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Geology of

Elmhirst and Rickaby Townships

District of Thunder Bay

By

W.O. Mackasey and H. Wallace

1978

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CONTENTS

Tables

Figures

Photographs

Geological Maps

(back pocket)

Map 2373 (coloured)–Elmhirst and Rickaby Townships, District of Thunder Bay.

Scale 1 inch to ½ mile (1:31,680).

ABSTRACT

This report describes the geology, mineral deposits and exploration history of Elmhirst and Rickaby Townships a 186 km² (72 square mile) area, east of Lake Nipigon which is about 190 km (120 miles) northeast of the city of Thunder Bay.

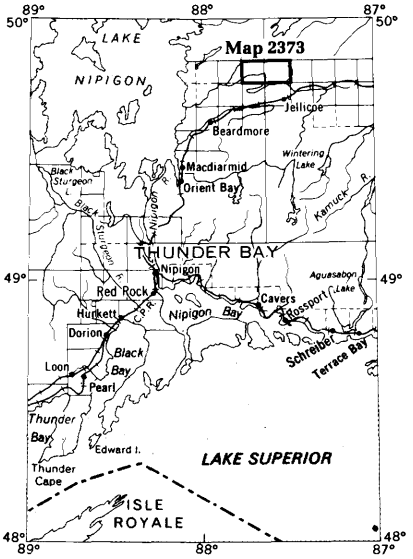

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Figure 1–Key map showing the location of Elmhirst and Rickaby Townships. Scale 1:3,168,000 (1 inch to 50 miles).

The map-area is underlain by metavolcanics and igneous intrusive rocks of Precambrian age, but a large part is covered by Pleistocene sand and Recent swamp deposits. The oldest rocks are Early Precambrian (Archean) metavolcanics ranging from mafic to felsic in composition. More than half the map-area is underlain by intermediate to felsic metavolcanics. Most of these are pyroclastic rocks, such as tuff-breccia, crystal tuff and bedded tuff, but massive, amygdaloidal, flow-banded and spherulitic flows are also common. These felsic to intermediate rocks are in conformable contact with a mafic sequence of massive, amygaloidal and pillow lavas and related breccias, which occurs in the southern and eastern parts of Rickaby Township. The metavolcanics are intruded by Early Precambrian subcircular stocks of granodiorite, a sill-like body of gabbro, and numerous minor intrusions ranging from granitic to lamprophyric and pyroxenitic in composition. All of these rocks have been metamorphosed to the greenschist facies and are intruded by north-trending Late Precambrian Keweenawan diabase dikes which cut all of the older rocks.

The map-area lies within the Wabigoon Belt of the Superior Structural Province. The metavolcanics in the map-area form the southern limb of a broad west-trending regional fold, and are locally only moderately deformed, with primary volcanic features well preserved. Faults do not form prominant topographic features, but several faults have been inferred at major lithologic contacts.

Deposits of gold, silver, copper, zinc, lead, nickel, molybdenum, sand and gravel are present. Gold, known in the region since the 1930s, is associated with quartz veins cutting metavolcanics, and with sulphide deposits within the metavolcanics. Disseminated base metal sulphide deposits occur within the felsic metavolcanics, particularly in sheared and brecciated rock. A deposit of copper-nickel sulphide minerals occurs in the gabbroic sill in northwestern Elmhirst Township, and nearby, molybdenite occurs locally within a granodiorite stock. The origins of the metallic deposits are considered.

Continued exploration for both gold and base metals are recommended. Geochemical techniques may be applicable to molybdenum-copper-gold exploration in felsic intrusions, and to base metal sulphide exploration in the metavolcanics. Further detailed mapping and drilling may indicate structural or stratigraphic controls of base metal sulphide minerallization. Transportation, communication and energy sources are available for the rapid development of mineral commodities.

Geology of

Elmhirst and Rickaby Townships

District of Thunder Bay

by

W.O. Mackasey[1] and H. Wallace[1]

INTRODUCTION

Elmhirst and Rickaby Townships form a rectangular area of about 186 km^2 (72 square miles) in the Sturgeon River Gold Belt, east of Lake Nipigon. The centre of the map-area is approximately 190 km (120 miles) northeast of the city of Thunder Bay and 13 km (8 miles) northwest of the village of Jellicoe on Highway 11. The only settlement within the map-area is Camp 58 in central Rickaby Township, a temporary centre of operations for Domtar Pulp and Paper Products Limited.

The current project, which involved field work in the summer of 1972, is part of a continuing effort by the Geological Branch, Ontario Division of Mines, to update the geological mapping of this belt and to report on recent local developments in mineral exploration.

Present Geological Survey

Geological mapping and property examination for this report was carried out during the 1972 field season. Pace-and-compass traverses were run at approximately 0.4 km (¼ mile) intervals across the regional structural trend. These were supplemented by outcrop mapping along the shorelines of major lakes and rivers and along the numerous roads within the map-area. Topographic control for locating outcrop areas was provided by 1:15,840 (one inch to ¼ mile) scale vertical air photographs that were taken in 1962 and provided by the Air Photo Library, Ministry of Natural Resources. More recent air photographs of parts of the area were made available by Domtar Pulp and Paper Products Limited. Special air photographs of the map-area were taken during the field season by the Ministry of Natural Resources as an aid to the authors. Traverse lines were tied

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to recognizable features on these photographs. Surveyed lines were generally not found to be useful because of their overgrown condition.

Additional information used in the preparation of this report and Map 2373 (back pocket) was obtained from reports, maps, plans, and drill hole data on file with the Assessment Files Research Office, Ontario Division of Mines, Toronto.

The geological maps of the area were prepared on base maps having a scale of 1:15,840 (1 inch to ¼ mile) prepared from Forest Resources Inventory maps.

Uncoloured preliminary maps P.801 of Elmhirst Township and P.802 of Rickaby Township were issued by the Geological Branch, Ontario Division of Mines in February, 1973.

History of Mining and Mineral Exploration

The Sturgeon River Gold Belt was originally explored for gold during the mid-1920s after a gold discovery near Beardmore in 1925. The first discovery of gold within the map-area was made in 1931, on the north shore of Atigogama Lake, Rickaby Township. This property, which was subsequently named the Orphan Mine, operated from 1934 to 1935. It has been the only producing mine within the map-area. However, the Sturgeon River gold mine, which between 1937 and 1942 produced 73,438 ounces of gold and 15,922 ounces of silver, is located about 0.4 km (¼ mile) beyond the southwestern corner of Elmhirst Township. The discovery of gold in Pifher Township during the summer of 1934 sparked a major prospecting and staking rush throughout the area. During this period several gold prospects, within the map-area and vicinity, were discovered and subsequently explored by trenching and diamond drilling. Exploration activity in the area decreased sharply after the rush of 1934. Several of the larger gold deposits were brought into production and remained in operation until the early 1940s. Most of these mines ceased production upon the advent of the Lend-Lease Act in 1941 and the entry of the United States into the Second World War (Horwood and Pye 1955). The Leitch Gold Mine near Beardmore, continued operating until 1965. No mines are currently operating within the belt.

Following the Second World War, prospecting for gold recommenced on a reduced scale but base metal exploration activity increased because of rising prices and newly developed geophysical methods. The first base metal discovery within the map-area was made in 1947, on the property now held by Jacobus Mining Corporation Limited in northwestern Elmhirst Township. Since 1947 the property has been extensively examined on several occasions and to date a deposit of some 940,000 tons of 0.42 percent Cu and 0.41 percent Ni has been outlined within a gabbro sill (Wheadon 1971a).

Interest in Cu-Zn mineralization related to felsic metavolcanics began in the early 1950s with the discoveries of the Martin and Kenty Showings, northeast of Seven-Foot Falls southwest Rickaby Township. Several companies including Noranda Mines Limited, Rio Tinto Canadian Exploration Limited and the Phelps Dodge Corporation of Canada Limited have held ground at different times in this area.

In 1959, a copper showing known as the "River Showing" was found below Barnum Green Rapids on the Namewaminikan (Sturgeon) River, Elmhirst

Township, on what is now the property of Carling Copper Mines Limited. Since that time, the metavolcanics in southwestern Elmhirst Township have been continuously explored by such companies as Norlex Mines Limited, Canadian Javelin Limited, Jupiter Minerals Incorporated and Carling Copper Mines Limited.

A molybdenite showing was found by August Mitto in 1971, in a granodiorite intrusion in northwestern Elmhirst Township. Trenching and drilling on the showing was carried out by Chemalloy Minerals Limited in the same year.

Recent exploration activity has been intense, particularly in the areas already described. Since 1969, electromagnetic, magnetometer and induced potential surveys as well as geological and geochemical mapping programs have been carried out by Chesterville Mines Limited over the Jacobus deposit. A total of 15 diamond drill holes have been drilled on the property since 1968, bringing the total number of holes to 71 since 1947.

In 1971 and 1972 Phelps Dodge Corporation of Canada Limited, which held ground in central Rickaby Township around the original Kenty and Martin showings, performed induced potential surveys and examined the geology of the area in detail. Eighteen diamond drill holes, including three deep holes, have been drilled in the vicinity of the Kenty showing since the winter of 1971/72.

Working in southwestern Elmhirst Township since 1970, Carling Copper Mines Limited have performed geological mapping, electromagnetic and induced potential surveys and to date have drilled 24 holes on their property to investigate base metal and gold occurrences. Some 27 diamond drill holes were drilled previously by W.W. Martin, Norlex Mines Limited and Canadian Javelin Limited to investigate the "River Showing". More drilling was anticipated in both areas of the property in 1972/73.

To the south of the Carling Copper Mines Limited property, Jupiter Minerals Incorporated was active in both gold and base metal exploration in 1972. Magnetometer, electromagnetic, and reconnaissance geological surveys and trenching have been carried out in an area of several old gold prospects close to the Sturgeon River gold mine. An induced potential survey and diamond drilling program are proposed for the property during 1973.

Several other companies and individuals have been engaged in various exploration activities during 1972. During the 1972 field season mining claims covered much of the map-area as outlined in Figure 8.

Access

Highway 11, the Northern Route of the Trans-Canada Highway and a line of the Canadian National Railway pass through the adjacent townships south of the map-area. A natural gas pipeline, a major electric transmission line, and a microwave communications system closely parallel Highway 11 in this area.

Access to the map-area itself, is by secondary Highway 801 which connects the southwestern corner of Elmhirst Township, where it crosses the Namewaminikan (Sturgeon) River, with Nezah on Highway 11. This all-weather road, which is maintained on the north side of the Namewaminikan River by Abitibi Pulp and Paper Company, continues toward Auden on the northern line of the

Canadian National Railway. Access to the northwestern part of Elmhirst Township is provided by a bush road which leaves the Abitibi road about 5.5 km (3½ mile) north of the Namewaminikan bridge.

A second all-weather road, maintained by Domtar Pulp and Paper Products Limited, intersects Highway 801 just south of the bridge. This road trends northeastward through the map-area crossing the Namewaminikan River about 0.4 km (¼ mile) below Seven-Foot Falls. It continues eastward past the Domtar Camp 58 on Kaby Lake, to the north side of Atigogama Lake then extends south to meet Highway 11 about 6.5 km (4 miles) east of Jellicoe.

A large number of subsidiary logging roads, most of which were in good to passable condition during the 1972 field season, provide excellent access to all parts of the map-area except south-central Elmhirst Township and southeastern Rickaby Township. Currently, logging is being carried out in northern Rickaby Township west of Kaby Lake, and in Elmhirst Township north of Wilkinson Lake. New roads are being extended north and east of the map-area.

The Namewaminikan River, the Wilkinson Lake-O'Neil Creek system, and the Kenneth Creek-Daphne Lake system are navigable by canoe with allowances for minor portages. All of the larger lakes may be used by float-equipped aircraft.

A 900 m (3,000-feet) gravel landing strip and facilities for float-equipped aircraft are available at Rolland Lake, near Jellicoe.

Accommodation, post office, and supplies are available at Jellicoe and at the nearby centres of Beardmore and Geraldton.

Previous Geological Work

According to Laird (1936, p.63), Robert Bell of the Geological Survey of Canada, and his assistant Peter McKellar, undertook the first recorded geological work in the region in 1869. Other early workers of the Geological Survey of Canada were W. McInnes,in 1894; D.B. Dowling in 1898; and W.A. Parks in 1901. The Ontario Bureau of Mines conducted studies of the iron deposits in the region in 1906 and 1907 (Coleman 1907; Moore 1907). A.W.G. Wilson in 1908 completed the field work started by the Federal government, the results of which form Memoir 1, of the Geological Survey of Canada, published in 1910.

A.G. Burrows examined the geology along the railway line in the Beardmore-Nezah area in 1916 for the Ontario Bureau of Mines (Burrows 1917).

The Windigokan Lake area and the railway to the south were mapped in 1917 by the Geological Survey of Canada (Tanton 1921). G.B. Langford mapped this area in greater detail in 1927 (Langford 1929).

Volume XLV, Part II, 1936 of the Ontario Department of Mines, by E.L. Bruce and A.C. Laird, forms a comprehensive report of the geology and mineral deposits of the area. Other, more recent workers in the region were Horwood and Pye (1955), Peach (1951), and Pye (1952). A geological compilation map (Map 2102) of the Tashota-Geraldton area was published by the Ontario Department of Mines (Pye *et al.* 1966).

In 1967, the senior author commenced a mapping program of the townships in the Beardmore-Jellicoe area for the Ontario Department of Mines and North-


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Photo 1–Flat sand plain, central Rickaby Township.

ern Affairs and has continued to work in the area since that date (Mackasey 1970b, 1971, 1972, 1975, 1976; Mackasey *et al.* 1976a,b).

Topography

Relief in this area is slight, generally less than 60 m (200 feet) with an average elevation of about 380 m (1,100 feet) above sea level. The Coyle Lake intrusion in south-central Elmhirst Township forms a topographic dome transected by linear swamps and creeks that follow fracture patterns. The other two major intrusions within the map-area locally form elevated outcrops, but are for the most part featureless and drift-covered. In the metavolcanic terrain, linear ridges of low outcrop alternate with narrow depressions filled by cedar and alder swamps, and parallel the regional east to northeast structural trend. Only in northwestern Elmhirst Township and along the Namewaminikan River around Martin Rapids do metavolcanics form topographic highs. In southwestern and northwestern parts of Rickaby Township, sand dunes and steep-sided ridges of sandy clay are in places up to 15 m (50 feet) high. However, most of the drift forms a flat plain dotted with small stagnant lakes and swamps (Photo 1).

The Namewaminikan River forms the main drainage system in the area flowing westward toward Lake Nipigon. Several tributary systems: the Dilla Lake-Atigogama Lake, the Daphne Lake-Dennis Lake-Kenneth Creek, the Wilkinson Lake-O'Neil Creek, and the Elmhirst Lake systems drain toward the south into the Namewaminikan River. Many lakes are generally sandy and quite shallow, particularly the two largest in the map-area, Kaby and Atigogama Lakes. The connecting creeks are narrow, shallow, and in some cases, fast running. Small log jams, beaver dams, and minor falls are numerous. The Namewaminikan River itself, has steep sided banks, and is quite fast-flowing within the map-area. The only major obstacles on the river within this map-area are Seven-Foot Falls and Martin Rapids.

Acknowledgments

The authors were aided in the field by R.J. Bathurst, R. Falls, D.S. Faust and J.S.R. Lee. Mr. Faust served as senior assistant and independently mapped approximately thirty-five percent of the map-area. He also undertook a study of the geology of the Jacobus Mining Corporation Limited Cu-Ni deposit as an undergraduate honours thesis at St. Francis Xavier University which has been incorporated in this report. Messrs. Bathurst, Falls, and Lee conducted independent traverses in the latter part of the field season.

Mr. K.G. Horton, Ministry of Natural Resources, MacDiarmid, completed a supplementary air photography program of the map-area for the authors during the field season. These photographs, along with photographs supplied by courtesy of Domtar Pulp and Paper Products Limited, enabled the field party to carry out a more effective geological mapping program. Mr. Bathurst compiled the road data shown on Map 2373 (back pocket) using the supplementary air photographs.

The help and co-operation of the other staff members of MacDiarmid base of the Ministry of Natural Resources is greatly appreciated.

The authors are grateful for the many profitable discussions with individuals concerning the geology and the mineral deposits of the map-area, especially: A.J. Douglas, Beardmore; P.J. Clarke, Phelps Dodge Corporation of Canada Limited; W. Miron, Rickaby Mines Limited; A. Mitto, Val d'Or; L.E. Morrison, Jellicoe; W. Plexman, Carling Copper Mines Limited; A.D.Pudifin, Consulting Geologist; O.A. Seeber, and Jupiter Minerals Incorporated.

GENERAL GEOLOGY

The Keewatin-type mafic and intermediate to felsic metavolcanics, which underlie most of the map-area, are tentatively interpreted to form part of the southern limb of a broad east-west fold as outlined by metavolcanic formations on ODM Map 2102 (Pye *et al.* 1966). The nose of this fold is east of the map-area in Lapierre Township, and the northern limb extends toward the Conglomerate Lake-Onaman River area.

TABLE 1 | TABLE OF LITHOLOGIC UNITS FOR ELMHIRST AND RICKABY TOWNSHIPS.

PHANEROZOIC

CENOZOIC

QUATERNARY

RECENT

Swamp, lake and stream deposits

PLEISTOCENE

Sand, gravel and clay

UNCONFORMITY

PRECAMBRIAN

MIDDLE TO LATE PRECAMBRIAN (PROTEROZOIC)

INTRUSIVE ROCKS

Diabase and related feldspar-quartz porphyry

INTRUSIVE CONTACT

EARLY PRECAMBRIAN (ARCHEAN)

FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

Granite, granodiorite, trondhjemite, quartz diorite, diorite and related hybrid rocks; feldspar and quartz-feldspar porphyries and pegmatite

MAFIC INTRUSIVE ROCKS

Diorite, quartz diorite, gabbro, lamprophyre, pyroxenite and andesite porphyry dikes

INTRUSIVE CONTACT

FELSIC TO INTERMEDIATE METAVOLCANICS

Tuff-breccia, lapilli-tuff, pyroclastic breccia, crystal tuff, laminated tuff, tuff and tuffaceous sericitic schist, massive, amygdaloidal and flow-banded lava, spherulitic lava, pillow lava and related breccia feldspar porphyry and quartz-feldspar porphyry

CONFORMABLE CONTACT

INTERCALATED IN PART

MAFIC METAVOLCANICS

Massive and amygdaloidal lava, volcanic breccia and agglomerate, pillow lava, chloritic schist related cherty tuff

Early Precambrian (Archean) mafic metavolcanics in Pifher Township appear to form the core of the fold and are surrounded by a thick succession of intermediate to felsic rocks which are predominant in the map-area. Most of these intermediate to felsic rocks are of pyroclastic origin. Tuff-breccia, lapilli-tuff and crystal tuff are abundant. Massive and amygdaloidal flows are common. Flow-banded and spherulitic felsic rocks occur in some areas. The intermediate to felsic succession is, in turn, enclosed by a second mafic metavolcanic sequence which occurs in the southern part of Rickaby Township. Most of this mafic sequence is comprised of chlorite schists, but massive and amygdaloidal lavas, as well as pillow lavas and flow breccias have been recognized in several places.

The metavolcanics are intruded by three relatively small stocks of massive granodiorite and by numerous minor felsic to intermediate intrusions all of Early Precambrian age. Mafic intrusions of unknown age in the form of a gabbro sill and small dikes also cut the metavolcanics.

All of the Early Precambrian rocks are intruded by north-trending Keweenawan (Late Precambrian) diabase dikes.

Pleistocene cover of sand and gravel is thick over some parts of the map-area.

Rock units observed within the map-area are outlined in Table 1.

Early Precambrian (Archean)

METAVOLCANICS

Mafic to Intermediate Metavolcanics.

Metavolcanics of basaltic to andesitic composition occur in southern and eastern Rickaby Township, and are particularly well exposed around Expansion and Atigogama Lakes. Pillow lava, massive and amygdaloidal flows, flow breccia, agglomerate and finer grained pyroclastic rocks have been identified in areas of clean lake shore outcrops. Such rock types are probably common throughout the mafic sequence, but exposures are generally poor so that the characteristic structures and primary volcanic features cannot be readily recognized. Between Daphne Lake and the southern boundary of the map-area, the mafic metavolcanics are chloritic schists which commonly contain remnant quartz-filled amygdules, volcanic clasts and plagioclase porphyroblasts. Although extensively silicified in places, most of the schistose rocks retain their original basaltic composition.

Andesitic, and rarely, basaltic flows have also been recognized within the predominantly intermediate to felsic sequence in the central part of Rickaby Township.

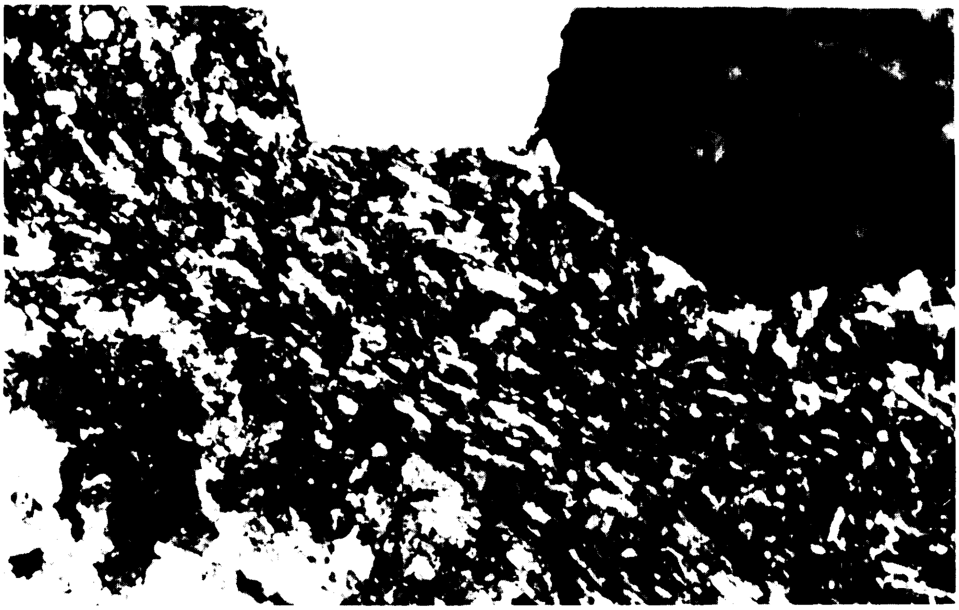

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Photo 2–Photomicrograph of pilotaxitic texture in metabasalt (crossed nicols).

MASSIVE AND AMYGDALOIDAL LAVAS

Where primary features can be recognized, massive and amygdaloidal flows are the predominant mafic volcanic rock types. These rocks are typically hard, well-jointed and devoid of flow structures, varying from aphanitic to medium-grained and from dark green to light grey. Few flow contacts were recognized, although scoriaceous zones within the massive outcrops were assumed to delineate flow tops or separate flows. Porphyritic basalts with plagioclase phenocrysts up to 5 mm long are relatively common. Basalts containing subhedral clots of intermixed biotite and chlorite, probably pseudomorphs after original ferromagnesian phenocrysts, were only observed on the northwest side of Atigogama Lake.

Amygdules occur in nearly all exposures and individual flows. Some flows or flow units appear to be entirely scoriaceous. The amygdules range up to one centimetre in diameter. Many amygdules are flattened to some degree in the plane of the foliation. Calcite, chert, and agate, crystalline quartz, epidote and chlorite are the most common materials filling amygdules. In some outcrops amygdules are zoned with quartz rimming chlorite or calcite and calcite rimming epidote.

On microscopic examination, typical basaltic features such as seriate, intergranular, diabasic and pilotaxitic textures were found to be well preserved in many of these rocks (Photos 2 and 3). In some rocks, particularly where silicifica-

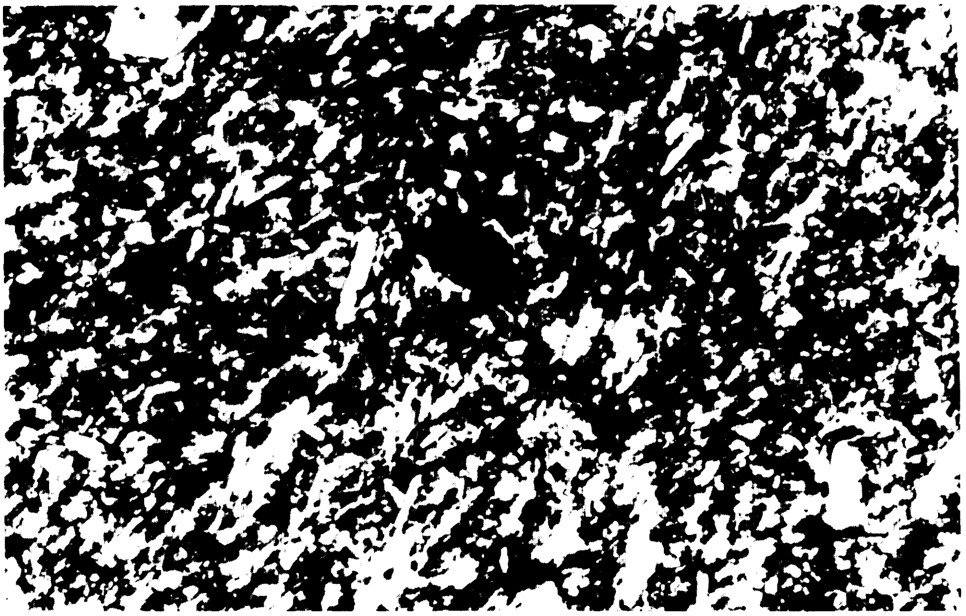

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Photo 3–Photomicrograph of seriate-diabasic texture in metabasalt (crossed nicols).

tion or feldspathization of the rock has occurred, few lath-shaped plagioclase grains are preserved and the matrix has become a fine, granular mosaic of plagioclase and quartz with abundant sericite, chlorite, biotite, and epidote. Euhedral to subhedral pseudomorphs of epidote after plagioclase phenocrysts are common in these rocks (Photo 4). In the recrystallized and feldspathized rocks, subhedral patches of granular plagioclase (An$<$10) and sericite from 5 to 10 mm long are common metacrysts. Subhedral clots of chlorite, biotite, and epidote, commonly smaller than the plagioclase metacrysts, are present and are probably pseudomorphs after augite phenocrysts. These clots occur in most of the mafic metavolcanics but are not readily apparent in hand specimen.

Although most plagioclase phenocrysts are completely epidotized, groundmass plagioclase laths, which range up to 1 mm in length, are only slightly sericitized. In all of the thin sections examined, plagioclase is albite in composition. The rocks have been metamorphosed to greenschist facies and no original ferromagnesian minerals were observed. Biotite is the most abundant ferromagnesian metamorphic alteration product in some thin-sections, but chlorite and epidote are more common. The more highly schistose rocks have been entirely recrystallized to saussurite, quartz, chlorite, epidote, and carbonate. Apatite, pyrite and Fe-Ti oxides are the most common accessory minerals.

A chemical analysis of a massive mafic lava from the west side of Atigogama Lake is shown in Table 2. Several partial chemical analyses of mafic lavas are included in Table 3.

ODM 9738

Photo 4–Photomicrograph of epidote alteration of a plagioclase phenocryst (crossed nicols).

PILLOW LAVA

Although pillow lavas are common south of the map-area (Mackasey 1976) they were observed in only a few places in southern Rickaby Township. On one exposure on the east shore of Expansion Lake, pillows which form part of a basalt flow, are up to 2 m (6 feet) long and 0.7 m (2 feet)wide. These pillows are only slightly deformed, with long axes parallel to the regional foliation. Well formed cusps give a good indication of tops to the south. Smaller bun-shaped pillows occur on the west side of Expansion Lake and on the south shore of Kenneth Lake.

A chemical analysis of a pillowed tholeiitic basalt flow found on a small peninsula in the southeastern corner of Expansion Lake is listed in Table 2.

AUTOCLASTIC BRECCIAS

Volcanic breccias produced by movement in partially solidified lavas are very common within the mafic volcanic sequence. Most of these appear to be flow-top breccias, in which fragments of massive and scoriaceous lava are scattered throughout an amygdaloidal matrix. The breccias grade into ordinary massive and amygdaloidal flows or agglomeratic rocks both laterally and vertically.

TABLE 2 COMPLETE CHEMICAL ANALYSES OF METAVOLCANIC ROCKS IN ELMHIRST AND RICKABY TOWNSHIPS. APPROXIMATE SAMPLE LOCATIONS ARE SHOWN IN FIGURE 3.

	I	II	III	IV	V	VI	VII	VIII
SiO_2	61.30	63.00	59.00	54.60	72.80	61.30	71.10	56.30
Al_2O_3	16.30	16.60	15.50	15.30	13.70	15.70	14.80	16.50
Fe_2O_3	2.79	2.00	2.31	3.53	0.82	0.82	1.62	1.88
FeO	3.69	4.06	4.13	4.85	0.81	5.02	1.55	4.87
MgO	3.13	2.28	3.72	5.03	0.37	3.23	0.40	5.11
CaO	5.08	3.46	8.58	8.08	1.63	3.34	2.20	6.82
Na_2O	3.11	3.29	3.08	3.67	4.04	4.07	5.23	2.54
K_2O	1.54	1.93	0.27	0.51	2.24	0.77	1.11	0.72
TiO_2	0.54	0.45	0.77	0.75	0.32	0.77	0.35	0.70
P_2O_5	0.11	0.12	0.17	0.17	0.04	0.17	0.06	0.14
MnO	0.11	0.17	0.11	0.15	0.06	0.09	0.03	0.12
S	0.01	0.02	0.01	0.06	0.02	0.01	0.01	0.01
CO_2	0.30	1.80	1.12	0.26	1.25	2.14	0.34	1.28
H_2O	1.20	2.57	2.06	1.93	1.10	2.99	1.00	2.87
Total	99.20	101.80	100.80	98.90	99.20	100.40	99.20	99.80
S.G.	2.79	2.73	2.88	2.94	2.71	2.72	2.69	2.83
Q*	19.98	24.13	17.86	6.75	37.81	20.78	31.33	14.94
C	0.56	3.18	0.00	0.00	1.82	2.63	1.16	0.00
Or	9.33	11.73	1.64	3.13	13.68	4.78	6.67	4.45
Ab	26.95	28.59	26.69	32.17	35.30	36.14	44.95	22.46
An	25.08	16.83	28.34	24.63	8.08	16.20	11.69	32.91
Di	0.00	0.00	7.92	8.18	0.00	0.00	0.00	0.84
He	0.00	0.00	3.51	4.67	0.00	0.00	0.00	0.37
En	7.98	5.83	5.82	9.19	0.95	8.44	1.01	12.91
Fs	5.78	5.65	2.96	6.02	0.41	7.81	1.00	6.55
Fo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mt	3.03	2.90	3.37	3.38	1.23	1.25	2.29	2.85
Il	1.05	0.88	1.50	1.48	0.63	1.54	0.68	1.39
Hm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ap	0.26	0.29	0.40	0.41	0.10	0.41	0.14	0.34
Ru	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D.I.	56.26	64.45	46.18	42.05	86.79	61.70	82.94	41.85
C.I.	17.84	15.26	25.07	32.91	3.21	19.03	5.07	24.90
N.P.	46.72	35.68	50.02	41.91	17.75	29.73	18.31	58.01

S.G. - Specific Gravity
D.I. - Differentiation Index
C.I. - Colour Index
N.P. - Normative Plagioclase Composition (An%)
*Normative Calculations were made following Barth (1952)

I Massive felsic flow, northern part of Pifher-Elmhirst boundary.
II Intermediate flow, Highway 801, 0.4 km (¼ mile) south of the Elmhirst-Walters Township boundary.
III Bedded tuff, southeastern Elmhirst Township, 3.2 km (2 miles) southwest of Seven-Foot Falls.
IV Mafic pillow lava, peninsula in southeastern corner of Expansion Lake.
V Spherulitic rhyolite flow, 2.5 km (1½ miles) southwest of Camp 58.
VI Intermediate tuff, 2.5 km (1½ miles) east of Seven-Foot Falls.
VII Felsic flow, 0.4 km (¼ mile) west of the northwest corner of Atigogama Lake.
VIII Massive mafic flow, west side of Atigogama Lake.

TABLE 3	PARTIAL CHEMICAL ANALYSES OF METAVOLCANIC ROCKS			
Location Number[1]	SiO_2[2] (Weight %)	Total Fe as FeO[2]	MgO (Weight %)	Rock Type (Field Description)
1	48.8	5.77	4.68	massive mafic lava
2	75.8	0.91	0.40	spherulitic rhyolite
3	57.0	6.05	3.55	feldspar porphyry flow
4	58.1	4.85	3.15	massive lava
5	75.0	1.19	0.70	massive felsic lava
6	57.0	5.10	2.44	massive mafic lava
7	69.4	3.17	0.90	felsic lava
8	50.8	6.83	4.92	amygdaloidal mafic lava
9	50.2	6.06	3.80	massive mafic lava
10	50.6	6.55	4.37	mafic flow breccia
11	63.7	4.16	1.14	sericitic schist
12	61.0	5.40	3.09	chloritic schist
13	48.9	9.10	6.40	chloritic schist
14	56.4	3.98	1.30	massive lava
15	46.7	6.47	4.99	porphyritic mafic lava
16	59.2	6.43	6.51	massive lava
17	53.2	6.59	3.84	massive mafic lava
18	56.3	5.73	5.52	porphyritic mafic flow
19	50.8	6.82	7.13	chloritic schist
20	44.1	8.99	9.10	massive mafic lava
21	54.9	5.86	4.72	porphyritic mafic flow
22	37.8	9.54	8.90	mafic lava
23	48.9	5.74	6.05	crystal tuff (?)

[1]Sample sites are shown approximately on Figure 3.
[2]Analyses were performed by a rapid X-ray fluorescence technique.

The fragments, which form a widely varying proportion of the rock, can be seen easily on weathered surfaces. They generally weather lighter in colour than the matrix, with different surface textures apparent in clean outcrop surfaces. Most fragments are elongated parallel to foliation, and range considerably in size, up to several feet across. Such breccias are well exposed in the northern part of Expansion Lake and on the islands of Atigogama Lake.

A distinctive mafic flow-breccia, containing a variety of types of fragments, occurs on a number of islands in the south-central part of Atigogama Lake. Visible fragments form almost 90 percent of the rock (Photo 5), with about 50 percent of these fragments angular, 40 percent subrounded, and the rest pillows or fragments of pillows with chilled selvages. The rock is apparently the product of considerable brecciation and abrasion possibly involving several flows and rock types incorporated from a number of earlier flows. Plastically deformed, stretched, and swirled fragments with feathered edges are also common in some exposures. Several samples of flow breccia are among the rocks for which partial chemical analyses are listed in Table 3.

ODM9739

Photo 5–"Chip-board" volcanic breccia, Atigogama Lake.

Mafic flows composed entirely of clinkers of massive and scoriaceous lava occur in the southwest shore of Expansion Lake south of the map-area. The rock is a loosely packed, poorly sorted, framework of sharp, angular fragments of basaltic composition which are a few millimetres to several centimetres across, in a matrix of aphanitic basalt. The matrix material weathers easily, producing a rugged surface characteristic of aa flows.

PYROCLASTIC ROCKS

Within the map-area coarse mafic pyroclastic rocks cannot be readily distinguished from autobrecciated flows, particularly where amygdules or flow features are lacking within the matrix. These features may have been present in the matrix and since been destroyed by shearing. With these reservations in mind, agglomerate (coarse pyroclastic rock) appears to be uncommon. Minor andesitic and basaltic agglomerate units too small to be shown on Map 2373 (back pocket) do occur intercalated with felsic to intermediate flows and finer pyroclastic rocks, northeast of Seven-Foot Falls and in the southwestern corner of the map-area. The bombs are ellipsoidal to irregular in shape and range up to a foot (0.3 m) in diameter. They constitute about 95 percent of the rock in some places, but generally the chloritic, schistose matrix makes up 40 to 50 percent of the rock.

In the southern and northeastern parts of Atigogama Lake agglomerate appears to grade into flow-breccia type rocks without distinct contacts. It should be noted however that exposures on some islands and shoreline outcrops were covered by algal slime making examination of the matrix textures difficult.

TUFFACEOUS CHERT

A single horizon of the rock type was found on the west side of Expansion Lake and traced over a distance of 1.2 km (¾ mile). The unit is approximately 1.5 m (5 feet) thick and is intercalated with mafic flows. The rock is light green to grey, thinly bedded to laminated and brittle, with conchoidal fracture. Some thin bands have a pitted appearance due to the weathering-out of fine pyrite grains. Similar thin chert horizons have been described and analyzed by Mackasey (1976) from the townships to the south, where they also occur intercalated with mafic volcanics. The origin of this rock type has been ascribed by Mackasey (1976) to chemical precipitation during fumarolic activity.

CHLORITIC SCHIST

A belt of chloritic schist, believed by the authors to have been derived from mafic metavolcanics, occurs along the southern part of Rickaby Township. Numerous lens-shaped patches of quartz-carbonate 0.5 to 2 cm long appear to be deformed amygdules, and some volcanic fragments can still be recognized, but in most outcrops schistosity has obliterated all primary volcanic features. Typically, bands and streaks of light grey more siliceous looking material alternate with layers of dark green chloritic schist. Two samples of chloritic schist were analysed and found to contain only 51 to 56 percent SiO_2 respectively, suggesting a basaltic composition (Table 3), however, the degree of silicification is intense in some localities.

