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Ontario Geological Survey

Report 213

**Geology of the
Wanapitei Lake Area
District of Sudbury**

By

Burkhard O. Dressler

1982



**Ministry of
Natural
Resources**

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**GEOLOGICAL MAPS
(back pocket)**

Map 2450 (coloured)—Otter Lake, District of Sudbury.
Scale 1:31 680 or 1 inch to ½ mile.

Map 2451 (coloured)—Massey Bay, District of Sudbury.
Scale 1:31 680 or 1 inch to ½ mile.

ABSTRACT

The map-area is 622 km² in extent, and the centre of it is located about 30 km northeast of Sudbury. The area is bounded by Latitudes 46°38' and 46°54' N and Longitudes 80°33', and 80°51' W. Precambrian rocks underlie the map-area and are overlain by Cenozoic glacial and fluvioglacial deposits.

Rocks of the Superior Structural Province are Early Precambrian rocks that outcrop west of Lake Wanapitei and consist of gneisses, metavolcanics and metasediments, ironstones, felsic plutonic rocks, migmatites, and mafic dike rocks. The felsic plutonic rocks were emplaced during or shortly after the Kenoran Orogeny some 2500 m.y. or more ago.

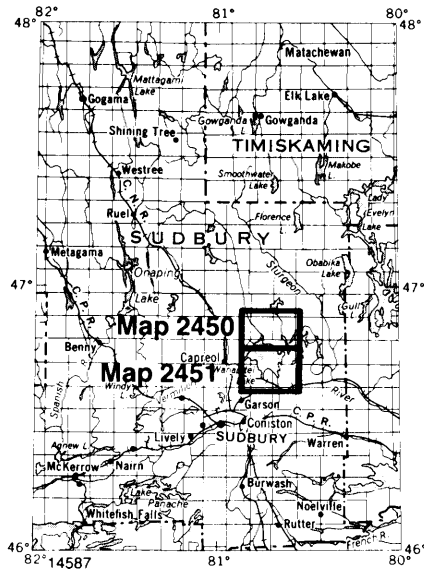


Figure 1—Key map showing location of the Lake Wanapitei Area.
Scale 1:3 168 000 (1 inch to 50 miles).

In the Southern Structural Province, Middle Precambrian supracrustal sedimentary rocks of the Huronian Supergroup were deposited about 2300 m.y. ago, and in the area, can be subdivided into six formations: namely the Mississagi, Bruce, Espanola, Serpent, Gowganda, and Lorrain Formations. The Huronian rocks are mainly clastic sedimentary rocks, namely quartz arenite, arkose, and wacke. A carbonate-rich unit, the Espanola Formation, is an excellent marker horizon.

The Huronian rocks and older rocks are invaded by intrusions of three ages; The Nipissing Intrusive Rocks (2160 m.y.), the Sudbury Nickel Irruptive (1840 m.y.), and olivine diabase (1290 m.y.).

The tuff and breccia of the Onaping Formation are the only rocks of the Whitewater Group present in the area. The Whitewater Group is somewhat older than the Nickel Irruptive and occurs only within the Sudbury Basin.

Continental glaciation during the Pleistocene resulted in erosion and deposition of a cover of unconsolidated sand and gravel.

Most of the map-area is located in the southernmost part of the Cobalt Embayment near the eastern end of the Penokean Fold Belt and just north of the Grenville Front Tectonic Zone. In the northern part of the map-area, the tectonic deformation was not intense. Faults and wide, open

folds are the main structural features. In the southern part of the area, the rocks are weakly to moderately deformed, and the geological information is suggestive of large scale folding and faulting. Sudbury-type breccias and pseudotachylites occur in all the area, but are most common near the Sudbury Nickel Irruptive.

The Early Precambrian rocks suffered moderate deformation and greenschist to amphibolite facies metamorphism. In the Southern Structural Province, the rocks commonly exhibit the effects of low greenschist facies metamorphism. In one place, a somewhat higher rank metamorphism is indicated by the presence of scapolite in Huronian rocks.

