor to Trace Ore Minerals
	VEIN-TYPE OCCURRENCES		
Middle Bay	Quartz veins in volcanics	galena, anglesite	sphalerite, argentian tetrahedrite, pyrite, chalcopyrite, pyrrhotite
Galena Island	Quartz stringers in carbonate zone in volcanics	galena, pyrite, sphalerite	pyrrhotite, argentian tetrahedrite, anglesite
Alcourt Mines Ltd.	Quartz veins in volcanics	galena, pyrite	chalcopyrite, silver telluride
Fox Farm	Quartz veins in metasediments	galena, sphalerite, anglesite	pyrrhotite, marcasite, chalcopyrite, pyrite
Peterson Red Lake Mines Ltd.	Lenses of altered quartz porphyry	chalcopyrite, pyrrhotite	sphalerite, magnetite, cobaltite, ilmenite

TABLE 2

Chemical Analyses of the Troup Bay Sulphide Ore*

Element	Wet Chemical Wt %	Assay oz/ton
Cu	1.49	
Pb	0.35	
Zn	7.64	
Ag		1.38
Au		0.01
Fe	26.68	
S	21.36	
Co	0.06	
Ni	0.06	
Sn	0.02	
As	0.04	
Sb	0.03	
Insol.	33.17	
Not detected by spectrographic analysis:- Ba, Mo, W, Nb, Ta, Ge, Bi, In, Zr, No, Sr.		

* Stemerowicz and Bruce, (1969).

Mineralogy

The major ore minerals identified are pyrrhotite, sphalerite, and chalcopyrite; there are minor to trace amounts of pyrite, arsenopyrite, galena, cassiterite, cobaltite, marcasite, ilmenite, argentian tetrahedrite, stannite, paracostibite, native silver, allargentum, pyrargyrite, breithauptite, nisbite, and gudmundite.

Pyrrhotite and sphalerite both occur in major amounts. The pyrrhotite is mainly the monoclinic or iron deficient magnetic variety, although X-ray diffraction analyses and etch tests indicate that there may also be a few per cent (less than 10%) of the non-magnetic hexagonal variety. Electron-probe analyses revealed a cobalt content of about 0.2%, nickel and copper were not detected. The pyrrhotite grains vary considerably in size, from several millimeters to less than 5 microns. They occur as inclusions in chalcopyrite, sphalerite, and galena, and often contain inclusions of these three minerals (Figures 4 and 5). Sphalerite is generally coarse-grained but is finer-grained in the chalcopyrite-rich sections of the ore. The abundance of sphalerite varies across the orebody and even within a few inches. It often contains inclusions of chalcopyrite and pyrrhotite down to 10 microns, or less, in diameter (Figures 5 and 6). The sphalerite was analyzed with the electron microprobe at several intervals across the two ore zones intersected by Hole 105 as shown in Figure 10. The iron content of about 5% remains fairly constant except for a slight increase towards the footwall of the second orebody. Other than zinc and sulphur, the sphalerite contains 0.1% Cd and 0.05% Mn.

Chalcopyrite varies in size from large aggregates of more than one millimeter in diameter to very small inclusions less than 5 microns in diameter (Figure 6). It also forms a fine intergrowth with some of the fibrous gangue minerals (Figure 4).

Galena occurs in minor amounts throughout the orebody generally as grains 50 to 300 microns in diameter (Figures 5 and 6).

Pyrite and marcasite are not very abundant and appear to decrease towards the footwall. Cobaltite is often euhedral in morphology and occurs in grains up to about 150 x 90 microns, generally associated with arsenopyrite (Figure 7).

Four silver-bearing minerals were found: native silver, allargentum ($Ag_{0.86}Sb_{0.14}$), pyrargyrite ($Ag_6Sb_2S_6$) and argentian tetrahedrite. Electron microprobe analyses showed that the native silver contains about 3% Sb, and the tetrahedrite was found to be very rich in Ag ($\approx$ 30% Ag).

The silver minerals are rare in the ore and were only identified in two galena-rich polished sections. In grain size, the native silver (Figure 8) varies from 12 to 30 microns; the pyrargyrite (Figure 6) occurs as irregular grains up to about 120 microns in diameter; while the tetrahedrite is generally 60 to 180 microns in diameter, although one grain up to 650 x 120 microns was observed.

Besides the silver-bearing minerals discussed above which contain antimony, four other antimony-bearing minerals were observed. Two of the minerals, paracostibite (CoSbS) and nisbite ($NiSb_2$) were determined to be new minerals and were described by Cabri et al. (1970). The other two minerals are gudmundite (FeSbS) and breithauptite (NiSb). Paracostibite was found in several sections throughout the ore and, without the microprobe, could be mistaken for cobaltite with which it is invariably associated. It occurs as grains up to about 130 microns in diameter. Nisbite is very rare, was identified in only two sections, and invariably occurs with breithauptite.

Two tin-bearing minerals were found: stannite and cassiterite. Stannite is the more common; although it is quite rare, it was identified in several polished sections. The mineral grains are seldom larger than 30 microns in diameter. Stannite occurs as inclusions in sphalerite and chalcopyrite and typically appears either adhering to sphalerite grains or as wedge-shaped inclusions along the borders of sphalerite grains (Figure 9). Cassiterite was found in several sections throughout the ore and the grains were seldom larger than 50 microns.

The host rock appears to be an altered mafic rock commonly called "greenstone" which consists mostly of anthophyllite, actinolite, chlorite, quartz and talc. Other minerals present are sphene, calcite, mica, and feldspar.

Figure 4. Photomicrograph showing the textural relationship of gangue (black) with sphalerite (dark grey), chalcopyrite (white) and pyrrhotite (8).

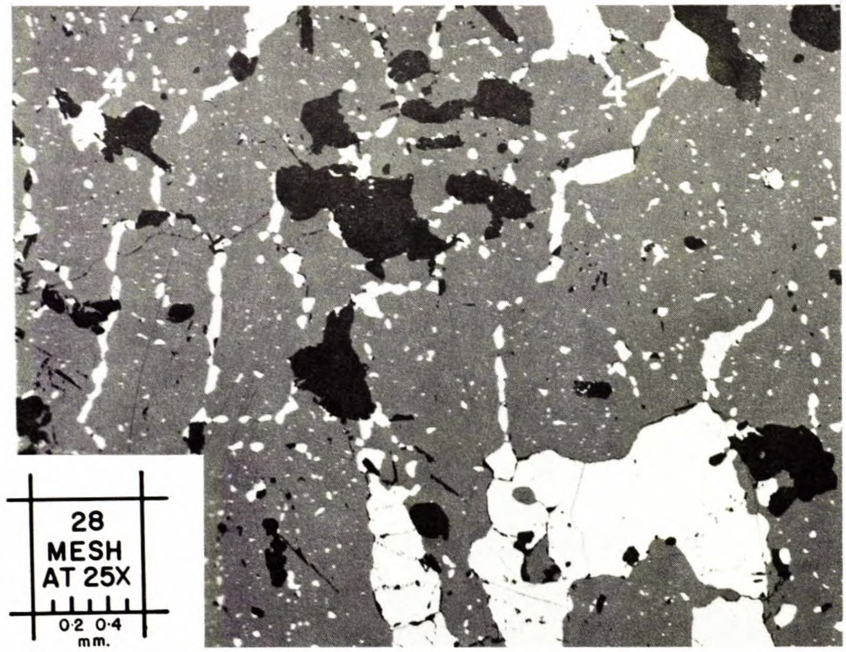

Figure 5. Photomicrograph of pyrrhotite and galena (4) inclusions in sphalerite. A few of the very small inclusions are chalcopyrite, but are not distinguishable from the pyrrhotite. The black inclusions are gangue.

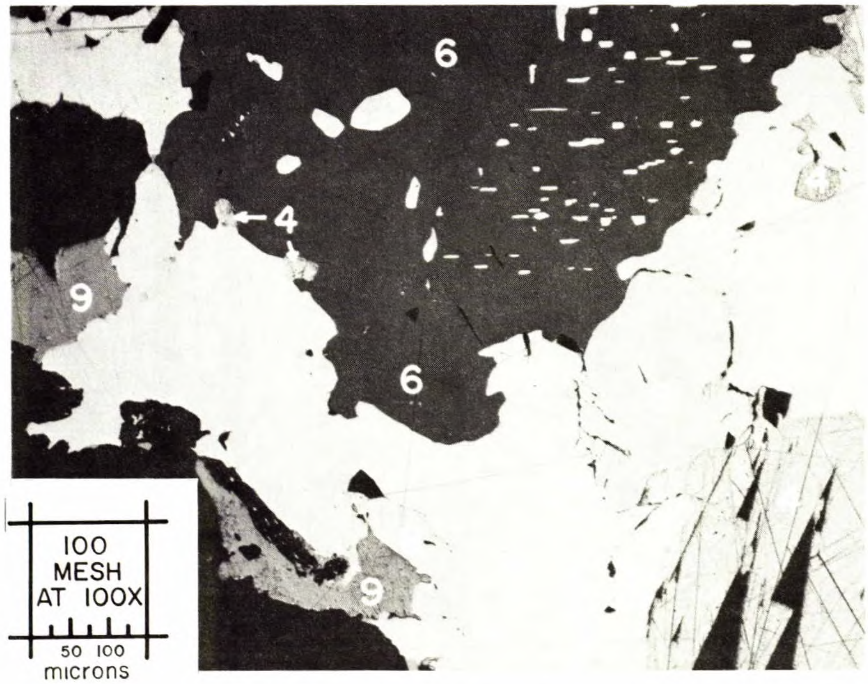

Figure 6. Photomicrograph showing chalcopyrite (greyish white) and sphalerite (6). The sphalerite contains small inclusions of chalcopyrite and galena (4) while the chalcopyrite contains inclusions of galena and pyrrhotite (8). Pyrargyrite (9) occurs along the border of chalcopyrite and gangue (black).