In thin section, the schist consists of patchy aggregates of sugary quartz, feldspar, chlorite, and hornblende with lesser amounts of interstitial sericite and epidote. Secondary quartz is abundant, occurring in veinlets and augen. Subhedral masses of epidote grains which are pseudomorphs after plagioclase phenocrysts are common.

Intermediate to Felsic Metavolcanics

Flows and pyroclastic rocks of felsic to intermediate composition form a thick sequence which underlies the central part of the map-area, and the northwestern and southwestern corners of Elmhirst Township. The sequence includes massive, amygdaloidal porphyritic, spherulitic and flow-banded lava, as well as tuff-breccia, bedded tuffs, and sericitic schist derived from the pyroclastic rocks. The pyroclastic rocks are predominant in terms of volume. Mafic agglomerate units and flows occur intercalated with the more felsic rocks but they are relatively uncommon in most of the sequence.

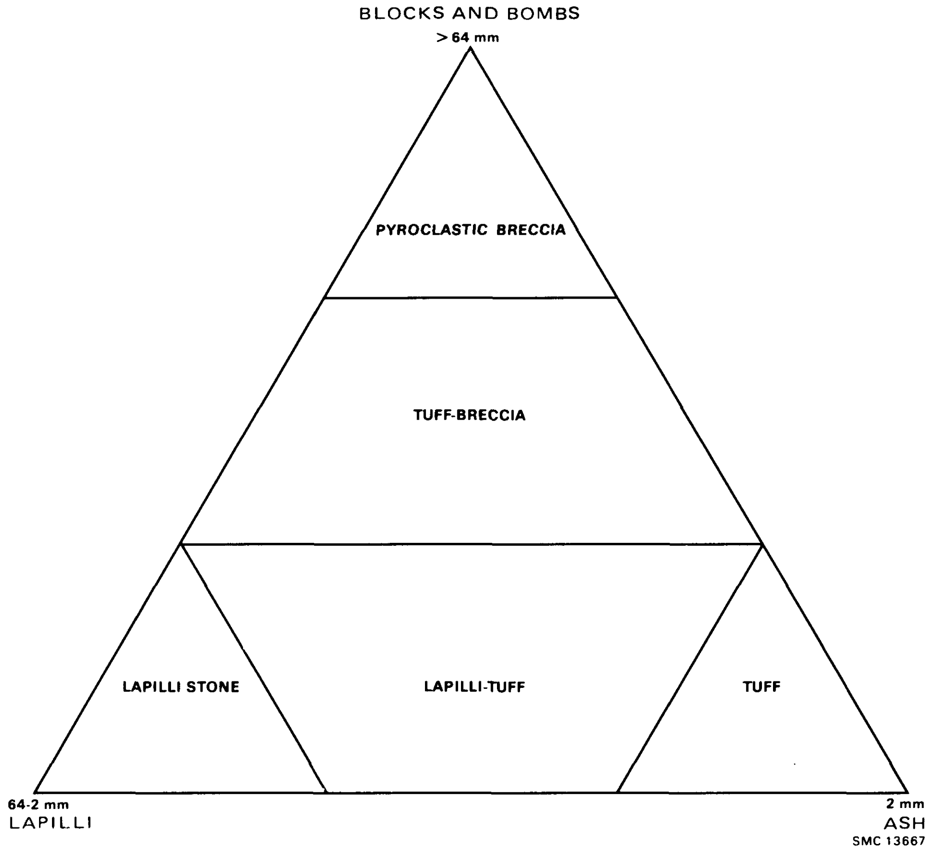
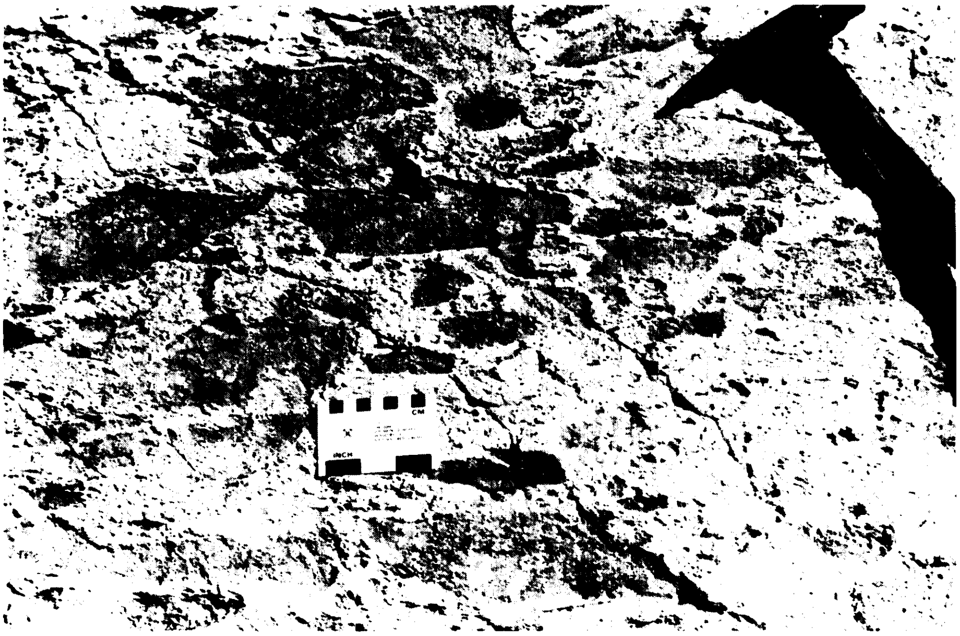


Figure 2–The system of classification of pyroclastic rocks followed in this report.

The more common rock types are described individually. Chemical composition and stratigraphic relationships are discussed under separate headings that follow.

PYROCLASTIC ROCKS

The pyroclastic rocks within the map-area vary from coarse pyroclastic breccia to finely laminated ferruginous tuff. However, since there is a complete gra-



ODM9740

Photo 6–Fragment elongation in tuff-breccia.

dation between rock types with variation in fragment size, proportion of fragments to matrix, and crystal content, these rocks are considered and described together. Pyroclastic rocks are here classified according to the system proposed by Fisher (1966) as shown in Figure 2.

Tuff-breccia is the most abundant and widespread pyroclastic rock type (Photo 6), commonly grading into lapilli-tuff or crystal tuff with decreasing fragment size or proportion of fragments, and into pyroclastic breccia in some locations with increasing fragment size. The tuff-breccia consists of bomb- and lapilli-sized volcanic fragments up to 30 cm (1 foot) across, in a tuffaceous matrix. The fragments are commonly deformed, elongated parallel to the regional foliation, but in many places they have retained their original angular or subrounded forms (Photo 7). Typical fragments are amygdaloidal and porphyritic and in most of these rocks resemble the matrix in colour and composition. The fragmental nature of the rock is often only apparent under good lighting conditions on clean well-weathered outcrops.

Many combinations of clast-matrix compositions and textures were observed in the field. Clasts having a colour index different than the surrounding matrix are very common. The matrix itself is commonly quite coarsely fragmental. In many rocks crystals and crystal fragments make up from 10 to 50 percent of the matrix.

Pyroclastic breccia, with angular blocks over 1 m (3 feet) across is uncommon in the map-area, but several outcrop areas of such rock were located to the north and west of Dennis Lake.

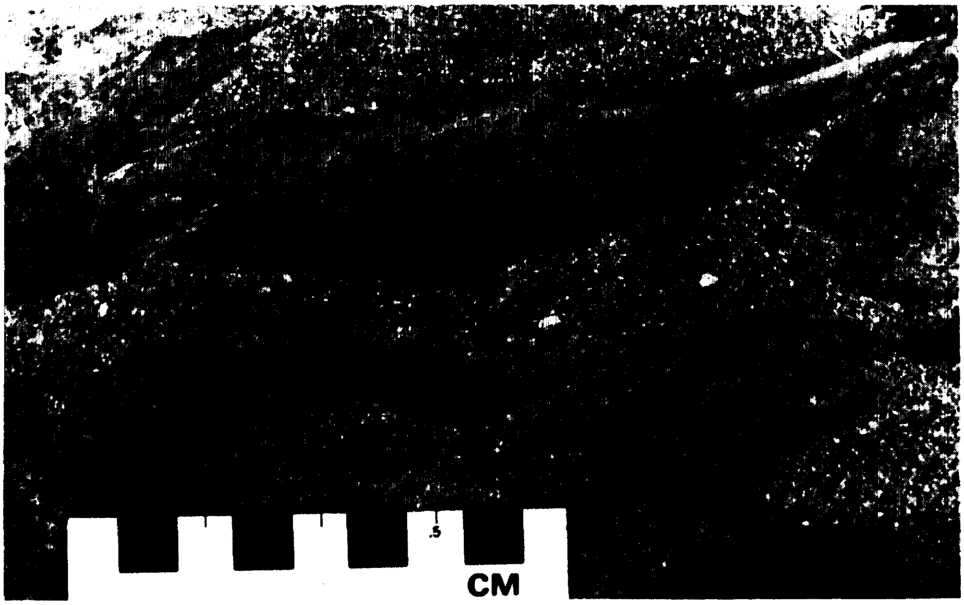


Photo 7–Slightly deformed angular and subround fragments in tuff-breccia. Matrix is composed of volcanic material of lapilli size.

Although bedding is not usually present in the coarser pyroclastic rocks, it is quite common within fine lapilli-tuff and crystal tuff.

Crystal tuff and thinly laminated tuff horizons commonly occur between coarser pyroclastic units. In several places, particularly north and west of Expansion Lake on both sides of the Namewaminikan River fine banded pyroclastic rocks form sequences, in the order of several hundred feet thick, with only a few intercalations of the coarser material.

The crystal tuff consists of subhedral crystals and crystal fragments of oligoclase and, less commonly, quartz, in a tuffaceous matrix. The crystals generally range from 2 to 5 mm long, and constitute up to 60 percent of the rock. In outcrop it is difficult to distinguish between such crystal tuff and feldspar porphyry flows and minor intrusions. The presence of broken crystals, crystal fragments, bedding and scattered lapilli or bomb-sized fragments are criteria useful in the recognition of these pyroclastic rocks.

In thin section, the crystal tuff appears to be poorly sorted. Most plagioclase grains are euhedral to suhhedral but many are bent or broken with jagged terminations (Photo 8). Quartz phenocrysts are partially resorbed by the microcrystalline quartzofeldspathic matrix. Smaller feldspar laths are commonly aligned parallel to bedding. Patches of chlorite, biotite and carbonate, as alteration products, have a similar alignment parallel to bedding. Feldspar phenocrysts are heavily sericitized and albitized. Some are completely epidotized. The subhedral aggregates of chlorite and epidote probably represent pseudomorphs after pri-

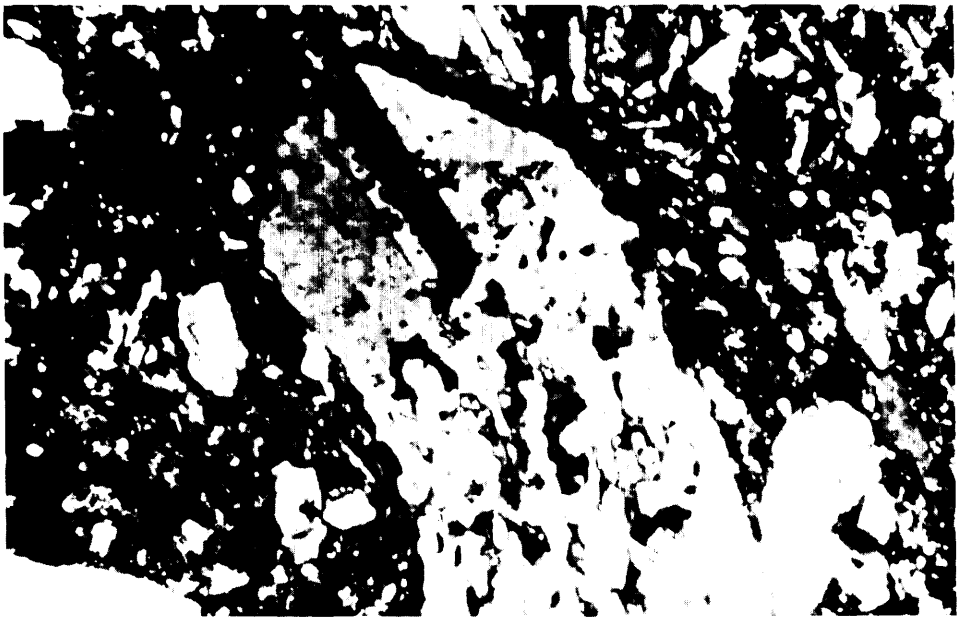


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Photo 8–Photomicrograph of bent plagioclase crystal in crystal tuff (crossed nicols).

mary ferromagnesian minerals. In plane polarized light, shard-like features were observed in the matrix of some thin sections.

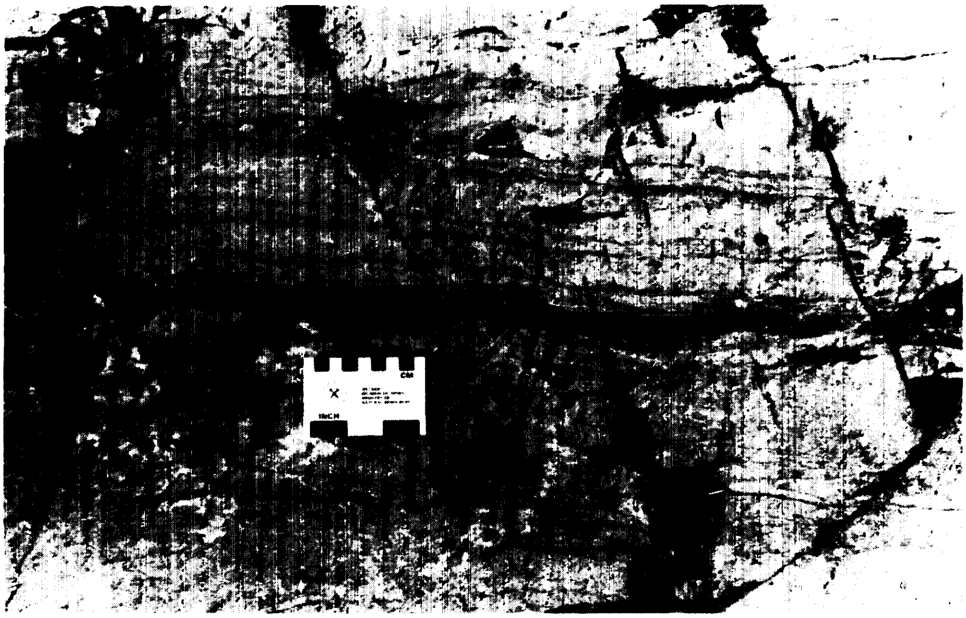
Thinly bedded tuffs in the map-area are comprised of individual beds from 1 to 10 cm (0.5 to 4 inches) thick, with most beds in the order of 2 to 3 cm (1 to 1.2 inches) thick. Alternate beds exhibit various shades of grey and brown (Photo 9). Some weakly magnetic ferruginous laminae which weather to a rusty brown occur between lighter coloured, more siliceous beds.

Most of these fine tuffs have been recrystallized and consist of a fine-grained mixture of quartz, plagioclase, and epidote with abundant chlorite, sericite and biotite flakes forming distinct foliations. Shards may be observed in thin-section of the tuffs where these rocks have not been subject to intense recrystallization. Colour differences between adjacent beds are due to variations in the proportions of sericite, chlorite, and opaque grains within the beds.

An analysis of a typical laminated tuff from southeastern Elmhirst Township is included in Table 2. On the basis of the criteria outlined under "Chemical Composition of Early Precambrian Metavolcanics" which follows, the rock is "mafic" in composition because of its high iron content.

MASSIVE, PORPHYRITIC AND AMYGDALOIDAL LAVAS

Although subordinate to pyroclastic rocks in abundance, intermediate and felsic flows are common throughout the map-area. In northwestern Elmhirst



ODM9743

Photo 9–Thinly bedded intermediate tuff, southeastern Elmhirst Township.

Township, flow rocks occur almost to the exclusion of pyroclastic rocks.

Most of the flows are massive, feldspar and feldspar-quartz porphyries which grade into amygdaloidal phases and flow breccias. Outcrops are for the most part light coloured and featureless, and since contacts are rarely observable, some of these rocks classified as flows may be of intrusive origin.

Pillows and possible pillow breccias were found east of the Namewaminikan River in the extreme southeastern corner of Elmhirst Township. These pillows are ellipsoidal to irregular in shape, and are not suitable for top determinations. They range up to 1 m (3 feet) in their longer dimension and individual pillows and pillow fragments constitute between 10 and 75 percent of the rock. In many of these pillows dark coloured selvages are well developed around the pale-weathering pillow interiors and elongated radiating amygdules are common.

Microscopic examination of these lavas shows a variety of textures from granular quartzofeldspathic mosaics to well preserved igneous textures such as trachytic and pilotaxitic arrangements of feldspar microlites. As in the other Early Precambrian rock types, plagioclase phenocrysts, which may be up to 5 mm long, are extensively altered. Glomeroporphyric clusters of plagioclase grains were seen in some flows. Quartz and potassic feldspar phenocrysts are generally rounded or irregular in shape. No primary ferromagnesian minerals were observed, but chlorite and (or) biotite and sericite are present and commonly form a crude foliation throughout the rocks.

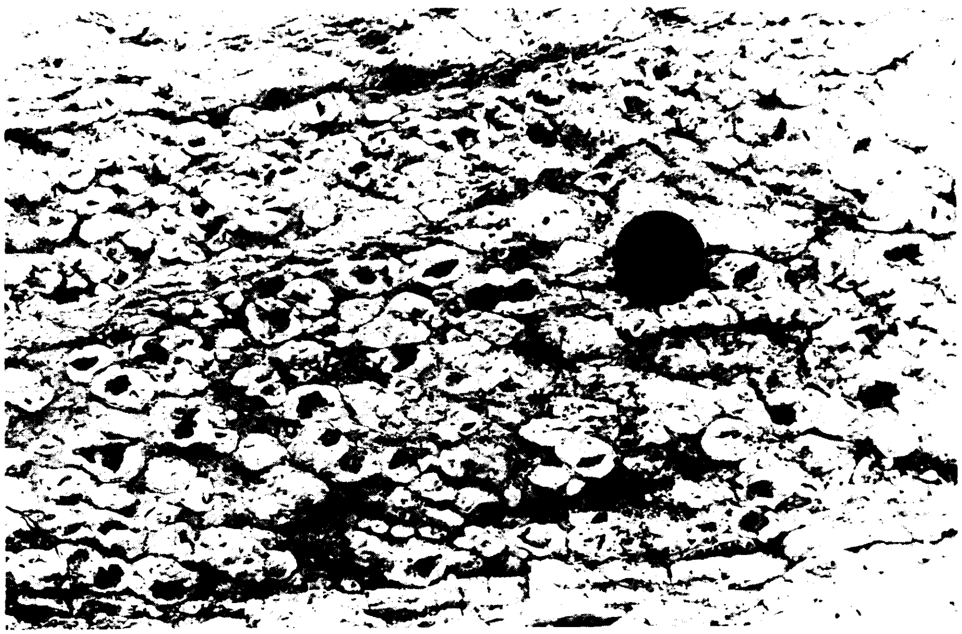


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Photo 10–Spherulites in a rhyolitic flow, west-central Rickaby Township.

SPHERULITIC AND FLOW-BANDED LAVAS

Siliceous lavas exhibiting spherulitic nodules and laminar flow-banding occur in west-central Rickaby Township and in at least one location in southwestern Elmhirst Township. The two features also occur together in the same rock, with spherulites commonly restricted to individual laminae (Photo 10). More commonly these features occur within separate but adjacent flows. Several distinct spherulitic rhyolite flows were observed in central Rickaby Township, but flow-banded units were less abundant. These rocks may be of importance as marker horizons in this area.

The spherulites range in size from only a few millimetres to 3 or 4 cm in diameter. On weathered surface they are white and are surrounded by yellow or brown interstitial material. Commonly the centres contain sphalerite, calcite or hematite which weather out leaving small epidote-lined cavities (Photos 11 and 12). In most outcrops the spherulites are deformed into an ellipsoidal shape, with long axes parallel to the regional structural trend. They constitute between 10 and 95 percent of the rock. The proportion of spherulites varies considerably within each flow both laterally and vertically. Size gradation within individual flows was also noted ln the field but the relationship with stratigraphic tops was not established.

Although the internal structure of the spherulites cannot be seen in hand specimen, the radial growth of plumose quartz and feldspar is apparent in some

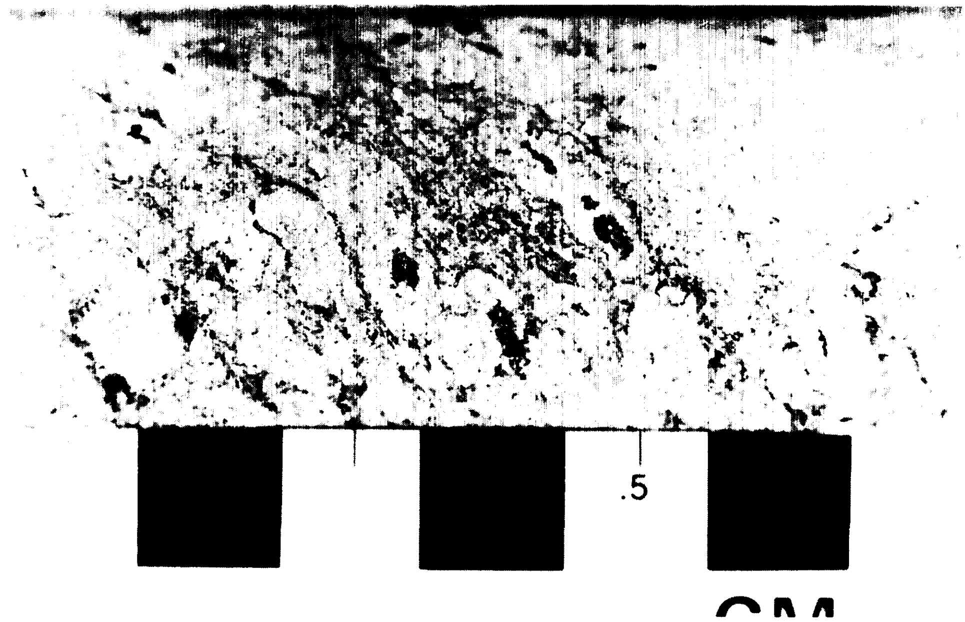

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Photo 11–Spherulites with cores of sphalerite.

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Photo 12–Cavities in large spherulites.

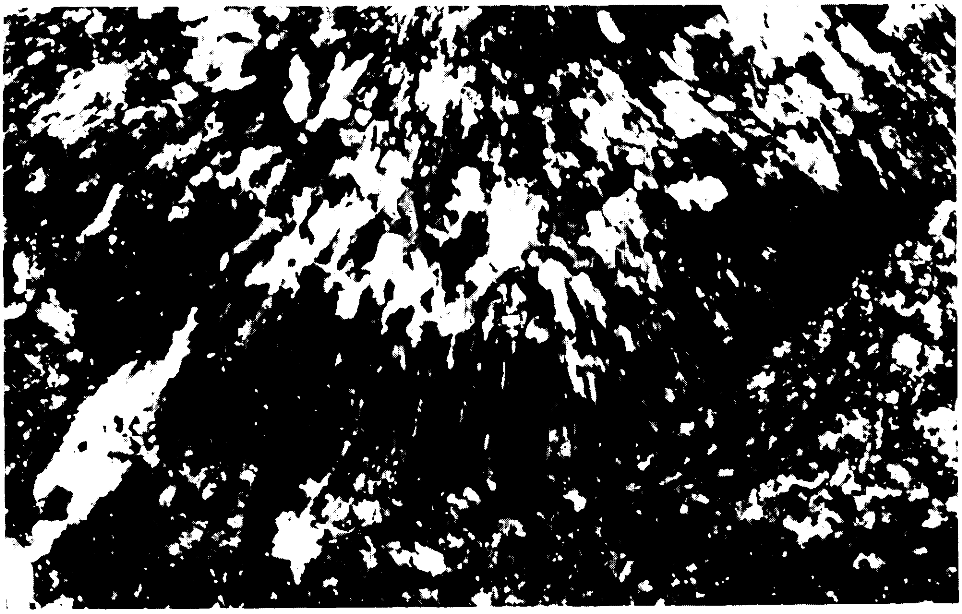

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Photo 13–Photomicrograph of radial growth in a spherulites (crossed nicols).

thin sections (Photo 13). Most of the structures have been recrystallized and the radial character has been destroyed, but even where this has occurred the spherulites are distinctly outlined by the coarse matted sericite in the groundmass around them (Photo 14). Quartz appears to be dominant in the spherulites, and variations in its habit produce concentric layering within the structures. The centre is generally formed of fine subhedral quartz crystals partially replaced by carbonate, and the outer fringe, which constitutes about two-thirds of the structure, consists of radiating plumose quartz and feldspar. Amygdules filled with calcite occur rarely within the spherulites and the surrounding sericitic groundmass. Small phenocrysts of potassic feldspar (probably originally sanidine) and quartz are abundant, and many transect the spherulite boundaries.

Some workers have interpreted these structures as accretionary lapilli, but on the basis of their obvious radial growth patterns, the great size of some examples, and the fact that amygdules and phenocrysts transect their boundaries, it appears likely that they are a devitrification phenomena and are not related to pyroclastic effusion.

Flow-banded rhyolites consist of red, yellow, or light grey alternating layers commonly from several millimetres to 3 cm thick. The rocks are microcrystalline aggregates of quartz and feldspar, containing small quartz and feldspar phenocrysts and small amygdules. Colour variation between bands is produced by relatively small amounts of biotite and hematite within the red laminae and sericite or epidote within the yellow and light grey laminae.

An analysis of a spherulitic rhyolite is included in Table 2.

ODM9748

Photo 14–Photomicrograph of spherulites outlined by matrix of matted sericite (plane polarized light).

SERICITIC SCHIST

Sericitic schist containing quartz and plagioclase metacrysts is believed to have been derived from felsic pyroclastic rocks. Such schists are usually associated with shear zones, and are common northwest of Dennis Lake in central Rickaby Township.

The weathered rock is dark brown to light grey with white metacrysts, up to 5 mm across, which stand out prominantly. On fresh surfaces it is pale green or yellowish brown. The rock is highly schistose and very soft.

In thin section, it consists of approximately equal amounts of equigranular quartz and feldspar which form a mosaic separated by fine sericite and calcite. The ovoidal metacrysts are granular aggregates of quartz after former plagioclase phenocrysts. Sericitized feldspar metacrysts are corroded and embayed by the quartzofeldspathic matrix.

Chemical Composition of Metavolcanics

In a study of Precambrian volcanic rocks associated with sulphide deposits, Descarreaux (1973, p.62) emphasized the difficulties involved in accurately and consistently classifying metavolcanics in the field. He demonstrates that some field geologists, as chemical data have later shown, have the tendency to give "too felsic a name" to some volcanic rocks. Many geologists working with metavolcanics have experienced the same problem. In Elmhirst and Rickaby Townships, the authors found that the distinction between basaltic and andesitic, or even dacitic rocks was made difficult by recrystallization, silicification, and foliation. Differences in the style of weathering on lakeshore and inland outcrops make consistent classification by the recognition of gross features dubious. For these reasons chemical criteria were relied on considerably in the classification of the metavolcanics described in this report.

During the course of field work, eight samples were selected for complete chemical analyses. These samples were felt to be representative of the volcanic succession within the map-area. An additional 23 samples of metavolcanics were submitted for partial chemical analyses to aid in chemical classification.

The locations of chemically analyzed samples collected within the map-area are shown in Figure 3. The complete rock analyses are listed in Table 2 and the partial analyses in Table 3. The rocks analyzed were grab samples taken from unweathered outcrops, selected primarily to help delineate boundaries between the mafic and felsic to intermediate metavolcanic sequences. Hence, the sample sites are concentrated in eastern and southern Rickaby Township. Samples were also collected from within the succession of felsic metavolcanics northeast of Seven-Foot Falls in an attempt to more precisely identify rocks that had been mapped in the field as rhyolites.

The partial analyses were done by the Mineral Research Branch, Ontario Division of Mines, using X-ray fluorescence to determine the amounts of SiO_2, FeO (total) and MgO in each sample, following the suggestions of W.J. Wolfe (Geochemist, Ontario Division of Mines, personal communication 1972). This type of analysis was found to be adequate for the petrochemical classification of the metavolcanics.

Arbitrarily, *mafic* rocks including basalts and some andesites are defined for the purpose of this report as containing more than 5 percent FeO (total) and generally less than 58 percent SiO_2; *intermediate* rocks were defined as containing between 2 and 5 percent FeO (total)[1] and 58 to 72 percent silica. The intermediate class includes dacites and siliceous andesites. *Felsic* rocks were defined as containing over 72 percent SiO_2 and less than 2 percent FeO (total). The only felsic rocks found by the writers were rhyolites. This system is illustrated in Figure 4.

Using the chemical criteria just described the following general observations were made on the composition of metavolcanics within Elmhirst and Rickaby Townships.

(1) Spherulitic and flow-banded rocks in central Rickaby Township are rhyolitic in composition, as are many other flows, pyroclastic rocks and sericite schist in that general area.

(2) Mafic flows and agglomerate units are quite common in the felsic to intermediate sequence in the map-area.

(3) The bulk of the felsic to intermediate rocks in the map-area, including bedded tuff, is dacitic to andesitic in composition.

[1]FeO (Total) = weight percent FeO + 0.8998 weight percent Fe_2O_3.

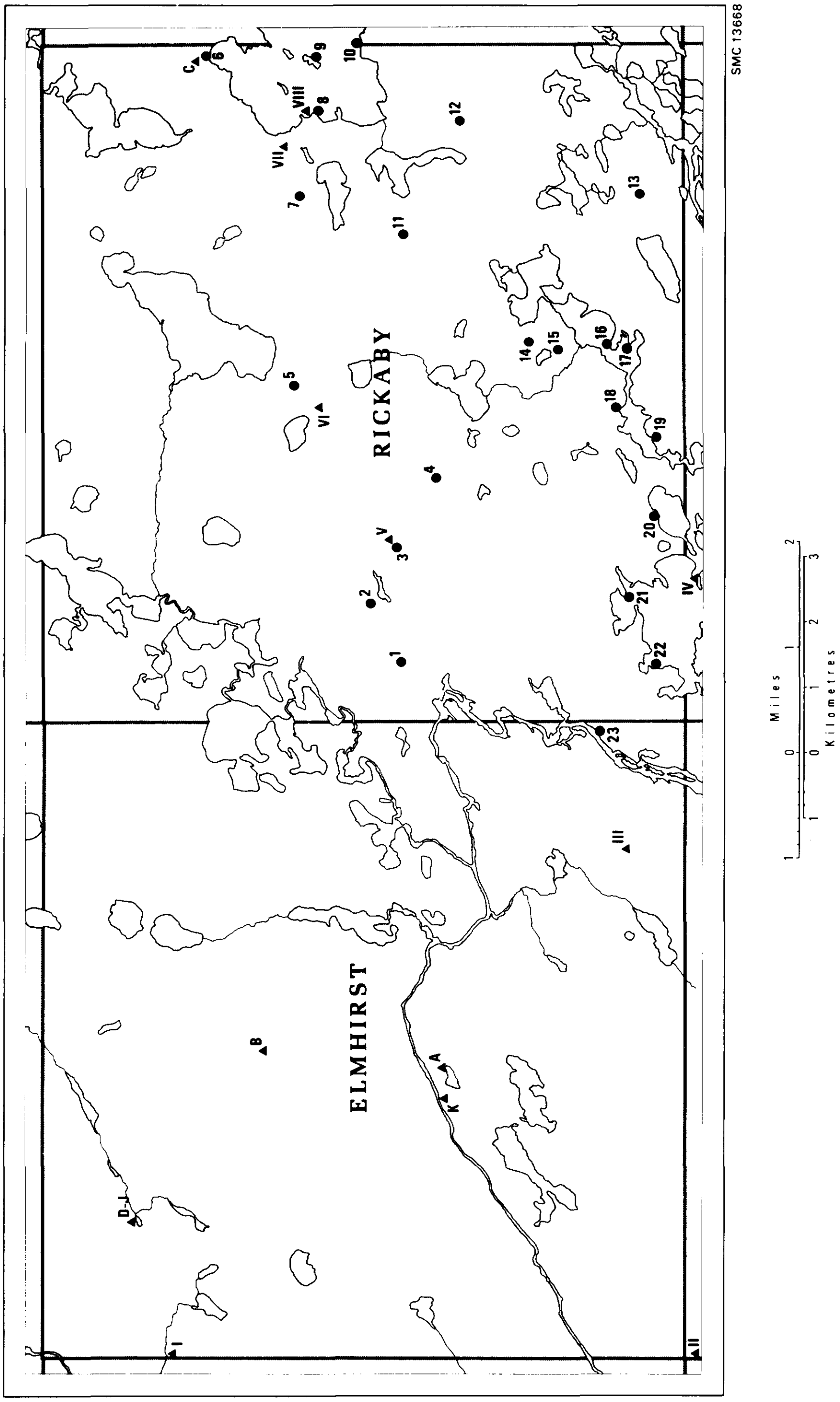

Figure 3–Location map showing the sites of samples collected for the chemical analyses listed in Tables 2, 3, 5, and 6.

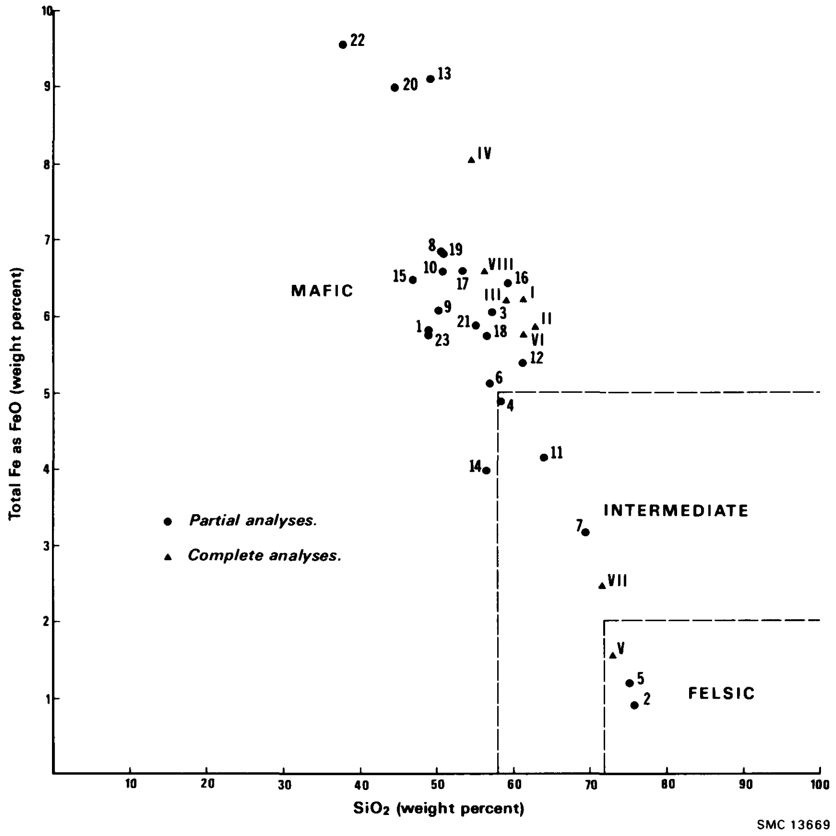

Figure 4–An illustration of the system of chemical classification used in this report.

(4) At least some chloritic schists of the mafic sequence in southern Rickaby Township retain their original basalitc composition.
(5) Andesitic rocks appear to be subordinate to basaltic rocks in the mafic sequence.
(6) The contact between felsic to intermediate and mafic rocks in the southern part of Rickaby Township, as defined by field mapping, is confirmed by chemical analyses.

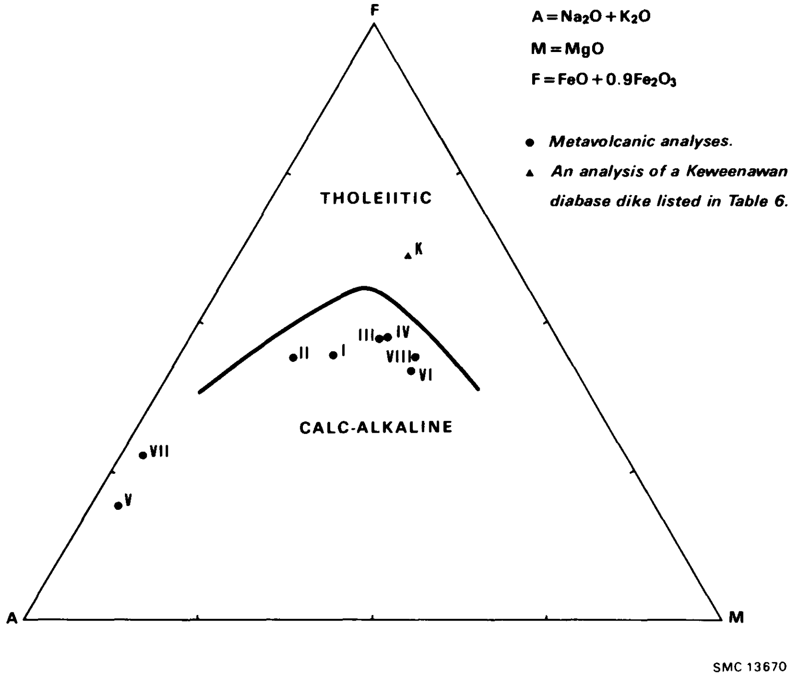

Figure 5—AMF plot of eight complete chemical analyses of metavolcanics from the map-area with the classifications of Irvine and Baragar (1971).