The origin of the Sudbury Structure and of the Lake Wanapitei Structure is a matter for debate. The Sudbury Structure originated either by explosive volcanism or by meteorite impact. An origin by meteorite impact has also been advocated for the Lake Wanapitei Structure.

There are several mineral deposits in the area. Early Precambrian ironstones occur northwest of Lake Wanapitei. Gold occurrences at the contacts of Nipissing gabbro with Huronian sedimentary rocks are numerous. Copper and nickel sulphide deposits occur in Nipissing gabbro. At the southern end of Rathbun Lake, one of these deposits has impressive tenors of precious metals. Three past-producing nickel-copper mines are located at the lower contact of the Nickel Irruptive west and south of Lake Wanapitei. Hydrothermal copper mineralization occurs in brecciated Gowganda Formation siltstones in central Aylmer Township. Uraniferous quartz-pebble conglomerates outcrop at Massey Bay, part of Lake Wanapitei. A decorative breccia stone pit is being operated in central Aylmer Township.

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LENGTH					
1 mm	0.039 37	inches	1 inch	25.4	mm
1 cm	0.393 70	inches	1 inch	2.54	cm
1 m	3.280 84	feet	1 foot	0.304 8	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	1.609 344	km
AREA					
1 cm ²	0.155 0	square inches	1 square inch	6.451 6	cm ²
1 m ²	10.763 9	square feet	1 square foot	0.092 903 04	m ²
1 km ²	0.386 10	square miles	1 square mile	2.589 988	km ²
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
VOLUME					
1 cm ³	0.061 02	cubic inches	1 cubic inch	16.387 064	cm ³
1 m ³	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m ³
1 m ³	1.308 0	cubic yards	1 cubic yard	0.764 555	m ³
CAPACITY					
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	4.546 090	L
MASS					
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	31.103 476 8	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	0.453 592 37	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	907.184 74	kg
1 t	1.102 311	tons (short)	1 ton (short)	0.907 184 74	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	1016.046 908 8	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	1.016 046 908 8	t
CONCENTRATION					
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

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1 ounce (troy)/ton (short)	20.0	pennyweights/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

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Geology
of the
Wanapitei Lake Area
District of Sudbury

By

Burkhard O. Dressler¹

INTRODUCTION

Location and Access

The centre of the Lake Wanapitei area is located about 30 km northeast of Sudbury. The area comprises approximately 622 km² and is bounded by Latitudes 46°38' and 46°54' and Longitudes 80°33' and 80°51'.

The southern half of the map-area is accessible by road and water. Access to Aylmer Township is provided by Highway 545 from Capreol and a gravel road to the northern shore of Lake Wanapitei. Scadding Township, Portage Bay, Matagamasi, and Kukagami Lakes in Rathbun Township can be reached via a gravel road from Highway 17 east of the village of Wanapitei.

The Wanapitei Lake map-area comprises Aylmer, Mackelcan' and Rathbun Townships, almost the whole of Maclellan and Scadding Townships and small sectors of Davis, Fraleck, Kelly, McCarthy, McConnell, Norman, Parkin, and Telfer Townships. It also includes the eastern three quarters of the Wanapitei Indian Reserve Number 11.

Previous Geological Work

Early reconnaissance geological mapping was carried out by Alexander Murray (1853-56) and R. Bell (1890). A. Murray explored the Wanapitei River and Bell described the rocks of Lake Wanapitei. In 1912, W.H. Collins (1914a) studied an area south of Lake Wanapitei. T.T. Quirke (1922) mapped the entire area surrounding Lake Wanapitei. L.F. Kindle (1933) surveyed the Moose Mountain - Wanapitei area, which includes the northwesternmost part of the

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current map-area, and H.W. Fairbairn (1939) surveyed the Ashigami Lake area. In 1957 and 1959, J.E. Thomson (1961) mapped Maclellan and Scadding Townships and in 1959, J.E. Thomson and K.D. Card (1963) mapped Kelly and Davis Townships. Hutton and Parkin Townships were studied by H.D. Meyn (1970). K.D. Card *et al.* (1977) described the stratigraphy, sedimentology, and petrology of the Huronian Supergroup in the Sudbury-Espanola Area.