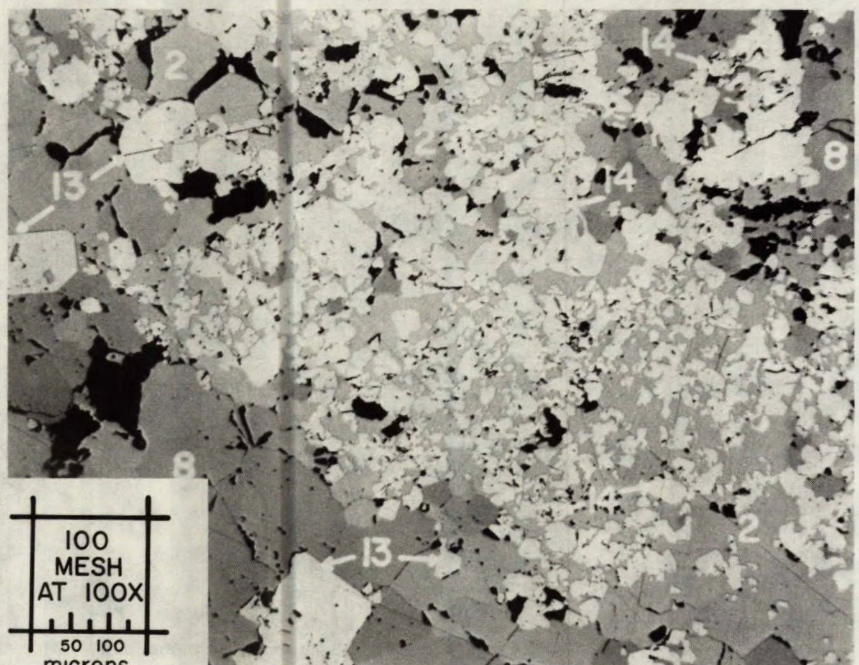

Figure 7. Photomicrograph showing euhedral crystals of cobaltite (13) and arsenopyrite (14) in chalcopyrite (2) and pyrrhotite (8).

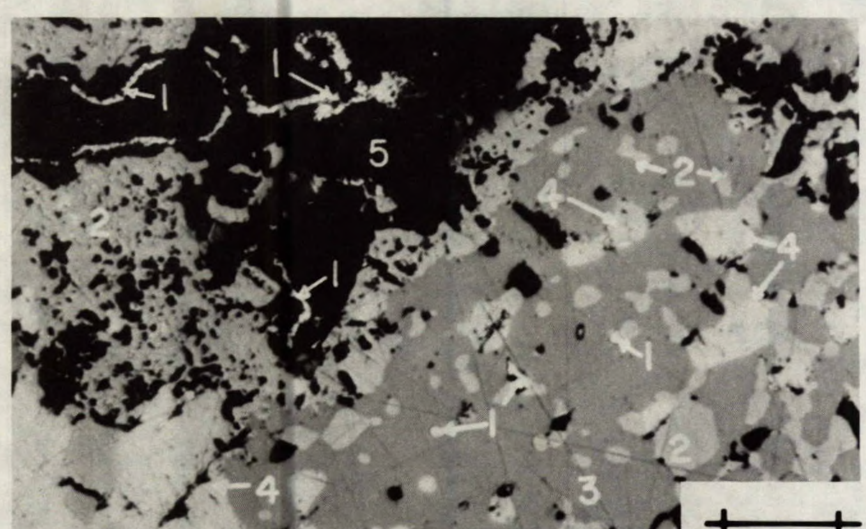

Figure 8. Photomicrograph showing native silver (1) as inclusions in tetrahedrite (3) and rims about gangue (5). The tetrahedrite also contains inclusions of galena (4) and chalcopyrite (2).

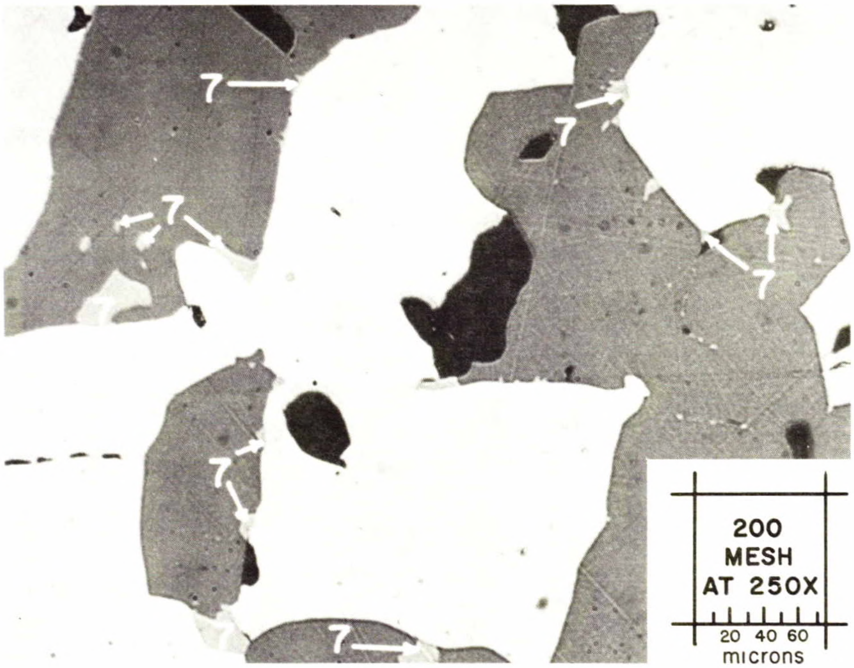

Figure 9. Photomicrograph showing small inclusions of stannite (7) interstitial to sphalerite (grey) and chalcopyrite (white).

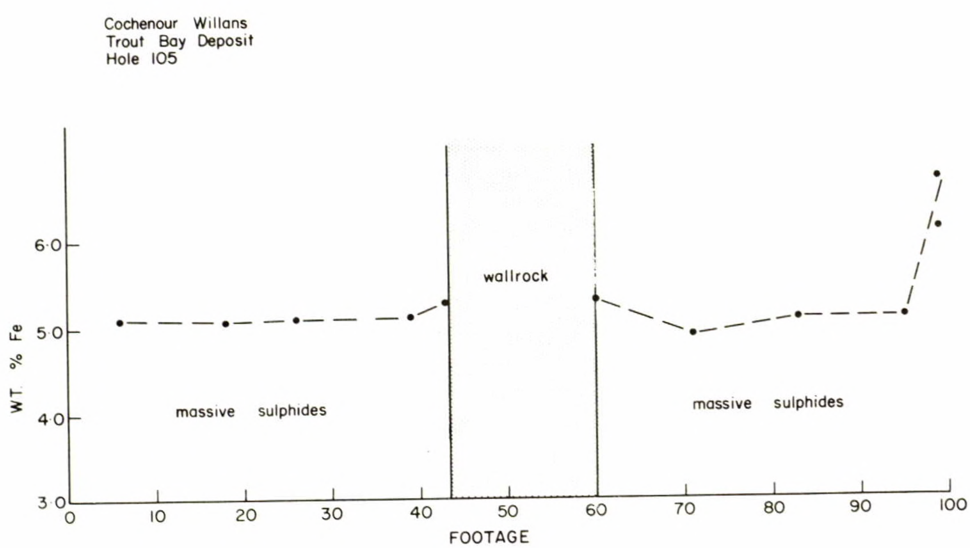

Figure 10. Diagram showing the iron content of sphalerite in the Trout Bay deposit as intersected by Hole 105. The hanging wall is at 0 footage and the footwall at 100.

South Bay Mine (No. 1 (Figure 3)

The property of South Bay Mine, a new company formed by Selco Exploration Limited, is located 50 miles east of Red Lake, northwestern Ontario, approximately 3/4 mile west-northwest of the southeast corner of Dent Township. The mine site is at Confederation Lake, only a few miles from the former mine of Uchi Gold Mines at Uchi Lake. The deposit was discovered in 1968, and production at 500 tons per day commenced in the summer of 1971.

The property was visited in July 1970 and two drill holes, designated by the company as UG2 and UG20, were sampled at approximately one-foot intervals. The two holes are approximately 300 feet apart and both intersect the main orebody, and UG20 also intersects a small off-shoot on the west side; UG2 dips 45° north, and UG20 dips 45° south.

The ore occurs within a zone approximately 50 feet wide and 600 feet long in a complex series of porphyrtic felsic metavolcanics. To date, along an east-west strike length, three massive orebodies have been outlined. Exact figures on tonnage and grade have not been published, but indications are in the order of one million tons grading 2.5% Cu, 14% Zn, and 3 oz Ag. These grades are confirmed by our analyses of a bulk sample of chips of massive sulphides selected at five-foot intervals from hole UG2. The results of the semi-quantitative spectrochemical, wet chemical analysis and assays are given in Table 3.

Mineralogy

The major ore minerals identified in the ore are pyrite, sphalerite, and chalcopyrite, with minor to trace amounts of arsenopyrite, galena, tetrahedrite, cassiterite, pyrrhotite, marcasite, scheelite, wolframite, and native bismuth.

TABLE 3

Chemical Analysis of the South Bay Sulphide Ore

Spectrochemical %		Wet Chemical %	Assay oz/ton
Cu	0.1	4.15	
Pb	0.5	0.39	
Zn	pc	17.6	
Fe	pc	20.8	
Sn	0.2	0.33	
Ni	nd	< 0.01	
Cd	-	0.10	
Mn	0.02	0.02	
Au	-		0.01
Ag	0.02		3.58
As	0.2		
Mg	0.07		
Si	pc		
Mo	0.04		
Ti	0.05		
Co	0.05		

pc = principal constituent

not detected: Ba, Bi, P, Sb, Ge, Cr, Ga, Nb, Ta, V, Be, Ca, In, Na, Zr, Sb.

The orebody, although fairly narrow, is composed of massive sulphides. In particular, sphalerite is enriched in certain layers which gives the ore a banded appearance.