(7) According to the system of classification of volcanic rocks proposed by Irvine and Baragar (1971), the rocks for which complete chemical analyses are available belong to the calc-alkaline series. All of the analyses, including those of basalts, occur within or very close to the calc-alkaline fields on AFM and Al_2O_3 versus normative plagioclase composition plots (Figures 5 and 6).

Rocks of calc-alkaline affinity are common within the metavolcanic belts of the Canadian Shield, where they are usually associated with mafic rocks of the tholeiitic series. In Cenozoic volcanic island arcs of the western Pacific, calc-alkaline rocks overlie mafic tholeiitic rocks in a situation believed to be analagous to that of Early Precambrian greenstone belts (McGlynn 1970; Wilson *et al.* 1965).

Although the calc-alkaline series and the tholeiitic series may represent different paths of magmatic differentiation this distinction is primarily chemical and essentially non-genetic (Irvine and Baragar 1971).

Volcanic Stratigraphy

Stratigraphic classification and correlation within the map-area is difficult because of the monotony of lithology over much of the felsic to intermediate vol-

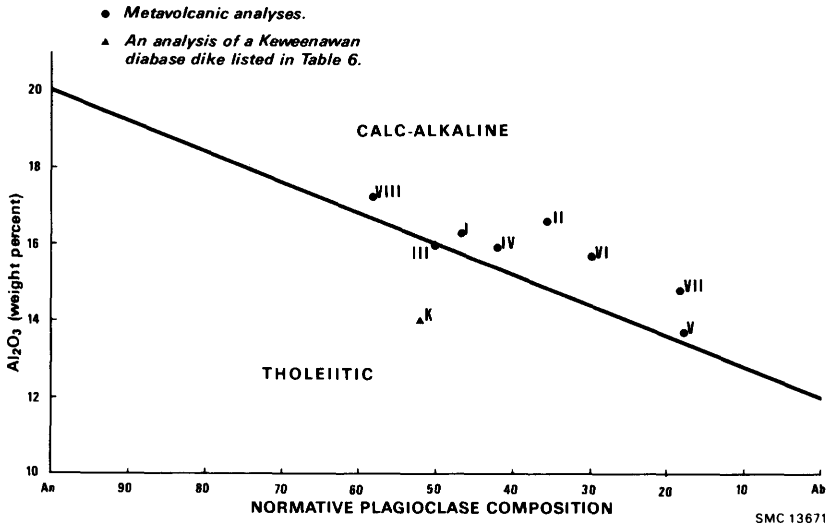

Figure 6–Plot of normative plagioclase composition versus Al_2O_3 content showing eight chemical analyses of metavolcanic rocks from the map-area.

canic sequence. Contacts between flows and (or) pyroclastic units are rarely exposed. Foliation and metamorphic effects tend to obscure original textural and compositional differences.

Few marker horizons can be used over appreciable distances. Discontinuous outcrop, and limited areal extent and thickness of individual volcanic units make tracing of distinctive horizons difficult and in most instances unrewarding. Locally, spherulitic rocks in central Rickaby Township may be used as marker horizons but variability within individual flows makes long range correlation, based on the recognition of specific units, doubtful. Nevertheless, the recognition of spherulitic structures in flows in southwestern Elmhirst Township, similar to those in Rickaby Township, is believed to be significant in the correlation of felsic rocks, and possibly mineralization, in these two areas. If this correlation is assumed to be correct, spherulitic felsic flows occur in a discontinuous manner along a strike length of about 22 km (13 miles) in a linear belt parallel to the southern limb of the regional structure (see "Structural Geology").

The coarseness of most of the pyroclastic rocks, and the concentration of felsic to intermediate rocks, suggest that this map-area was a volcanic centre or dome. The felsic to intermediate sequence is probably much thicker in Rickaby Township than in other parts of the southern and northern limbs of the regional fold. The occurrence of bedded tuffs, exhibiting graded bedding in several parts

TABLE 4 GENERALIZED STRATIGRAPHIC CROSS-SECTION IN ELMHIRST AND RICKABY TOWNSHIPS THROUGH THE METAVOLCANIC SUCCESSION ON THE SOUTHERN LIMB OF THE REGIONAL FOLD BETWEEN KABY CREEK AND EXPANSION LAKE (MAP 2102).

Thickness		
Feet	Metres	Lithology
North		
3,000-4,000	900-1,200	Massive, andesitic and dacitic flows and minor, coarse pyroclastic rocks.
3,000	900	Coarse pyroclastic rocks, mostly tuff-breccia and crystal tuff, with minor fine pyroclastic rocks and flows of intermediate composition.
4,000-6,000	1,200-1,800	Massive, spherulitic and flow-banded felsic flows intercalated with massive and amygdaloidal mafic and intermediate flows and pyroclastic rocks.
10,000	3,000	Intermediate pyroclastic material, mostly tuff-breccia, lapilli tuff and fine bedded tuff with few intercalated flows and a small proportion of felsic rocks.
6,000	1,800	Massive and amygdaloidal flows, breccias, pillow lavas and derived schist.
South		
26,000-28,000	7,800-8,700	Total Thickness

of the map-area, and pillow lavas is evidence that much of the volcanic activity was subaqueous. However, the occurrence of fumarolic chert and aa lava flows suggest that some of the extrusion may have been subaerial. Since no sedimentary rocks were found anywhere within the map-area, extrusion must have been rapid and continuous.

Assuming no structural repetition, and generally steeply dipping strata, a simplified stratigraphic cross-section through the thickest part of the volcanic sequence is summarized in Table 4.

Several rhyolitic horizons separated by mafic and intermediate rocks occur in central Rickaby Township. These probably correspond to cycles of volcanic activity varying from mafic to felsic with time. Since the cycles appear to be relatively thin and yet the extrusion appears to have been continuous, rapid differentiation and replenishment of the source magma may have occurred.

INTRUSIVE ROCKS

Mafic Intrusive Rocks

Mafic intrusive rocks which are interpreted by the authors to be of Early Precambrian age occur within the map-area as (1) a sill-like body in northwestern Elmhirst Township; (2) large inclusions in the Elmhirst Lake intrusion; and (3) numerous narrow dikes. These occurrences are described separately.

PINEL CREEK INTRUSION

This sill-like body was the subject of a B.Sc. thesis by D. Faust (1973), which was done in conjunction with the present geological survey. Most of the description which follows is taken from that study.

On the basis of drill hole data, the body strikes at about N70E and dips to the north at 50°. The true thickness is not known since the depth of the lower contact is unknown, but Faust (1973, p.12) suggests a minimum thickness of 185 m (600 feet).

The intrusion cuts dacitic and andesitic flows which border it to the north, west, and south. To the east this intrusion is in contact with granodiorite of the Elmhirst Lake stock. This contact was not observed and the age relationship between the intrusions is not evident. The linear nature of the contact suggests that it is a fault. Faust (1973, p.12) assumes the mafic intrusion to be of pre-granodiorite age because of the lithological similarities between this intrusion and the mafic intrusions of the Lac des Isles area (Pye 1968, p.24).

The Pinel Creek intrusion may be related to a larger mafic intrusion to the northwest. Moorhouse (1938) described this subcircular intrusion, west of Crooked Green Lake, as a diorite-quartz diorite body. From Moorhouse's thin section descriptions the mineralogy and alteration effects in the Crooked Green Lake intrusion are similar to those in the Pinel Creek Intrusion.

Faust (1973) recognized only two lithological phases in hand specimen: a leucocratic gabbro and a "normal" melanocratic gabbro. He found no apparent zonal arrangement of these rock types during field mapping. The leucocratic gabbro is a light brown to grey weathering, medium-grained rock containing about 60 to 65 percent albitized plagioclase, 30 percent amphibole and 5 percent quartz. The "normal" melanocratic gabbro has a similar appearance on weathered surfaces but on a fresh surface it is noticeably darker. This rock contains between 40 and 50 percent amphibole, 50 percent plagioclase and about 5 percent quartz. Both varieties of gabbro vary considerably in grain size within the intrusion, averaging about 3 mm. No particular pattern in the grain size variation was observed by Faust.

A cross-section through part of the body, provided by one of the deep drill holes which intersect the intrusion, was studied by Faust (1973), both petrographically and chemically. The petrographic study shows that the rocks are composed of variable amounts of plagioclase, pyroxene, chlorite and amphibole, quartz and related alteration products of the plagioclase; namely zoisite, epidote, sericite, and carbonate. Magnetite, pyrrhotite, chalcopyrite and pentlandite are present as opaques. Variations in the modal composition of the rocks with depth are illustrated in Figure 7. The upper part of the intrusion consists of quartz gabbro and quartz-rich leucocratic gabbro. About 60 m (200 feet) below the upper contact "normal" gabbro becomes more common. Several alternating layers of leucocratic gabbro and normal gabbro occur from 75 to 105 m (250 to 350 feet) below the upper contact. Faust (1973) interprets a 1.5 m (5 feet) thick unit, con-

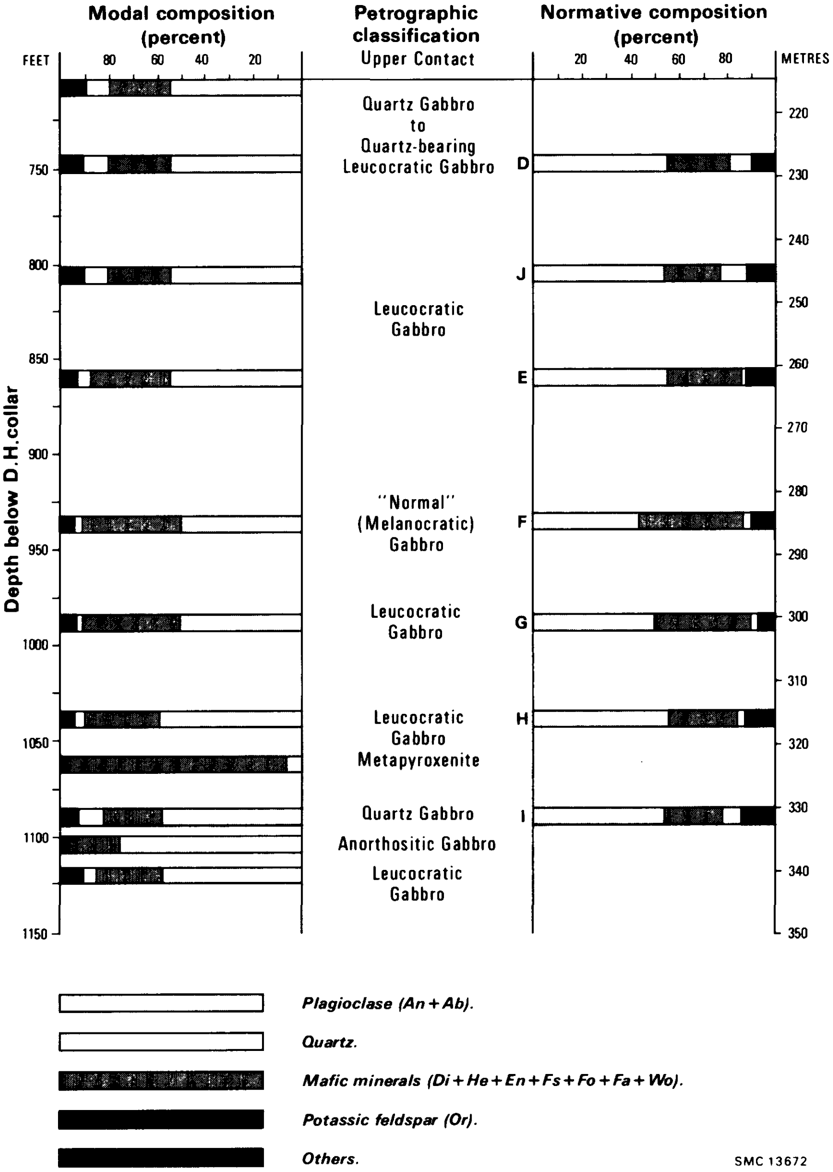

Figure 7–Schematic partial cross-section through the Pinel Creek Intrusion as described by Faust (1973).

sisting of over 90 percent chlorite and amphibole, which occurs about 110 m (360 feet) below the upper contact as a metapyroxenite layer. An anorthositic gabbro, with 70 to 80 percent plagioclase, occurs at the bottom of the diamond drill hole.

Very extensive alteration of both pyroxene and plagioclase has destroyed much of the original texture. Plagioclase is invariably heavily altered to zoisite, epidote, sericite and (or) carbonate, but retains its subhedral to euhedral lath shape. The normative plagioclase composition has been determined by Faust (1973) to be labradorite. Quartz occurs interstitial to the plagioclase in large, commonly strained, rounded grains. Remnant pyroxene, surrounded by an amphibole, does not occur until about 45 m (150 feet) below the upper contact. Aggregates and flakes of chlorite, actinolite and hornblende form the alteration products of original pyroxene in the upper part of the body.

Faust (1973), because of the presence of the metapyroxenite and anorthositic gabbro layers at the bottom of the drill hole, suggested that more mafic and ultramafic rocks may exist below the presently known gabbro layers. He assumes the intrusion to be a differentiated, layered complex of mafic and ultramafic rocks of which only the upper mafic layers are exposed.

The results of chemical analyses of seven samples of core collected by the field party from the same diamond drill hole are listed in Table 5 and depicted graphically by the writers in terms of normative mineralogy in Figure 7. This illustration also supports the interpretation of differentiation and crude layering within the intrusion proposed by Faust. The normative quartz content decreases

TABLE 5 COMPLETE CHEMICAL ANALYSES OF FELSIC TO INTERMEDIATE INTRUSIVE ROCKS IN ELMHIRST AND RICKABY TOWNSHIPS (FROM BRUCE 1936, p.24). APPROXIMATE SAMPLE LOCATIONS ARE SHOWN IN FIGURE 3.

	A	B	C
SiO_2	69.98	68.06	66.68
Al_2O_3	15.12	14.64	16.33
Fe_2O_3	1.23	1.16	1.85
FeO	1.75	2.42	2.57
MgO	0.98	1.57	1.48
CaO	3.25	3.68	4.12
Na_2O	2.80	3.07	2.95
K_2O	2.81	2.61	1.51
TiO_2	0.51	0.51	0.62
P_2O_5	0.13	0.16	0.11
MnO	0.40	0.60	0.10
H_2O	1.11	1.13	0.89

Sample A - "Granite" described by Bruce (1936) from the Coyle Lake Stock, from a small lake ½ mile south of Martin Rapids.
Sample B - "Granite" described by Bruce (1936) from the Elmhirst Lake Stock.
Sample C - Granodiorite described by Bruce (1936) from the Orphan mine, the Kaby Lake.

to a point about 48 m (160 feet) below the upper contact of the body and then increases with depth. The normative pyroxene content varies inversely with the normative quartz.

Sulphide mineralization in the rocks studied is limited in occurrence to the normal gabbro and is not common in the quartz-rich facies. The sulphide mineralogy and economic aspects of this mafic intrusion are discussed under the "Economic Geology" section of this report.

GABBROIC INCLUSIONS

In east-central Elmhirst Township at least two mappable bodies of quartz gabbro and gabbro occur within the Elmhirst Lake stock. These are believed to be xenoliths or possibly the remnants of roof pendants because they are coarse-grained and show no chilled margins at the contact with the surrounding granodiorite. Numerous smaller xenoliths of intermediate metavolcanics and mafic intrusive rocks are also found in the same vicinity.

The bodies are lenses of medium-grained, dark green to dark grey metagabbro, having a marked igneous layering. Layers of about 2 to 3 cm (1 to 1.2 inches) thick are caused by variation in the ratio of hornblende to plagioclase. The mafic content is between 40 and 80 percent of the rock and quartz constitutes up to 5 percent.

Chalcopyrite, bornite, malachite and specular hematite were found in fractures cutting one of the large gabbroic inclusions. None of these minerals were observed to be disseminated within the rock itself.

MAFIC DIKES

Narrow mafic dikes are widespread throughout the map-area. Relative ages are not known. Some of these dikes intrude granodiorite while others can be found cutting the metavolcanics.

The most common are andesite porphyry dikes which range up to 1.3 m (4 feet) in width. This type of dike has a well-developed fissility parallel to contacts. Phenocrysts of epidotized and chloritized plagioclase and ragged hornblende crystals are abundant. The matrix consists of chlorite flakes and laths of albite which exhibit a pilotaxitic texture.

Dark green lamprophyre dikes up to 9 m (30 feet) wide occur in several places. One such dike can be traced for several hundred feet on surface striking almost east-west across the Phelps Dodge property (Figure 15). Drilling shows this dike to have a dip of about 45° to the south. Euhedral hornblende crystals and large biotite flakes constitute about 80 percent of the rock with the remainder being a mosaic of subhedral feldspar grains (Photo 15). Alteration is minimal, with only slight sericitization and saussuritization of the feldspars which suggests that the lamprophyre dikes are relatively young.

Fresh, black pyroxenite dikes about 35 to 70 cm (1 to 2 feet) wide, also occur within the metavolcanics north of Expansion Lake. These pyroxenites consist of euhedral augite grains in a fine-grained biotite and feldspar matrix (Photo 16).

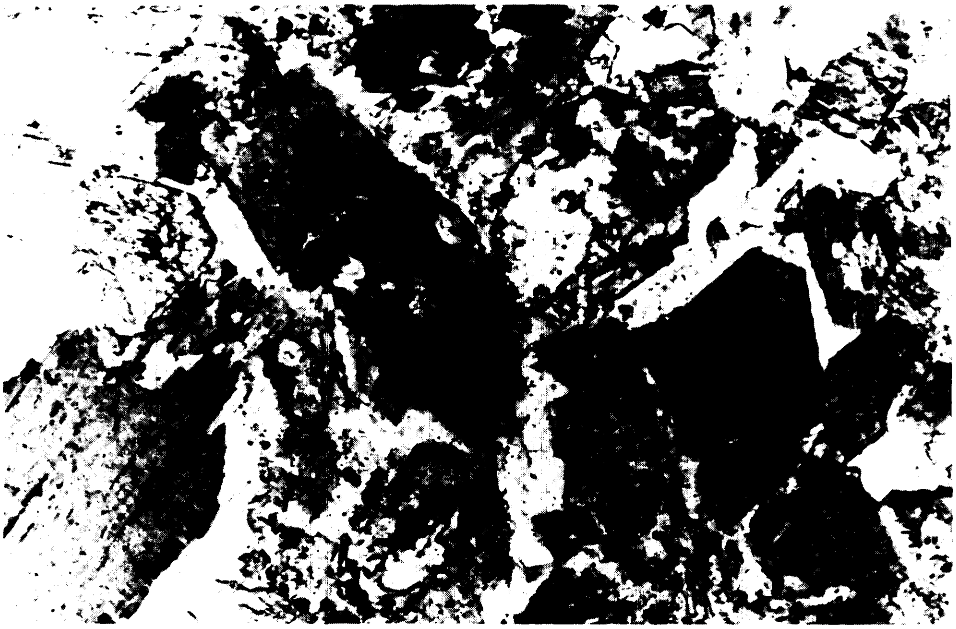

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Photo 15–Photomicrograph of lamprophyre (plane polarized light).

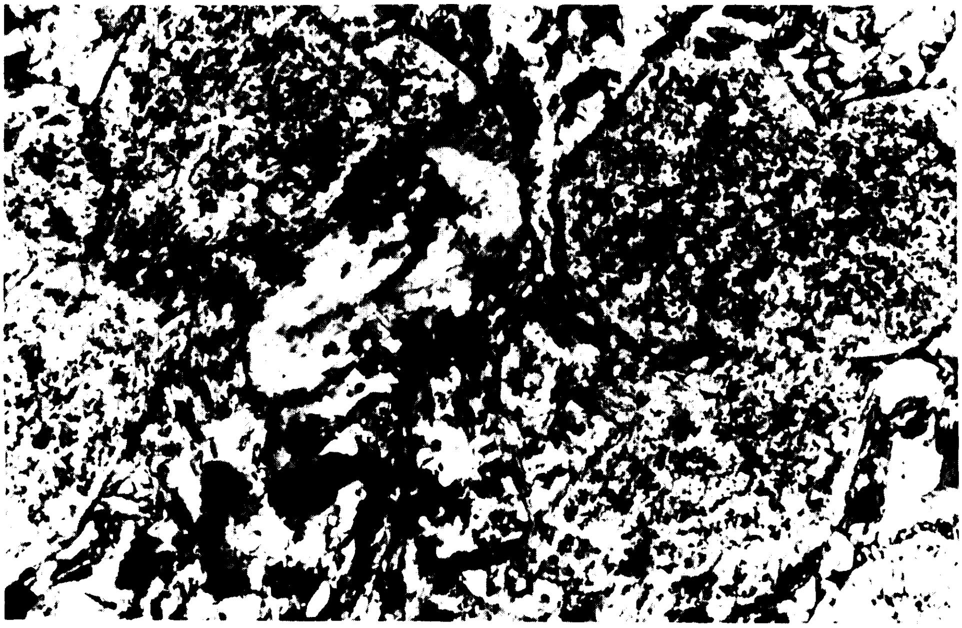

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Photo 16–Photomicrograph of pyroxenite (plane polarized light).

The biotite is commonly sagenitic.

Intermediate to Felsic Intrusive Rocks

Early Precambrian intermediate to felsic intrusive rocks underlie most of Elmhirst Township and much of northern Rickaby Township. These rocks belong to three distinct subcircular stocks, which are described separately below. Considerable variation in composition exists within and among the intrusions, but granodiorite is the most common rock type. Nothing is yet known of their relative ages. Dikes and minor intrusions of pegmatite and felsic porphyry are common throughout the map-area, particularly in the vicinity of the stocks.

COYLE LAKE STOCK

This stock occurs in Elmhirst Township south of the Namewaminikan River, and extends into Walters Township where it has been described by Mackasey (1976). The dominant mineralogy is that of trondhjemite or granodiorite. Most of the intrusion consists of massive, medium grained, light pink or dark grey granitoid rock, which is locally porphyritic.

The irregular contact zone is narrow compared to those of the other two intrusions. It consists of hybrid porphyritic dioritic rock which has similarities in colour, texture and grain size to both metavolcanic and plutonic rocks. Small intrusions of diorite porphyry are found cutting feldspathized and silicified metavolcanics for several hundred feet around the stock. Narrow metavolcanic inclusions up to 30 m (100 feet) long are present along the northern part of the intrusion near the contact.

In thin section, the rocks are dominated by euhedral crystals of saussuritized and sericitized plagioclase ranging from oligoclase to sodic andesine in composition. Quartz, which forms 10 to 35 percent of the rocks, occurs as highly strained andheral grains and granular aggregates interstitial to the feldspar. Potassic feldspar, in the form of microcline, rarely makes up 3 percent of the rocks and most of the specimens examined contained negligible amounts. Like quartz, the microcline occurs as anhedral, interstitial grains which are commonly unaltered, and as myrmekitic intergrowths with quartz. The most abundant ferromagnesian mineral is hornblende, which commonly constitutes 5 to 15 percent of the rock. Chlorite and epidote are very common as the alteration products of the hornblende. Red and green pleochroic biotite are the most abundant ferromagnesian minerals in some samples forming up to 15 percent of the rocks. Magnetite, apatite and sphene were observed as accessory minerals.

One whole-rock chemical analysis of a granitic phase of this intrusion is included in Table 6. For a separate study by Wolfe (1971), a large number of partial chemical analyses were done of rocks collected systematically over much of this intrusion. The results affirmed the overall composition of the pluton as granodiorite, with silica analyses ranging from 60 to 70 percent and most values between 62 and 67 percent. Soda is consistently between 3 and 4 percent and

TABLE 6	COMPLETE CHEMICAL ANALYSES OF MAFIC INTRUSIVE ROCKS IN ELMHIRST AND RICKABY TOWNSHIPS. SAMPLE LOCATIONS ARE SHOWN IN FIGURES 3 AND 7.

	D	E	F	G	H	I	J	K
SiO_2	54.40	51.00	51.20	51.70	51.60	50.90	54.50	49.00
Al_2O_3	17.10	17.30	13.50	15.60	17.70	16.50	16.60	14.00
Fe_2O_3	1.70	1.58	1.68	1.30	1.91	4.41	2.27	2.58
FeO	5.21	5.31	7.74	6.38	5.19	6.64	4.50	10.90
MgO	5.98	7.13	9.59	9.00	7.18	4.95	6.37	5.21
CaO	8.30	10.30	9.70	9.42	8.85	8.64	7.98	9.64
Na_2O	2.60	2.40	2.00	2.16	2.43	2.32	2.56	2.43
K_2O	0.97	0.92	0.48	0.63	1.20	0.77	1.14	0.58
TiO_2	0.55	0.46	0.50	0.51	0.49	1.14	0.53	1.58
P_2O_5	0.09	0.05	0.07	0.09	0.07	0.23	0.09	0.18
MnO	0.13	0.13	0.16	0.15	0.13	0.17	0.12	0.23
S	0.05	0.05	0.84	0.09	0.05	0.22	0.05	0.14
CO_2	0.35	0.78	0.65	0.24	0.46	0.41	0.41	0.18
H_2O	3.01	2.20	2.70	2.50	2.52	2.59	2.31	2.41
Total	99.60	99.60	100.40	99.80	99.80	99.90	99.40	99.10
S.G.	2.92	2.96	2.98	2.96	2.95	2.99	2.88	3.02
Q*	7.76		1.89	2.12	2.18	6.20	8.14	17.86
C	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Or	5.91		2.94	3.84	7.34	4.72	6.98	1.64
Ab	22.67		17.51	18.85	21.25	20.34	22.41	26.69
An	33.11		27.37	31.99	34.98	33.51	31.50	28.34
Di	4.91		12.28	9.05	5.88	4.28	5.29	7.92
He	2.16		5.51	3.55	2.12	3.44	1.84	3.51
En	13.07		19.02	18.92	15.76	10.79	13.96	5.82
Fs	6.58		9.80	8.51	6.51	9.95	5.57	2.96
Fo	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Fa	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Wo	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Mt	2.54		2.52	1.94	2.86	3.97	3.05	3.37
Il	1.08		0.98	1.00	0.96	2.24	1.04	1.50
Hm	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Ap	0.22		0.17	0.22	0.17	0.55	0.22	0.40
Ru	0.00		0.00	0.00	0.00	0.00	0.00	0.00
D.I.	36.35		22.35	24.82	30.77	31.26	37.53	46.18
C.I.	30.33		50.12	42.98	34.08	34.67	30.75	25.07
N.P.	57.92		59.56	61.53	60.81	60.83	56.98	50.02

S.G. - Specific Gravity
D.I. - Differentiation Index
C.I. - Colour Index
N.P. - Normative Plagioclase Composition (An%)
* Normative calculations were made following Barth (1952).

Samples D-J: Gabbro to quartz gabbro of the Pinel Creek Intrusion (see Figure 7).
Sample K: Keweenawan diabase, dike north of Coyle Lake.

most potash values are from 1 to 2 percent. No obvious chemical zonation within the stock was found (Wolfe, Ontario Division of Mines, personal communication, 1973).

ELMHIRST LAKE STOCK

This intrusion occupies the north-central part of Elmhirst Township and extends into the eastern part of Pifher Township. It is relatively homogeneous, having a composition between that of granodiorite and quartz diorite except within the wide contact zone which varies extensively in composition and texture. The southeastern contact is characterized by a zone of porphyritic diorite and minor tongue-like intrusions that cut the surrounding metavolcanics. This contact is similar to that around the Coyle Lake stock but the hybrid zone of the Elmhirst Lake stock is in the order of 0.8 km (½ mile) in width. Northeast of Barnum Green Rapids, the Coyle Lake and Elmhirst Lake stocks come in contact; the hybrid zones of both merge. No intrusive relationships were found between the two bodies to give an indication of their relative ages.

The northwestern contact of the Elmhirst Lake stock is characterized by numerous small metavolcanic inclusions within the pluton, as well as small granitic intrusions cutting the surrounding rocks. Along the Pifher-Elmhirst Township boundary in the southwestern part of the stock, the granitoid rocks enclose large metavolcanic areas which may be the remnants of roof pendants.

The northern and eastern parts of the intrusion consist of massive, equigranular pink to grey granitoid rock, but the southern and western rocks are commonly porphyritic with abundant andesine phenocrysts.

In thin section, the rocks are similar to those of the Coyle Lake stock. In more mafic samples, hornblende and its alteration products, chlorite, biotite and epidote constitute up to 50 percent of the rocks. The green biotite is commonly sagenitic (Photo 17). Locally, in the northeastern part of the intrusion microcline forms over 10 percent of the rocks but in most samples the small amounts of potassic feldspar present can only be detected by microchemical staining techniques.

An analysis of a sample from near the centre of this intrusion is included in Table 6.

KABY LAKE STOCK

This body underlies the northern part of Rickaby Township and extends north toward O'Neil Lake which is outside the map-area. Most of the intrusion is massive pink to light grey granodiorite to trondhjemite with local occurrences of granite and quartz monzonite. Contacts are generally poorly exposed. In the vicinity of Atigogama and Dilla Lakes the contact is sharp between grey granodiorite and feldspathized intermediate volcanic flows. Near the assumed contact in the western part of the stock, inclusions of porphyritic lava are abundant.

In thin section, as in hand specimen, there is considerable variation through-

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Photo 17–Photomicrograph of sagenitic biotite in granodiorite (plane polarized light).

out the intrusion. Biotite and hornblende occur and are almost mutually exclusive. The quartz content is high, between 20 and 40 percent, but the microcline or perthite content varies from very small amounts in the trondhjemitic rocks to 25 percent in the granitic phases. Alteration is similar to that of the other intrusions. The andesine to oligoclase plagioclase is heavily sericitized and saussuritized. Hornblende is altered to chlorite, epidote and muscovite. Brown sagenitic biotite is gradational in many grains through green biotite to chlorite. Potassic feldspar is unaltered.

An analysis of the grey granodiorite near the Orphan mine is given in Table 6.

MINOR FELSIC INTRUSIONS

Narrow, irregular intrusions of feldspar porphyry, quartz-feldspar porphyry and pegmatite are found throughout the map-area, and are probably associated with the major intrusions.

Pegmatite veins, generally less than 30 cm (1 foot) wide, are most abundant in and around the Elmhirst Lake stock. The veins appear to be of the simple quartz-feldspar type.

Porphyry dikes are more numerous, and are generally more irregular in shape than the pegmatite dikes. The porphyries consist of phenocrysts of quartz, feldspar and hornblende in a leucocratic aphanitic matrix. The rocks weather white to light pink with patches of pale green hornblende.

Absolute Age of Early Precambrian (Archean) Rocks

The assignment of the metavolcanics and intrusive rocks other than the diabase dikes in the map-area to the Early Precambrian is done on the basis of their obvious pre-diabase (i.e. pre-Keweeanwan) age and radiometric dating of metasediments that are correlative with rocks to the south of the map-area.

Wanless (1970) reported potassium-argon age of 2555 m.y. on biotite from a sample of metasediments in the Geraldton area. The continuation of this metasedimentary belt is in fault contact with metavolcanics in the map-area and hence the relative age of these rocks is not well established. No information is available on the age of Early Precambrian intrusive rocks in the area.

Diabase dikes in the region have been shown to be of two ages (Wanless 1970). Whole-rock, potassium-argon determinations for two dikes gave ages of 1545 m.y. and 1569 m.y. Biotite from a third dike gave a potassium-argon age of 1125 m.y. According to paleomagnetic and potassium-argon age studies by Palmer (1970), diabase sills in the Lake Nipigon area have ages of about 1100 m.y.

Middle to Late Precambrian (Proterozoic)

INTRUSIVE ROCKS

Diabase Dikes

North- to northeast-striking, vertical diabase dikes, presumed to be of Keweenawan age intrude all of the older rocks within the map-area. Because of traverse direction and spacing, these dikes are probably more numerous than shown on the Map 2373 (back pocket). Several of the larger dikes are over 24 m (80 feet) wide, but smaller dikes from 0.6 to 3 m (2 to 10 feet) wide are very common. In the metavolcanic terrain the dikes are generally wider and more numerous than in the granodioritic stocks.

The diabase is dark brown on weathered surface, and black with light green plagioclase laths when freshly exposed. Most of this rock is equigranular, with grain size ranging from aphanitic, in chilled margins, up to 5 mm; but in some dikes individual plagioclase phenocrysts are up to 1 cm in length. The diabase generally has high magnetic susceptibility relative to surrounding rocks, and dikes are quite easily delineated by ground magnetometer surveys.

In thin section, typical diabase texture is well preserved. Augite grains are interstitial between lath-shaped labradorite crystals in approximately equal proportions. Olivine was not observed but interstitial quartz and potassic feldspar are visible in the coarser grained rocks. Magnetite, skeletal ilmenite and apatite are common accessory minerals. Large plagioclase laths are partially sericitized. Augite has undergone limited alteration to uralite, biotite and chlorite. Small amounts of carbonate occur interstitially, in small amygdules which occur in the margins, or as an alteration product in plagioclase grains.

A whole-rock chemical analysis of a sample from the wide diabase dike north of east Coyle Lake, is included in Table 5. According to the classifications of Irvine and Baragar (1971) the basaltic magma which produced the diabase was clearly tholeiitic in affinity (Figures 5 and 6).

FELDSPAR-QUARTZ PORPHYRY

Several narrow, pink feldspar-quartz porphyry dikes were found cutting metavolcanics in Rickaby Township in the Expansion Lake area. These rocks are tentatively classified as Late Precambrian because they are undeformed and appear only slightly altered both in outcrop and thin section. Dikes are up to 3 m (10 feet) wide but generally the rock forms narrow irregular lenses less than 1 metre (3 feet) long. Commonly they are north-trending and steeply dipping parallel to the larger diabase dikes or local joint sets.

Microscopic examination shows that the rock consists of phenocrysts of oligoclase, quartz, microcline and microcline-perthite, hornblende, and biotite in a matrix of cryptocrystalline quartz and feldspar. Small amounts of fine hematite in the matrix imparts the pink colour to the rock. The plagioclase and perthite form the largest and most numerous phenocrysts. Grains up to 1 cm long are common. They are typically euhedral and exhibit complex zoning and twinning. Anhedral quartz inclusions are abundant within these phenocrysts. Most of the quartz and microcline phenocrysts are subhedral to anhedral and are much smaller. Biotite and amphibole occur as thin ragged plates and subhedral crystals, and together they constitute only about 5 percent of the rock, whereas feldspar phenocrysts make up about 30 percent and quartz, 10 percent. Plagioclase and perthite grains are only lightly sericitized and biotite flakes appear somewhat chloritized, but the overall alteration effect is slight.

This rock type is believed to be the granophyric equivalent of the Keweenawan diabase intrusions in the area.

Metamorphism

Most of the Early Precambrian rocks in the map-area have been metamorphosed to the lower greenschist facies rank, and are characterized by metamorphic assemblages such as quartz-albite-chlorite-epidote and quartz-albite-epidote-biotite. Talc and actinolite also occur within the mafic metavolcanics. No consistent changes were found in metamorphic assemblages with stratigraphic or structural position.

Contact metamorphism and possible mild metasomatic effects are superimposed on the regional metamorphism around the granodioritic stocks. Generally the mineralogy is not changed from the quartz, albite, epidote, muscovite, biotite, chlorite, and actinolite assemblages found in the greenschist facies rocks. The most obvious effects of the contact metamorphism are silicification, recrystallization, and (or) feldspathization in the surrounding metavolcanics. Secondary quartz is most readily observed in recrystallized intermediate flows where it occurs interstitially, in veinlets and replacing phenocrysts. Recrystallization and (or) feldspathization causes the growth of albitic plagioclase metacrysts in intermediate metavolcanics.

This effect is found around all three of the major felsic intrusions in the map-area. The pale yellow to green plagioclase metacrysts give the rocks the appearance of diorite porphyry.

Epidotization of plagioclase phenocrysts is most intense in the vicinity of the large intrusions, and disseminated pyrite is common for several hundred feet around the contact of the Coyle Lake stock.

The Pinel Creek intrusion studied by Faust (1973) appears to have undergone metamorphism of upper greenschist facies rank characterized by the association epidote-zoisite-actinolite-hornblende-chlorite.

For a few inches next to the contacts of the Keweenawan diabase dikes, country rocks are recrystallized and silicified producing a hornfelsic texture.

Cenozoic

QUATERNARY

Pleistocene

The extensive glacial deposits which form a thin veneer over much of the map-area are well exposed because of the numerous roads and large logged-over areas. Most of the map-area is covered by between 1.5 to 4.5 m (5 to 15 feet) of ground moraine consisting of silty to sandy till. In the southern part of Rickaby Township and in some parts of northeastern Rickaby Township, there are deposits of fine, pebble-free sand, in places over 15 m (50 feet) thick, which probably represent part of an outwash plain reworked by wind. A few well-shaped barchan dunes and steep-sided sand ridges occur in the Dennis Lake area. These indicate wind action from the west which is consistent with those studied in other parts of the region (Zoltai 1965).

A long but low and discontinuous esker consisting of boulders and pebbles in a matrix of silty sand, trends southwestward through the centre of the map-area.

Glacial striations, showing southwesterly ice movement, are found on clean, smooth exposures, particularly along lake shores. Two directions of ice movement were observed in the vicinity of Atigogama Lake. The older striations trend approximately 240° and the second trend 220°.