The literature on the Sudbury Nickel Irruptive is voluminous. The reader is referred to K.D. Card (1978a, p.7) who gave references and a short historical summary of the work on the Sudbury Nickel Irruptive.

The map-area is covered by aeromagnetic maps of the Geological Survey of Canada, the Capreol Map 1511G and the Milnet Map 1512G, at a scale of 1 inch to 1 mile (Geological Survey of Canada 1965a and b).

Preliminary geological maps of the area have been published in 1978 and 1979 (Dressler 1978a,b, and 1979a,b).

Acknowledgments

The author was assisted in the field by Kevin Greenwood, Irene Underhill, Roy Underhill, and Garry Lawrence in 1977 and by Gregory Finn, Dan Bray, Nicole Dupre, and Christina Kerr in 1978. Garry Lawrence mapped about half of Aylmer and Rathbun Townships, and Gregory Finn about half of the remainder of the Wanapitei Lake map-area in 1978.

The author received all possible assistance from employees of the Ministry of Natural Resources, Sudbury District, and the author is grateful for this.

The writer also thanks his colleague, E.C. Grunsky, Ontario Geological Survey, for processing the structural data by computer. G. Finn did much of the drafting, and modally analyzed some of the samples of the Huronian sedimentary rocks and Nipissing-type gabbros during the time he was employed as a geological assistant during the winter of 1978-1979.

Topography

The map-area is located in the Precambrian Shield of northeastern Ontario. The average topographic elevation above sea level is about 300 m in most of the southern part of the map-area, and about 350 m in the northern part. Although this suggests a relatively even terrain, it is nevertheless rugged. The highest elevation in the map-area is in northwestern Mackelcan Township, and is 503 m. The lowest elevation in the map-area is 260 m, and is located in the Wanapitei River valley in southern Scadding Township. Maximum local topographic relief is only about 90 m; in one place, just west of Dewdney Lake in Mackelcan Township it is 150 m.

Bedrock is well exposed in much of the map-area. In the northern part of the region, it may amount to about 40 percent of the map-area. Locally, extensive and thick Cenozoic deposits occur, for instance just north of Lake Wanapitei and in southern Scadding and Maclellan Townships.

The topography is strongly controlled by bedrock lithology and by struc-

ture. Early Precambrian granitic rocks, the sandstones of the Huronian Lorrain Formation, Nipissing-type gabbros, and the rocks of the Sudbury Nickel Irruptive are resistant to erosion and form hills and ridges. Other rocks of the Huronian Supergroup generally give rise to lower elevations.

Most of the map-area is drained by the south-flowing Wanapitei River. The northeastern and eastern parts of the area, however, are drained by the easterly flowing Sturgeon River. The pattern of streams and lakes within about 5 km of Lake Wanapitei, is approximately concentric with the circular northern part of Lake Wanapitei. This general topographic similarity of Lake Wanapitei to Lac Couture, Lake Manicougan, and Lake Mouchalagane in Quebec, and Deep Bay in Saskatchewan, all meteorite impact craters, together with other evidence, prompted M.R. Dence and J. Popelar (1972) to speculate that Lake Wanapitei may have also originated through meteorite impact.

GENERAL GEOLOGY

The rocks of the Lake Wanapitei area were formed during the Early, Middle, and Late Precambrian (Table 1). The northern and eastern parts of the map-area are underlain mainly by sedimentary rocks of the Huronian Supergroup and by Nipissing gabbro. In the south and west parts of the area are exposed Early Precambrian metasediments and metavolcanics, gneisses, granitic rocks, and diabases. Onaping tuff and breccia and rocks of the Sudbury Nickel Irruptive are exposed in the southwestern corner of the area. Late Precambrian olivine diabase dikes are common in almost the whole of the map-area. Pleistocene glaciation scoured the Precambrian bedrock and left behind a discontinuous cover of glacial and glaciofluvial deposits.