Pyrite occurs mainly as euhedral crystals up to a millimeter in diameter. It is widespread and, in the sphalerite-rich sections, it occurs as disseminated individual crystals (Figure 11), but frequently forms massive zones of euhedral crystals (Figure 12). The pyrite contains very minor inclusions of sphalerite and galena, except in certain parts of the orebody in which there has been extensive fracturing with subsequent replacement and fracture filling by chalcopyrite and sphalerite (Figure 13).

Sphalerite is generally coarse-grained and, within the orebody, it occurs as thick lenses or layers of massive sphalerite. The massive sphalerite in these zones generally contains disseminated euhedral pyrite (Figure 11). The mineral often contains inclusions of chalcopyrite (Figure 14) as small as 5 microns. The composition of the sphalerite was determined in situ with the electron microprobe and the variation in iron content of the mineral was determined at intervals across the orebody for the two cores UG2 and UG20. Results of the analyses are plotted in Figure 12. The cadmium content was between 0.18 and 0.4%, manganese was less than 0.1%; and copper was not detected.

Chalcopyrite occurs as aggregates, more than one millimeter in diameter, that enclose and partially replace pyrite (Figure 16) and as 5-μ inclusions and stringers in sphalerite (Figure 14) or in pyrite. Chalcopyrite is widespread in the orebody, but tends to be associated with the pyrite.

Tetrahedrite was the only silver-bearing mineral identified in the ore. It occurs as irregular grains generally associated with chalcopyrite and galena in sphalerite. It varies in size from small inclusions (10 microns) to fairly coarse (300 microns) grains (Figure 17). The silver content of the tetrahedrite is variable, ranging from 3.7 to 21.0 wt %. Microprobe analyses of two typical grains are given in Table 4.

TABLE 4

Microprobe Analysis of Tetrahedrite from South Bay Mine

Cu	3.27	36.6
Fe	5.3	5.3
Zn	2.1	2.1
Ag	8.3	3.7
Sb	26.8	22.7
As	2.4	4.8
S	24.9	25.1
Total	102.5	100.3

Galena is quite rare in the ore and very seldom does it occur as large irregular grains. It commonly is found as small inclusions or remnants in sphalerite and occasionally in pyrite. Pyrrhotite is very rare and occurs mainly as inclusions (<50 microns) in sphalerite and chalcopyrite. Cassiterite is widespread in the massive sulphides and shows no tendency to associate with any particular mineral. It occurs as rounded 10 to 100-μ grains whose average diameter is about 40 microns. It was not observed as inclusions in pyrite, but quite often occurs in sphalerite (Figure 18).

Native bismuth, scheelite and wolframite were identified in only one polished section. The native bismuth occurs with tetrahedrite and pyrrhotite, but the scheelite and wolframite were observed in gangue. Arsenopyrite occurs as euhedral crystals mainly associated with pyrite. Marcasite is rare in the ore and occurs either associated with pyrite or as narrow rims between some of the chalcopyrite and gangue (Figure 19).

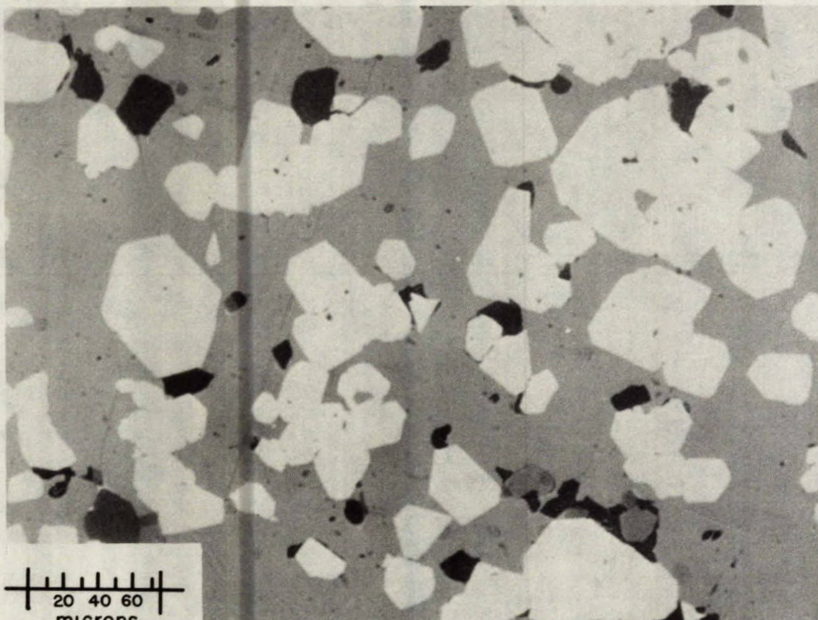

Figure 11. Photomicrograph of euhedral pyrite crystals (white) in sphalerite (grey).

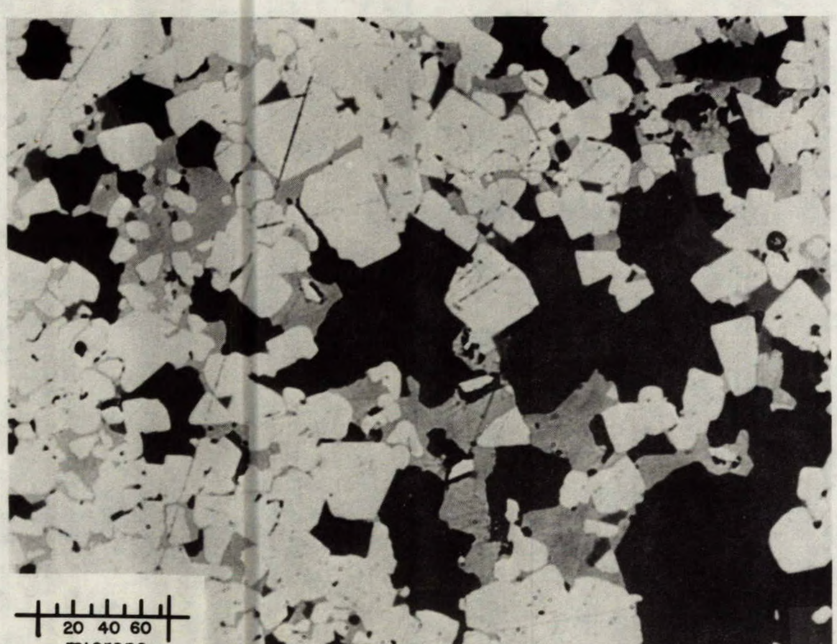

Figure 12. Photomicrograph of massive euhedral pyrite crystals (white) with interstitial chalcopyrite (grey). Fine grinding is required to liberate the chalcopyrite.

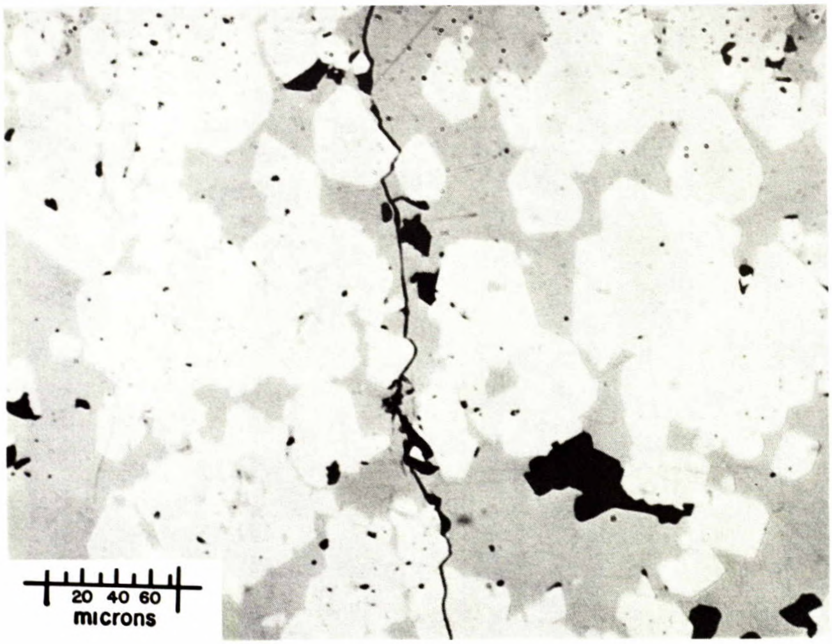

Figure 13. Photomicrograph of partly replaced pyrite (white) crystals in chalcopyrite (grey).

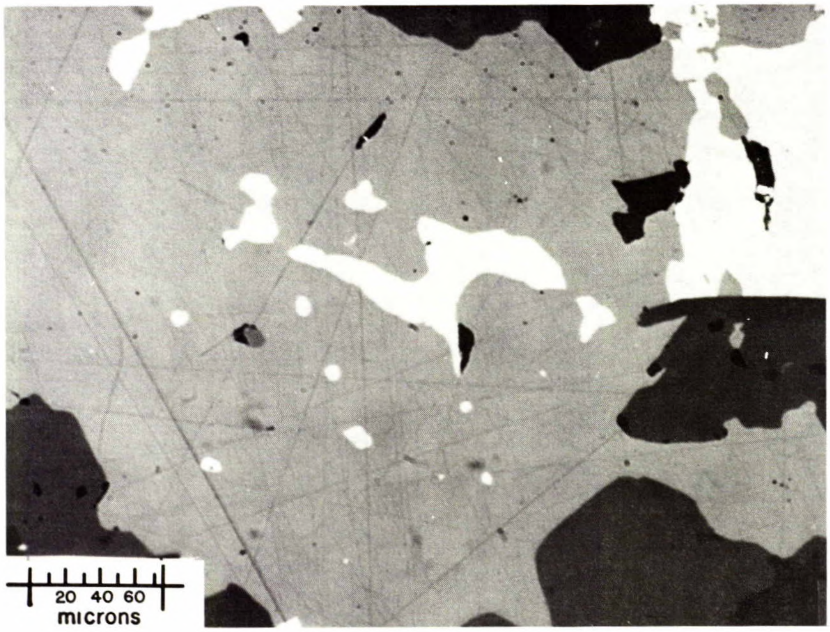

Figure 14. Photomicrograph of chalcopyrite (white) remnants in sphalerite (grey). The black areas are gangue.