Sand and fine gravel are used locally for the construction and maintenance of logging roads.

STRUCTURAL GEOLOGY

Regional Structural Setting

The Early Precambrian rocks within the map-area form part of the Wabigoon Belt (Goodwin 1970), a major subdivision of the Superior Province of the Canadian Shield. The belt is a linear east-trending zone, dominated by highly deformed metavolcanics and intrusive granitic batholiths, and bounded by and intercalated with subparallel zones of metasediments. About 11 km (7 miles) to the south of the map-area, the Wabigoon rocks are in contact with metasediments and granitic rocks of the Quetico Belt, and to the north of Lake Nipigon metavolcanics are in contact with highly metamorphosed metasediments of the English River Belt. These lithological and structural subdivisions are outlined in Diagram A of the Geological Map of Ontario (Ayres *et al.* 1970).

In the southern part of the Wabigoon Belt the rocks are isoclinally folded and severely faulted in an east-west direction. In the vicinity of the map-area, north of the major structural discontinuity known as the Paint Lake Fault (Mackasey 1976), the metavolcanics appear to the authors to form a broad west-trending fold, the outline of which can be seen on ODM Map 2102 (Pye *et al.* 1966). Mafic metavolcanics in Meader and Pifher Townships are enclosed to the northeast and south by a felsic to intermediate sequence which is thickest in Elmhirst and Rickaby Townships, and these are in turn enclosed by a second mafic succession exposed in Rickaby and Lapierre Townships and along the northern limb of the inferred fold which extends toward the Castlewood Lake area. This interpretation of the fold is reinforced by the pattern of planar elements such as foliation and volcanic layering. Ontario Department of Mines Map 45a (Bruce 1936; Laird 1936) shows that the orientation of foliation changes from east to east-northeast in the present map-area, which is on the southern limb of the inferred fold; to north at the nose of the structure, in central Lapierre Township. Map 47h (Moorhouse 1938) also shows north-trending foliation and bedding in the metavolcanics of central Lapierre Township but the orientation swings abruptly to northwest-trending on the northern limb, in the area between Altitude and O'Neil Lakes.

The structure is tentatively classified by the authors as a syncline on the basis of top determination from pillows in Lapierre Township (Mackasey 1974) and near Altitude Lake (Moorhouse 1938).

Folding

MAJOR FEATURES

Perhaps mainly because of the almost total lack of reliable top determinations in the central and northern part of the map-area, and the monotony of the felsic to intermediate volcanic sequence, no major folds have been recognized, other than the postulated regional west-trending syncline. Pillows in the mafic sequence to the south of the felsic to intermediate belt indicate stratigraphic tops to the south. Tops also appear to be to the south, east of Seven-Foot Falls, where flow contact phenomena can be used to determine the orientation of the volcanic rocks. Certain distinctive horizons, such as spherulitic rhyolite flows of central Rickaby Township, appear to be consistent in their strike to the east-northeast over several thousands of feet, suggesting than no large scale folds occur in that vicinity. The simplest interpretation based on the available evidence is that the volcanics within most of the map-area form an essentially homoclinal sequence dipping steeply to the south. Insufficient volcanic outcrop occurs in the northern part of Rickaby Township and northeastern Elmhirst Township to reliably estimate the orientation of the rocks in that area.

MINOR STRUCTURES

Foliation

All of the metavolcanics are affected to some degree by a regional east-west foliation. This foliation is interpreted to parallel the axis of the regional fold, which appears to occur just to the north of the map-area. Schistosity is well developed within the intermediate pyroclastic rocks and mafic flows, generally striking at a low angle to the primary igneous layering and dipping steeply. Flattening of pillows, pyroclastic fragments, amygdules and spherulites parallel to the schistosity is very common. Two foliations were observed in an outcrop of tuff-breccia southwest of Kaby Lake on the Camp 58 road (Photo 18). Fragment alignment in this outcrop which may be related to primary volcanic layering trends about 65°E. Cleavage at about 105°E intersects the first foliation forming a lineation trending 255°E and plunging at 30°. The cleavage is well developed in the large fragments but it is not visible in the tuffaceous matrix.

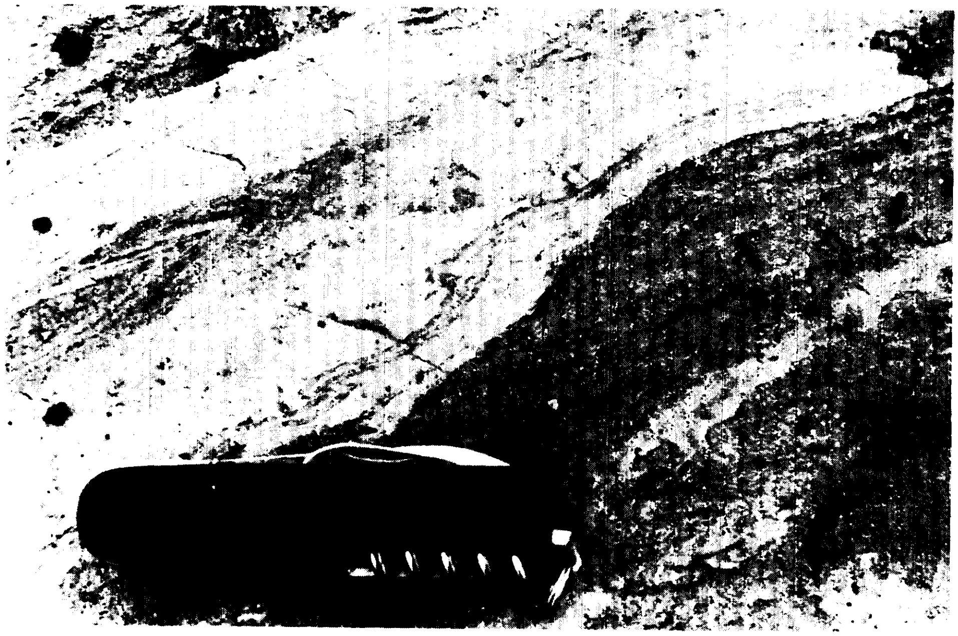
Minor Folds

Small intraformational folds are numerous within the fine-grained pyroclastic rocks (Photo 19). They were observed particularly in the laminated tuffs where the deformation is easily recognized.

Because of larger folds in those rocks, which are several tens of feet in amplitude, top determinations are not reliable. These are probably "drag" folds related to tectonic deformation of the incompetent, fine pyroclastic rocks during regional deformation. Minor folds are also found in quartz veins cutting many types of pyroclastic rocks and flows in southern Rickaby Township. They differ widely in their axial trend, but most are subparallel to the regional trend and plunge both eastward and westward.

ODM9752

Photo 18–Intersecting foliations, southwest of Kaby Lake. Compass is aligned parallel to secondary foliation.



ODM9753

Photo 19–Small-scale intraformational folds in laminated tuff, southwestern Rickaby Township.

Lineations

Rodding formed by elongation of volcanic fragments, pillows, amygdules, spherulites and lenses of vein material are common lineations observed within the map-area. Obvious fold hinge lines and crenulations on folded beds, which are believed to parallel hinge lines, were also found in several places. Most of these linear features trend east-west with moderate plunges to both east and west.

Faulting and Shearing

Faults and shear zones do not prominantly influence the topography of the map-area, in contrast to the major troughs produced by faults in the townships to the south (Mackasey 1976). Faults within the map-area are rarely observed in outcrop, and are generally associated with narrow, low-lying, linear areas best seen on air photographs. In a few cases significant stratigraphic displacement along these zones can be demonstrated. Many other similar linear features which are not associated with such offsets are designated as lineaments on Map 2373 (back pocket), and are probably related to jointing.

Two sets of lineaments, northeast- and northwest-trending, occur within the map-area, but the northeast-trending features are by far the more prominant in number, length, and continuity. One obvious fault which offsets the contact of the Coyle Lake stock southwest of Seven-Foot Falls, parallels the northeast-trending features.

As inferred the north-trending fault in northwestern Elmhirst Township separates gabbro and intermediate metavolcanics on the west side from granodiorite on the east. No topographic expression of this fault is recognizable on the ground, and only a weak linear feature is visible on air photographs. The fault is inferred on the basis of the linear contact which exists between the lithologies in that area.

A major fault is inferred in eastern Rickaby Township, just west of Atigogama Lake. A north-trending linear feature there coincides with the change in lithology from felsic to intermediate metavolcanics in the west to mafic rocks in the east. The fault was not observed in outcrop despite reasonably good exposure west of the lake. Its extension, north, into the Kaby Lake stock is not clear. To the south this fault appears to be terminated by the Paint Lake Fault (Mackasey 1976).

East- to northeast-trending shear zones and associated quartz vein systems are common within the metavolcanics. No large displacements are suspected along these zones. The most significant of these occurs in the southwestern part of Elmhirst Township, where there is a broad area some 500 m (1500 feet) wide containing zones of sheared metavolcanics with numerous parallel quartz veins.

A northward extension of the Jellicoe Fault, identified by Mackasey (1976) can be projected across the extreme southeastern corner of the map-area where it is obscured by a cover of glacial drift.

At least some of the faults in the map-area show indication of movement after the emplacement of Keweenanwan diabase dikes. Ground magnetic maps of the area east of Seven-Foot Falls suggest several small scale offests along the dikes probably produced by northeast-trending faults (Spence 1967).

ECONOMIC GEOLOGY

Gold, silver, nickel, copper, zinc, lead, molybdenum, sand, and gravel are present within the map-area. The Orphan mine, a small gold producer in 1934-35, is located north of Atigogama Lake in Rickaby Township. The Sturgeon River Gold mine which produced 73,438 ounces of gold and 15,922 ounces of silver between 1937 and 1942, is located only 0.4 km (¼ mile) southwest of Elmhirst Township. The sand and gravel deposits are currently being used by local lumber companies for road construction.

Exploration for gold has gone on continuously since the mid-1930s in this area. The recent increase in the price of gold has served to renew interest in local gold potential. Although base metal sulphides were recognized during the gold rush period, exploration for base metals did not take place until the late 1940s. Most of the recent exploration activity in the map-area has been directed toward copper and zinc sulphides disseminated within felsic metavolcanics.

During the present survey, much of the map-area was extensively staked. Figure 8 shows the approximate locations of blocks of mining claims held in Rickaby and Elmhirst Townships as of September 1972. Exploration activity in the area since 1970 can be described as moderately heavy. A compilation of reports on mining exploration surveys and diamond drilling programs which had been submitted for assessment credit as of December 31st, 1972, is given in Table 7.

The following section is a summary of the types of mineral deposits occurring in the vicinity of the map-area. Descriptions of individual occurrences and properties are listed separately in a following section.

Gold Deposits

Gold mineralization in this area is associated with (1) quartz veins and stringers in shear zones, and (2) sulphide occurrences in metavolcanics. Variable amounts of silver accompanies the gold, and tellurium-bearing minerals have been reported in the area (Bruce 1936).

QUARTZ VEIN-SHEAR ZONE OCCURRENCES

Auriferous quartz veins have been found within both the Early Precambrian metavolcanics and granodioritic intrusions. Most of the gold occurrences in the map-area are in veins which cut metavolcanics near the major intrusions, or in veins that are associated with large metavolcanic inclusions within the intrusions. Individual veins vary in width up to 2 m (6 feet), but commonly they form

TABLE 7 INFORMATION ON PROPERTIES IN ELMHIRST AND RICKABY TOWNSHIPS, ON FILE WITH THE ASSESSMENT FILES RESEARCH OFFICE, O.D.M. TORONTO AS OF DECEMBER 31, 1972.

File Name	Township	Property Reference Number	Type of Work
Ambassador Mining Developments Ltd.	Elmhirst	5, 24	D.H., G.R., G.M., M.
Augustus Exploration Limited	Elmhirst	9	D.H.
Barymin Company Limited	Rickaby	37	R.
Carling Copper Mines Limited	Elmhirst	4	D.H., S., M., E.M., I.P., G.R., G.M.
Cartier-Quebec Explorations Limited	Elmhirst	20	M.
Cerro Ming Corporation of Canada Limited	Elmhirst & Rickaby	5, 28	G.R., G.M., W., E.M., M.
Chemalloy Minerals Limited	Elmhirst	6	D.H., S., G.R., G.M.
Chesterville Mines Limited	Rickaby	37	D.H.
Church-Sturgeon River Gold Mines Limited	Elmhirst	4	D.H.
Cominco Limited	Elmhirst & Rickaby	8, 28	M.
Continental Exploration Ltd.	Elmhirst	9, 13	D.H., R.M.
Elmwood Mines Limited	Elmhirst	4, 17	D.H., W.
Greenoaks Mines Limited	Elmhirst	13	G.G., R., M.
International Nickel Company of Canada Limited, The	Elmhirst	14	D.H.
Jacobus Mining Corporation Ltd.	Elmhirst	14	D.H., S., G.R., G.M., E.M., M. I.P.
Martin-Sturgeon Property	Elmhirst	4	D.H., E.M.
Monarch Gold Mines Limited	Elmhirst	19, 20	G.R., G.M., M., E.M.
Noranda Mines Limited	Rickaby	37	D.H.
Paramaque Mines Limited	Elmhirst	4	D.H.
Phelps Dodge Corporation of Canada Limited	Rickaby	37	D.H.
H.K. Porter Company Incorporated	Elmhirst	5, 15 22	M., E.M.
Rio Tinto Canadian Ex. Exploration Ltd.	Rickaby	37	D.H., G.R., G.M., M., E.M.
Sturgeon Basin Mines Limited	Rickaby	10	D.H., G.R., G.M.

Abbreviations used:
E.M. - Electromagnetic Survey and Map
I.P. - Induced Potential Survey and Map
M. - Ground Magnetometer Survey and Map
R. - Resistivity Survey and Map
D.H. - Diamond Drill Hole Logs
S. - Diamond Drill Hole Plans and Sections
G.R. - Geological Report
G.M. - Geological Map
W. - Work Plans (showing trenches etc.)

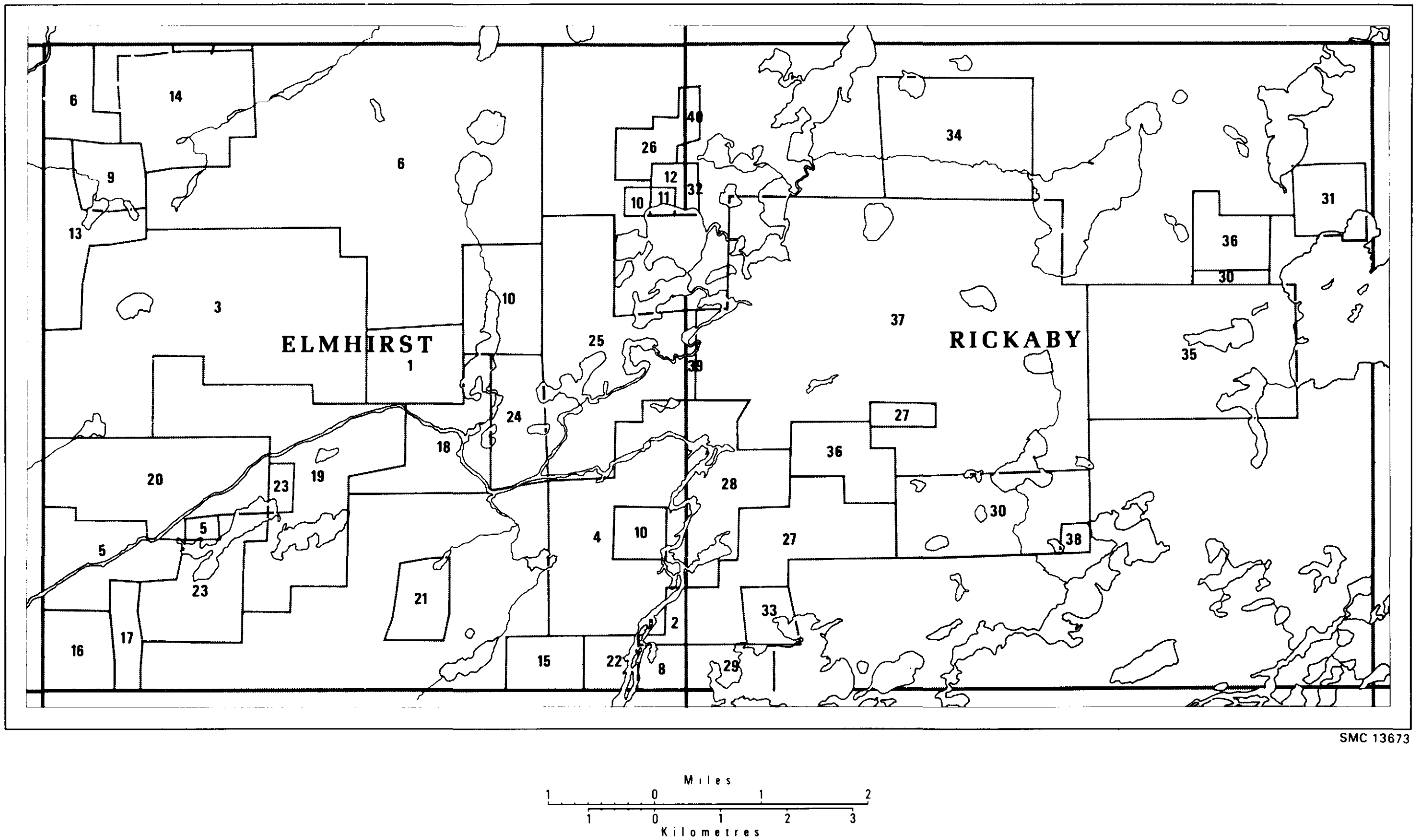


Figure 8–Sketch map of properties held in Elmhirst and Rickaby Townships as of September 1972.

irregular bifurcating networks restricted to wide chloritic or sericitic shear zones.

Gold mainly occurs alone, very finely divided, in the native state. Lesser amounts occur in veinlets in the gangue which consists mostly of quartz and chlorite, and as blebs or veinlets in sulphides. Electrum and gold tellurides have been identified in the Sturgeon River Gold mine (Bruce 1936, p.34, 35).

Conventional prospecting by means of stripping, trenching, and diamond drilling has been the main method used in the past gold exploration programs.

SULPHIDE-RELATED OCCURRENCES

Gold, in highly variable amounts, is associated with disseminated pyrite-sphalerite-chalcopyrite and pyrrhotite-chalcopyrite mineralization found throughout the felsic to intermediate metavolcanics in the map-area. In general, gold appears to be concomitant with copper, and zinc-rich mineralization is relatively low in gold. Silver is also associated with higher copper content, but it particularly reflects the proportion of galena within the sulphides.

RELATIONSHIPS OF GOLD OCCURRENCE TO GEOLOGICAL FEATURES

Both the Orphan mine and the Sturgeon River Gold mine occur in close proximity to granodioritic stocks, but most of the veins which were mined occur in intermediate to felsic metavolcanics around the intrusions. Few interesting occurrences have been found completely within the intrusions. A reconnaissance geochemical survey of the Coyle Lake stock in 1971 by Dr. W.J. Wolfe, Ontario Division of Mines (personal communication) has indicated that no abnormal gold concentration occurs within the granodioritic body.

Many other gold occurrences in the region occur in intermediate to felsic metavolcanics and in metasediments, apparently not related to intrusions. The occurrences in metasediments are commonly found close to iron formation, suggesting that gold may be genetically related to this rock type.

Tyson (1945) compared the spatial relationship of gold deposits to major faults such as the Paint Lake Fault. He points out that in other gold camps, major faults have been postulated to serve as channelways that have allowed gold-bearing hydrothermal solutions to permeate into the upper part of the earth's crust.

Sulphide Deposits

Four different types of base metal sulphide deposits, probably of differing origins, occur within the map-area. These may be summarized as: 1) disseminated copper and zinc deposits associated with felsic to intermediate metavolcanics; 2) quartz-vein type copper and copper-zinc deposits; 3) a molybdenite deposit associated with a granodioritic stock; and 4) a copper-nickel deposit associated with a mafic intrusion.

The characteristics and possible modes of origin of each of these types of deposits are discussed separately below.

DISSEMINATED COPPER AND ZINC DEPOSITS

Sparsely disseminated base metal sulphides are widespread within the felsic to intermediate metavolcanics. Pyrite and pyrrhotite commonly constitute up to 2 percent of these rocks. Chalcopyrite, sphalerite, and rarely galena are also found in these rocks, alone or in various combinations with the iron sulphides. The ratio of copper to zinc is extremely variable, but the two generally occur together in roughly equal proportions, or in sub-parallel zones in which one or the other is predominant. Locally in sheared or brecciated rhyolitic and dacitic metavolcanics, seams and pods, in the order of 10 to 15 cm (4 to 6 inches) wide in central Rickaby and southwestern Elmhirst Townships, containing concentrations of several percent combined copper and zinc have been found (e.g. see property description of Phelps Dodge Corporation of Canada Limited).

ORIGIN OF DISSEMINATED SULPHIDE DEPOSITS

It remains to be determined whether the disseminated sulphide mineralization in this area originated syngenetically with fumarolic and (or) volcanic activity or whether it was introduced at a later date by replacement restricted to the vicinity of sheared and (or) brecciated rock accessible to metal-bearing solutions. Very finely disseminated sulphides which are present in the mafic metavolcanics in the map-area may be related to primary accessory minerals.

Evidence for the syngenetic origin of the sulphide mineralization includes: a) the restriction of the sulphide concentrations to felsic and intermediate metavolcanics, b) the uniformity of distribution of disseminated sulphides throughout the more felsic metavolcanics, c) the occurrence of several deposits near the assumed tops of rhyolitic units in central Rickaby Township, and d) the presence of cherty material of possible fumarolic origin in the region which, in at least one case, is close to copper mineralization (Mackasey 1976). However, so far no obvious stratigraphic control of the mineralization has been recognized, and no massive or banded ("volcanogenic") sulphides have been reported.

An epigenetic origin for some of the mineralization is suggested by the concentration of the sulphides in sheared and brecciated rocks, and, to a lesser extend, around the contacts of granodioritic stocks such as the Coyle Lake stock. Sulphide occurrences spatially related to faults and breccia zones and to felsic and intermediate stocks are well documented in this region (Mackasey 1976).

VEIN-TYPE SULPHIDE DEPOSITS

Quartz veins bearing erratic amounts of sulphide minerals, mostly pyrite, chalcopyrite and sphalerite, occur within the metavolcanic and felsic intrusions. Gold content commonly increases with the proportion of sulphide minerals in these veins. The sulphide minerals occur as clots and lenses up to several inches in diameter and can constitute up to 20 percent of the vein material, such as in the Miron Showing (Carling Copper Mines Limited). Sulphide concentrations occur where the veins narrow or bifurcate, whereas other parts of the veins are virtually barren.

ORIGIN OF THE VEIN-TYPE SULPHIDE DEPOSITS.

The sulphide minerals present within quartz veins formed with the gangue material, crystallizing from hydrothermal solutions. Metals within such solutions may have been introduced (a) directly from a primary magmatic source from which the solutions were derived, or (b) by leaching of the sulphide-rich volcanic wall rocks, through which the solutions passed. Since these quartz veins cut across both Early Precambrian metavolcanic and plutonic rocks, they were formed relatively late. The quartz veins probably represent the products of a silica-rich aqueous fluid given off as the final fraction of a cooling felsic magma. Metals are generally considered to be able to concentrate in such fluids and travel considerable distances before precipitating as sulphides or in some cases as sulfosalts or oxides, within the quartz veins.

MOLYBDENUM DEPOSITS

An occurrence of molybdenum is located in northwestern Elmhirst Township, within a quartz vein and quartz-rich shear zone about 3 m (10 feet) wide striking northwest, which cuts the Elmhirst Lake stock (see property description of Chemalloy Minerals Limited). The molybdenite is disseminated within bluish grey quartz and is difficult to detect in hand specimen. In patches of the vein, however, flakes and clots of the mineral are clearly visible. The granodiorite surrounding the main vein is highly sheared and foliated, and contains over 50 percent quartz. Visible molybdenite, as small disseminated specks and as thin leaves or smears along shear planes, occurs in altered foliated rock, but no mineralization was seen in the massive country rocks. Minor molybdenite occurs in narrow quartz stringers forming offshoots from the main vein. Pyrite forms up to 5 percent of the rocks in a narrow zone along the contact between the vein and the sheared granodiorite. Minor chalcopyrite was also observed by the writers.

So far only one such zone has been found in the local granodiorite stocks. A disseminated chalcopyrite-molybdenite deposit occurs in a granodiorite lens in Dorothea Township to the southwest of the map-area (Mackasey 1975). Numerous molybdenite occurrences north of the map-area were reported by Moorhouse (1938).

ORIGIN OF MOLYBDENUM DEPOSITS

The molybdenum and copper associated with these deposits probably originated from within the felsic intrusions. Metals, concentrated in late-formed fluid differentiates of the magma, were injected into fracture networks and shear zones to form what can be called a porphyry-molybdenum deposit.

COPPER-NICKEL DEPOSIT IN A MAFIC INTRUSION

A copper-nickel deposit, estimated to consist of 937,538 tons of 0.42 percent copper and 0.41 percent nickel (Wheadon 1971b), occurs within the Pinel Creek intrusion in northwestern Elmhirst Township (see Jacobus Mining Corporation Limited Property description). This intrusion is interpreted by Faust (1973) to be a layered sill-like body composed predominantly of gabbro and quartz-rich leucocratic gabbro with minor layers of pyroxenite and anorthositic gabbro. Disseminated sulphide minerals, interstitial to the silicate minerals, are concentrated in the melanocratic gabbro phase of the intrusion located near the upper contact of the body. The sulphide minerals, mainly pyrrhotite, chalcopyrite, and pentlandite occur together, in that order of abundance, and commonly constitute between 4 and 6 percent of the rock within the mineralized zone. Drilling indicates that this zone is cylindrical, dipping to the north at about 45°, roughly parallel to the upper contact of the intrusion, and plunging westward, varying from 7 to 45 m (20 to 150 feet) in diameter.

ORIGIN OF THE COPPER-NICKEL SULPHIDE MINERALS IN THE PINEL CREEK INTRUSION

Faust (1973) attributes the presence of sulphide minerals in this body to the separation of an immiscible sulphide melt early in the crystallization history of the mafic magma which formed the intrusion. He believes that sulphide minerals formed prior to crystallization of most of the silicates. His study of polished sections of drill core indicates that the silicate minerals embay and replace all of the sulphide phases.

McCulloch (1968) also believes the deposit to have a syngenetic primary magmatic origin, but he states that the sulphide minerals are the product of a residual sulphide liquid which cooled more slowly and crystallized later than the silicate minerals.

Sand and Gravel Deposits

Deposits of sand and gravel occur throughout the map-area. Fine sand forms particularly extensive and thick deposits in southern and eastern Rickaby Township. Coarse, poorly sorted gravel occurs in the esker in Elmhirst Township. Numerous sand and gravel pits along the local roads have been used to provide road building materials.

Suggestions for Mineral Exploration

Facilities affording relatively low cost exploration activity and rapid development of potential mineral deposits are already in the vicinity. Access to the map-area is excellent and hydroelectric, natural gas, railway, highway and communications systems are near at hand.

Based on the past mining history of the area, the favourable geological environment, and the present pace of mineral exploration, the mineral potential of the area is considered to be moderately high. The following comments should be regarded when planning exploration programs in this area.

METAVOLCANICS

The possibility of economic deposits of copper-zinc-gold within the felsic volcanic rocks in the map-area has been recognized for several years. Numerous base metal sulphide occurrences have already been found and considerable effort is being expended in several parts of the map-area to determine the extent of known mineralization and to locate new occurrences.

Felsic rocks within the map-area are concentrated along a belt approximately 1.6 km (one mile) in width, extending from southwest of the Seven-Foot Falls area toward the west shore of Atigogama Lake. A faulted extension of this belt may occur to the north and east of Atigogama Lake, but the amount and direction of movement along the inferred fault has not been established. Felsic rocks also occur in the southwest and northwest corners of Elmhirst Township. Those in the southwest part resemble, and are approximately on strike with, the belt of felsic rocks in Rickaby Township.

Most of the sulphide occurrences are concentrated in zones of sheared and brecciated rock where the sulphide minerals form small veins and pods, but broad zones of disseminated mineralization in felsic pyroclastic rocks have also been found. Electromagnetic and magnetometer surveys have not been successful in locating the disseminated mineralization, although several shear zone occurrences have been located using these techniques. Induced polarization surveys have served to outline some disseminated deposits in the area. Rock and soil geochemical prospecting has been used with success to locate near-surface sulphide showings.

If a syngenetic model for sulphide mineralization in this area is assumed, a number of features associated with that type of deposit may prove useful in ex-

ODM9754

Photo 20–Tuff-Breccia composed dominantly of angular felsic volcanic fragments, Phelps Dodge Property, Rickaby Township.

ploration. A geological environment often considered to be favourable, occurs at the interface of rhyolitic domes overlain by rocks more mafic in composition. Coarse pyroclastic material such as pyroclastic breccia and tuff-breccia may be associated with such domes, and are commonly closely spatially related to known ore bodies (Sangster 1972). Such rhyolitic dome-like features and coarse pyroclastic rocks (Photo 20) occur in several places in central Rickaby Township. Rocks of possible fumarolic origin such as chert and banded pyritic iron formation are closely related to many syngenetic deposits. Although banded sulphides are not recognized within the map-area they are found on the northern limb of the regional fold in the vicinity of Humbolt Bay, and may occur elsewhere within the structure.

A more likely model for mineralization in this area is one of epigenetic replacement and fracture filling. Barriers to metal-bearing hydrothermal solutions could be formed by relatively massive impermeable felsic flows and porphyry intrusions. Structural traps formed by such massive rocks surrounding relatively porous pyroclastic material would create environments suitable for precipitations of sulphide minerals. The most extensive mineralized zones found so far are pipe-shaped bodies which plunge southwestward, parallel to lineations recorded in the metavolcanics. These bodies may occupy specific horizons in hitherto unrecognized folds with hinge lines gently plunging to the southwest. In any exploration programme therefore, consideration should be given to down plunge tracing of known mineral zones.

Sulphides also occur near the contacts of the felsic to intermediate intrusions. Potential channelways such as faults and lineaments close to the plutons may warrant investigation, as well as on both sides of the contact where sulphide-bearing felsic volcanic rocks have been cut by intrusions. Heat and aqueous fluids liberated during the injection of these intrusions may have caused remobilization and concentration of volcanogenic sulphide minerals.

FELSIC TO INTERMEDIATE INTRUSIONS

So far almost all of the prospecting done in the granodiorite stocks has been the trenching of gold-bearing quartz veins. Very little consideration has been given to the search for low grade, high tonnage porphyry-type deposits of copper, molybdenum and (or) gold. Chalcopyrite, molybdenite, and gold mineralization occurs in shear zones and fractures in the Elmhirst Lake stock. However, a trace element study of the Coyle Lake stock by W.J. Wolfe (Ontario Division of Mines, personal communication) in 1970 indicated no abnormal concentrations of these metals in this stock. Biogeochemical and rock geochemical prospecting programs should be useful in detecting any low grade occurrences. In this region, arsenic may serve as a pathfinder element for detecting gold in geochemical surveys (Mackasey 1976).

MAFIC TO ULTRAMAFIC INTRUSIONS

The possibility of the northwestward extension of the zone of copper-nickel mineralization in the Pinel Creek intrusion has been recognized by Wheadon (1971a). If Faust (1973) is correct and this intrusion is a layered mafic-ultramafic complex, additional mineralized zones may occur at greater stratigraphic depth in the inferred ultramafic portion of the body.

The eastern contact of the Pinel Creek intrusion with the Elmhirst Lake stock should be examined with the following possibilities in mind. If the contact is a fault, as shown in Map 2373 (back pocket), mineralization within the mafic body may have been concentrated along the fault zone. Also depending upon the movement along the fault, extensions of the Pinel Creek body may be found to the north of the map-area. If the eastern contact is an intrusive one rather than a fault, mineralization within the mafic body may have been remobilized by the intrusion of the granodiorite and deposited at the contact or in structural traps nearby.

The Pinel Creek body may be an offshoot from the much larger gabbro-quartz diorite intrusion to the northwest of Elmhirst Township described by Moorhouse (1938). This body is associated with strong aeromagnetic highs (ODM-GSC Map 2136G). It too should be examined for sulphide mineralization.

Description of Properties

The descriptions of properties are listed alphabetically under the names of the 1972 owners. The number in brackets following the property name is the property location number which is shown on the accompanying geological map and on Figure 8. References are also made to some of those companies and individuals who did not hold ground in 1972, but who have held property in the map-area for which assessment data is recorded in Table 7.

The field party attempted to visit as many of the properties as possible, but were unable to locate many of the older showings and workings because of infilling and overgrowth.

Details of the history of the various properties are taken from company reports on file with the Assessment Files Research Office, Ontario Division of Mines, Toronto, from reports and records of the Ontario Division of Mines, and from information made available to the authors by the companies and individuals concerned.

AMBASSADOR MINING DEVELOPMENTS LIMITED

In the summer of 1960 this company carried out geological and magnetometer surveys over a group of 12 claims east of Elmhirst Lake (Properties 10, 24, 25). During October of that year, five shallow diamond drill holes were put down near the centre of the property. According to company reports, no magnetic anomalies were located and drilling in felsic volcanic rocks intersected only sparsely disseminated pyrite. No further work by this company is on record. The geology of this area is described under the holders of the ground in 1972, J.A. Douglas, H.E. Rutherford and A. Turcotte.

Y. AUGER (1)

In 1972, Y. Auger held 12 claims, 318190 to 318201 inclusive, west of Elmhirst Lake. No assessment data was on file for this property as of December 1972. Most of the claims are underlain by intermediate flows and pyroclastic rocks, but granodiorite of the Elmhirst Lake intrusion occurs in the northern and western claims.

M. BERUBE (2, 27)

An irregular block of 22 claims, east of the Sturgeon River and north of Expansion Lake, was held by M. Berube in 1972. The property included claims 333932 to 333940 inclusive, 334343 to 334345 inclusive and 334528 to 334537 inclusive. A second group of claims held by Mr. Berube is located about 1.6 km (1 mile) northeast of the main block. The properties are underlain by intermediate and felsic metavolcanics, most of which appear to be pyroclastic rocks. No information is on file for these claims in the Assessment Files Research Office.

F. BILODEAU (3)

In 1972, a large block of 82 claims in west-central Elmhirst Township and the adjacent part of Pifher Township, was held by F. Bilodeau. The property consisted of claims 318002, 318003, 318005, and 318007 to 318085 inclusive. The claims are almost entirely underlain by granitoid rocks of the Elmhirst Lake intrusion, and adjoin another large property to the north held by Chemalloy Minerals Limited. No assessment data had been filed for this property as of December 1972.

CARLING COPPER MINES LIMITED (4)

In 1972, this company held a block of unpatented claims which straddled the Namewaminikan River in the vicinity of Barnum Green Rapids. Claims 128006, 128007, 128008, 128016, 128017, 128040, 128041, 221343 and 221344 occur in southwestern Elmhirst Township and in part overlap with the surveyed claims shown on Map 2373 (back pocket).
Adjacent to these claims, the company held claims 128033 to 128039 inclusive and 286973 to 286988 inclusive in Pifher Township.

History of Exploration

This area was staked in 1959 by W.W.Martin, after his discovery of a copper showing on the south side of the Namewaminikan River at Barnum Green Rapids. This has since been known as the "River showing". Mr. Martin carried out a ground electromagnetic survey in 1960, which outlined a number of weak conductive anomalies, and in the winter of 1960/61 eight diamond drill holes were drilled from the north side of the river to investigate the conductive zone associated with the original showing. These holes are shown in Figure 9, as the M series. Erratic copper values from these holes, mainly in a zone beneath the bed of the river, led to a loss of interest in the property at that time. Between 1961 and 1966 only surface prospecting took place.

In 1966, Norlex Mines Limited began a diamond drilling program in the vicinity of the "River showing" to intersect the mineralized zone at greater depth. This program was continued in 1967 under a working option agreement with Canadian Javelin Limited who completed 12 of the 19 holes drilled. All but one of these holes are in the vicinity of the "River showing". They are shown in Figure 9 as the N series of drill holes. Canadian Javelin Limited also performed an additional electromagnetic survey over the property. This work resulted in the interpretation of the presence of a flat, moderately-dipping zone of disseminated pyritic mineralization, from 15 to 30 m (50 to 100 feet) thick, with erratic copper and zinc mineralization. At that time, the copper mineralization was believed to be controlled by an east-west shear zone along a formational bulge or fold in andesitic lava.

In 1970, Carling Copper Mines Limited acquired some of the claims of Norlex Mines Limited. During that summer another electromagnetic survey, an induced potential survey, and detailed geological mapping took place. In the fall of 1970, a program of diamond drilling was started to test geophysical anomalies and known mineralization. As of the summer of 1972, 24 diamond drill holes totalling 2,144 m (7,028 feet) had been drilled. These are shown as the C series in Figure 9. Seven of these holes were put down on the north side of the river and the remainder are located on claim 221344. Nine holes are concentrated around a surface copper-zinc showing in the west-central part of that claim. Several of those nine holes were drilled in an attempt to trace a zone of brecciated quartz diorite which, in one of the first holes, returned 16.69 ounces gold/ton over 0.7 m (2.3 feet) of core length (Pudifin 1972a). The breccia zone was intersected but no additional gold values were obtained. A second concentration of holes was put down to investigate electromagnetic anomalies in the southwestern corner of claim 221344. Stripping and trenching in the vicinity of the gold intersections were carried out during the summer of 1972.