Early Precambrian

Early Precambrian rocks are exposed west of Lake Wanapitei, namely from Skead north to southeastern Parkin Township. These rocks are metavolcanics and metasediments, gneisses, granitic rocks, and diabases. The metavolcanics and metasediments are remnants of a greenstone assemblage. These rocks form inclusions within Early Precambrian granitic rocks, are bounded by faults, and form clasts or megaclasts in the footwall breccias of the Sudbury Nickel Irruptive. No clear picture of their original extent can be obtained in the map-area.

Geology of the Lake Wanapitei Area

TABLE 1 | TABLE OF LITHOLOGIC UNITS FOR THE LAKE WANAPITEI AREA.

PHANEROZOIC

CENOZOIC

QUATERNARY

RECENT

Swamp, lake, and stream deposits.

PLEISTOCENE

Glacial and glaciofluvial sand and gravel deposits.

Unconformity

PRECAMBRIAN

LATE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS

Olivine diabase.

Intrusive Contact

MIDDLE PRECAMBRIAN

SUDBURY NICKEL IRRUPTIVE

Sublayer, norite, transition zone norite, micropegmatite, granitic rock.

Intrusive Contact

WHITEWATER GROUP

ONAPING FORMATION

Tuff, quartzite breccia.

SUDBURY EVENT

Explosive volcanism or meteorite impact; Sudbury-type brecciation.

NIPISSING INTRUSIVE ROCKS

Gabbro, granophyre, granitic dike rock, pegmatite, quartz-plagioclase porphyry.

Intrusive Contact

HURONIAN SUPERGROUP

COBALT GROUP

LORRAIN FORMATION

Arkose, subarkose, subarkosic wacke, quartz wacke, arenites.

GOWGANDA FORMATION

Wacke, arkose, conglomerate.

QUIRKE LAKE GROUP

SERPENT FORMATION

Arkose, arkosic wacke, calcareous arkose, minor conglomerate.

ESPANOLA FORMATION

Calcareous siltstone, limestone, calcareous wacke.

BRUCE FORMATION

Conglomerate, pebbly wacke, minor arkose, wacke.

HOUGH LAKE GROUP

MISSISSAGI FORMATION

Arkose, subarkose, arkosic wacke, subarkosic wacke, conglomerate, and silty wacke.

Table 1 continued....

	<i>Unconformity</i>
EARLY PRECAMBRIAN	
MAFIC INTRUSIVE ROCKS	Diabase, glomeroporphyritic diabase, porphyritic diabase.
	<i>Intrusive Contact</i>
FELSIC PLUTONIC ROCKS	Granodiorite, diorite, migmatite.
	<i>Intrusive Contact</i>
METAVOLCANICS AND METASEDIMENTS	
METASEDIMENTS	Wacke, arkose, gneisses, ironstone, ferruginous chert.
METAVOLCANICS	
FELSIC METAVOLCANICS	
MAFIC AND INTERMEDIATE METAVOLCANICS	Mafic and intermediate metavolcanics, amphibolite, dacite.

METAVOLCANICS AND METASEDIMENTS

Metavolcanics

Mafic, intermediate, and felsic metavolcanics occur in northeastern Norman Township and southeastern Parkin Township. Felsic metavolcanics appear to be absent in the area underlain by Early Precambrian rocks south of Indian Reserve Number 11. Here, are only mafic metavolcanics and subordinate intermediate metavolcanics.

MAFIC AND INTERMEDIATE METAVOLCANICS

Mafic and intermediate metavolcanics underlie only small parts of the map-area. Intermediate volcanic rocks are less abundant than the mafic rocks.