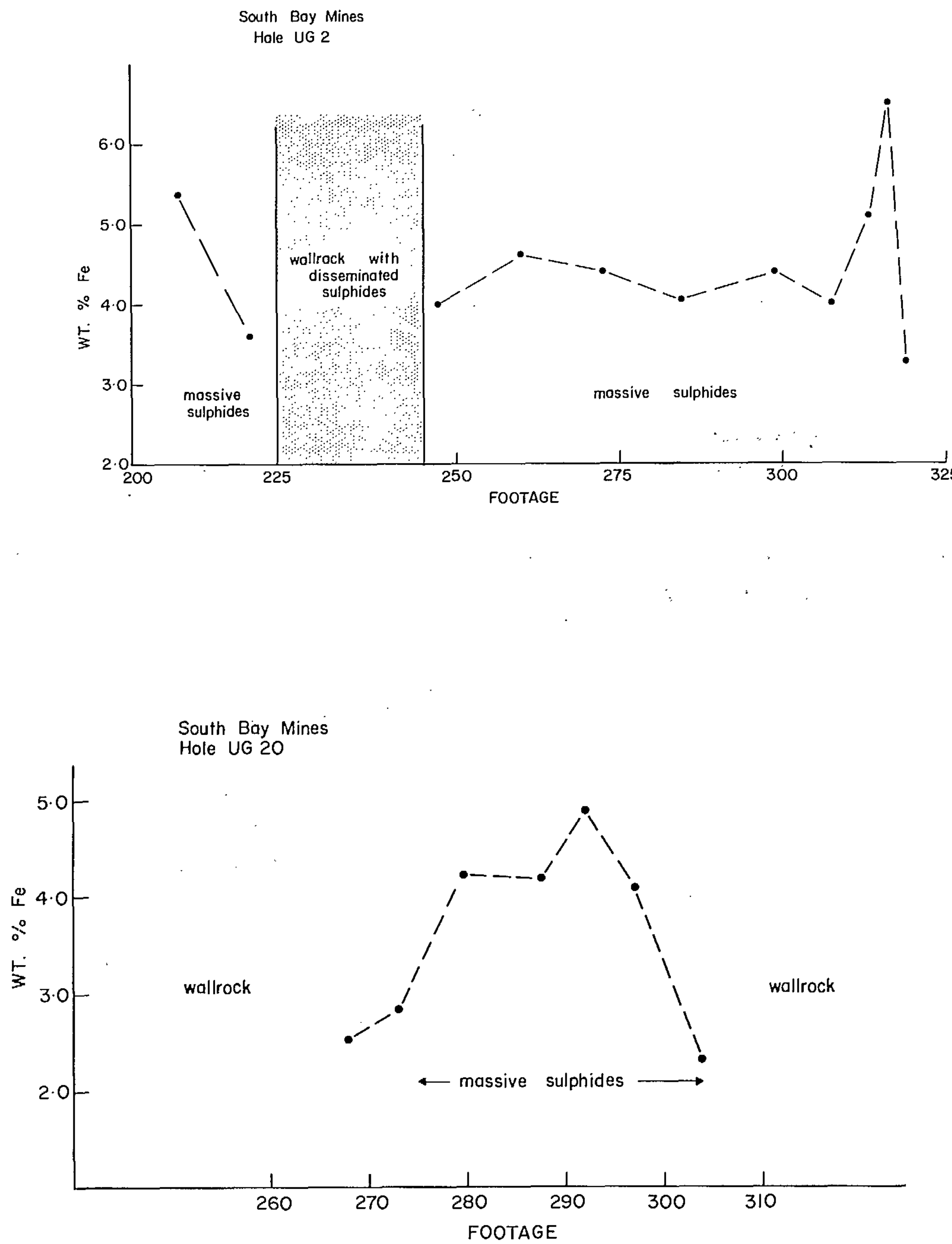

Figure 15. Diagrams showing the variation of iron content in sphalerite of the South Bay Mine deposit intersected by Hole UG2 and UG20.

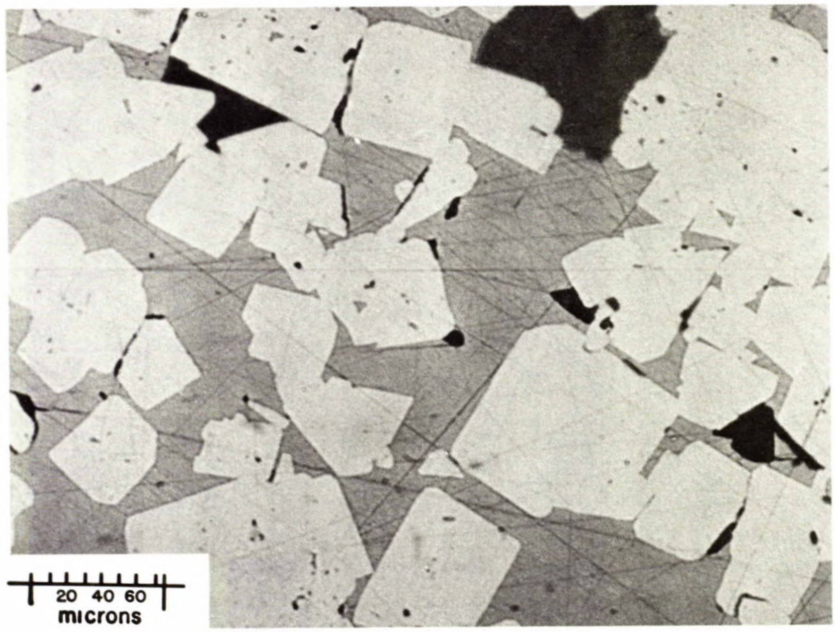

Figure 16. Photomicrograph of euhedral pyrite crystals (white) in a matrix of chalcopyrite (grey).

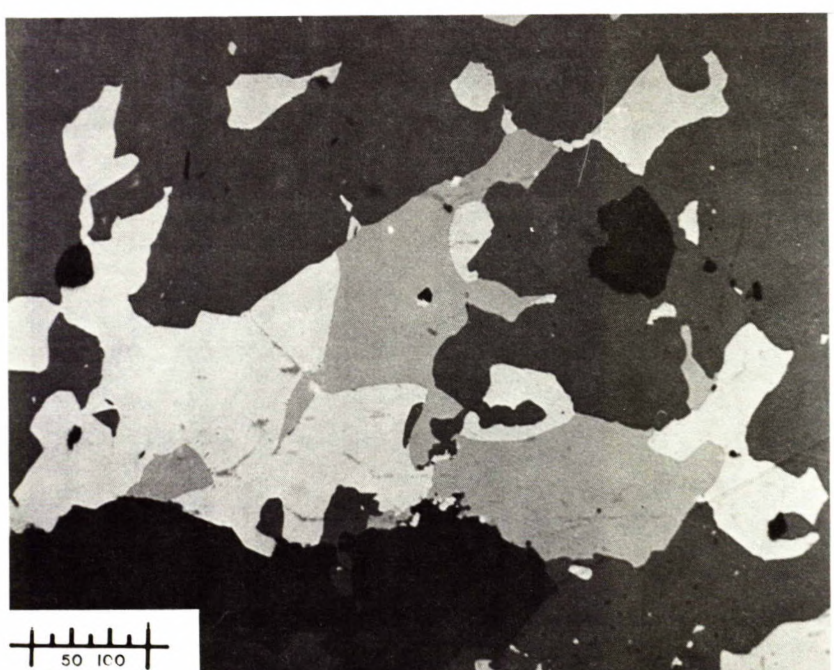

Figure 17. Photomicrograph of tetrahedrite (light grey) associated with chalcopyrite (white) in a matrix of sphalerite (dark grey). The black areas are gangue.

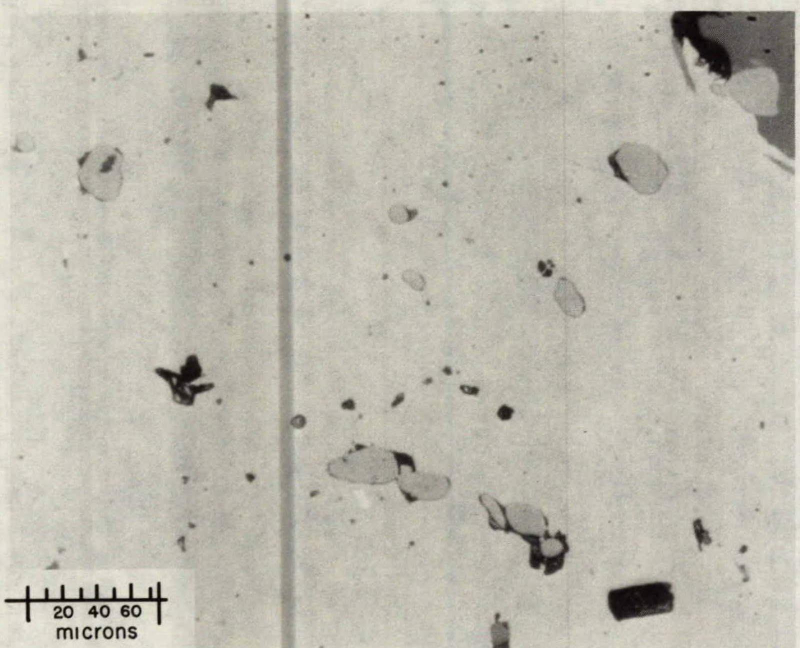

Figure 18. Photomicrograph of cassiterite inclusions (grey) in a matrix of sphalerite.