More diamond drilling in the southwestern part of claim 221344, and along the mineralized zone under the Namewaminikan River was recommended in a report by Pudifin (1972a), and a pit in the area of the high grade gold intersection was planned.

Geology

Claims 221344, 128041 and 128007 are for the most part underlain by intermediate to felsic metavolcanics. Most of the other claims in Elmhirst Township are underlain by intrusive rocks of both the Coyle Lake and Elmhirst Lake stocks. In the claims immediately north of the Namewaminikan River, silicified metavolcanics occur intermixed with hybridized granodiorite.

The metavolcanics on the property strike northeastward and dip moderately to steeply to the northwest. Although cut off by intrusive rocks to the north, east and west, the metavolcanics continue to the southwest through property held by Jupiter Minerals Incorporated. The metavolcanics on the Carling Copper Mines Limited property are mostly dacite, rhyolite, and andesite flows intercalated with agglomerate and tuff-breccia units which are abundant in the northern part of the property. Silicification and chloritization has affected the more mafic flows, particularly in zones of shearing. Near contacts with plutonic rocks, the metavolcanics have been recrystallized and slightly metasomatized, taking on the appearance of porphyritic diorite which grades into the hybridized granodiorite of the intrusions.

Numerous chloritized shear zones, which generally parallel the foliation, occur on the property in both metavolcanic and intrusive rocks.

Mineralization

Pudifin (1972a) reports mapping at least 16 mineralized occurrences containing zinc and (or) copper on this property. So far, the bulk of the exploration here

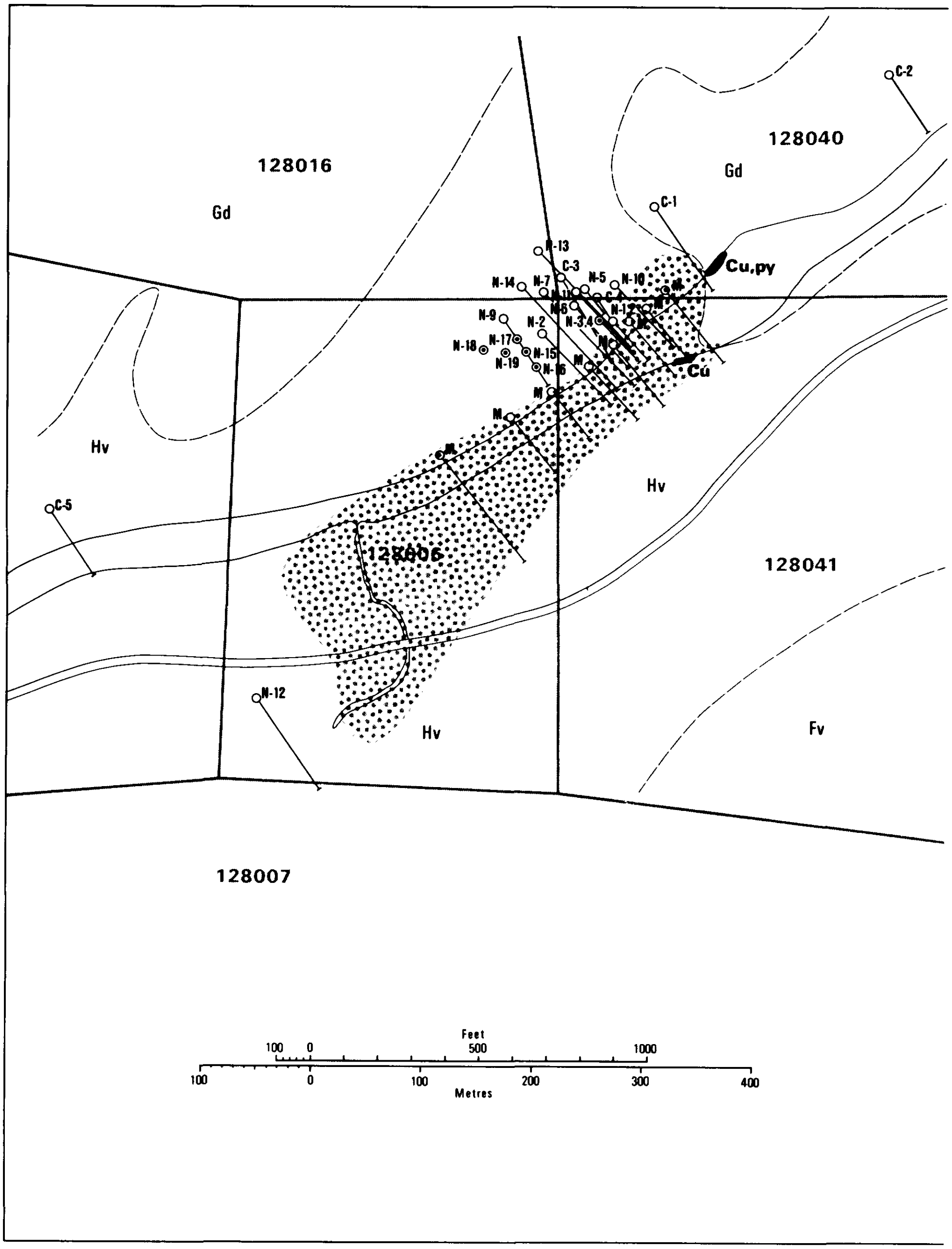
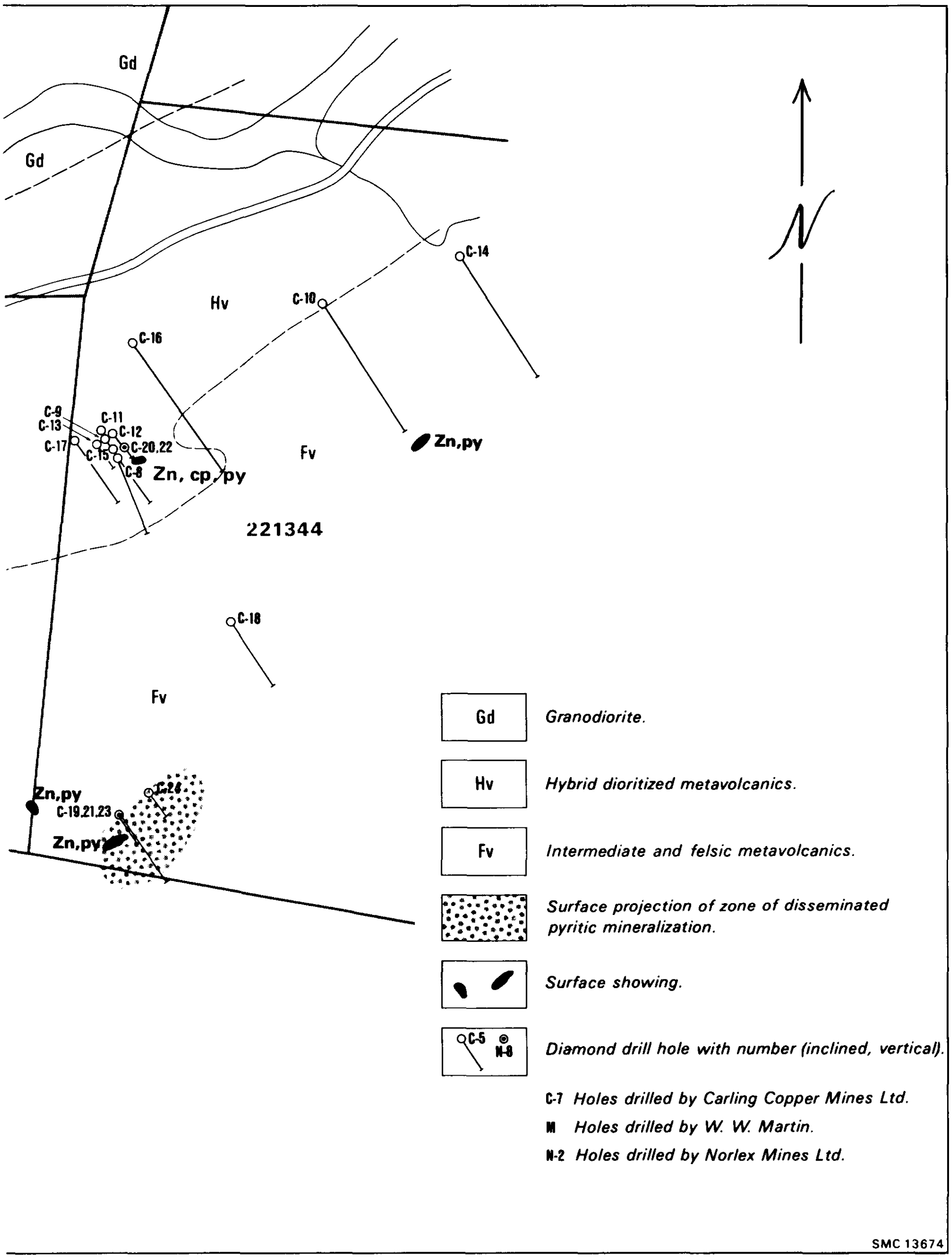


Figure 9–Sketch map of part of the



Carling Copper Mines Limited property.

has been devoted to determining the extent of the mineralized zone sub-parallel to, and in part beneath, the Namewaminikan River, and to locating pockets of ore grade copper and (or) zinc within the zone. The following description of this zone is taken from a report written by Pudifin (1972a, p.3-4):

The sphalerite mineralization in this area appears to occur on the hanging wall side of the pyrite zone, with chalcopyrite occurring more in the central part. It appears probable that the chalcopyrite mineralization at least, occurs in a shear zone at a shallow angle transgressing the main shear zone. The zone appears to be pipe-like in form with a shallow plunge rather than a sheet-like occurrence hence it could have been largely missed in the drilling.

About 90% of the diamond drilling carried out previous to 1970 investigated a strike length of about 450 feet of this zone to a depth of 400 feet. The majority of these holes were put down to test the zone at about 225 feet vertical depth.

The results of the drilling indicate a wide zone of lightly disseminated pyrite mineralization in sheared dacitic volcanics which strikes at 50° and dips northwesterly at 50 to 60°. Width of the zone generally is about 50 to 100 feet with enlargements up to 500 feet along strike and down dip. Within this pyrite zone, lenses of chalcopyrite and sphalerite have been outlined.

A number of high grade copper showings, including the "River showing", have been discovered along the Namewaminikan River along a strike length of about 1.6 km (1 mile) and a weakly mineralized zone about 300 m (1,000 feet) wide assaying 0.2 percent copper is reported by Pudifin (1972a). Some of these showings and the mineralized zone are located in Figure 9.

A second zone of disseminated pyritic mineralization parallel to the first is believed to strike diagonally across claim 221344. The extent of this zone is not well defined, but where it has been intersected in drill holes little copper has been reported, although zinc values up to 4.5 percent over 1.6 m (5.1 feet) were obtained (Pudifin 1972a).

Gold and silver occur in many places with the sulphide mineralization, particularly with chalcopyrite. Commonly gold ranges up to 0.1 ounce/ton, and silver up to 1.0 ounce/ton (Pudifin 1972a). However, in the area of the zinc showing in the west-central part of claim 221344, a high grade gold and silver intersection has received considerable attention. Of this occurrence Pudifin (1972a, p.10) writes:

Nine short holes were put down in an area south of the river, the first of which investigated a 55 foot wide zinc with copper zone exposed by a surface trench. This showing occurred at the end of an Induced Polarization anomaly. Some copper occurred where the hole collared in bedrock. The next hole was backed up 75 feet to investigate for possible extension of the copper mineralization. This hole, C-9, cut in a silicified and brecciated zone from 55.0′ to 57.3′ (2.3 feet) which assayed 16.69 ounces gold/ton, and 7.32 ounces silver/ton. The following 2.7 feet assayed 0.10 oz. gold/ton. The remainder of the holes in this group were put down to trace the extension of the structure and gold mineralization. The breccia zone was picked up in two of the holes but did not assay in gold. A number of low grade zinc sections were obtained.

CERRO MINING COMPANY OF CANADA LIMITED (5, 28)

In 1971 this company held options on 53 claims recorded under the names of A.J. Douglas (4 claims numbered TB 303238 to 303240 inclusive and TB 304689) and C.E. Bye (49 claims numbered TB 282654 to 282663 inclusive and TB 282755 to 282793 inclusive). The block of claims straddled the southern part of the Elmhirst-Rickaby Township boundary.

Until 1971 no work had been reported on the property since the 1930s gold rush when all of the map-area was prospected. In 1971, A.J. Douglas discovered a number of showings containing chalcopyrite, sphalerite and galena, and staked the four claims in the centre of the present block. In the fall of that year, an electromagnetic survey was conducted over the property by the company and magnetometer surveys were carried out around known mineralized occurrences. Considerable trenching was carried out in an attempt to extend the known showings.

Most of the claims are underlain by felsic to intermediate coarse pyroclastic rocks such as tuff-breccia, lapilli-tuff and crystal tuff. The metavolcanics strike at about N70°E and dip quite steeply to the south. Patches of gossan covering the felsic metavolcanics are common, and in some places pyrite forms as much as 10 percent of the rock.

Figure 10 shows the location of trenches and pits dug by Cerro Mining Company of Canada Limited in 1971. Pit #5 on claim 303240 proved the most interesting. Here, massive chalcopyrite and pyrite lenses occur in a quartz sericite schist over a width of about 18 cm (7 inches). Giblin (1971) reported that a chip sample across a 18 cm (7 inch) width assayed 3.32 percent copper, 0.08 percent zinc, 0.01 ounce of gold/ton and 0.43 ounce of silver/ton. In the vicinity of Pit #1 stringers of chalcopyrite, pyrite, and pyrrhotite occur in chlorite schist. Giblin (1971) reported that this assayed 0.70 percent copper and 0.03 percent zinc with traces of gold and silver over a width of 1.3 m (4.4 feet). In other pits and trenches, small lenses of chalcopyrite occur with minor amounts of pyrite in sheared and silicified metavolcanics and quartz veins. In general, Giblin interpreted the mineralization to be discontinuous and of limited extent. This coupled with the inability of geophysical surveys to outline additional targets led to the termination of exploration work after the fall of 1971. No further work in this area has been reported.

CHEMALLOY MINERALS LIMITED (6)

In 1972, a total of 117 claims numbered TB 296943 to 296980 inclusive, TB 296986, TB 318104 to 318151 inclusive, TB 318162 to 318189, TB 318004 and TB 318006, in northern Elmhirst Township, were held by Chemalloy Minerals Limited. A small block of claims to the west of the property held by Chesterville Mines Limited is underlain by intermediate metavolcanics, but a much larger block to the east of the Chesterville Mines Limited property is underlain for the most part by granodiorite rocks of the Elmhirst Lake stock.

A showing of molybdenite associated with quartz veins in granodiorite was discovered on claim 296949 by A. Mitto in the summer of 1971. The property was subsequently acquired by Chemalloy Minerals Limited, and a program of bulldozing, trenching and diamond drilling was completed by September of that year. Four diamond drill holes totalling 150 m (500 feet) were put down to intersect the mineralized zone at various depths, but only one hole, number 4, (Figure 11) produced consistent molybdenum assays over appreciable widths. Wheadon (1971b) reported averages of 0.10 percent MoS_2 over 6 m (20 feet), and 0.06 percent MoS_2 over a core length of 15 m (50 feet).

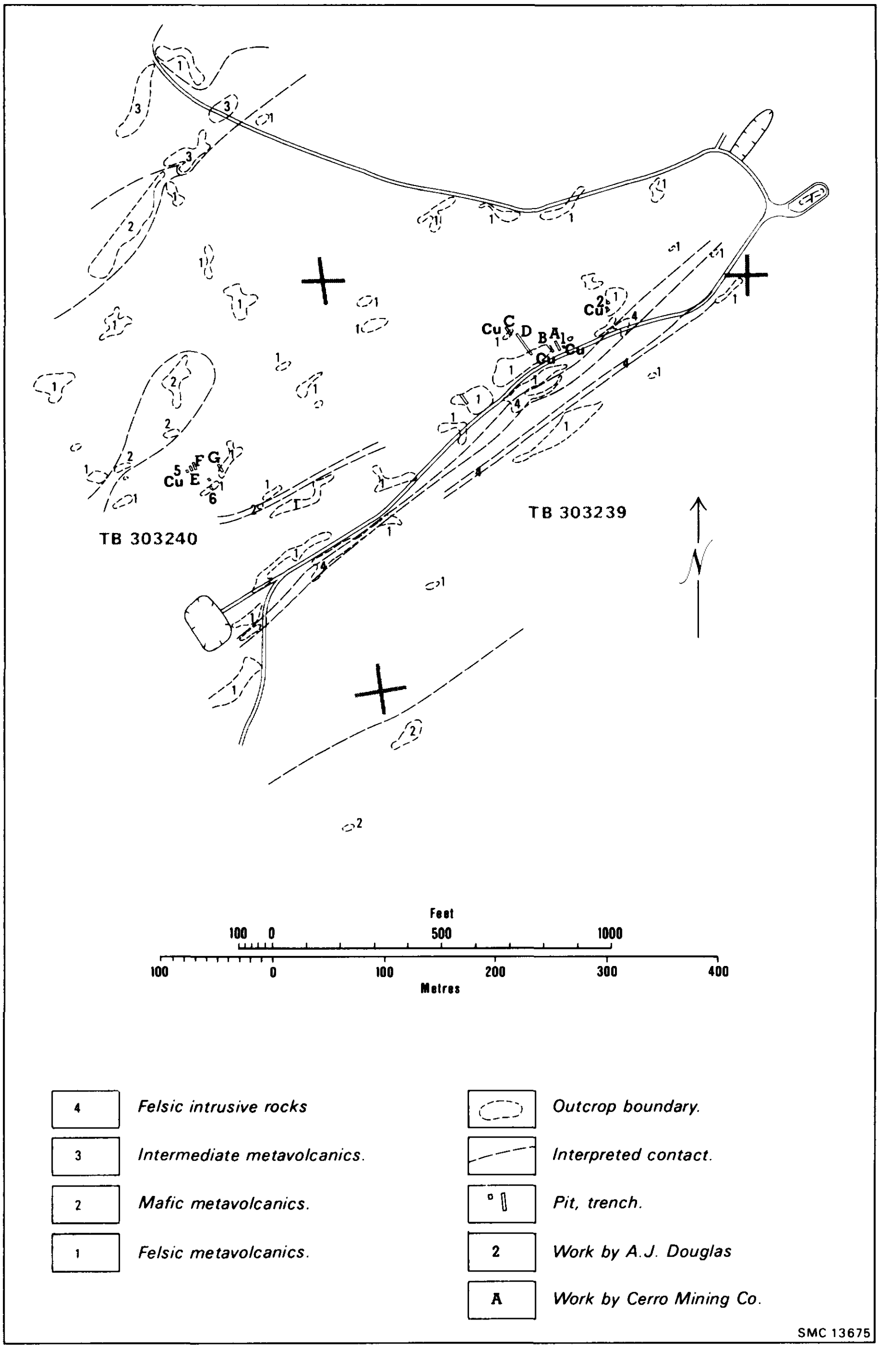


Figure 10–Geology and workings in part of the Douglas Property in east-central Elmhirst Township.

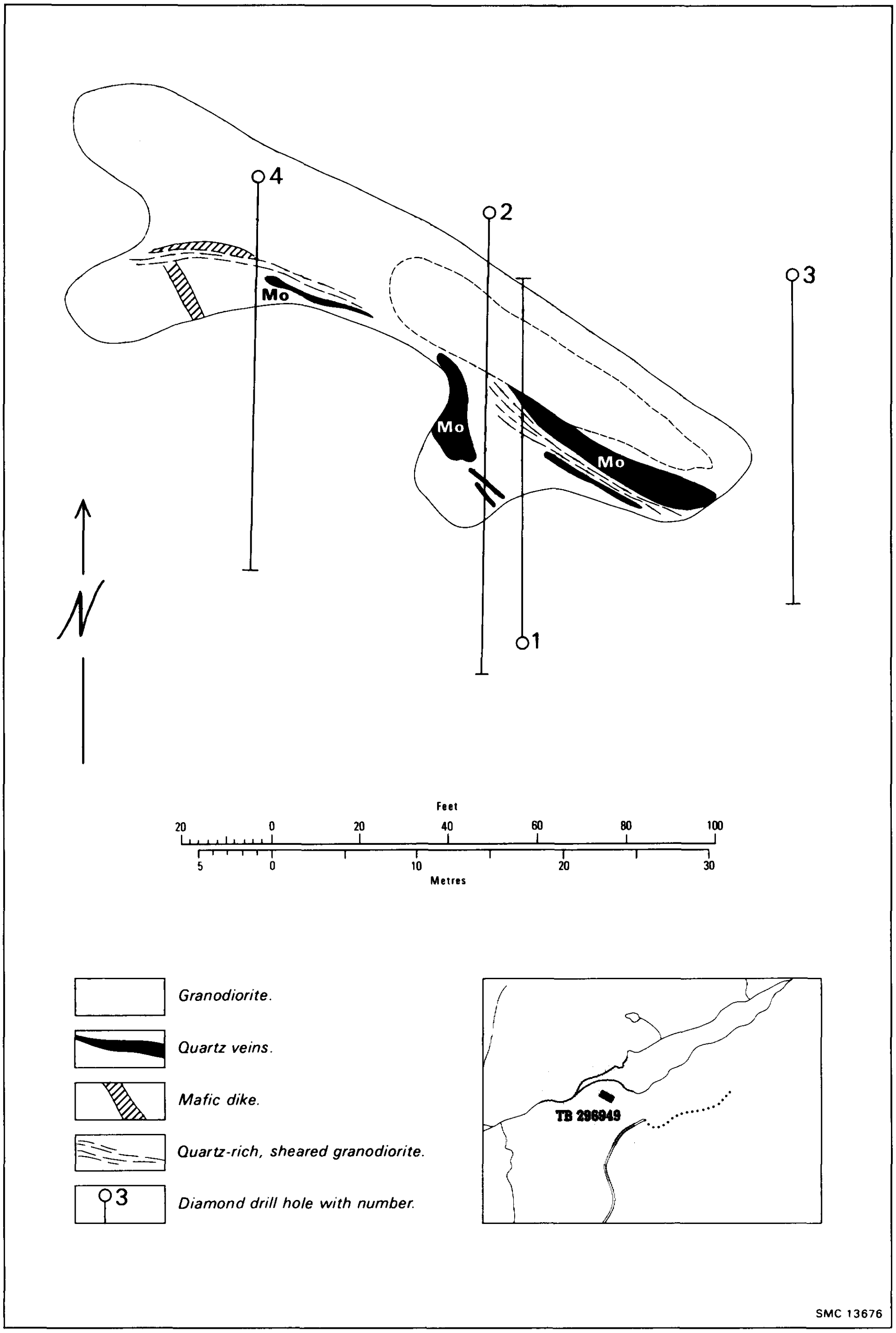


Figure 11–Sketch map of the Mitto Showing held by Chemalloy Minerals Limited.

A sketch map of the showing appears in Figure 11. The main zone consists of sheared granodiorite with quartz veins striking between 110°E and 125°E and dipping steeply to the north. The main quartz vein varies in width from about 1 m (3 feet) at the northwestern end of the showing, to 2 m (6 feet) at the southeastern end. The sheared granodiorite contains more chlorite and much more quartz than the massive country rock. In the sheared granodiorite, fine quartz constitutes up to 50 percent of the rock.

Extremely fine-grained molybdenite imparts a blue-gray colouration to the vein quartz and to the quartz-rich sheared granodiorite. Visible molybdenite was also seen in the veins and in thin plates along fractures in the sheared rock. Molybdenite has also been reported in drill core (Assessment Files Research Office, Ontario Division of Mines, Toronto). Pyrite and minor chalcopyrite occur disseminated in both the quartz veins and sheared granodiorite, particularly around the southeast end of the exposure where they constitute 1 to 5 percent of the vein material. No mineralization was observed in the massive granodiorite.

A selected grab sample of the blue-grey quartz collected by the field party, was analyzed by the Mineral Laboratory Branch, Ontario Division of Mines, and found to contain 0.51 percent MoS_2, 0.02 ounce of gold/ton and 0.36 ounce silver/ton. A grab sample of the sheared granodiorite was also analyzed and found to contain 0.32 percent MoS_2 and 0.01 ounce of gold/ton.

An old gold occurrence worked by S. Dodd in the 1930s is located in the northeastern part of the main claim block, about 2.4 km (1½ miles) northeast of the molybdenite showing. This occurrence was not found by the field party. The following description is taken from Moorhouse (1938, p.19):

> The S. Dodd find is located eight chains south of the north boundary of Elmhirst Township, some 28 chains west of Mile II.
>
> Some gold values were obtained by S. Dodd, working for P.E. Hopkins, from a silicified shear zone in diorite. The shear zone strikes N50W. It has been stripped for 90 feet and ranges in width from 1 inch to 3 feet.
>
> The chief sulphide present is pyrite. A little copper stain and magnetite were also noted. Silver sulphides are reported. The quartz is not abundant, but is well fractured, with inclusions of chloritic material, in whose vicinity it tends to be dark-bluish in colour. Other minerals include yellow and white carbonate and pink feldspar, the last-mentioned occurring as a 3-inch dikelet at the north end of the shear zone. Work was also done on a 16-foot mass of quartz, which failed to give good values.

CHESTERVILLE MINES LIMITED (7)

This company in 1972, was the registered holder of three claims, 304259 to 304261 inclusive, in northwestern Elmhirst Township. The claims are believed to be underlain by intermediate metavolcanics. Only a few outcrops on the property were found by the field party. No assessment work was reported for these claims as of December 1972.

COMINCO LIMITED (8, 29)

In 1972, Cominco Limited held a large block of claims in the area, including 288315 to 288322 inclusive and 288536 to 288539 inclusive in Elmhirst and Rickaby Townships on the west side of Expansion Lake. Most of the claim block is in the adjacent townships to the south.

All of the property is underlain by intermediate metavolcanics including andesite flows, tuff-breccia, crystal tuff, pillow lava and possible pillow breccia. In the spring of 1972, a magnetometer survey was conducted over the property. During the summer follow-up geological mapping was carried out to examine magnetic anomalies and spatially related electromagnetic anomalies outlined in an earlier survey (Assessment Files Research Office, Ontario Division of Mines, Toronto). Most of this activity was centred in Walters Township on Claims 288540 and 288541.

CONSOLIDATED CANADIAN FARADAY LIMITED (9)

In 1972, a block of four leased claims, 47123 to 47126 inclusive, in northwestern Elmhirst Township, were held by this company. No work has been reported on the property since it was held by Augustus Exploration Limited in 1960. At that time geological and geophysical surveys were undertaken in a joint venture with Greenoaks Mines Limited, whose property adjoins to the south and west. Three diamond drill holes were put down near the centre of claim 47123, and several holes were drilled on the Greenoaks Mines Limited property to test the continuity of gold-bearing surface showings associated with east-west shear zones and cross fractures cutting felsic to intermediate metavolcanics (Assessment Files Research Office, Ontario Division of Mines, Toronto).

Most of these four claims are underlain by felsic to intermediate metavolcanics. Tuff-breccia and massive flows are predominant. Part of the two southern claims is underlain by granodiorite of the Elmhirst Lake stock and part of the eastern claims is underlain by the Pinel Creek gabbro body. A more complete description of the local geology and exploration activities is given under the heading Greenoaks Mines Limited.

N. COX (30)

Two groups of claims in Rickaby Township were held by Nolan Cox in 1972. The larger block consisted of 20 claims, 334726 to 334745 inclusive, west of Daphne Lake, adjoining the property held by Phelps Dodge Corporation of Canada Limited. These claims are underlain by intermediate metavolcanics most of which appear to be of pyroclastic origin. Tuff-breccia and lapilli-tuff are dominant and crystal tuff containing plagioclase phenocrysts is common in the western part of the claim block. No mineralization was found when mapping the area, and no development work has been recorded for assessment.

The second property held by M. Cox consisted of two claims, 336362 and 336363, west of Atigogama Lake and north of the claim block held by Lynx-Canada Explorations Limited. The claims are underlain by felsic flows, intermediate pyroclastic rocks and hybrid plutonic rocks of the Kaby Lake stock. On claim 336363, rhyodacitic and dacitic rocks contain up to 2 percent disseminated pyrite in several places, but no copper mineralization was found in mapping the area. Part of the western claim was geologically mapped by Sturgeon Basin Mines Limited in 1960, but no further work has been reported.

H.K. CRAIBBE (31)

In 1972, Mr. Craibbe held title to nine patented claims, 11070 to 11078 inclusive, in the northeastern corner of Rickaby Township. The property includes the workings of the Orphan (Dik-Dik) Mine, a former gold producer of the 1930s.

History

The gold-bearing quartz vein which became the mine was discovered in 1931 by T. Johnson. In 1933-1934, the Dik-Dik Mining Corporation Limited sank a shaft to a depth of 48 m (160 feet) with a level at 45 m (150 feet). While the shaft was being sunk an open cut along the vein, 25 m (80 feet) long and 15 m (50 feet) deep was mined.

In 1934-1935, the mine became known as the J. Bruce McMartin mine. The shaft was deepened to 80 m (262 feet) and an additional level was established at 75 m (250 feet). A total of 202 m (663 feet) of drifting and cross-cutting took place. A cross-section through the shaft and plans of the levels are shown in Figure 12.

A 20 T.P.D. mill was built in 1935, and production for 1934-1935 was 2,460 ounces of gold and 1,558 ounces of silver worth $86,756 at that time. Recovery of the gold through the mill averaged 0.70 ounces/ton.

In 1935-1936, the mine belonged to the Orphan Gold Mines Limited, but no development or production took place. Sulmac Gold Mining Corporation obtained ownership and dewatered the mine. That company held the property until after 1940 but no further work or production was reported. Very little exploration has taken place on the property since the mid 1930s. The shaft and open cut have been fenced off and all of the buildings have been removed.

Geology and Mineralization

The present condition of the mine did not allow the field party to examine the auriferous quartz veins. Much of the surface geology is covered by waste rock. Most of the claim block is underlain by granodiorite of the Kaby Lake stock. The mine site occurs in the extreme eastern part of the claim 11071, about 210 m (700 feet) north of Atigogama Lake. Around the lake shore and to the east of the mine there are intermediate to mafic flows which form an irregular contact with the granodiorite in the vicinity of the mine.

The following description is taken from Bruce (1936, p.50-54) who examined the geology of the mine site while it was in production in 1934-1935:

A large part of the block of nine claims of the Orphan Gold Mines is heavily drift covered; the scattered outcrops show that much of the consolidated rock on them is granite. Apparently lavas occur only on the southeastern claims, T.B. 11,070 and 11,071. Tongues of granite extend southwestward from the main mass into the greenstone.

The lavas to the west of Atigogama Lake are fine-grained, dark-green massive rocks, which under the microscope appear porphyritic with poorly formed phenocrysts of plagioclase. Chlorite, epidote, and calcite make up the fine-grained groundmass. Oval areas of quartz with a mosaic texture are probably amygdules. The phenocrysts have the appearance of being recrystallized rather than original in character, but in other parts of this area the feldspars are well formed. In any case the lavas were probably andesites.

The granite is a grey, fairly coarse grained type, made up of quartz, oligoclase, biotite and magnetite, with epidote, chlorite, sericite, and kaolin as alteration products. The feldspars are rather badly altered. The biotite occurs in aggregates of small crystals....

The contact between granite and andesite is remarkably sharp. There is no granodioritic contact phase such as that which borders the granite batholiths farther west. The attitude of the contact of the main mass is unknown. In the mine workings the granite tongue seems to plunge southward at a high angle (see plan of 150-foot level, Figure 12).

The ore body of the Orphan mine is on claim T.B. 11,070. Quartz lenses occur in a shear zone crossing the contact between the granite and andesite. The strike is N.40°W., and the dip nearly vertical. A parallel vein on the adjacent claim to the east is wholly in andesite, but the relation of this vein to the contact in depth is not known. The shear zones are clearly later than the consolidation of the granite, since the contact seems to be slightly offset and the granite is somewhat gneissoid along the vein. The ore bodies are parts of irregular lenses of quartz which in places bulge to widths of 6 feet. A width of 9 feet is recorded in one place. From the contact in both directions the vein becomes narrower and finally seems to feather out.

The quartz of the vein is white and so fine grained that it is almost chalcedonic. In parts of the lenses metallic minerals make up a considerable part of the vein filling. The most abundant of these is pyrite. Chalcopyrite is common; pyrrhotite, sphalerite, and galena less so. Under the microscope a little arsenopyrite and tetrahedrite have been recognized. Gold in visible amounts occurs sparingly. It is very pale in colour on account of a large mixture of silver; the mineral can with propriety be called electrum. Under the microscope gold can be recognized as a late mineral. It usually occurs in pyrite and is commonly associated with galena.

The gold content of the narrow lens that was removed in the open cut was exceptionally high. In general the values are higher and more consistent where the wall rock is lava. There are, however, lenses of good grade in the granite, but the gold seems to be much more erratically distributed in them than it is in lenses within the lavas. Apparently also the content diminishes rather rapidly as the lenses are followed into the granite. Fritzsche states that the widest as well as the richest parts of the ore lenses occur where narrow fissures now filled with calcite intersect the quartz-filled fissure.

Lava forming the walls of the vein was apparently not much affected by the vein-forming solutions. Granite wall rocks show considerable alteration. Lava from the wall of the vein is dark-green in colour, massive, and fine-grained. Pyrite occurs commonly as disseminated grains. In a specimen examined under the microscope no original minerals are recognizable. Chlorite and epidote make up most of the rock. Quartz and calcite occur in stringers and as areas apparently introduced. The mineral most distinctive of the alteration is biotite. Crystals of it are disseminated through the slide, but none of them are well formed and all of them contain a quantity of foreign material. There has evidently been an introduction of potassium, but except for the presence of biotite the rock does not differ much from that at some distance from the vein.

Granite near the vein is a grey, granular rock with abundant quartz. Under the microscope it is found to be thoroughly altered. It contains quartz, sericite, calcite, pyrite, and chlorite. Feldspars have been changed to a mat of sericite. Some quartz occurs as mosaics, probably formed by the breaking-down of silicates. Pyrite is evidently an introduced mineral, and veinlets of calcite and quartz traverse the section.

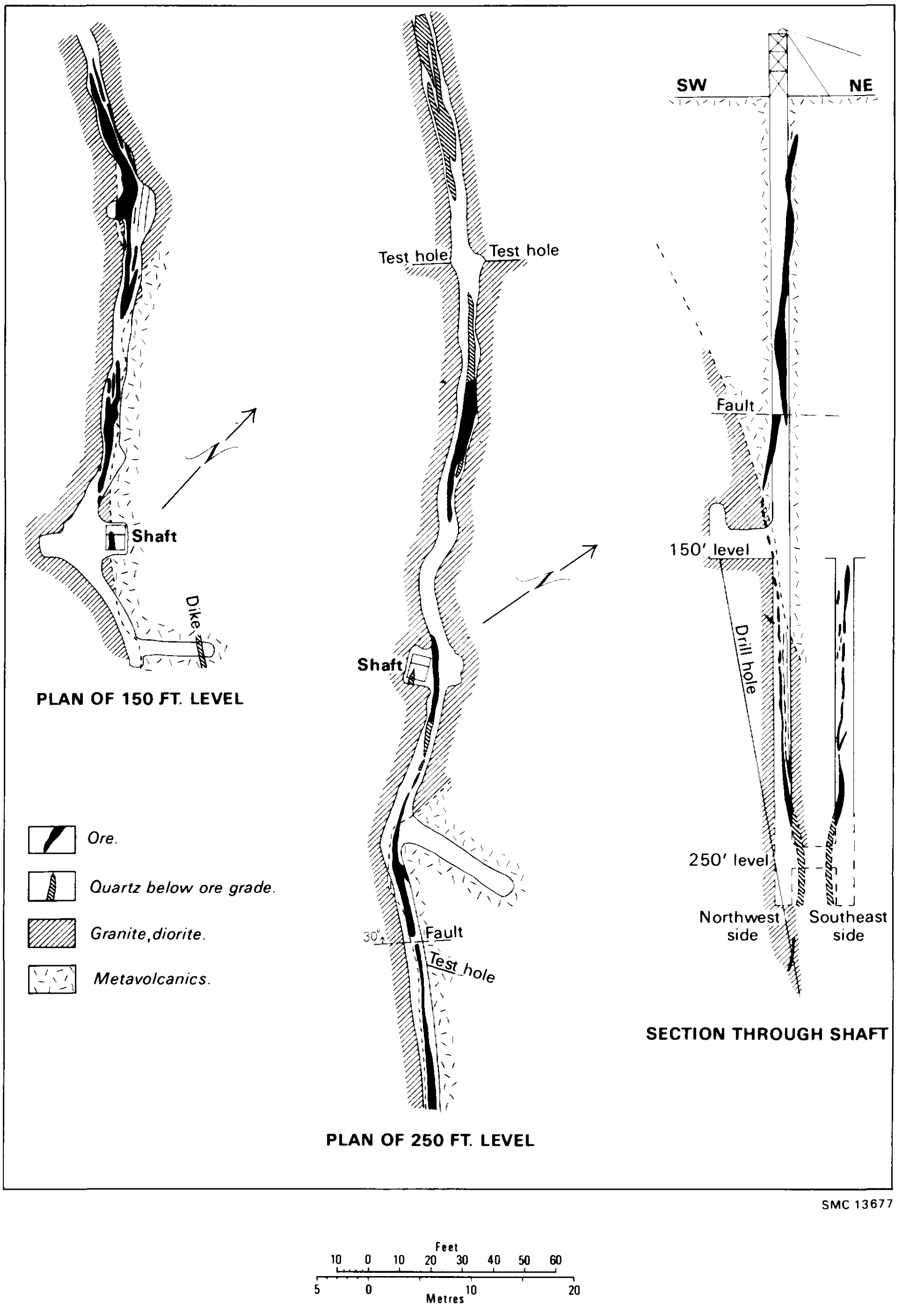


Figure 12–Plan of the 150- and 250-foot levels and section through the shaft, Orphan mine.