In most places, these rocks have been sufficiently metamorphosed and deformed to obliterate all original textures and structures. Intermediate metavolcanics can only be recognized as a lapilli-tuff at one place; namely, at the Canadian National railroad tracks south of the village of Skead. At all other locations, intermediate metavolcanics are dark grey or dark greenish grey, massive or less commonly schistose and fine grained. These features do not allow a more precise petrographic classification other than "mafic" or "intermediate metavolcanics". The rocks have been subjected to a regional metamorphism

Geology of the Lake Wanapitei Area

that ranges from greenschist to lower almandine-amphibolite facies rank. The higher metamorphic rank mafic metavolcanics commonly form, fine- to medium-grained, massive or weakly foliated amphibolites. These rocks consist of plagioclase (An 30 ± 5), green hornblende, minor quartz, and accessory apatite and opaque minerals. In the greenschist facies metavolcanics, plagioclase is completely altered to saussurite, and the pyroxene is altered to actinolitic hornblende. Leucoxene, chlorite, opaque minerals, a little carbonate and quartz also occur in these rocks.

H.D. Meyn (1970, p.6) described poorly banded mafic to intermediate metavolcanics from southeastern Parkin Township which form a part of the current map-area. He classified the banded rocks as probably pyroclastic in origin. These rocks contain small light grey-yellow felsic fragments set in a dark green mafic matrix. Due to structural deformation, these fragments appear as lenses in the rock and vary in thickness from 3 mm to 2.5 cm, and in length from 2.5 cm to 7.5 cm.

A chemical analysis of a mafic metavolcanic (Sample 76G10B; see Figure 27) from south of Skead, just north of the Canadian National railroad tracks is listed as follows:

SiO₂ (55.5) Al₂O₃ (16.9) Fe₂O₃ total (14.7) MgO (3.21) CaO (2.82) Na₂O (3.59) K₂O (1.42) TiO₂ (0.94) P₂O₅ (0.16) MnO (0.17) CO₂ (0.10) S (0.02).

Dacite

A rock classified in the field as dacite by the field party is exposed between Blue Lake and Capre Lake. Dacite forms the base of a steep outcrop, and is in contact with granitic rocks which occur above it. In the same outcrop, mafic metavolcanics are also exposed, and the granite possibly was intruded along the mafic volcanic-dacite contact.

In thin section, the rock consists of recrystallized plagioclase (An₄₀₋₄₅), quartz, actinolite-tremolite, apatite, chlorite, and epidote. Some original plagioclase phenocrysts and parts of the former fine-grained rock matrix are not recrystallized and consist of fine-grained chlorite, epidote, and albite. Actinolite-tremolite makes up an estimated 2 to 3 percent of the rock and forms small, thin, commonly bent needles or larger hypidiomorphic laths which are up to 1 by 3 mm in size and which in places contain small relicts of an almost colourless clinopyroxene. Small carbonate inclusions were also observed in the actinolite-tremolite. Apatite forms hypidiomorphic crystals up to 0.2 by 0.5 mm in size and makes up an estimated 0.5 to 1.0 percent of the rock. Quartz fills the space between plagioclase crystals.

A chemical analysis of a sample of dacite (Sample number 63G17B; see Figure 27) is as follows:

SiO₂ (54.40) Al₂O₃ (22.70) Fe₂O₃ total (1.28) MgO (5.87) CaO (7.58) Na₂O (4.94) K₂O (0.36) TiO₂ (0.59) P₂O₅ (0.39) MnO (0.02) Loss on ignition (7.10).

In T.N. Irvine and W.R.A. Baragar's (1971) chemical classification of volcanic rocks, the rock classified as dacite in the field is andesitic; in L.S. Jensen's (1976) classification, the rock is a calc-alkalic dacite.

FELSIC METAVOLCANICS

Felsic metavolcanics were observed in northeastern Norman Township, and in the southeastern part of Parkin Township where they were mapped by Meyn (1970). The following petrographic descriptions, are mainly based on Meyn's observations. Additional observations were obtained by the author during the field season and from the study of about 15 thin sections of felsic metavolcanics most of which were provided by H.D. Meyn, Geologist, Ontario Geological Survey.

Meyn (1970) subdivided his map-unit "Felsic Metavolcanics" into flows and fragmental rocks. Pyroclastic rocks, however, were not observed by Meyn in the very southeastern corner of Parkin Township forming part of the current map-area. Also, in northeastern Norman Township, only felsic flows were observed by the author and his field assistants during the current investigations.