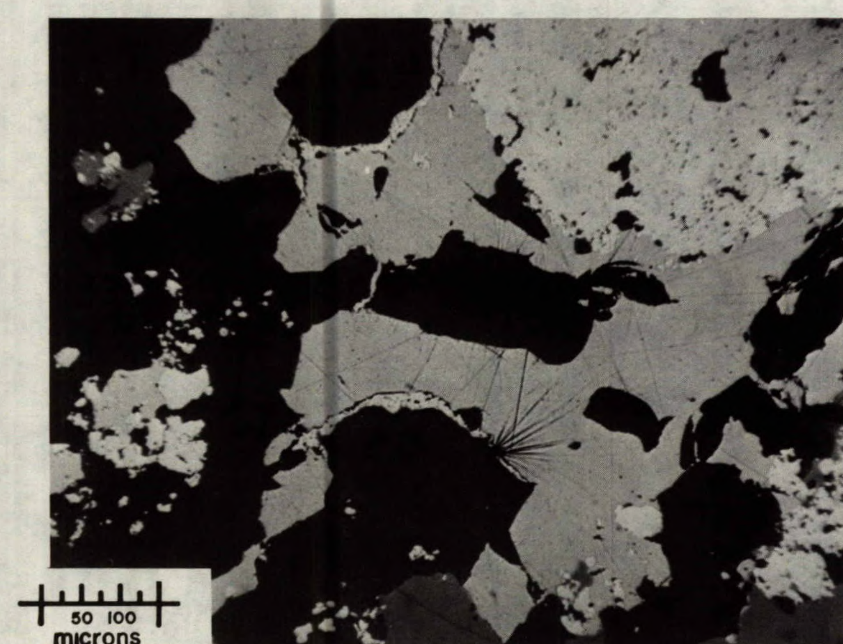

Figure 19. Photomicrograph of pyrite-marcasite (white) associated with chalcopyrite (medium grey) and sphalerite (dark grey) in gangue (black). Note how the marcasite occurs as narrow rims between some of the chalcopyrite and gangue.

Horseshoe (Elbow) Lake Prospect No. 2 (Figure 3)

The property is located on the south side of Horseshoe (Elbow) Lake, Mitchell Township (51° 00' N, 92° 45' W). Sulphide-rich hand specimens taken from the prospect were obtained from Mr. G. D. Pollock, Selco Exploration Ltd. and R.A. Riley, Resident Geologist, Red Lake.

The mineralization lies within a shear zone from 60 to 100 feet wide and has been traced for 3,400 feet along strike in paragneiss surrounded by granite rocks

Mineralogy

The ore minerals consist mainly of sphalerite and pyrite with minor chalcopyrite and galena. Cassiterite, stannite, and pyrrhotite occur in trace amounts. Pyrite occurs as euhedral to rounded crystals from 15 microns to 1 millimeter in diameter (Figure 20). The mineral commonly occurs as individual crystals distributed throughout the rock but occasionally as clusters in which case the ore becomes more massive. Sphalerite frequently surrounds and partly replaces the pyrite, but most is present as massive irregular grains interstitial to the gangue minerals. Pyrrhotite was observed only as small inclusions ($<40\mu$) in sphalerite, and galena and chalcopyrite occur either as inclusions in sphalerite or as irregular grains in the gangue. The pyrite is relatively free of inclusions.

Cassiterite, which seldom is larger than 30 microns, is associated with the gangue minerals and occasionally enclosed in sphalerite. The stannite occurs as irregular grains in contact with sphalerite.

The mineralogy and ore textures closely resemble those found in the South Bay Mine deposit, which suggests that the minerals were deposited under similar conditions.

Snakeweed Lake Prospect No. 5 (Figure 3)

The Snakeweed Lake Prospect, a property of Rexdale Mines Ltd., is located approximately 3/4 mile southeast of Snakeweed Lake (Lat. 50° 45' N., Long. 92° 45' W.).

The mineralization occurs in coarse-grained, garnetiferous biotite schists and amphibolites and a metamorphic phase of highly sheared basic tuffs (Shklanka, 1969, p. 174). Samples were taken from the mineralized zones in the core of Drill Hole 79-17 between 183 and 1000 ft.

Mineralogy

Pyrrhotite, chalcopyrite, sphalerite, pyrite, and galena occur as blebs, veinlets, and disseminations, mainly interstitial to the mafic gangue minerals. Minor chalcopyrite and pyrrhotite also occur in the sections of magnetite-rich iron formation intersected by this hole. Other minerals which occur in minor to trace amounts are cubanite, ilmenite, cassiterite, stannite, bismuthinite, native bismuth, native silver, a silver telluride (hessite?), and mackinawite.

Pyrrhotite and chalcopyrite both occur in major amounts. The pyrrhotite is mainly the monoclinic or iron deficient magnetic variety with minor amounts of the non-magnetic hexagonal variety. Nickel and copper were not detected in the pyrrhotite by electron microprobe analysis. The pyrrhotite grains are from several millimeters to a few microns in diameter. The mineral occurs as irregular grains interstitial to the gangue minerals (Figure 21) often associated with chalcopyrite and minor amounts of sphalerite and galena

Chalcopyrite commonly occurs as irregular grains from a few microns to several millimeters in diameter and is often associated with pyrrhotite and sphalerite. In certain portions of the drill core, the chalcopyrite occurs as partially replaced irregular grains, in gangue, which appear to have been redistributed (Figure 22). A polished section of the drill core taken at

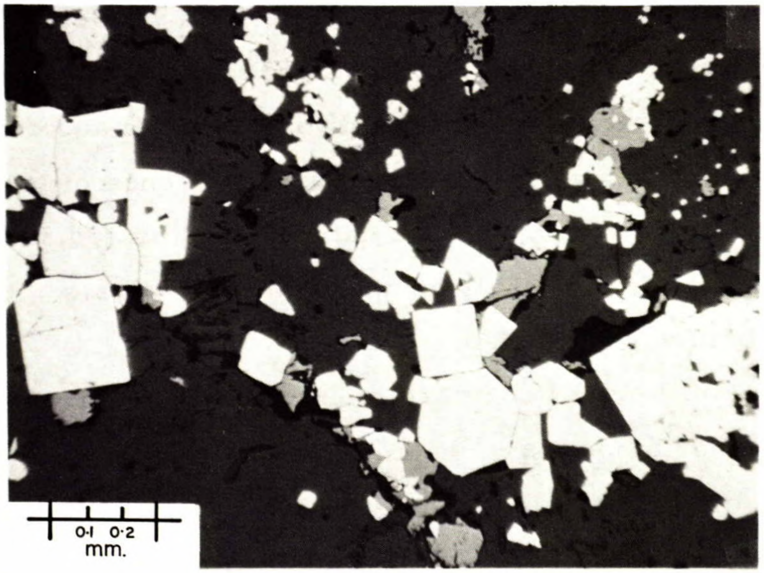

Figure 20. Photomicrograph of euhedral pyrite with interstitial sphalerite (grey) in a matrix of gangue.

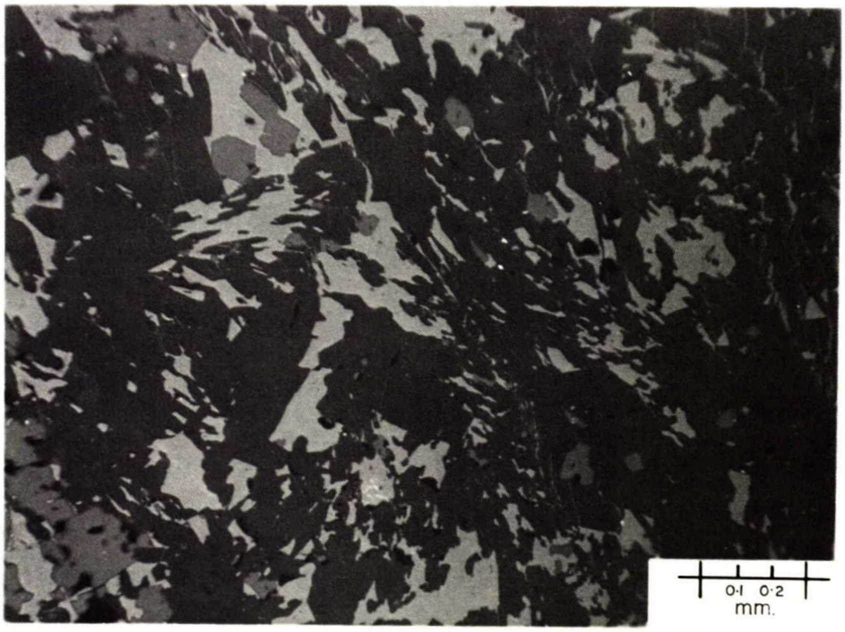

Figure 21. Photomicrograph showing the textural relationships of sulphides in the fibrous gangue minerals. The light grains are pyrrhotite and chalcopyrite and the grey ones are sphalerite.

542 feet, shows chalcopyrite occurring either as veinlets in pyrrhotite or as narrow veins around sphalerite grains (Figure 23) in pyrrhotite. The veinlets of chalcopyrite are associated with cubanite and contain numerous inclusions of mackinawite (Figure 24). The presence of mackinawite suggests that this portion of the ore had re-equilibrated at low temperatures. The mackinawite was too small for quantitative analysis, but traces of nickel and cobalt were detected.

Portions of the drill core are iron formations that contain massive magnetite. Minor amounts of chalcopyrite and pyrrhotite occur interstitial to the grains of magnetite (Figure 25) which grades with depth to a sulphide-rich zone. Nickel was not detected in the magnetite.

Sphalerite and galena occur in minor amounts mainly as inclusions, or in contact with pyrrhotite and chalcopyrite. The iron content of the sphalerite varies from 6.6 to 9.8 wt % Fe. Manganese and cadmium were not determined. Minor amounts of a zinc spinel, gahnite, were identified in one section. The spinel contains approximately 25% Zn. Galena grains are seldom larger than 200 microns in diameter.

Pyrite is not abundant and occurs as euhedral crystals in both chalcopyrite and pyrrhotite (Figure 26).

The silver-bearing minerals are native silver and a silver telluride (probably hessite), both of which are rare. The silver telluride was too small for positive identification, but silver and tellurium were detected by microprobe analysis.