DOUGLAS PROPERTIES (10, 11)

In 1972, three properties in Elmhirst Township were held by A.J. Douglas, and one claim was registered to Mrs. D. Douglas.

The largest block consisted of 12 claims, 287795 to 287800 inclusive, 288713, 288714, and 324960 to 324963 inclusive, surrounding the northern half of Elmhirst Lake. The southern part of this property previously underwent a ground magnetometer and geological survey by Ambassador Mining Development Limited in 1960. No further work has been reported.

Most of the three southern claims are underlain by intermediate and felsic pyroclastic rocks containing sparsely disseminated pyritic mineralization. The northern part of the property consists of granodiorite and hybridized granitic rocks. A large inclusion of gabbro occurs near the northeastern corner of Elmhirst Lake. Specular hematite, chalcopyrite, bornite, azurite, and malachite were found in fractures within the gabbro body and around its contacts.

The second property southwest of Seven-Foot Falls, held by Mr. Douglas, is surrounded by land staked for Cerro Mining Company of Canada Limited by C.E. Bye. This property consists of four claims 304689, and 303238 to 303240 inclusive. The geology of the property and work performed on these claims is described elsewhere in this report under Cerro Mining Company of Canada Limited who obtained an option on the claims from Mr. Douglas in October 1971.

A single claim, 303240, northwest of Wilkinson Lake, is held by Mr. Douglas and the adjoining claim to the east, 334677, is held by Mrs. D. Douglas. The two claims are underlain by intermediate metavolcanics of both pyroclastic and flow origin. Commonly pyrite makes up 1 to 2 percent of these rocks. A southeast-striking quartz vein and parallel shear zone at least 5 m (15 feet) wide, containing abundant pyrite and some chalcopyrite, also occurs on the property. No work has been submitted for assessment work credit on these claims.

O. GOULET (12, 32)

In 1972, Mr. Goulet held three claims, 324911 to 324913 inclusive, straddling the Elmhirst-Rickaby Township boundary just north of Wilkinson Lake. No work has been reported on these claims. They are believed to be underlain by intermediate metavolcanics but outcrop is very sparse in that area.

GREENOAKS MINES LIMITED (13)

The Greenoaks Mines Limited property in 1972 consisted of 15 patented claims, 7 of which, 35571 to 35574 inclusive, 35568, 38746 and 38747, are in western Elmhirst Township. This property has been explored on several occasions for gold and base metals.

History

The main gold showing, on claim 35563, in Pifher Township, was discovered in the summer of 1947. Stripping and diamond drilling totalling 449 m (1,472 feet) in 22 holes, were carried out in that year. In 1953, resistivity and ground magnetometer surveys were conducted and a geological map of the property was prepared. Later in 1953, three drill holes totalling 509 m (1,667 feet) were put down over resistivity anomalies but little mineralization was found. The claims were patented in 1954, but no further work took place until 1960 when a magnetometer survey took place followed by a detailed geological mapping program. An additional five holes totalling 303 m (990 feet) were put down in the summer of 1960. No further work appears to have taken place since that time.

General Geology

Most of this property in Elmhirst Township is underlain by felsic to intermediate metavolcanics and fine-grained porphyritic rocks believed to be intermediate intrusives, but which may in part be recrystallized volcanic rocks. The general strike is east to northeast and dips are steep. Parts of the two easternmost claims in the block are underlain by granitoid rocks of the Elmhirst Lake stock, and hybridization has rendered metavolcanic and intrusive lithologies indistinguishable in that area.

The metavolcanics include massive light green rhyolitic to dacitic flows and possible tuffs along with andesitic flows which are commonly porphyritic, and intermediate to mafic agglomerate units. Flows appear to be more abundant than pyroclastic rocks.

Shearing is predominant in several places, cutting both volcanic and intrusive rocks at between N75E and N85E.

Mineralization

Gold mineralization has been reported by Burr (1953) in several trenches and diamond drill hole intersections where felsic volcanic rocks are cut by shear zones.

A number of electrical conductors outlined on the property were investigated because of the possibility that they represented auriferous shear zones. Several of these turned out to be occurrences of disseminated sulphide minerals, mostly pyrite and pyrrhotite with specks of chalcopyrite and a low gold content (Burr 1953).

JACOBUS MINING CORPORATION LIMITED (14)

In 1972, the property in northwest Elmhirst Township held by the Jacobus Mining Corporation Limited consisted of 18 leased claims 78410 to 78427 inclusive, and 5 unsurveyed mining claims, 138087 to 138091 inclusive.

History

In 1947, a copper-nickel showing in a gabbro body was discovered within this claim block by Christianson Prospectors Syndicate, and a number of trenches were dug to test the mineralization. Later in 1947, The International Nickel Company of Canada Limited optioned the property and drilled 9 deep drill holes, but later dropped the option. In 1957, the area was investigated by the Jacobus Mining Corporation Limited who carried out a geological and geophysical program including magnetometer and electromagnetic surveys. As a result a total of 46 drill holes were put down, most of these in the area of the original trenches on claim 78423 (see J series of holes, Figure 13). This program outlined an estimated 540,250 tons of 0.38 percent copper and 0.36 percent nickel in a cylindrical zone within the gabbro body which underlies the southern part of the property (Czikan 1969). Work continued in 1968 with a series of 9 diamond drill holes having a total length of 2,580 m (8,458 feet) (see 68 series of drill holes, Figure 13). This drilling served to increase the deposit to an estimated 920,000 tons of 0.42 percent copper and 0.42 percent nickel (McCulloch 1968). In 1969, electromagnetic and magnetometer surveys were again conducted over most of the property. This was followed by detailed geological mapping, geochemical work and sampling of existing trenches. In the spring of 1971 an induced potential survey was conducted in the vicinity of the mineralized zone, and during the winter of 1971/1972 six diamond drill holes were put down to investigate outlying geophysical anomalies (see 72 series of holes, Figure 13). This program did not locate additional significant mineralization (Wheadon 1971a). The most recent calculations on the deposit indicates an estimated 937,538 tons of 0.42 percent copper and 0.41 percent nickel (Wheadon 1971a). The mineralized zone was not drilled off to the northwest where the zone appears to thicken and increase in grade. Further drilling in that area was recommended by Wheadon (1971a).

General Geology

Four of the southern claims in the block are underlain by the Pinel Creek intrusion, a body of gabbroic rock described in the section on Mafic Intrusive Rocks. This has been studied at length in a B.Sc. thesis by Faust (1973). The remaining claims to the north are underlain by felsic to intermediate metavolcanics, and parts of the easternmost claims occur within the Elmhirst Lake stock.

Figure 13 shows the geology of the southern part of the claim block. The metavolcanics intruded by the metagabbro body are described by Faust (1973) as massive, porphyritic flows of dacitic to rhyodacitic composition. The upper contact of the intrusion is found to be sharp in drill core. From the drilling it is estimated that the body forms a sill striking about N70E and dipping between 45° and 60° to the north, and has a thickness of at least 180 m (600 feet). The attitude of the intrusion is shown in Figure 14 which represents a partial cross-sec-

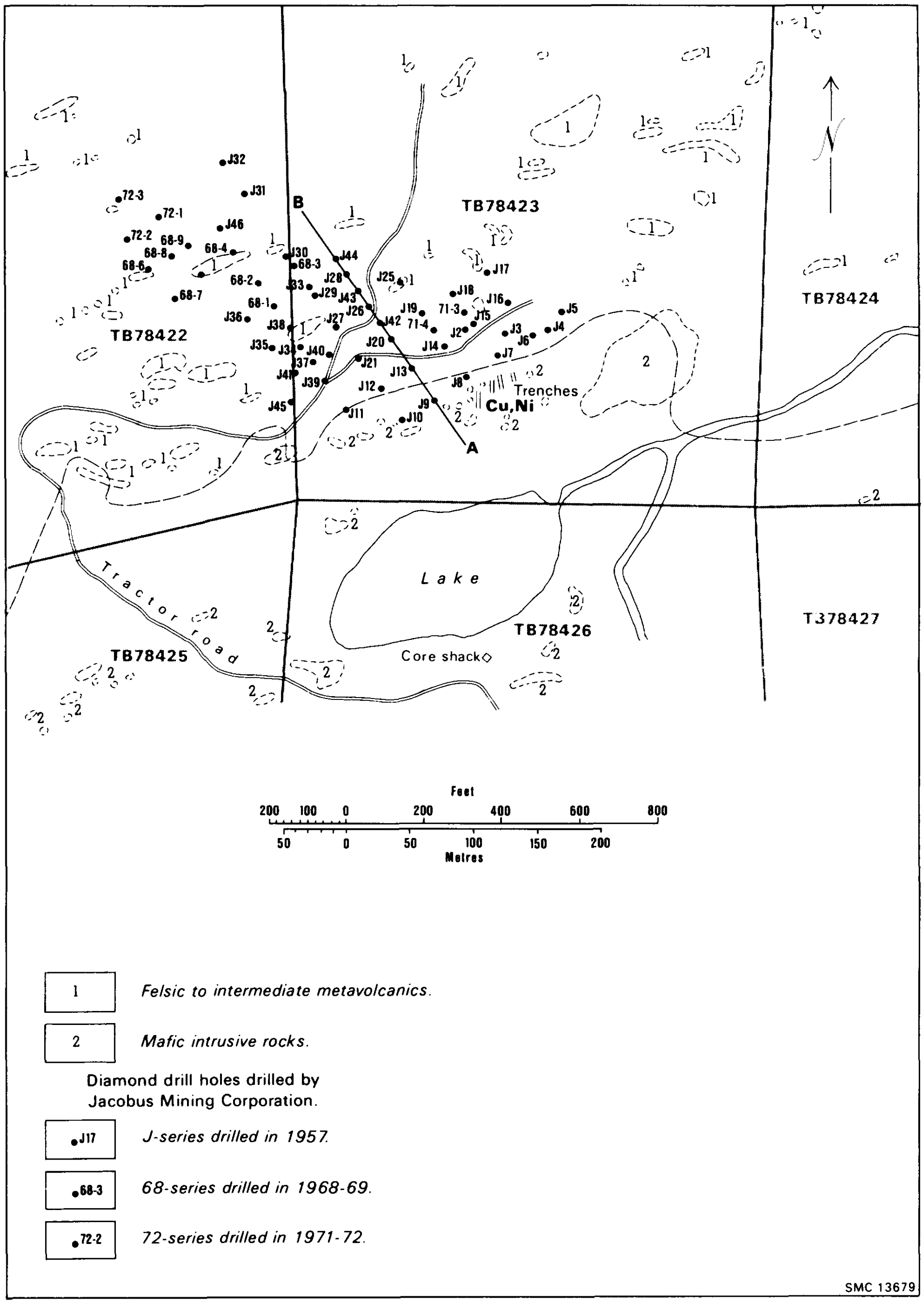


Figure 13–Geology and diamond drill hole locations on part of the property held by Jacobus Mining Corporation Limited.

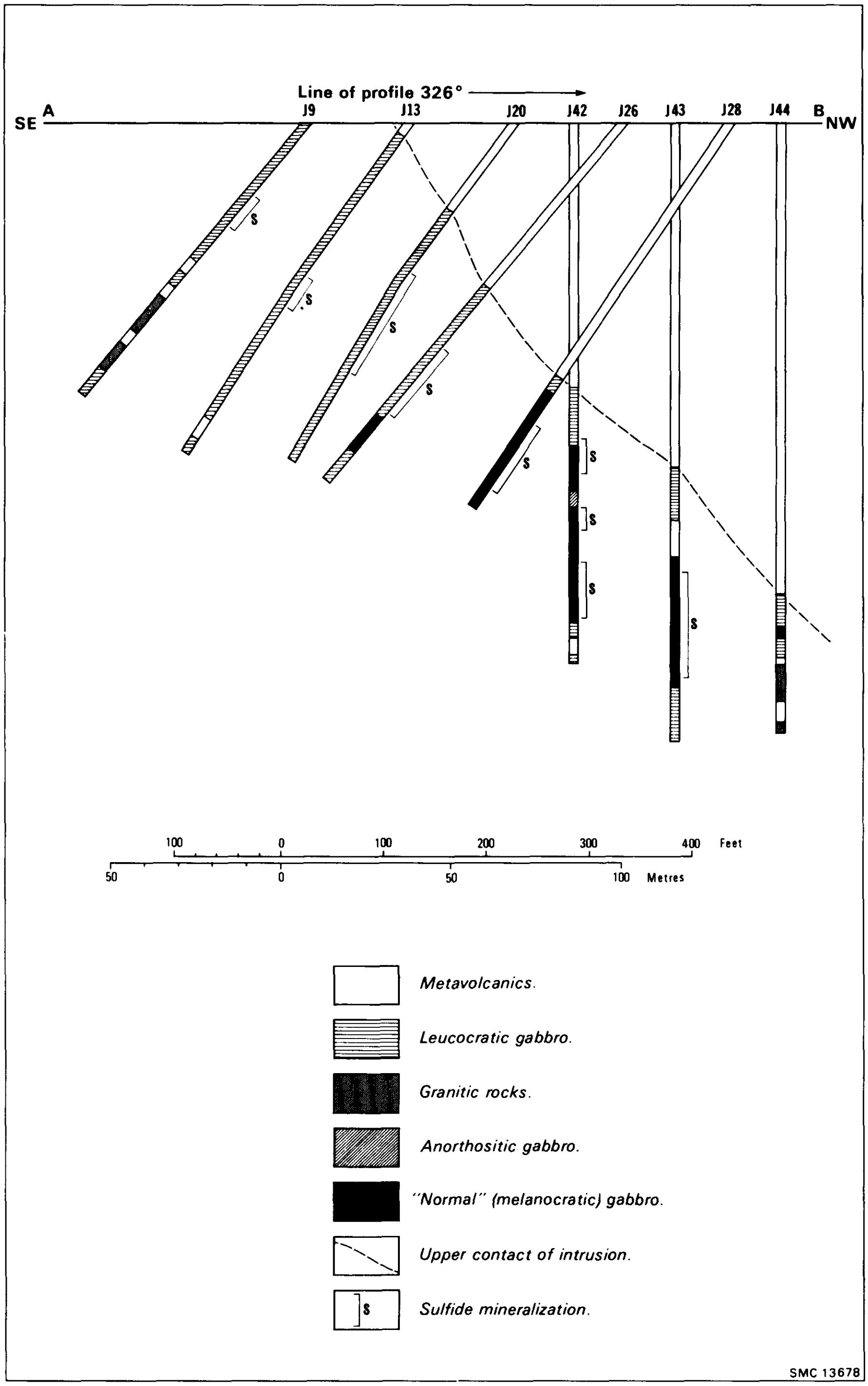


Figure 14–Vertical cross-section through part of the Pinel Creek Intrusion.

tion through the body approximately perpendicular to its strike. Faust's study suggests that the body is a differentiated layered mafic-ultramafic sill. Although gabbro and quartz gabbro are by far the most prominant rock types encountered, the occurrence of metapyroxenite and anorthositic gabbro suggested that more ultramafic differentiates may occur within the intrusion.

Mineralization

The sulphide mineralogy consists of pyrrhotite, chalcopyrite, and pentlandite which constitute between 4 and 6 percent of the gabbro within the mineralized zone. This zone is cylindrical or lensoidal, dipping to the north at about 45°, approximately parallel to the upper contact of the intrusion, and plunging westward at about 40°. Drilling has shown that it varies between 6 to 45 m (20 to 150 feet), averaging about 12 m (40 feet) in diameter, and extending for at least 300 m (1,000 feet) in a N60W direction.

According to McCulloch (1969), the sulphide mineralization is disseminated interstitially within melanocratic gabbro which contains about 90 percent ferromagnesian minerals. Non-mineralized gabbro consists of approximately equal amounts of plagioclase and ferromagnesian minerals. Faust (1973) found that mineralization occurred in "normal" gabbro containing 40 to 50 percent ferromagnesian minerals, whereas no sulphides occurred in the quartz-rich leucocratic gabbro.

Examination of polished sections from this deposit by Faust led to the following observations:

1) Pyrrhotite, chalcopyrite, and pentlandite are present in that order of abundance. They occur alone or together in the same polished section.
2) Pyrrhotite occurs as large irregular blebs, 2 to 3 mm, across, commonly rimmed by chalcopyrite and pentlandite, as fine inclusions in the mafic silicates and subrounded blebs interstitial to the silicate minerals.
3) Chalcopyrite also occurs in discrete, irregular masses, in rounded to irregular blebs peripheral to and within the pyrrhotite and as interstitial droplets between silicate minerals.
4) Pentlandite occurs as grains peripheral to the pyrrhotite masses and forms flame-like exsolution lamellae along the basal pyrrhotite cleavage direction.

According to Faust (1973) all of the sulphides are embayed or replaced by silicate minerals. The silicates also fill fractures in the sulphide grains. The sulphide textures are attributed to the reaction of the first formed pyrrhotite with the residual sulphide melt to form pentlandite, the exsolution of pentlandite from pyrrhotite at a lower temperature, and the exsolution of chalcopyrite from pyrrhotite at a still lower temperature.

McCulloch (1968) and Faust (1973) both describe the sulphides as a syngenetic magmatic deposit formed after the separation of an immiscible sulphide melt from the crystallizing magma (see "Economic Geology, Origin of Copper-Nickel Deposit in the Pinel Lake Intrusion").

A.E. JEROME (15)

In 1972, this property consisted of six claims 324286 to 324291 inclusive in southeastern Elmhirst Township, on the township line with Walters Township. Between 1968 and 1970, part of this property was held by H.K. Porter Company (Canada) Limited, as part of a larger claim block and was covered by magnetometer, electromagnetic and geological surveys during that time. These surveys were conducted to investigate an aeromagnetic anomaly along the southeastern contact of the Coyle Lake stock. No further work was reported after 1970 by this company.

The claims are underlain by intermediate pyroclastic rocks, mostly tuff-breccias, finely bedded tuff and crystal tuff.

JUPITER MINERALS INCORPORATED (16)

In 1972, Jupiter Minerals Incorporated held nine leased claims in southwestern Elmhirst Township, 13392 to 13400 inclusive, and a large block of adjoining unsurveyed claims in Irwin and Pifher Townships. The property includes the former Sturgeon River gold mine in northeastern Irwin Township.

History

The claims in Elmhirst Township were originally staked in 1934 and held by Agaura Exploration Limited (Bruce 1936). Most of the trenching and other prospecting took place in the vicinity of the Sturgeon River gold mine, but visible gold was found in several places associated with the numerous quartz veins on the property (Figure 15). At that time sulphides in and around these vein systems were ignored.

Early in 1972, the Coniagas Mines Limited, which was then the registered holder of these claims, began an exploration program for gold and base metals on the porperty. Magnetometer and electromagnetic surveys were conducted in the winter of 1971/1972, and in the following summer reconnaissance geochemical surveying and prospecting took place. This program disclosed a number of pyritiferous zinc showings which appeared to be spatially related to electromagnetic anomalies. In the fall, a detailed geological map was prepared and more geochemical work was carried out. At that time, additional electromagnetic and induced potential surveys were planned for the area, and a limited amount of diamond drilling was proposed under the newly formed company, Jupiter Minerals Incorporated.

Geology

The northwestern and southeastern parts of the property are underlain by intermediate intrusive rocks, but the main feature of the property is a band of

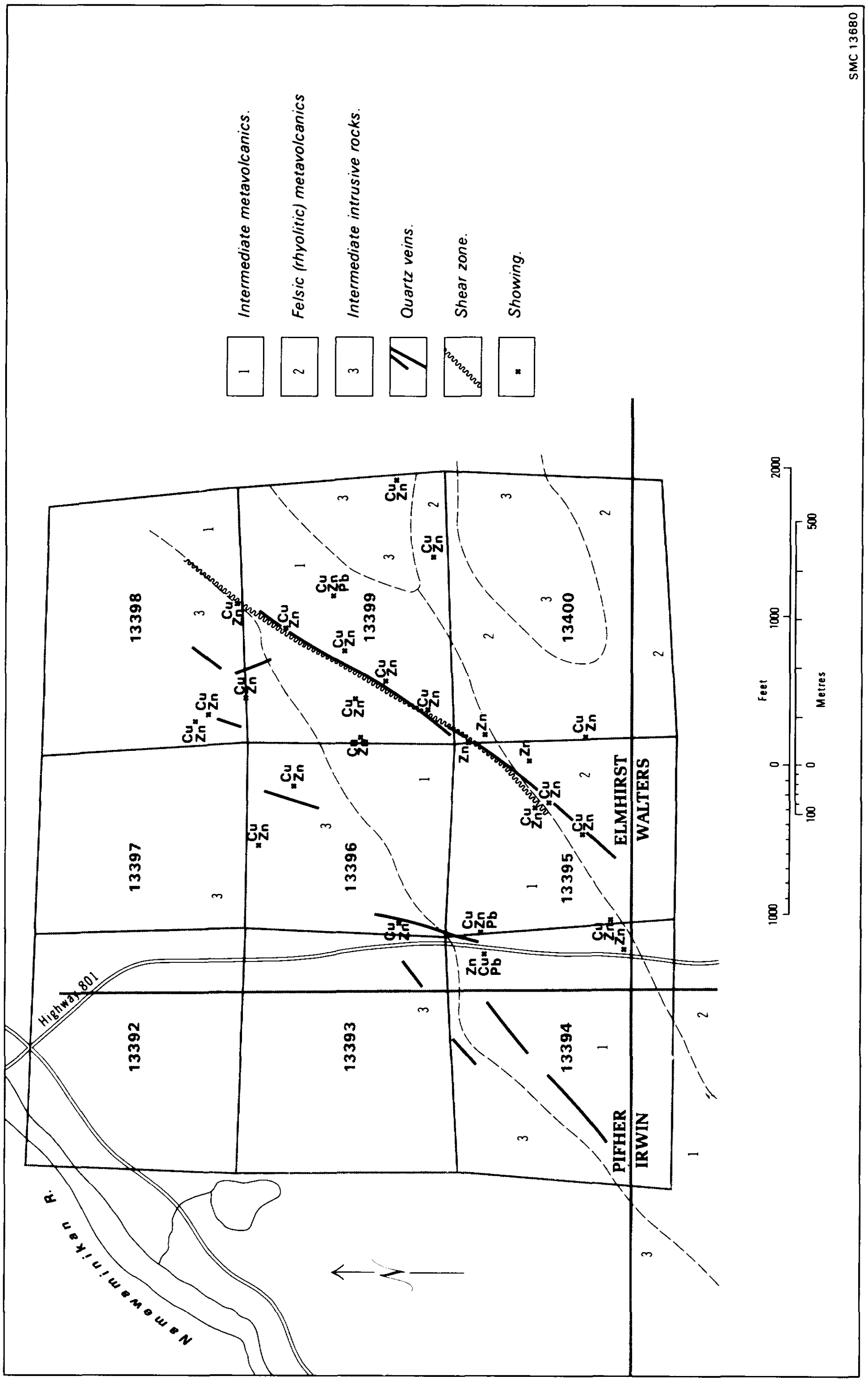


Figure 15–Geological sketch map of property held by Jupiter Minerals Inc. in southwestern Elmhirst Township.

northeast-trending felsic to intermediate metavolcanics that occurs between the granodioritic stocks.

Most of the quartz vein systems are found within the metavolcanics and strike subparallel to the foliation of the metavolcanics. The metavolcanics are mostly rhyolitic to andesitic flows and associated breccias, but coarse pyroclastic rocks occur intercalated with the flows. These rocks are affected by a zone of shearing and brecciation several hundred feet wide, parallel to and including, many of the prominant quartz veins (Figure 15).

An isolated occurrence of spherulitic rhyolite, similar to that occurring in central Rickaby Township, was found in the extreme southwestern corner of Elmhirst Township on claim 13395. The spherulitic rocks appear to be intercalated with dacitic and rhyolitic massive flows, but poor bedrock exposure prevented the spherulitic unit from being traced further. Several zinc-copper showings have been found in the immediate vicinity of the spherulitic occurrence and along its probable strike.

Mineralization

A large number of zinc and copper showings have been found on this property (Figure 15). Many of these are within old trenches and pits along the gold-bearing quartz veins. Massive sphalerite occurs in small pods and veins and surrounding sheared volcanic rocks. Pyrite, chalcopyrite, and minor galena also occur with the sphalerite. In one of the new trenches observed by the field party, visible sphalerite, ranging up to about 25 percent of the sheared rock, occurred over a width of 18 m (60 feet).

Assay results from selected grab samples collected by the field party at approximately 150 m (500 feet) intervals along the main northeast-trending vein and shear zone (Figure 15) are given in Table 8.

TABLE 8 ASSAYS OF SELECTED GRAB SAMPLES COLLECTED AT 500-FOOT (150 m) INTERVALS (APPROXIMATE) ALONG THE MAIN NORTHEAST-TRENDING VEIN AND SHEAR ZONE WHICH TRANSECTS CLAIMS TB 13395 AND TB 13399 AS SHOWN IN FIGURE 15 (ASSAYS DONE BY MINERAL RESEARCH BRANCH, ODM). SAMPLE NUMBERS RUN FROM SW TO NE.

Sample	% copper	% zinc	% lead	oz/ton gold	oz/ton silver
1	0.35	19.20	N.D.	0.02	0.84
2	0.04	24.60	N.D.	0.02	0.18
3	N.D.	14.50	N.D.	0.10	tr
4	0.22	6.79	0.04	0.12	0.32
5	0.15	1.55	0.04	0.01	0.33

Copper and zinc mineralization also occurs disseminated within felsic breccia. Commonly, sphalerite and chalcopyrite occur almost to the exclusion of one another. In another recent trench, chalcopyrite averaging between 2 to 4 percent of the rhyolite breccia occurred continuously across a width of 3.6 m (12 feet). A grab sample collected by the field party from this showing was analyzed and found to contain 1.80 percent copper, 10.6 percent zinc and 0.27 ounces of gold/-ton. Appreciable gold values are associated with the sulphides, and visible gold can be seen in some quartz veins. In a submission to the Ministry of Natural Resources in 1972, the Coniagas Mines Limited reported an assay of 0.59 ounces of gold/ton in a selected grab sample also containing 9.15 percent zinc (Assessment Files Research Office, Ontario Division of Mines, Toronto).

A selected grab sample collected by the field party from a 6 m (20 feet) wide northeast-trending zone of mineralized fractures about 300 m (100 feet) north of Walters Township on the west side of Highway 801, was analyzed by the Mineral Research Branch, Ontario Division of Mines, and found to contain 1.68 percent copper, 1.90 percent zinc, 0.03 ounces of gold/ton and 1.01 ounces of silver/-ton. A selected grab sample was also collected from a pod of sphalerite about 20 cm (8 inches) in diameter within the mineralized zone. This was found to contain (Mineral Research Branch, Ontario Division of Mines) 54.2 percent zinc, 0.19 percent copper, 1.22 percent lead, 0.25 percent cadmium, 0.01 ounces of gold-/ton and 2.69 ounces of silver/ton.

A. LAFONTAINE (33)

In 1972, Mr. Lafontaine held four claims 325689 to 325692 inclusive, covering the northwestern part of Expansion Lake in Rickaby Township. No assessment work has been reported for this property. Deep sand and very little bedrock was encountered in mapping in that vicinity, except in the southern part of claim 325692, where outcrops of mafic metavolcanics are quite common along the lakeshore. The claim block is bisected by the contact between the mafic and felsic to intermediate metavolcanic sequences. The two northern claims are believed to be underlain by intermediate rocks such as crystal tuff and finely bedded tuff.

G. LELIEVER (34)

In 1972, this property consisted of 24 claims in the northern part of Rickaby Township. With the exception of the extreme southwestern corner of the property, which is probably underlain by felsic metavolcanic rocks, these claims are underlain by rocks of the Kaby Lake stock, ranging in composition from granite to quartz diorite. No exploration work on this property has been reported. Some narrow, sheared andesite porphyry dikes in this area contain pyrite and small amounts of chalcopyrite.

LYNX-CANADA EXPLORATIONS LIMITED (35)

In 1972, Lynx-Canada Explorations Limited held a block of 40 contiguous claims numbered TB 334058 to 334097 inclusive, west of Atigogama Lake in Rickaby Township. This claim group adjoins the eastern boundary of the Phelps Dodge Corporation of Canada Limited property.

No work on these claims has yet been reported by the present owners. The northwestern part of the property was geologically mapped in 1960 by Sturgeon Basin Mines Limited.

Most of the claims are underlain by felsic to intermediate metavolcanics. Granodiorite, quartz diorite and hybridized plutonic rocks resembling porphyritic metavolcanics occur on the claims in the northwestern part of the block.

The metavolcanics vary in composition from rhyodacitic and dacitic flows and tuffs west of Atigogama Lake, to amygdaloidal andesitic and basaltic flows and breccias in the southern and southeastern part of the property.

Disseminated pyrite, forming up to 2 percent of the rocks, was observed in several places in felsic metavolcanics in the northeastern part of the property, and in the zone of hybrid porphyritic rocks to the north of the property. On the west shore of Atigogama Lake, the field party located two small showings containing minor chalcopyrite along with the disseminated pyrite. Grab samples from these showings taken by the field party were analyzed by the Mineral Research Branch, Ontario Division of Mines and found to contain trace amounts of gold.

MILESTONE EXPLORATION LIMITED (17)

In 1972, this company held four leased claims in southwestern Elmhirst Township, 31383, 15056, 13639, and 13640. Unlike the property to the west, these claims are not described by Bruce (1936), and with the exception of some diamond drilling in 1953 no assessment work has been reported.

Most of claim 15056 is underlain by granodioritic rock, but the northern three claims occur in an area of felsic metavolcanics along strike with those on the Jupiter Minerals and Carling Copper Mines Corporation properties. Several small showings of chalcopyrite-pyrite occur on claims 31383 and 13639 in sheared rhyolitic rock. In 1953, six diamond drill holes were put down in the southeastern corner of claim 31383. These intersected felsic metavolcanics but no mineralization, apart from minor disseminated pyrite in some horizons, was reported (Assessment Files Research Office, Ontario Division of Mines, Toronto).

A. MITTO (18)

In 1972, Mr. A. Mitto held a group of 13 claims, 304262 to 304274 inclusive, south and southwest of Elmhirst Lake. The claims north of the Namewaminikan River are underlain by intermediate and felsic metavolcanics, but bedrock exposure over most of that area is relatively sparse. To the south of the river most of this property is underlain by granodioritic rock of the Elmhirst Lake stock. No mineralization was encountered by the field party in this area, and no report of exploration activity has been submitted for assessment credit with the Ministry of Natural Resources.

B. NELSON (19)

An irregular shaped block of 32 unsurveyed claims numbered TB 325016 to 325028 inclusive, TB 325630 to 325635 inclusive and TB 334497 to 334509 inclusive, in central Elmhirst Township was held by Mr. B. Nelson in 1972. The central part of this property, along the Namewaminikan River, is underlain by intermediate metavolcanics, most of which are dacitic and andesitic flows, and by minor hybrid diorite porphyry intrusions. The northwestern and southern claims are underlain by plutonic rocks of the Elmhirst Lake and Coyle Lake stocks.

Part of the property north of the river was covered by a magnetometer survey run by Cartier-Quebec Explorations Limited in 1959. Another nine claims north of the river were included in magnetometer and electromagnetic surveys by Monarch Gold Mines Limited in 1960. These surveys were carried out for the most part over quartz diorite-granodiorite. No further work on this property has been reported.

M.H. NELSON (36)

In 1972, M.H. Nelson held two blocks of claims in Rickaby Township. One block, southwest of Dilla Lake, consisted of seven claims, 304052 to 304058 inclusive. This area has been staked on a number of occasions, but the only work reported on the property was geological mapping and diamond drilling in the northernmost part by Sturgeon Basin Mines Limited in 1960. Quon (1960) reported an average of less than 2 percent pyrite in a number of trenches in granodiorite, with a few exceptional areas of up to 15 percent pyrite. Three holes were drilled in the granodiorite, but very little mineralization was intersected.

The claims are almost entirely underlain by granodiorite and quartz diorite of the Kaby Lake stock, but the southernmost part of the block is hybridized felsic metavolcanics. No occurrences of sulphides were observed on the property during the present survey, with the exception of sparsely disseminated pyrite in the metavolcanics.

The second property held by Mr. Nelson is located 1.6 km (1 mile) east of Seven-Foot Falls. The property consisted of nine contiguous claims numbered TB 302759 to 302763 inclusive and TB 302269 to 302272 inclusive, which adjoin the property of the Phelps Dodge Corporation of Canada Limited located to the north. No exploration work has been reported on these claims. Much of the property is underlain by coarse pyroclastic rocks of dacitic to andesitic composition. In the northern claims, however, rhyolitic and rhyodacitic flows occur intercalated with dacitic units. Several horizons of spherulitic rhyolite, porphyritic rhyolite and sericitic schist were encountered in mapping in this vicinity but no significant sulphide mineralization was observed.

NORLEX MINES LIMITED (20)

This company in 1972, held a block of 22 claims numbered TB 128018 to 128021 inclusive, TB 128023 to 128026 inclusive, TB 129294, TB 129298, TB 130673 to 130677 inclusive, TB 130680, TB 130682, TB 130683, TB 130685, TB 130686, TB 130688 and TB 130689, north of the Carling Copper Mines Limited property in southwestern Elmhirst Towmship. Most of the property now held by Carling Copper Mines Limited was previously held under option by Norlex Mines Limited. Diamond drilling on the north side of the Namewaminikan River in 1966-1967, performed by Norlex and Canadian Javelin Limited, and geological and geophysical surveys carried out by those companies are described under the heading of "Carling Copper Mines Limited" elsewhere in this report.

The only exploration work reported on the ground currently held by Norlex Mines Limited in Elmhirst Township is a magnetometer survey carried out by Cartier-Quebec Explorations Limited in 1959, which covered the central claims in the Norlex block. Most of the property is underlain by granodioritic rock with the exception of the easternmost claims which include intermediate metavolcanics and hybridized plutonic rocks. No mineralization was encountered in mapping by the field party.

OLIVER SEVERN GOLD MINES LIMITED (21)

In 1972, this company held a group of six leased claims, 13654 to 13659 inclusive, in south-central Elmhirst Township. Although the property was traversed during the field survey, no workings or showings were found. The following account is thus taken from Bruce (1936, p.57):

> All the consolidated rock on the claims is granite except a small lenticular remnant of older rocks in which the veins occur. Apparently the roof of the batholith was not far above the present surface. Dark-coloured and gneissic areas in the granite at several other places in the vicinity are probably the lower parts of other roof pendants now almost completely assimilated.
>
> The main lava inclusion of the Oliver-Severn claims is now chlorite schist. It is 225 feet in length and 35 feet in width at the widest part. The strike is N65°E. In the schist there are large and irregular quartz veins roughly parallel to the schistosity. Individual quartz veins in the wide part of the lens have widths up to 5 feet and at the point where the schist inclusion has a total width of 30 feet, approximately one-half of it is quartz. At the southwest end where the schist tapers out, a quartz vein continues into the granite beyond the end of the schist but narrows sharply and fingers out.
>
> The quartz is a white, vitreous variety. Metallic minerals form 5 to 10 percent of the vein material. Pyrite and chalcopyrite are in approximately equal proportions, and in places quite large masses of mixed sulphides occur in the quartz. Sampling of trenches indicated an average gold content of 0.17 ounces per ton over a width of 4 feet 8 inches, for a length of 200 feet.
>
> The chlorite schist in which the quartz veins occur contains only small quantities of sulphides. Thomson reports the examination of two specimens, one of which consisted mainly of sulphides, the other mainly of gangue. In the former, pyrite and galena were the predominant metallic minerals

with subordinate quantities of sphalerite, chalcopyrite, hematite, and gold; the latter specimen showed chalcopyrite as the common metallic mineral, with pyrite and hematite in minor amounts.

Trenches were put down to the consolidated rock for a length of 340 feet. Some diamond-drilling was done in the winter of 1934-1935, and the schist was found to narrow and finger out in depths as it does on the surface. In most of the holes little schist was found at vertical depths of 100 feet. The veins apparently do not continue far into the granite beneath, and work was discontinued.

No work has been reported for assessment credit, and no exploration work appears to have taken place since the 1930s in this area.

PHELPS DODGE CORPORATION OF CANADA LIMITED (22, 37)

In the summer of 1972, the Phelps Dodge Corporation of Canada Limited held two groups of claims: a large block in Rickaby Township (East Group), and a small property in southeastern Elmhirst Township (West Group).

The West group consisted of four claims, 302155 to 302158 inclusive, west of the Namewaminikan River. Part of this group was covered by electromagnetic and magnetometer surveys by H.K. Porter Company (Canada) Limited in 1968 in the vicinity of an aeromagnetic anomaly on the eastern contact of the Coyle Lake stock. No other work has been reported on these claims which are underlain by intermediate pyroclastic rocks, mosty thinly bedded tuff and crystal tuff.