The tin minerals, stannite and cassiterite occur in trace amounts throughout the orebody. Neither mineral is larger than 40 microns.

Native bismuth was only identified in one polished section at 187 feet. It occurs as inclusions in chalcopyrite (up to 100 microns), often associated with galena (Figure 27). Bismuthinite is very rare and was only observed in the polished section which contained native bismuth.

Ilmenite was identified in all polished sections, essentially in the gangue.

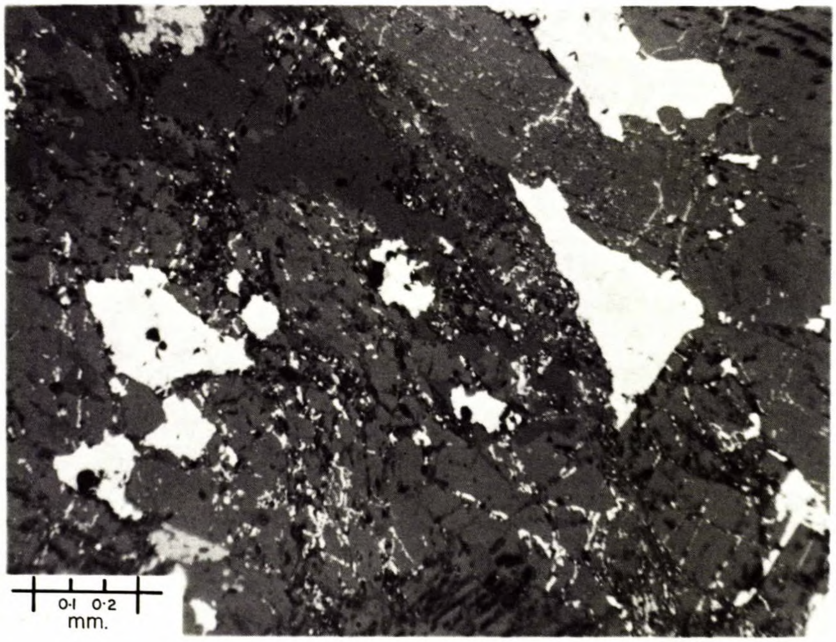

Figure 22. Photomicrograph of chalcopyrite (white) in gangue. The chalcopyrite grains appear to be redistributed throughout the gangue.

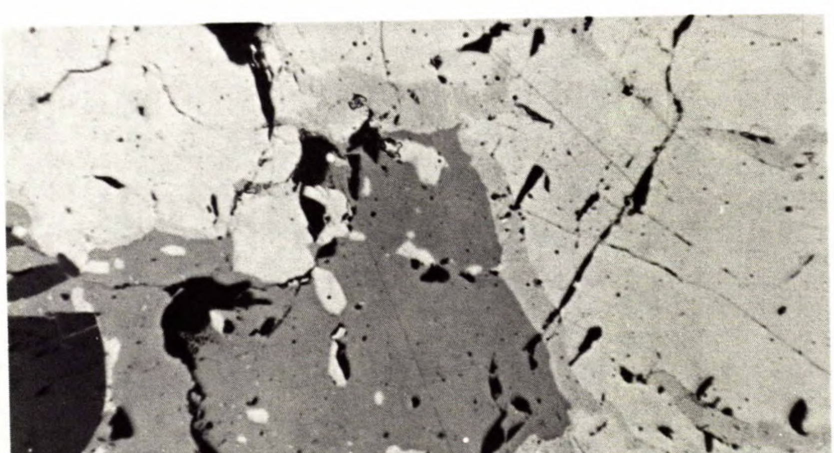

Figure 23. Photomicrograph of sphalerite (dark grey) rimmed by chalcopyrite (light grey) in a matrix of pyrrhotite.

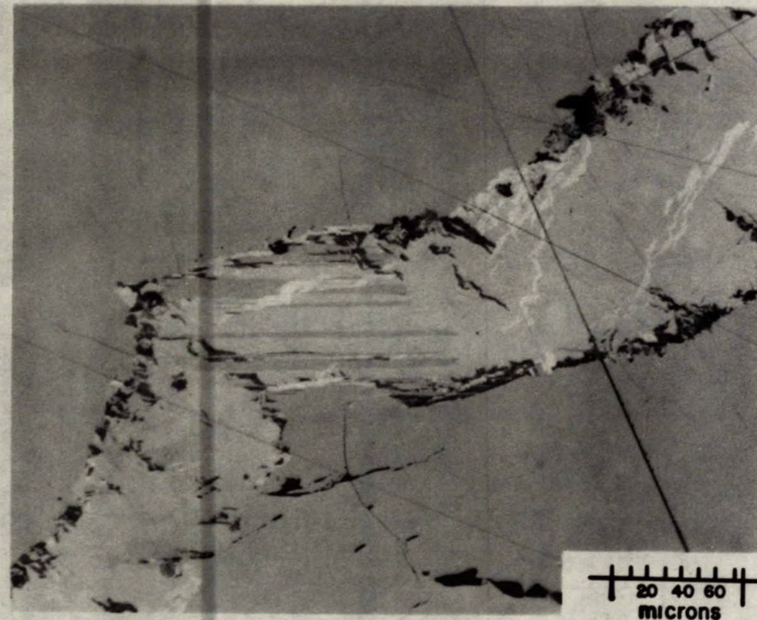

Figure 24. Photomicrograph of mackinawite flames (dark grey) in a veinlet of cubanite and chalcopyrite in a matrix of pyrrhotite.

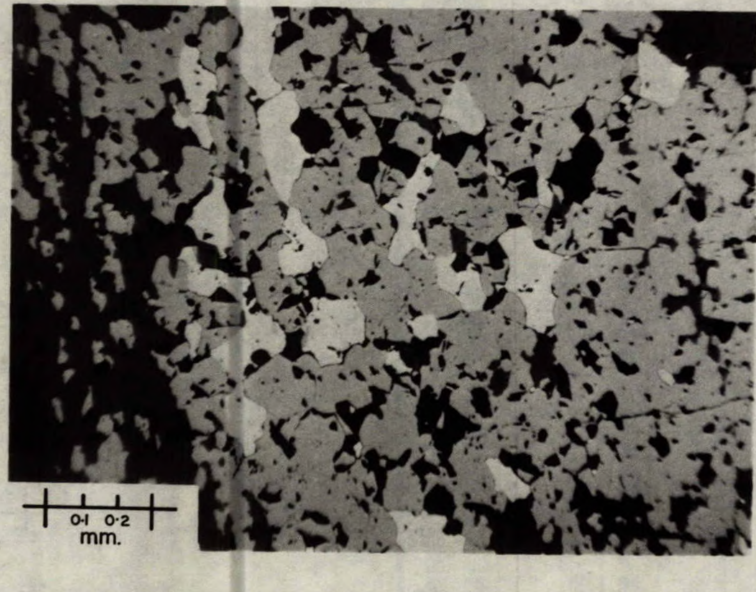

Figure 25. Photomicrograph of chalcopyrite and pyrrhotite occurring interstitial to magnetite in the iron-rich zones.

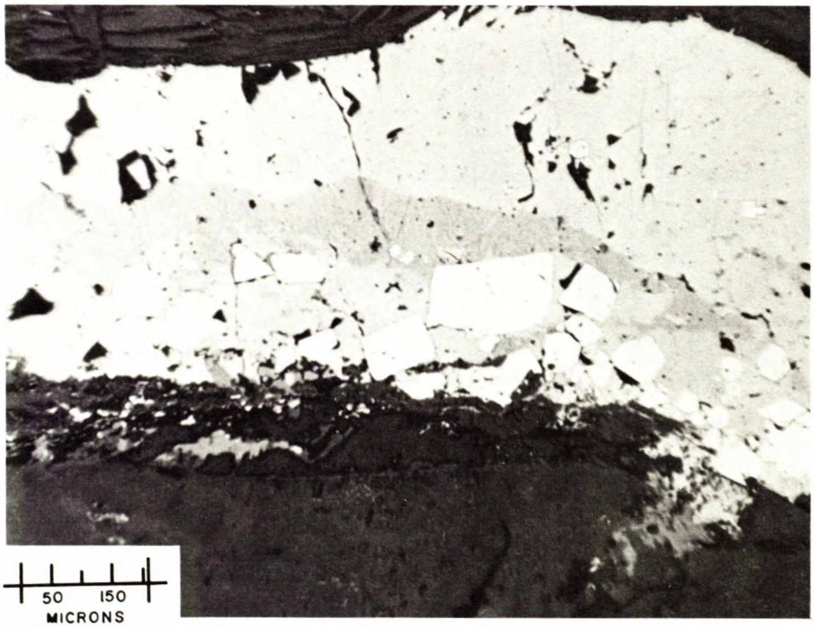

Figure 26. Photomicrograph of euhedral pyrite (white) in a veinlet of pyrrhotite (light grey) and chalcopyrite (medium grey). The dark border minerals are gangue.

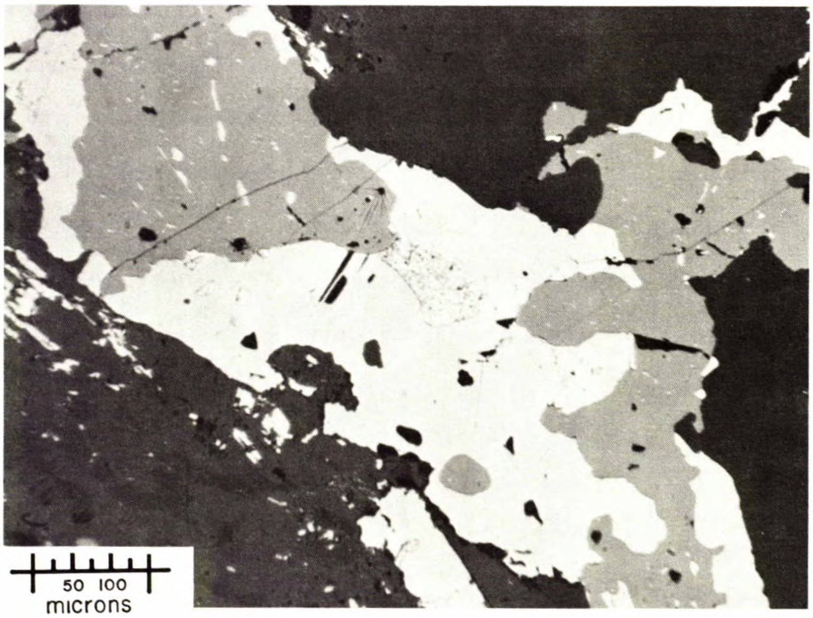

Figure 27. Photomicrograph of chalcopyrite (white) with inclusions of native bismuth (pitted) associated with sphalerite (grey), itself containing inclusions of chalcopyrite.

Copper Lode Deposit No. 3 (Figure 3)

The Copper Lode deposit is located in Belanger township, approximately 1 mile southeast of Fredart Lake.

A brief summary of the geology as reported by Shklanka (1969, p. 145-146) is as follows: Four NE-trending mineralized zones are present. The two westerly zones are 1,200 feet and 700 feet long and contain en echelon pods of mineralization in coarse-grained garnetiferous amphibolite along its contact with a thick metadiorite sill. The two easterly zones are 1,700 feet and 800 feet long, and mineralization is confined to shear zones in metasediments.

Economic mineralization has been encountered in only the most easterly zone where drilling has outlined a body 800 feet long and about 14 feet thick, which contains 0.83% Cu, 4.57% Zn, and 0.36 oz/ton Ag.

A recent announcement in the Northern Miner (Jan. 20, 1972, states that a feasibility study has been completed and a proposal has been detailed to develop 241,874 tons that contains 1.94% Cu and 1.22 oz/ton Ag by a low-angle decline from the surface to a vertical depth of 400 feet. The proposal involves underground development, mainly in the mineralized zone, a small open pit, and a portable mill to treat 300 tons per day.

At the time of this investigation, a hand specimen was obtained from R.A. Riley, Resident Geologist. In this specimen, the sulphides occur in a very coarse-grained garnetiferous amphibolite containing large grains of quartz. Radial clusters of dark green actinolite needles and phenocrysts of garnets are prominent.

Mineralogy

Pyrrhotite, chalcopyrite and sphalerite are the main sulphides, and pyrite and galena occur in minor amounts. The sulphides are fairly coarse-grained (up to 3 millimeters in diameter) and occur interstitial to the gangue minerals. Minor ilmenite is disseminated throughout the rock.

Fredart Lake Prospect No. 4 (Figure 3)

The Fredart Lake prospect lies in the western portion of Belanger township.

One hand specimen, from the mineralized zone, was obtained from R.A. Riley.

Mineralogy

The mineralization consists mainly of sphalerite with minor amounts of pyrite, pyrrhotite, galena, chalcopyrite, marcasite, and ilmenite in a matrix of quartz and calcite.

Sphalerite occurs as coarse, irregular grains, several millimeters in diameter. Pyrrhotite was observed only as inclusions (1-100μ) in sphalerite; galena and pyrite occur as inclusions in, but more commonly as coarse, interlocking grains, with sphalerite. Marcasite is rare and occurs intergrown with pyrite. Ilmenite occurs only as irregular grains up to 300 μ in the gangue. Chalcopyrite, which is sparse, is very seldom larger than 100 μ and is found as inclusions in sphalerite but, more frequently, as irregular grains in the gangue.

LOW-GRADE DISSEMINATED SULPHIDE DEPOSITS

Trout Bay Nickel Prospect No. 2 (Figure 2)

The mineralization occurs in an antigorite-tremolite schist which lies along the stratigraphic top of a chert-magnetite iron formation. It has been traced intermittently for a distance of 2¾ miles in a northwest-southeast direction. The schist represents a sheared and altered basal portion of a metagabbro sill. More detailed information is given by (Shklanka (1969), p. 155, and Pye (1968) p. 10-12.

Several hand specimens from this low-grade Ni-Cu-bearing metagabbro were obtained from R.A. Riley; the specimens were from the property of Cochenour Willans Gold Mines Ltd.

Mineralogy

Magnetite is the most abundant ore mineral in the metagabbro, and the specimens examined in this study contain approximately 30% of the mineral. It occurs as subhedral to euhedral 10- to 200-micron grains (Figure 28). Electron microprobe analysis of the magnetite gave a nickel content of 0.2 wt %.

Minor amounts of violarite, chalcopyrite, and pyrite were found in the samples studied. They occur either as disseminations interstitial to the magnetite grains or as clusters which form elongate lenticles up to 3/4 inches long and $\frac{1}{4}$ inch wide.

Violarite and chalcopyrite are the most abundant of the sulphides. with violarite being the major nickel-bearing mineral. It is generally coarse-grained where it occurs in the lenticles but is finer-grained (10 to 50 microns) with the magnetite (Figure 29). Analysis of the violarite gave approximately 31% nickel. In polished sections the violarite shows a pitted texture, suggestive of alteration. Earlier investigation of the Trout Bay nickel deposits by Kuryliw (1963) suggested that the original mineral was pentlandite with alteration to violarite near the surface. It was not possible in this study to determine that the violarite grains were intimate intergrowths of pentlandite and violarite or pure violarite. Chalcopyrite is the copper-bearing mineral identified in the specimen and, like violarite, is coarser-grained where it occurs in the lenticles but finer-grained (10 to 40 microns) with the magnetite.

Pyrite compositions are rather complex; as shown by microprobe analyses, three varieties were identified as follows: pyrite with no nickel or cobalt; pyrite with approximately 1.6% nickel and no cobalt; pyrite with approximately 2.5% cobalt and 0.2% nickel. Optically, only the higher-nickel pyrite could be distinguished because of its highly fractured appearance (Figure 30).

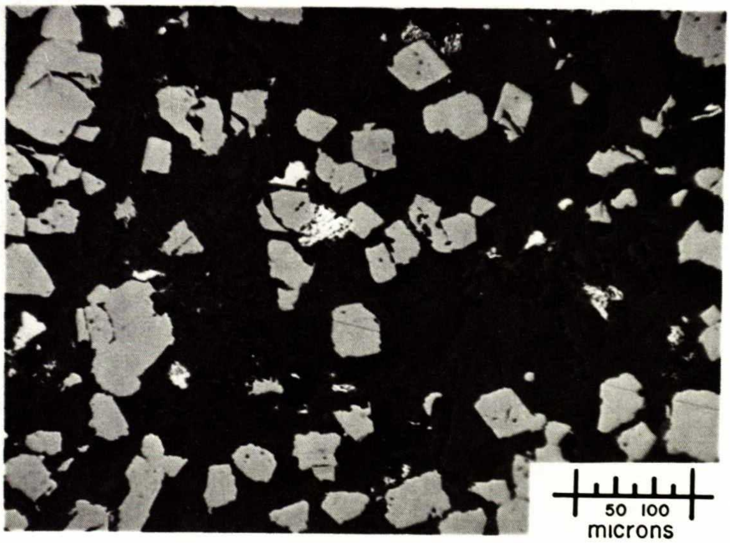

Figure 28. Photomicrograph of subhedral grains of magnetite (grey) with disseminated interstitial sulphides (white) of violarite and pyrite. The dark matrix is gangue.

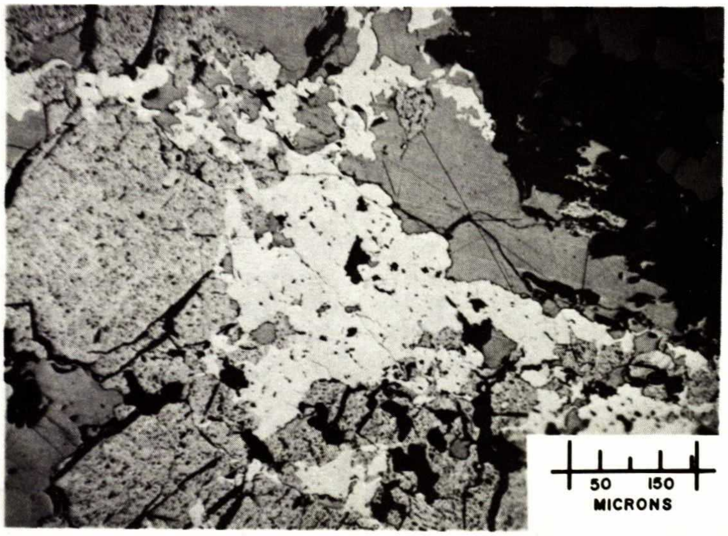

Figure 29. Photomicrograph of violarite (pitted surface) with pyrite (white) and chalcopyrite (medium grey) as they occur in the lenticles.

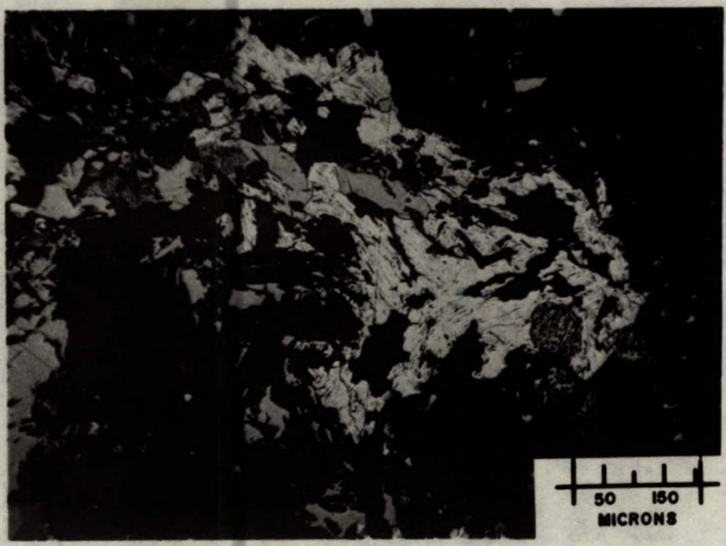

Figure 30. Photomicrograph of fractured pyrite with pitted violarite and chalcopyrite (grey).