The East Group of claims consisted of claims 287733, 287793, 287794, 303226 to 303237 inclusive, 333941 to 333962 inclusive, 334098 to 334113 inclusive, 339406 to 339419 inclusive and 339421 to 339459 inclusive.

Exploration History of the East Group[1]

Most of this property had been held previously by Noranda Mines Limited in the mid-1950s and by Rio Tinto Canadian Exploration Limited in the late 1960s. The first significant sulphide occurrence, known as the Kenty Showing, was discovered on the property about 3 km (2 miles) northeast of Seven-Foot Falls in 1950. Subsequently, that year Barymin Company Limited conducted a resistivity survey in the vicinity of the showing. In 1956, Noranda Mines Limited drilled 13 diamond drill holes, totalling 1,232 m (4,040 feet), to investigate the main showing and resistivity anomalies nearby (see N series of diamond drill holes, Figure 16). Although disseminated pyrite mineralization was encountered in most holes, copper values were low (Assessment Files Research Office, Ontario Divison of Mines, Toronto).

A second base metal sulphide occurrence, known as the Martin or Dickson Showing, was discovered in 1952, about 1.6 km (1 mile) south of the Kenty Showing. A total of 14 drill holes were put down that year around the showing by Chesterville Mines Limited. No encouraging intersections were obtained and the property was dropped at that time.

[1]Phelps Dodge Corporation dropped their option on this property in August, 1972. The claims were subsequently acquired by Rickaby Mines Limited.

In 1967, Rio Tinto Canadian Exploration Limited assembled, through option agreements with A.J. Taylor, A.E. Tyson, and H. Assad Syndicate, a large block of claims which included the Kenty and Martin showings. That year, a detailed geological map was prepared and electromagnetic and magnetometer surveys were carried out over the property. In 1968, more detailed mapping and a Turam electromagnetic survey were conducted, but no geophysical targets were located. No drilling was attempted and the options were dropped.

In 1971, the Phelps Dodge Corporation of Canada Limited, optioned the property from the owner of most of the claims, Mr. A.J. Douglas. This company performed an induced potential survey and commenced diamond drilling in the winter of 1971/1972 in the vicinity of the Kenty Showing. A total of 27 holes were put down, most of those on claim 287733 (Figure 16). A detailed geological mapping program was undertaken in 1972 and a further induced potential survey was conducted. In the later part of that summer, three deep drill holes were put down just south of the Camp 58 road on claim 287733 to test the extent of a mineralized zone within felsic metavolcanics indicated by previous drilling.

General Geology

With the exception of a number of the more northern claims which included part of the Kaby Lake stock, the property is underlain by felsic and intermediate metavolcanics. These strike at about N60E and dip steeply to the southeast.

The area to the north of the Camp 58 road is, for the most part, underlain by dacitic tuff-breccia and lapilli-tuff intercalated with small, discontinuous units of finely bedded tuff and amygdaloidal andesitic flows. The geology of the property along, and to the south of the Camp 58 road, is shown in Figure 17. In that area, there is a high proportion of felsic rocks within a volcanic succession having a stratigraphic thickness of 1,200 to 1,500m (4,000 to 5,000 feet).

The major rhyolitic rock units appear to form two groups, separated by a band of andesitic and dacitic flows and pyroclastic rocks. The northern felsic group which is interpreted to be stratigraphically lower, appears to consist of a major rhyolitic flow or a number of contiguous units and at least two minor rhyolitic units. This group, which is about 2200 m (7,000 feet) long and from 100 to 180 m (300 to 600 feet) thick, includes the Kenty Showing and most of the other sulphide occurrences on the property. The second felsic group, which includes the Martin Showing, consists of several discontinuous rhyolitic and rhyodacitic flows and tuff horizons intercalated with dacitic and andesitic units of similar dimensions.

Spherulitic and flow-banded rhyolitic rocks occur in both of the felsic-rich groups in the vicinity of the sulphide showings. Most of the felsic rocks however are fine pyroclastic rocks such as tuff, crystal tuff, lapilli-tuff and derived sericitic schist. Coarse-grained intermediate to felsic pyroclastics are also common. The more mafic rocks are basaltic and andesitic agglomerate, tuff-breccia and massive and amygdaloidal andesitic flows. In general, units within the predominantly felsic metavolcanic sequence are similar in appearance and composition. The distinction between the units can only be made on the basis of subtle colour

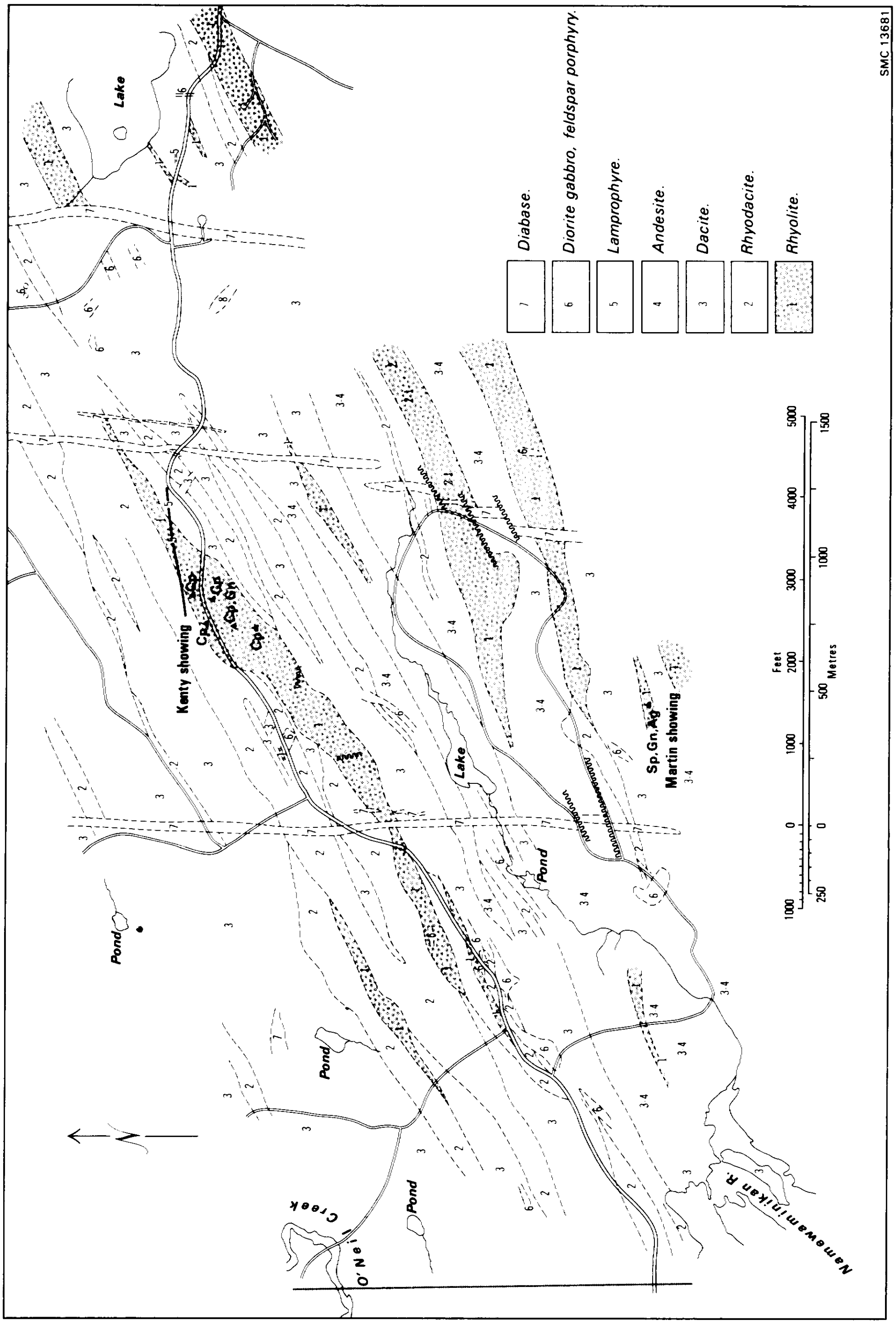


Figure 16—The geology of west-central Rickaby Township.

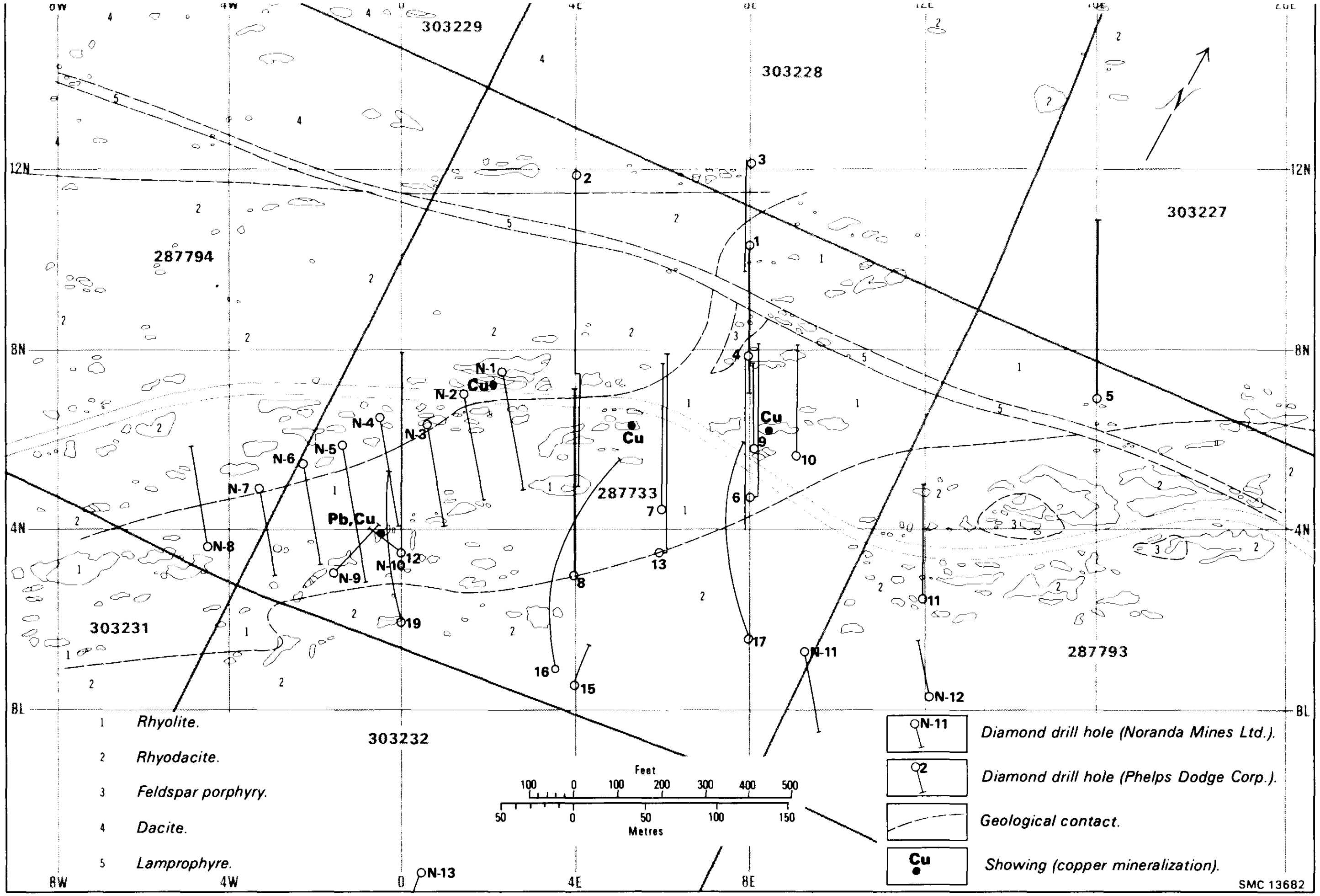


Figure 17–Geology and diamond drilling in the vicinity of the Kenty Showing.

differences and the presence or absence of such features as quartz and feldspar phenocrysts, amygdules, and spherulites. Feldspathization of all of the volcanic rock types makes it difficult to distinguish between individual flows or pyroclastic units on the basis of petrographic examination. Most of the metavolcanics on the property are cut by irregularly shaped, narrow intrusions of andesitic feldspar porphyry, which are probably of Early Precambrian age. An east-trending lamprophyre dike about 9 m (30 feet) wide has been traced over several hundred feet in the vicinity of the Kenty Showing (Figure 16). Several north-trending, Keweenawan diabase dikes up to 30 m (100 feet) wide have been recognized on the property and coincide with several linear ground magnetic anomalies.

Mineralization

Lightly disseminated pyrite mineralization is very common on this property, particularly in the rhyolitic rocks. Pyrite and variable amounts of chalcopyrite are concentrated in sheared and brecciated rock. Several sulphide occurrences are shown in Figure 16, but the main showings are around the original Kenty and Martin discoveries. The Kenty Showing consists of a series of trenches to the north and south of the Camp 58 road on claim 287733. Most of the trenches contain only pyrite with minor amounts of chalcopyrite. Spence (1967, p.14) states that:

> The more southerly trenches show rhyolite and rhyolite breccia with scattered irregular seams and pools of pyrite with lesser amounts of sphalerite, galena and chalcopyrite. The sulphides, locally massive over a few inches, are erratic and are vaguely controlled by E-W fractures.
>
> In the southernmost trench, near S on line 4W, massive magnetite occurs in several lenses near the contact. The rhyolite here is massive and fine grained or it may be massive chert. Black weathering carbonate occurs with chlorite with the magnetite.
>
> Along the south side of the road, chalcopyrite and pyrite are exposed in several trenches. Irregular replacement seams of chalcopyrite up to one foot in width occur with pyrite and chlorite along E-W fractures. Some sphalerite and galena are present and a high silver tenor is shown by assays. This copper mineralization is exposed in trenches over a strike length of 800 feet.

The Martin or Dickson Showing consists of a number of trenches in a different felsic horizon from the Kenty Showing. These trenches contain pyrite with sphalerite and silver-bearing galena over narrow widths (Spence 1967, p.15). The only work done in this area was by Chesterville Mines Limited who conducted a diamond drilling program in 1952.

The bulk of the recent exploration activity on the property has centred on the thick rhyolitic band around the Kenty Showing. Diamond drilling by the Phelps Dodge Corporation of Canada Limited intersected widespread low grade copper and zinc mineralization. Some of the best intersections as reported by Pudifin (1972b, p.6) are listed in Table 9.

According to Pudifin (1972b), the higher grade mineralization forms a pipe-like zone trending 225°E to 235°E and plunging 25° to 30°. This is approximately parallel to other linear features such as rodding of clasts, spherulites and amygdules observed by the authors in this vicinity. The mineralized zone, as it is presently known, is approximately 360 m (1,200 feet) long and a maximum of 60 m (200 feet) in diameter (Figure 18). Pudifin (1972b, p.4) states that:

TABLE 9 SELECTED RESULTS OF DRILLING BY PHELPS DODGE CORPORATION IN RICKABY TOWNSHIP.

Hole	From	To	Length (ft).	Copper %	Zinc %	Silver oz/ton
1	337	357	20.0	.22	.05	.11
	390	417	27.0	.51	.06	.39
2	701	741	40.0	.48	.15	.70
	761	791	30.0	1.18	1.10	
4	63.5	71	7.5	1.52		
	124	204	80.0	1.22		
7	132	372	240.0	.378		.33
8	418	448	30.0	.59		.52
9	84	154	70.0	1.03		.468
10	270	290	20.0	.49		.35
12	308	328	20.0	.29		.39
13	522	582	60.0	.29	.30	.46
16	757	767	10.0	.58	.49	1.24

This [mineralized zone] is substantiated by the higher grade sections obtained in holes 4 and 9, drilled on the same section, and by hole No.2 at a deeper level on a section 400 feet further westward. All other holes would have missed this higher grade zone, including the Noranda drilling which was following up a different zone on surface, a short distance to the south.

On the basis of diamond drill logs (Assessment Files Research Office, Ontario Division of Mines, Toronto), the mineralization appears to be crudely layered. Very little zinc is reported in the upper part of the mineralized zone but zinc grade increases with depth, and is highest at the base of the zone.

Electromagnetic and magnetometer surveys have not indicated the existence of anomalous zones, even over the known mineralization. Very little magnetite is associated with the deposit, and chlorite is the only common ferromagnesian mineral in the host rhyolite. Although pyrrhotite was not reported in drill logs, it is present in considerable amounts in polished sections. The examination of drill core has shown that the sulphide minerals are evenly disseminated throughout the mineralized zone and do not form massive pods or connected stringers suitable for electromagnetic response. Induced potential surveys conducted by Phelps Dodge Corporation of Canada Limited were successful in outlining three anomalous areas, one of which roughly coincides with the mineralized zone. Only one drill hole, known as Phelps Dodge Corporation hole No.5, which intersected low grade mineralization, has been put down to test the other two induced potential anomalies.

A study of polished sections of the mineralization indicates that the sulphide mineralization consists of chalcopyrite, pyrrhotite, pyrite, marcasite, sphalerite and minor galena. Chalcopyrite, pyrrhotite, marcasite and sphalerite occur to-

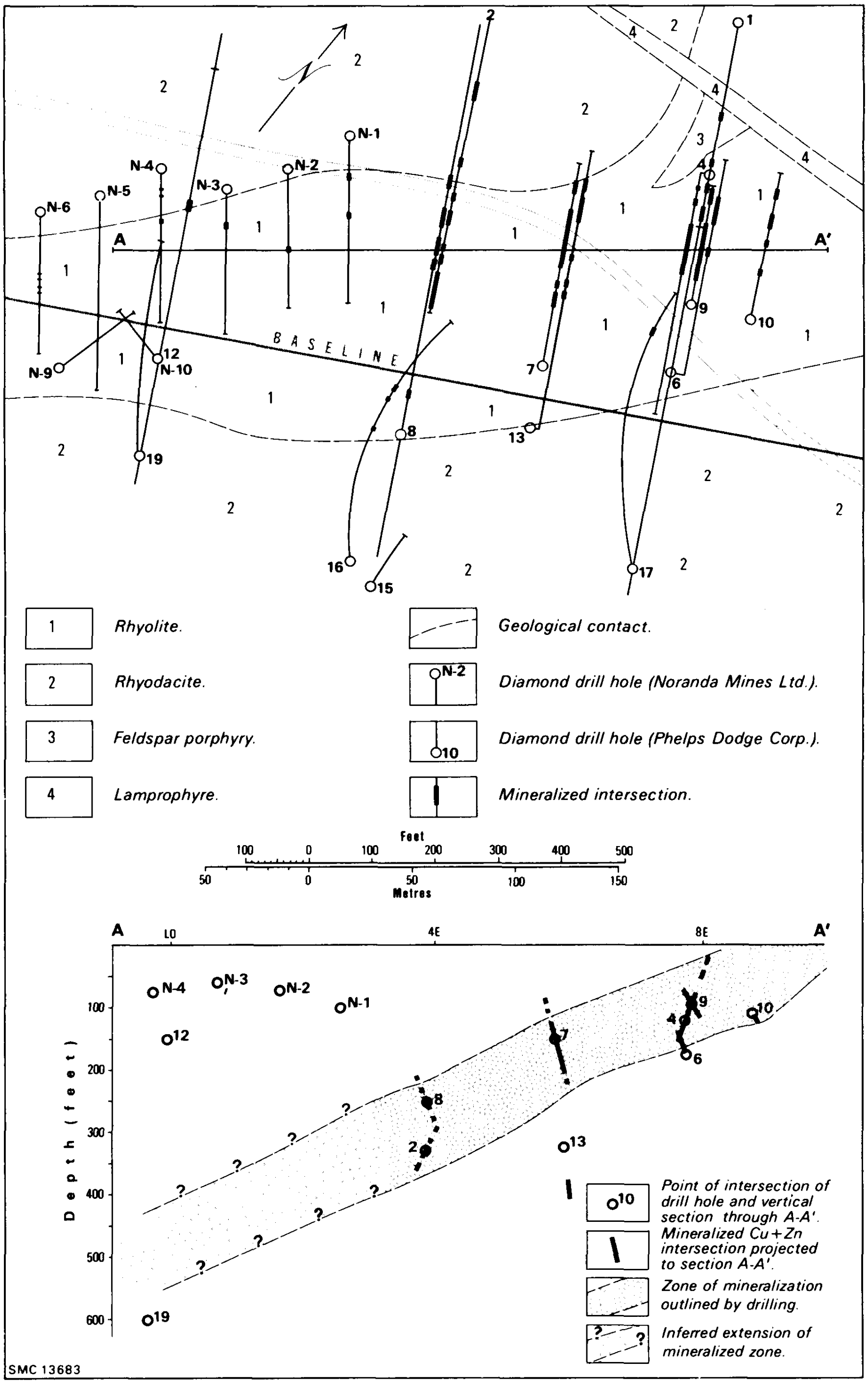


Figure 18–Diamond drill plan and longitudinal section of the main mineralized zone in the vicinity of the Kenty Showing.

ODM9755

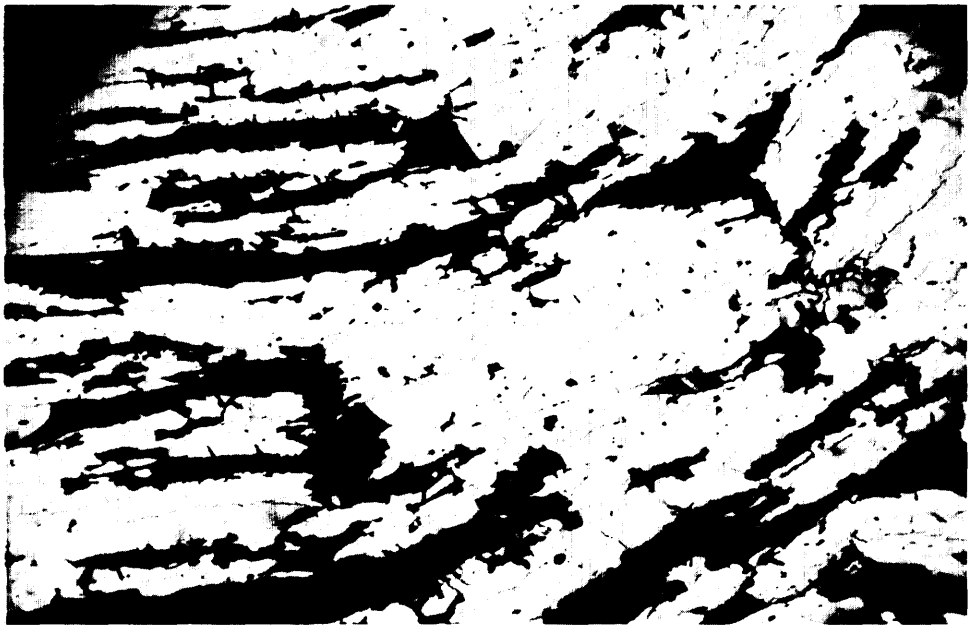
Photo 21–Photomicrograph showing a skeltal eutectoid-like intergrowth of chalcopyrite (light gray), marcasite (white) and gangue material (dark gray). Plane polarized light. Photo by W. Hicks, Ontario Division of Mines.

gether or separately in masses 0.5 to 1 mm in diameter which commonly enclose silicate grains, and in short stringers up to several inches long. The sulphide minerals are generally interstitial to the silicate minerals, but they also occur finely disseminated within the silicates. A few galena cubes, and sphalerite commonly occur enclosed within chalcopyrite blebs. Photos 21 and 22 show a skeletal intergrowth of chalcopyrite and marcasite believed by the authors to be a eutectoid texture. In grains nearby, chalcopyrite contains abundant pyrrhotite inclusions.

Sphalerite occurs within the silicate grains and enclosed within chalcopyrite and pyrrhotite grains. It is also common in the centres of spherulitic structures (Photo 11).

Although there were traces of tin in some samples collected by the field party from the property, no cassiterite or other tin mineral was identified in polished section. One grab sample collected by the authors from the Kenty Showing was analyzed by the Mineral Research Branch, Ontario Division of Mines, Toronto, and was found to contain 5.00 percent copper, 0.67 percent zinc, 0.39 percent lead, 0.15 ounces of gold/ton, 15.60 ounces of silver/ton, 0.06 percent bismuth, and traces of tin, molybdenum, and nickel.

An occurrence of magnetite in a small vein near the Kenty Showing was sampled by the field party, analyzed and found to contain 6.80 percent manganese, but no separate manganese mineral was identified by X-ray crystallographic methods.



ODM9756

Photo 22–Photomicrograph showing fine detail of the chalcopyrite-marcasite intergrowth seen in Photo 21 (plane polarized light). Photo by W. Hicks, Ontario Division of Mines.

W. PLEXMAN (23)

Mr. Plexman in 1972 held an irregularly shaped block of claims consisting of 304045 to 304051 inclusive and 278346 to 278359 inclusive in southwestern Elmhirst Township. With the exception of a small area of metavolcanics in the western portion of claim 278350, nearly all of the ground is underlain by the Coyle Lake stock and its hybrid contact aureole. No showings are known to occur on the property and no exploration work has been reported.

H.E. RUTHERFORD (24)

In 1972, H.E. Rutherford held a block of 10 claims south and east of Elmhirst Lake. The claims are underlain by intermediate metavolcanics but overburden in the area leaves little bedrock exposed. The northern claims in the group were partially covered by geological and magnetometer surveys done by Ambassador Mining Development Limited in 1960. No further work has been reported on this ground.

D.THORSTEINSON (38)

A single claim, TB 334161, was held by Mr. Thorsteinson in 1972 in Rickaby Township. The claim, which is west of Daphne Lake and north of Kenneth Lake, has had no work reported for assessment credit. Very little outcrop was encountered in mapping the area. The only bedrock observed by the field party was foliated, light pink and grey, aphanitic intermediate metavolcanics, bearing no visible mineralization.

A. TURCOTTE (25, 39)

In 1972, Mr. Turcotte held title to a large block of claims in east-central Elmhirst Township. The property included claims 334193 to 334212 inclusive, 334329, 334330 and 334706 to 334713 inclusive.

The central part of the property, east of Elmhirst Lake was covered by geological and magnetometer surveys conducted by Ambassador Mining Development Limited in 1960. No further work has been reported for assessment credit.

The northern claims are underlain by rocks of the Elmhirst Lake stock. A large gabbroic inclusion occurs within the granodiorite on claim 334712. Most of the property is underlain by intermediate and felsic metavolcanics, but with the exception of a few areas, outcrop on the property is sparse. The most common rocks found in mapping this area were porphyritic andesite flows and coarse pyroclastic rocks such as tuff-breccia.

J.A. WILSON (26)

Mr. Wilson in 1972 held a group of four claims 334900 to 334903 in northeastern Rickaby Township. No work has been reported on the property for assessment credit. The claims are underlain by massive and porphyritic intermediate flows.

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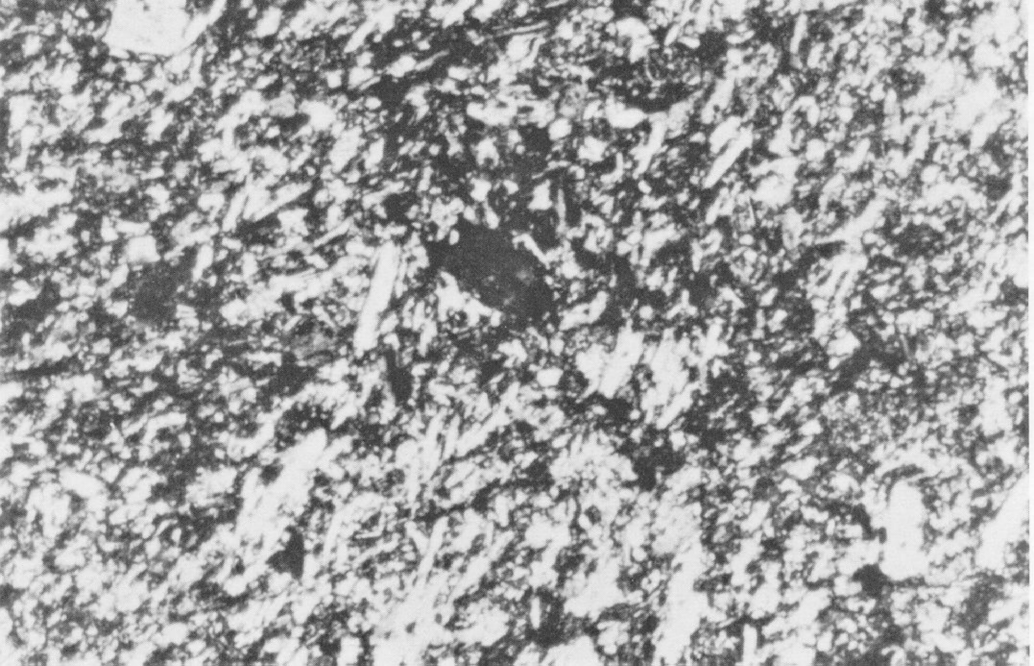
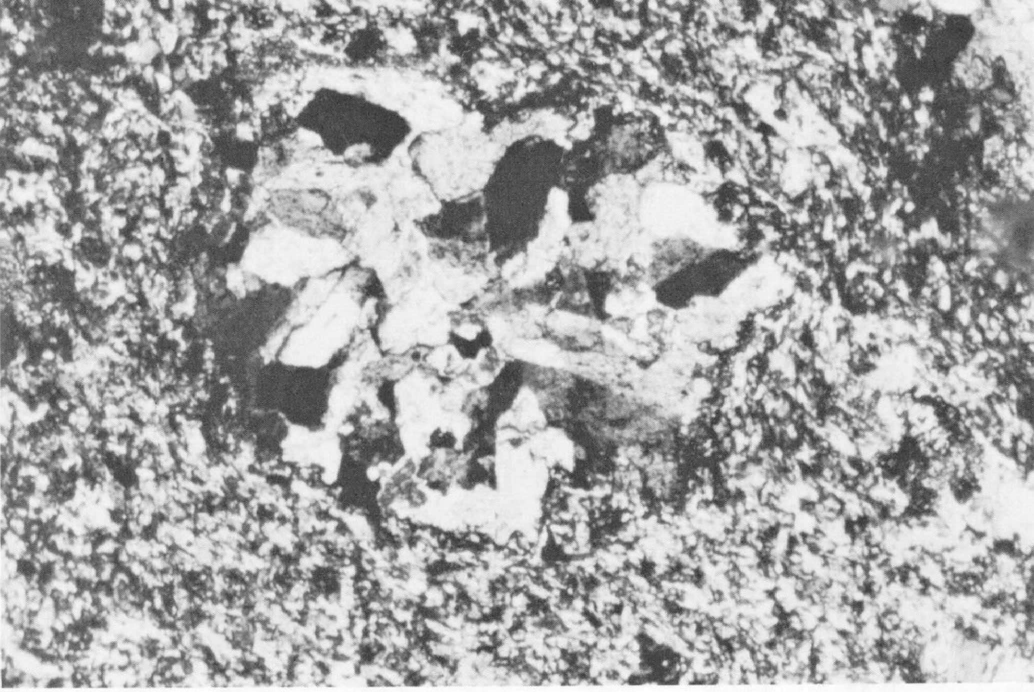
INDEX



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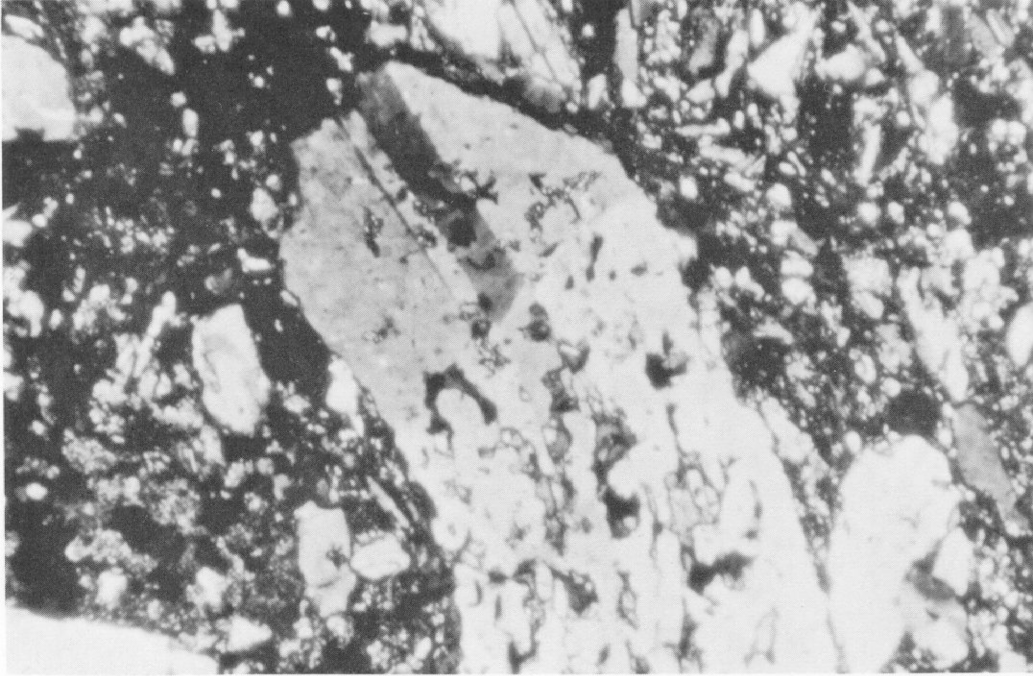

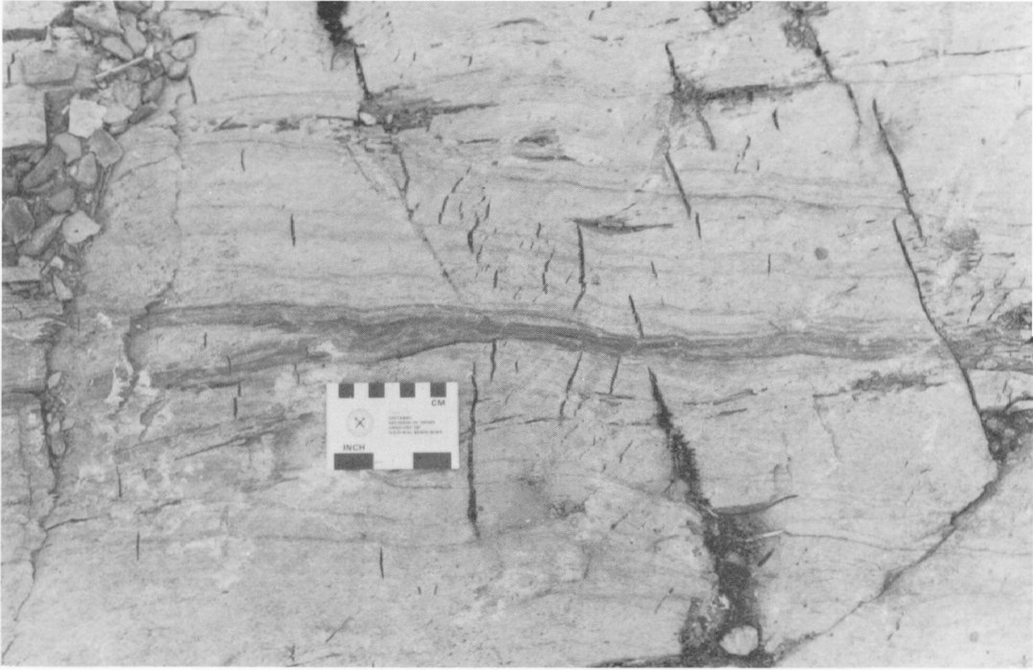
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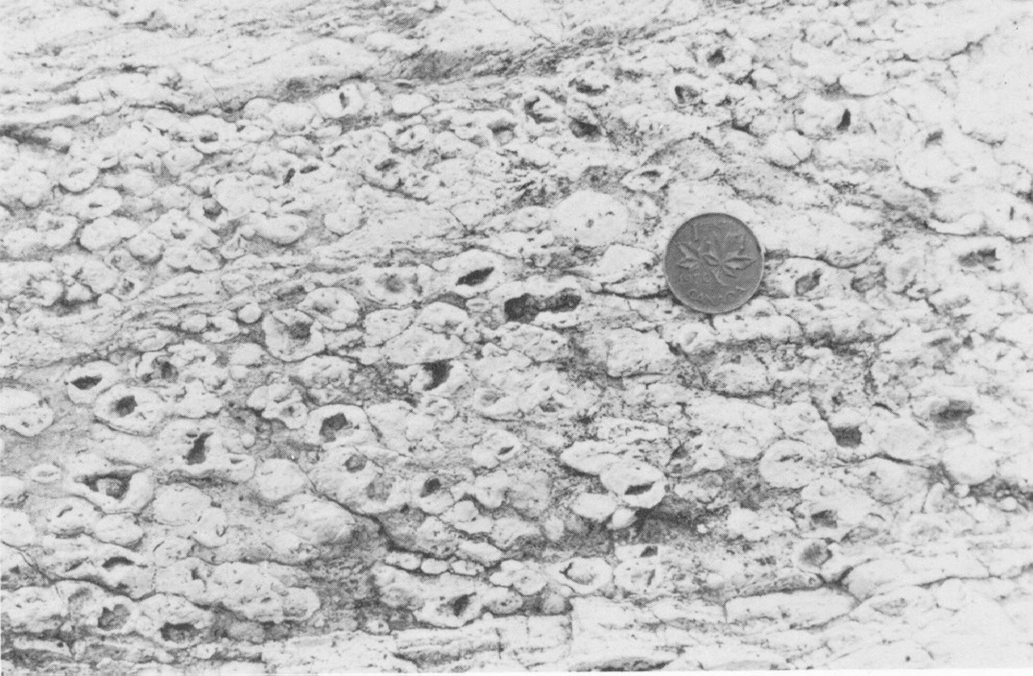