VEIN-TYPE OCCURRENCES

Middle Bay Mines Ltd. No. 4 (Figure 2)

The sulphide deposit of Middle Bay Mines Ltd. is located northwest of the west end of Trout Bay in the south-central part of Ball Township. The deposit occurred in an area that is underlain by Archean basalt which is intruded by quartz porphyry. A number of shear zones contain quartz veins, several hundred feet long and, usually, not more than 3 feet wide. The highly weathered rusty quartz veins contain small massive veinlets of galena.

Mineralogy

In polished section, the galena is coarse-grained and, in places, intensely altered to anglesite. Minor amounts of sphalerite and argentian tetrahedrite occur as up to 200-μ inclusions in galena. Pyrite, chalcopyrite, and pyrrhotite occur as small (200-micron) irregular grains interstitial to the gangue minerals.

Electron microprobe analysis of the tetrahedrite gave Cu 14.0, Fe 5.0, Zn 1.0, Ag 34.1, As 0.5, Sb 25.9, S 20.9, total 101.4 wt %. This corresponds to the formula $(Ag_{6.0}Cu_{4.0}Fe_{1.6}Zn_{0.4})(Sb_{4.0}As_{0.12})S_{12.52}$.

This tetrahedrite, like that reported from the Galena Island showing, contains an unusually high silver content. In fact, this tetrahedrite has a higher silver content than any reported in the literature, to the author's knowledge.

Galena Island Showing No. 5 (Figure 2)

The Galena Island deposit is located in Ball township, on the south side of an island $\frac{1}{4}$ mile west north-west of West Narrows. It lies in an east-west trending carbonate zone up to 400 feet thick, bordered on the north by quartz porphyry and metavolcanic rocks and on the south by metavolcanics. The carbonate is cut by numerous quartz stringers and veins. The mineralization occurs in a few irregular veinlets up to 2 inches thick within the commonly silicified carbonate and extends for at least 800 feet. A selected grab sample is reported to have run 12 oz/ton Ag and 0.45 oz/ton Au.

Mineralogy

The mineralization consists mainly of galena and pyrite, both of which occur as coarse, irregular grains, a few millimeters in diameter. The pyrite tends to be euhedral, while the galena is slightly altered to anglesite. Sphalerite is fairly abundant, but occurs as finely disseminated grains (20 microns or less) in gangue. Traces of pyrrhotite, partly altered, were noted.

The only silver-bearing phase is tetrahedrite which occurs as inclusions in, or associated with, galena. Electron microprobe analysis gace Cu 14.8, Fe 4.7, Zn 1.2, Ag 33.0, As 0.4, Sb 26.4, S 21.3, total 101.8 wt %, corresponding to the formula $Ag_{5.6}Cu_{4.4}Fe_{1.6}Zn_{0.4}Sb_{4.0}As_{0.12}S_{3.15}$. The silver content of the tetrahedrite is exceptionally high, almost identical to that reported from the Middle Bay Mines Ltd. showing.

Alcourt Mines Ltd. No. 6 (Figure 2)

The prospect of Alcourt Mines Ltd. is located in Fairlie township, approximately 3½ miles west of McKenzie Island.

Mineralogy

The hand specimen shows coarse crystalline galena disseminated in quartz veins. In polished section, the mineralization consists of coarse-grained galena (several millimeters in diameter slightly altered to anglesite with several large grains of pyrite. The pyrite contains minor inclusions of galena. Traces of chalcopyrite and a silver telluride (probably hessite) were noted. The telluride occurs as small inclusions in galena but is too small for positive information.

Fox Farm Showing No. 7 (Figure 2)

The Fox Farm showing is located in Willans township on the east shore of the north end of Gullrock Lake.

Mineralogy

Two hand specimens of massive galena in a quartz host rock were examined. Polished section examinations revealed that galena, sphalerite, and anglesite were the major components with minor to trace amounts of marcasite, pyrrhotite, chalcopyrite, and pyrite. The galena, sphalerite, and marcasite occur as coarse, irregular grains several millimeters in diameter. The pyrite occurs intergrown with the marcasite, and chalcopyrite occurs mainly as fine inclusions in sphalerite. Pyrrhotite is rare and is very seldom larger than 100 microns. No silver-bearing minerals were identified.

The anglesite is fairly abundant throughout the specimens. It occurs interstitial to the sphalerite and galena but more frequently around the galena, which is slightly altered.

Peterson Red Lake Mines Ltd. No. 3 (Figure 2)

The property is located in northwest Byshe township and in southwest Balmer township, about two miles east of the town of Red Lake. The property is underlain by metavolcanics and metagabbro, both of which are cut by lenses of a medium to coarse-grained grey-green rock, termed quartz porphyry in the field. The porphyry is composed primarily of quartz, sericite, altered plagioclase, minor chlorite and carbonate, and about 1% sulphides. Disseminated sulphides occur in the lenses of the altered quartz porphyry and, where shearing has left the rock with a pronounced foliation, cobalt bloom is commonly present on the foliation planes (Riley, 1969, p. 10). Hand specimens of the cobalt-bearing rock were obtained from R. A. Riley.

Mineralogy

Very minor sulphides of chalcopyrite, pyrrhotite, cobaltite and sphalerite occur, finely disseminated throughout the host rock. Chalcopyrite comprises an estimated 60% of the sulphides and it occurs as individual, up to 200-micron grains, or as composite grains with pyrrhotite and minor sphalerite. Magnetite and ilmenite are also present in minor amounts.

The cobalt bloom which is commonly observed on the foliation planes is due to alteration of euhedral crystals of cobaltite (up to 200 microns). Electron microprobe analysis of cobaltite gave Co 33.85, Fe 1.10, Ni 0.78, As 44.34, S 19.73, total 99.80%.

SUMMARY

The small massive copper-lead-zinc deposit of the South Bay Mine is the only viable deposit of this type discovered to date in the Red Lake Mining Division. The South Bay Mine, which commenced production in 1971, appears to be a forerunner of several other small producers in this area. The principal sulphides in these deposits are pyrrhotite and/or pyrite, sphalerite, and chalcopyrite, with very minor arsenopyrite and galena.

Of the deposits in the Confederation-Uchi Lake area, the South Bay Mine and the Horseshoe Lake deposits exhibit similar mineralogical features. These deposits are characterized by the deposition of euhedral pyrite, followed by sphalerite and chalcopyrite, while pyrrhotite and galena are very minor. The outstanding feature of the South Bay deposit is its unusually high tin content (0.03 wt %) which occurs in the ore as the mineral cassiterite. Base-metal deposits with a tin content this high have not been previously reported in Canada.

The other base-metal deposits in this area, located in the vicinity of Fredart Lake, are characterized by zones of disseminated pyrrhotite, chalcopyrite, and sphalerite, with a wide variety of minor to trace minerals. Besides minor galena and pyrite, trace amounts of cassiterite, cubanite, stannite, native bismuth, native silver, a silver telluride, and mackinawite were identified. One of the more promising formations for mineralization in this area, is a coarse-grained garnetiferous-biotite schist or amphibolite as found in both the Copper Lode and Snakeweed Lake deposits. The textural features of the sulphides, in both hand specimen and polished section, indicates later deformation or metamorphism of the sulphide minerals. This has resulted in dissemination of the sulphides throughout the gangue minerals, as typified in the Snakeweed Lake deposit; this dissemination could reduce their recoverability during beneficiation.

The only viable base-metal deposit discovered to date in the vicinity of Red Lake is the Trout Bay sulphide occurrence of Cochenour Willans Gold Mines Ltd. The principal sulphides in this deposit are pyrrhotite, sphalerite, and chalcopyrite, with minor amounts of pyrite, arsenopyrite, and galena. The antimony minerals, identified during beneficiation tests carried out by the Mines Branch in 1969, are very rare and appear to have a restricted distribution in the ore.

ACKNOWLEDGEMENTS

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My thanks also to the technical staff of the Mineralogy Group; P. O'Donovan for the polished sections, D.R. Owens and D. Lister for the drafting, and R.G. Pinard for the photomicrographs.

REFERENCES

1. Cabri, L.J. (1969): Mineralogical Examination of a Complex Ore from the Red Lake District of Ontario, submitted by Cochenour Willans Gold Mines Ltd. Mines Branch Investigation Report IR 69-25, Dept. Energy, Mines and Resources, Ottawa.

2. Cabri, L.J., Harris, D.C. and Stewart, J.M. (1970): Paracostibite (CoSbS) and Nisbite ($NiSb_2$), new Minerals from the Red Lake Area, Ontario Canada. Can. Min., 10, p. 232-246.

3. Horwood, H.C. (1940): Geology and Mineral Deposits of the Red Lake Area, Ontario. Dept. of Mines Ann. Rept., 49, Pt.2.

4. Kuryliw, C.J. (1963): The Geology of the Trout Bay Nickel Deposits, Red Lake District, Northwestern Ontario. Unpubl. M.Sc. Thesis, University of Manitoba.

5. Pye, E.G. (1968) Editor: Summary of Field Work, 1968 by the Geological Branch, Ont. Dept. Mines, Misc. Paper 22.

6. Riley, R.A. (1969): Annual Report of Resident Geologist's Section Geological Branch. Ont. Dept. Mines, Misc. Paper 23.

7. Stemerowicz, A. and Bruce, R.W. (1969): Concentration of a Complex Base-Metal Ore from the Red Lake District of Ontario Submitted by Cochenour Willans Gold Mines Limited. Mines Branch Investigation Report IR 69-87, Dept. Energy, Mines and Resources, Ottawa.

8. Shklanka, R. (1969) Editor: Copper, Nickel and Zinc Deposits of Ontario. Ont. Dept. Mines, Min. Res. Circ. 12.