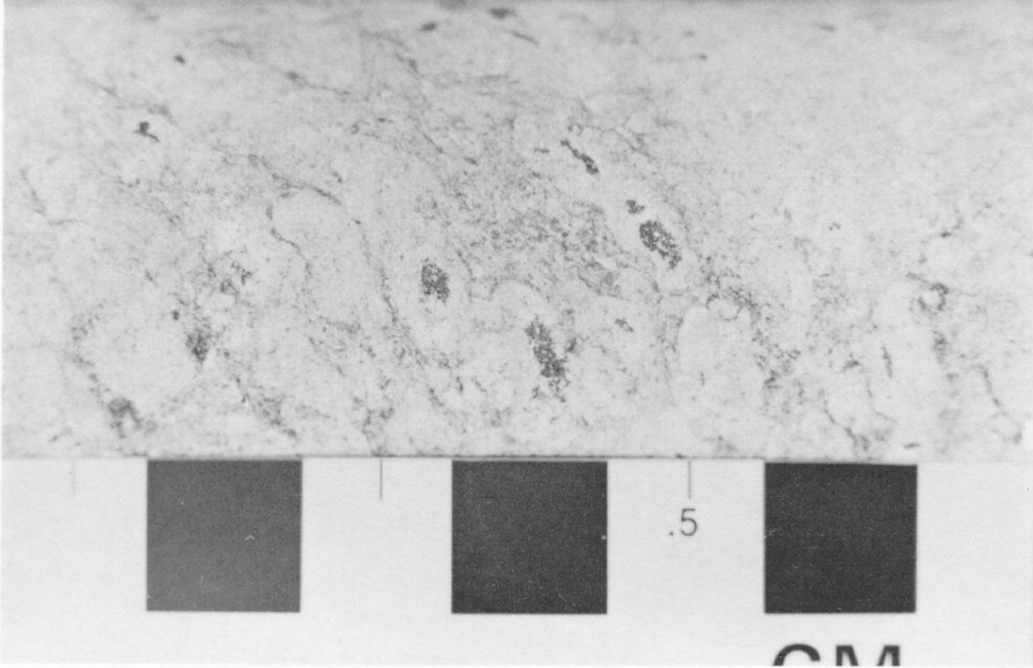
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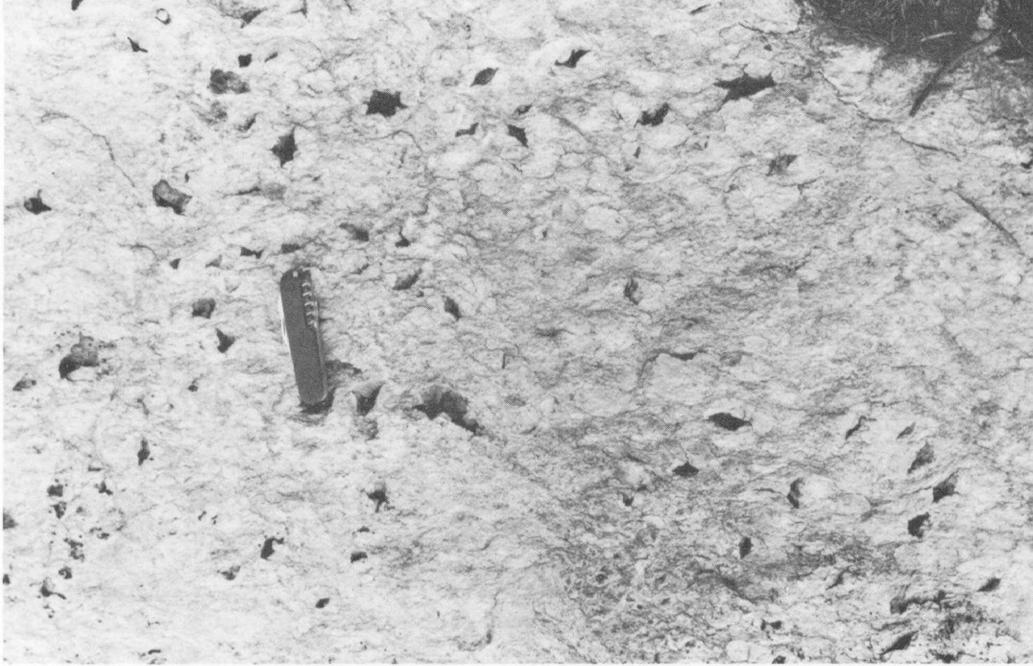

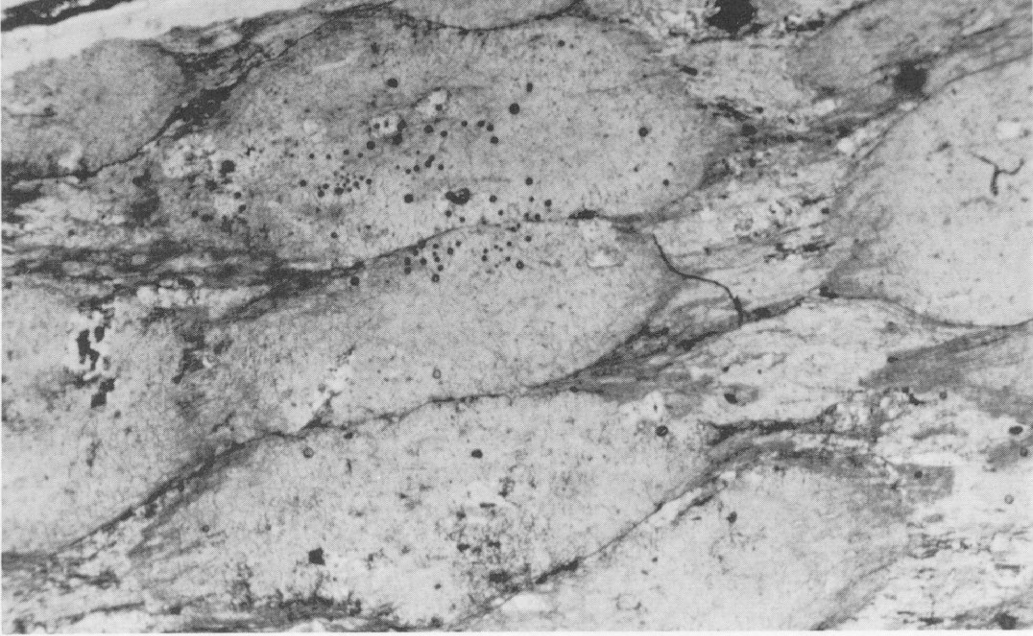

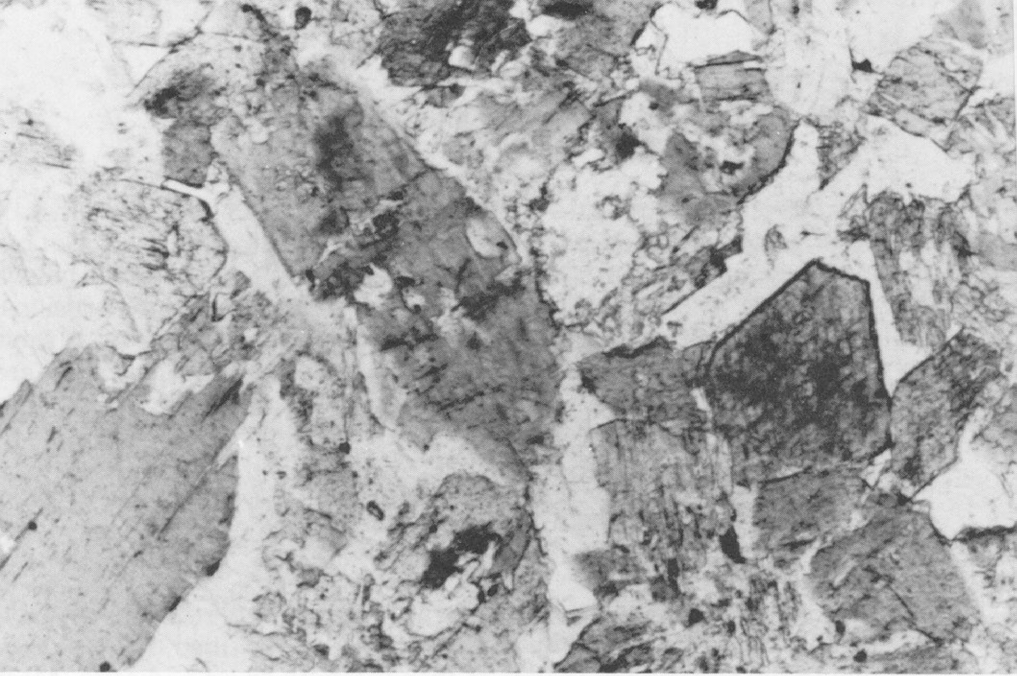

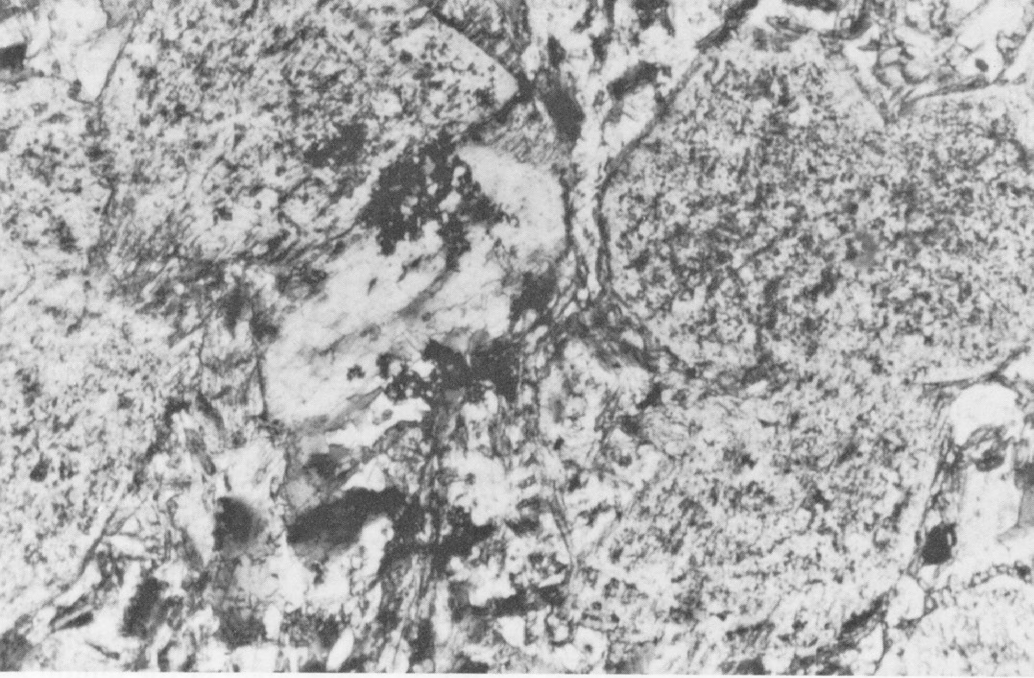

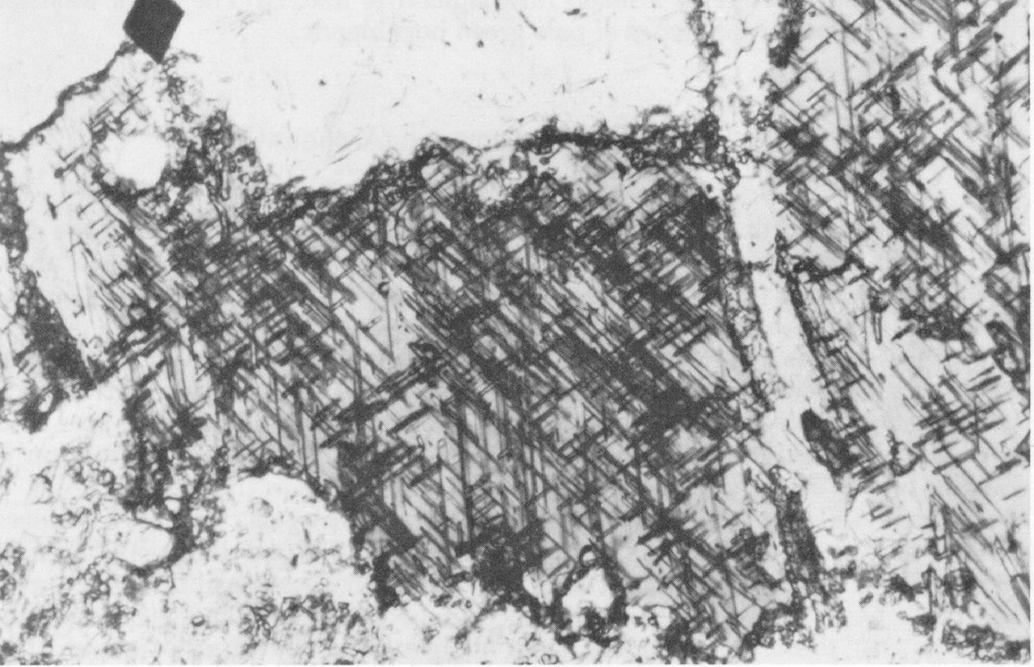


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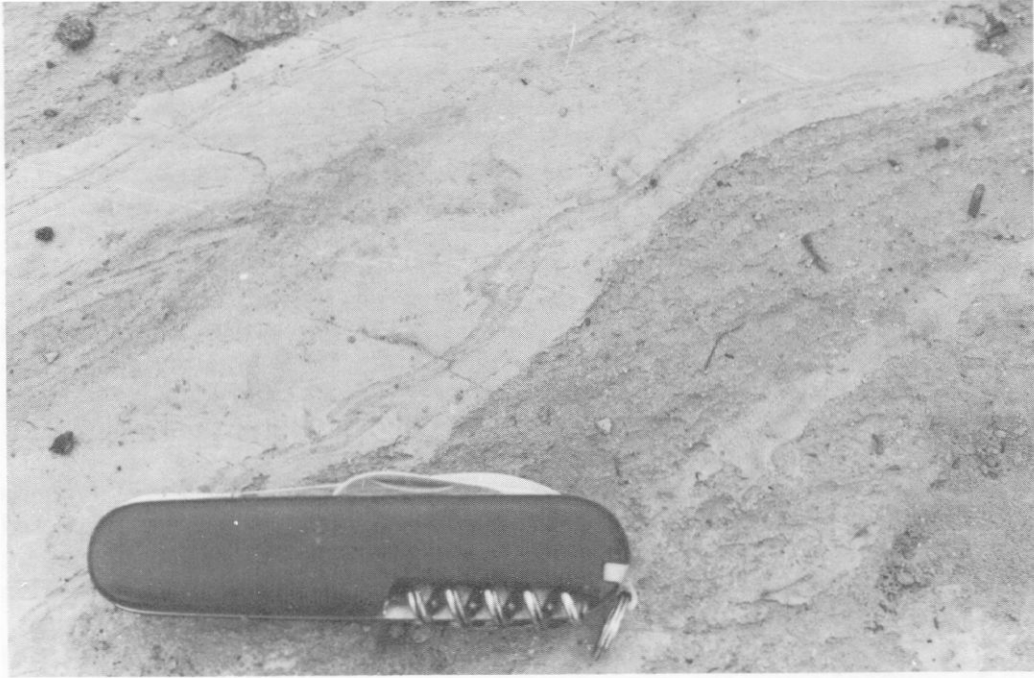
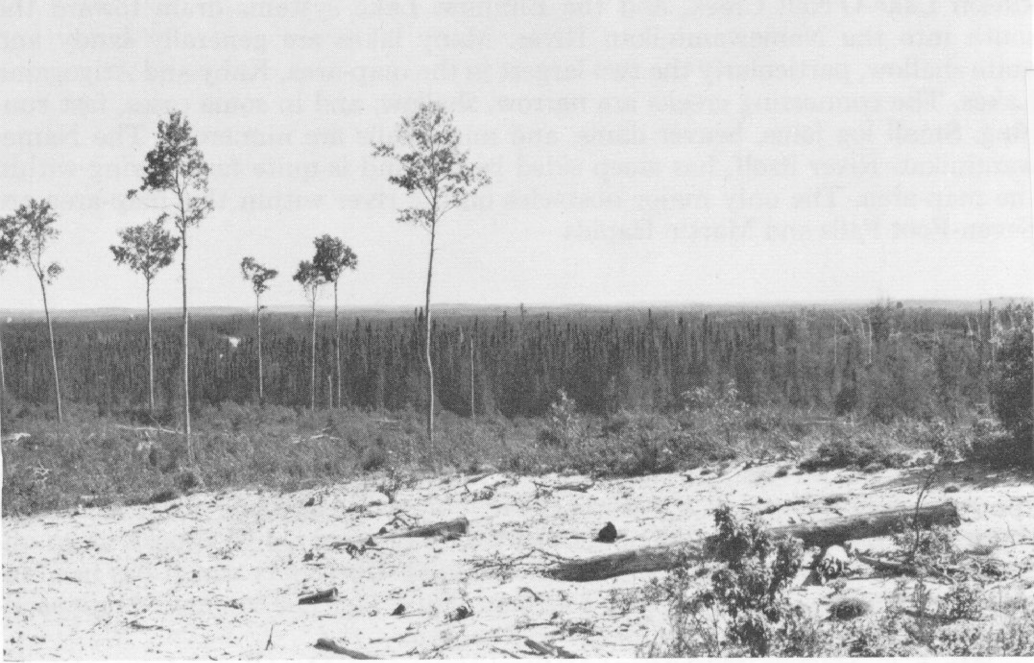
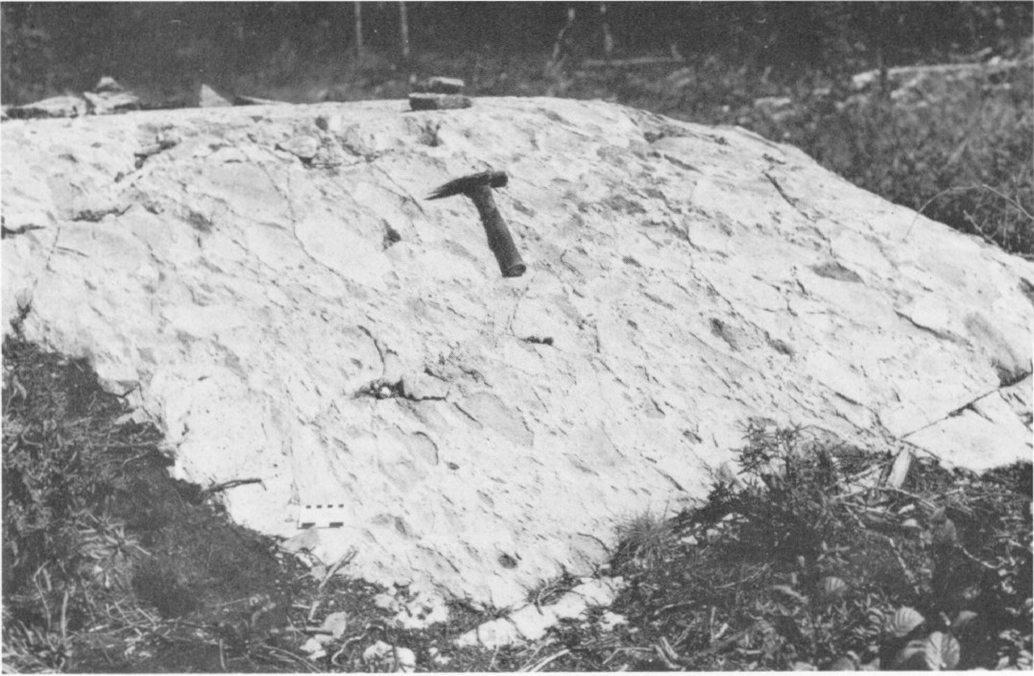
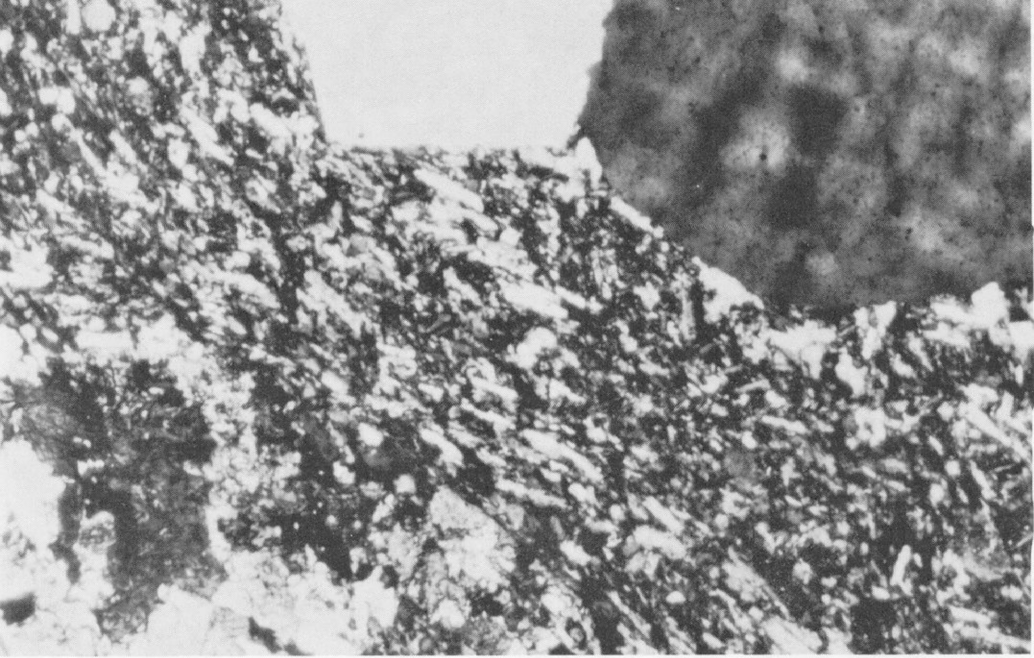
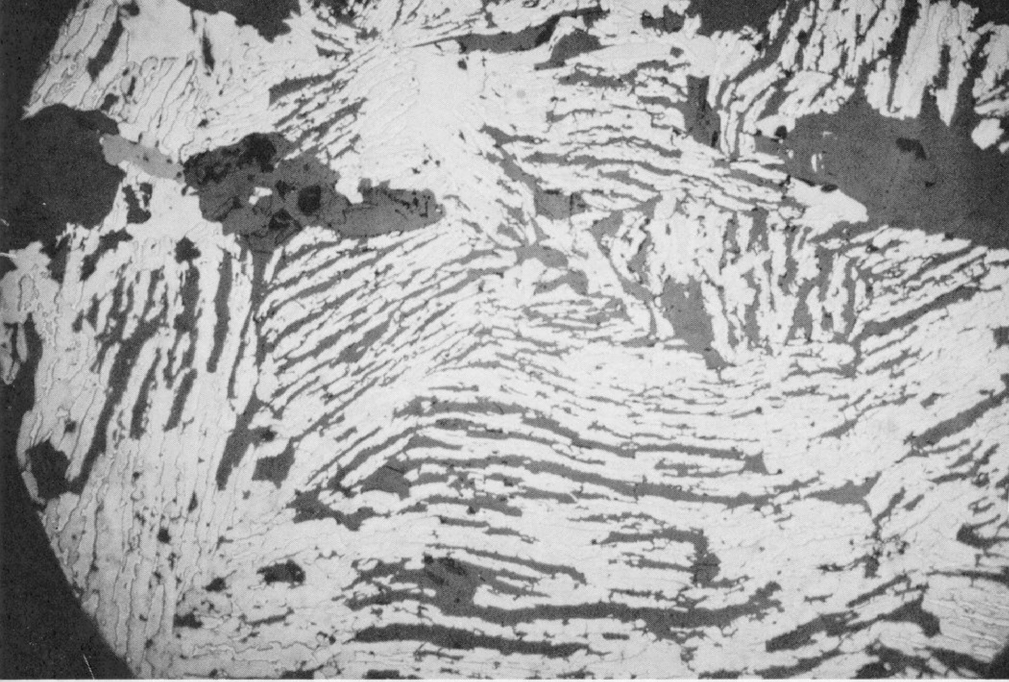
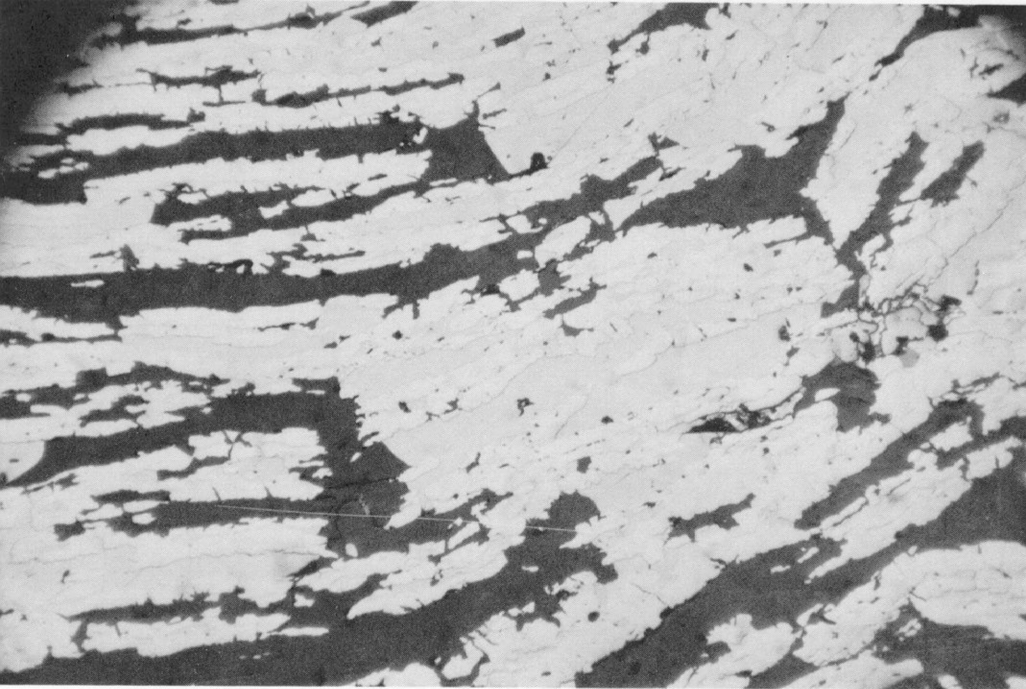








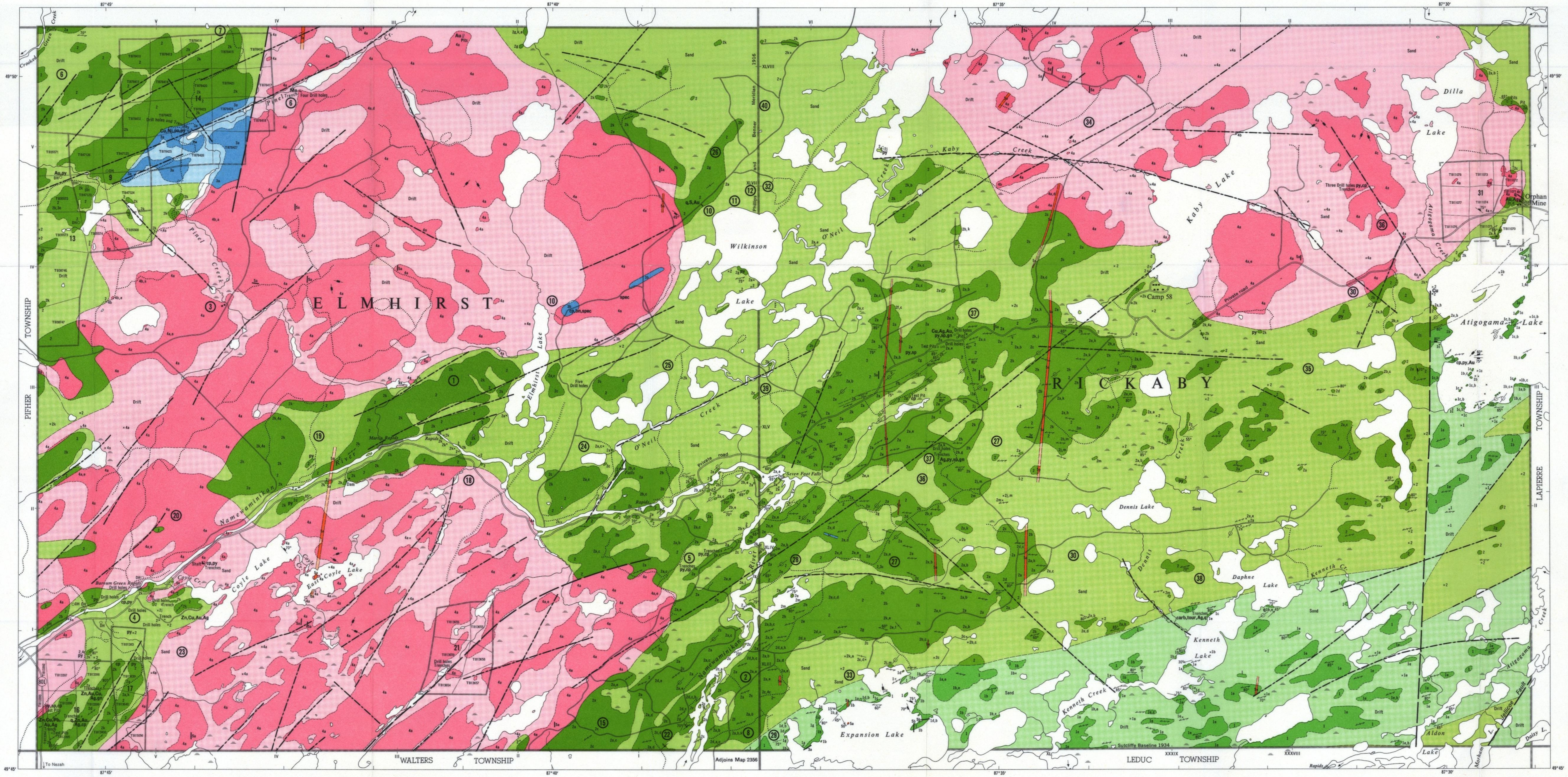




Ministry of Natural Resources
Ontario
Hon. Leo Bernier
Minister
Dr. J. K. Reynolds
Deputy Minister

SYMBOLS

- Glacial striae.
- Esker.
- Small bedrock outcrop.
- Area of bedrock outcrop.
- Bedding, top unknown; (inclined, vertical).
- Bedding, top indicated by arrow; (inclined, vertical, overturned).
- Bedding, top (arrow) from grain gradation; (inclined, vertical, overturned).
- Lava flow; top (arrow) from pillows shape and packing.
- Foliation; (horizontal, inclined, vertical).
- Lineation with plunge.
- Geological boundary, observed.
- Geological boundary, position interpreted.
- Fault; (observed, assumed). Spot indicates down throw side, arrows indicate horizontal movement.
- Lineament.
- Jointing; (horizontal, inclined, vertical).
- Drill hole; (vertical, inclined).
- Vein, vein network.
- Swamp.
- Motor road. Provincial highway number encircled where applicable.
- Other road.
- Trail, portage, winter road.
- Township boundary with mile posts, approximate position only.
- Mining property, surveyed.
- Mineral deposit; mining property, unsurveyed.
- Surveyed line, approximate position only.



PROPERTIES, MINERAL DEPOSITS

ELMHIRST TOWNSHIP

1. Auger, Y.
2. Berube, M.
3. Bilodeau, F.
4. Carling Copper Mines Ltd.
5. Cerro Mining Co. of Canada Ltd.
6. Chemalloy Minerals Ltd.
7. Chesterville Mines Ltd.
8. Cominco Ltd.
9. Consolidated Canadian Faraday Ltd.
10. Douglas, A. J.
11. Douglas, D. Mrs.
12. Goulet, O.
13. Greenoaks Mines Ltd.
14. Jacobus Mining Corp. Ltd.
15. Jerome, A. E.
16. Jupiter Minerals Inc.
17. Milestone Exploration Ltd.
18. Mitto, A.
19. Nelson, B.
20. Norlex Mines Ltd.
21. Oliver Severn Gold Mines Ltd.
22. Phelps Dodge Corp. of Canada Ltd.
23. Plexman, W.
24. Rutherford, H. E.
25. Turcotte, A.
26. Wilson, J. A.

RICKABY TOWNSHIP

27. Berube, M.
28. Cerro Mining Co. of Canada Ltd.
29. Cominco Ltd.
30. Cox, N.
31. Craibbe, H. K.
32. Goulet, O.
33. Lafontaine, A.
34. Leliever, G.
35. Lynx-Canada Explorations Ltd.
36. Nelson, M. H.
37. Phelps Dodge Corp. of Canada Ltd.
38. Thorsteinson, D.
39. Turcotte, A.
40. Wilson, J. A.

Information current to December 31st, 1972. For further information see report.

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ODM-GSC Aeromagnetic map 2136G, 2143G.

Preliminary maps, P. 801, Elmhirst Township and P. 802 Rickaby Township, scale 1 inch to ¼ mile, issued 1973.

Cartography by M. J. Colman and assistants, Ministry of Natural Resources, 1976.

Basemap derived from maps of the Forest Resources Inventory, Ministry of Natural Resources.

Magnetic declination in the area was 2°W, 1975.

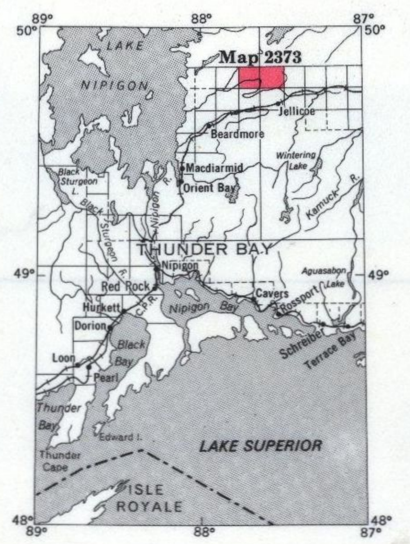
Ontario Geological Survey
Map 2373

ELMHIRST AND RICKABY TOWNSHIPS

THUNDER BAY DISTRICT

Scale 1:31,680 or 1 Inch to ½ Mile

Chains 80 60 40 20 0 1 2 Miles
Metres 1000 0 1 2 3 Kilometres
Feet 1000 0 5,000 10,000 Feet



Scale 1 inch to 50 miles
N.T.S. reference 42 E/13, 42 E/14

LEGEND

PHANEROZOIC

CENOZOIC[a]

QUATERNARY

RECENT

Swamp, lake, and stream deposits.

PLEISTOCENE

Sand, gravel, and clay.

UNCONFORMITY

PRECAMBRIAN[b]

MIDDLE TO LATE PRECAMBRIAN (PROTEROZOIC)

LATE INTRUSIVE ROCKS

5a Diabase.
5b Feldspar-quartz porphyry related to diabase.

INTRUSIVE CONTACT

EARLY PRECAMBRIAN (ARCHEAN)

FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

4a Granodiorite, trondhjemite, quartz diorite, diorite.
4b Granite, quartz monzonite.
4c Feldspar porphyry and quartz-feldspar porphyry dikes.
4d Granitic and pegmatitic dikes related to 4a and 4b.
4e Hybrid felsic to intermediate intrusive rocks.

MAFIC INTRUSIVE ROCKS

3a Diorite, quartz-diorite, gabbro.
3b Gabbro.
3c Mafic dikes.

INTRUSIVE CONTACT

METAVOLCANICS[c]

FELSIC TO INTERMEDIATE METAVOLCANICS

2 Unsubdivided.
2a Tuff-breccia and pyroclastic breccia.
2b Lapilli-tuff.
2c Crystal tuff.
2d Laminated tuff.
2e Amygdaloidal lava.
2f Pillow lava and related breccia.
2g Massive and flow-banded lavas.
2h Spherulitic and flow-banded lavas.
2j Quartz-feldspar porphyry.
2k Feldspar porphyry.
2m Derived sericitic schist.

CONFORMABLE CONTACT INTERCALATED IN PART

MAFIC TO INTERMEDIATE METAVOLCANICS

1 Unsubdivided.
1a Massive lava.
1b Amygdaloidal lava.
1c Volcanic breccia and agglomerate.
1d Pillow lava.
1e Derived chloritic schist.
1g Tuffaceous chert associated with mafic metavolcanics.

Ag	*Silver.*
Au	*Gold.*
bn	*Bornite.*
carb	*Carbonate.*
cp	*Chalcopyrite.*
Cu	*Copper.*
gn	*Galena.*
Mo	*Molybdenum.*
Ni	*Nickel.*
Pb	*Lead.*
po	*Pyrrhotite.*
py	*Pyrite.*
q	*Quartz.*
sp	*Sphalerite.*
spec	*Specularite.*
S	*Sulphide mineralization.*
tour	*Tourmaline.*
Zn	*Zinc.*

[a] *Unconsolidated deposits. Cenozoic deposits are represented by the lighter coloured parts of the map.*

[b] *Bedrock geology. Outcrops and inferred extensions of each map rock unit are shown respectively in deep and light tones of the same colour. Where in places a formation is too narrow to show colour and must be represented in black, a short black bar appears in the appropriate block.*

[c] *Rocks in these groups are subdivided lithologically and the order does not imply age relationship within or among groups.*