The felsic flows are very fine grained and weather light grey to pinkish grey. In thin section these flows are seen to be composed of quartz, plagioclase (An_{25±5}), microcline, biotite, muscovite, and a small amount of opaque minerals. Spene, tourmaline, chlorite, and carbonate were also observed in minor amounts. Porphyritic flows are scarce, and contain idiomorphic plagioclase phenocrysts (An_{25±5}) and corroded quartz grains in a very fine grained rhyolitic matrix. Plagioclase phenocrysts range in maximum dimension from about 0.2 to 1.5 mm, the quartz grains from 0.3 to 2.0 mm.

Metasediments

Early Precambrian metasediments occur west of Lake Wanapitei and south of the village of Skead. These rocks were classified as Early Precambrian because of the following: they appear to be more strongly metamorphosed than the Huronian rocks, in places these rocks are clearly foliated, and in a few places they are cut by diabase dikes and glomeroporphyritic diabase dikes. Huronian sedimentary rocks near Skead do not contain metamorphic biotite as do the Early Precambrian sedimentary rocks and are not foliated. Post-Huronian glomeroporphyritic diabase dikes, to the author's knowledge, were not reported from anywhere in the Sudbury-Cobalt area. The author considered classifying the metasediments that occur just west of Lake Wanapitei and near Skead as belonging to the McKim Formation because the lithologies in question resemble the McKim Formation lithologic descriptions of K.D. Card *et al.* (1977). No other characteristics besides the lithological similarities, however, would support a classification of the rocks as being part of the Huronian Supergroup.

The most common Early Precambrian metasediment is a fine-grained, grey to greenish grey wacke. In a few places it is laminated. Near the village of Skead arkose beds are as much as 1.5 m thick, but commonly are only 5 to 20 cm thick. These rocks are not common. The arkose is medium grained, pinkish grey, and weathers pink. No sedimentary features such as lamination and crossbedding were observed in the arkose.

In thin section, the wackes are revealed to be weakly recrystallized, showing angular to granular quartz and feldspar grains and biotite arranged in an

Geology of the Lake Wanapitei Area

TABLE 2 | MODAL ANALYSES IN VOLUME PERCENT OF EARLY PRECAMBRIAN METASEDIMENTS, WANAPITEI LAKE AREA.

Specimen Number	40G12	53G7	62G3	35G4
Quartz	24.0	31.3	41.0	17.8
Plagioclase	42.2	40.0	7.7	16.4
Biotite	4.2	28.4		
Muscovite			1.1	39.4
Chlorite	25.3		45.4	19.7
Epidote	4.0	tr	3.6	
Apatite	tr	tr		
Leucoxene	tr			4.1
Opaque minerals	0.4	0.3	1.3	2.6
Field name	Wacke	Quartz-rich silt-stone	Wacke	Wacke

Abbreviations
tr — trace amounts

open to closed fabric. Other minerals observed in wacke are epidote, chlorite, apatite, muscovite, leucoxene, and opaque minerals. The biotite is partly or completely chloritized. Epidote is zoned. The centre of epidote is brownish and possibly radioactive; the rims are pale greenish, almost colourless.

Quartz siltstone is less common than wacke; all transitions take place between wacke and quartz siltstone. Siltstone is a grey, massive looking sedimentary rock. A faint lamination is present in places. No other sedimentary features were observed.

In thin section, these rocks contain an estimated 5 to 25 percent metamorphic biotite set in a granoblastic groundmass of quartz and plagioclase. Quartz siltstone and silty arkose appear to be present.

No attempt has been made here to classify the Early Precambrian metasediments by the modal analysis of a large number of thin sections (Table 2). The classification of the rocks as wacke and quartz siltstone, therefore, is based mainly on macroscopic features.

Ironstone and Ferruginous Chert

Ironstone was observed in the map-area only northwest of Lake Wanapitei, in northwestern Rathbun Township, northeastern Norman Township, and southeastern Parkin Township. Thin ironstone laminae are interlayered with light grey to black ferruginous chert or jasper and comprise units of "Algoma Type Iron-Formations" (Gross 1965). These rocks do not exhibit any features characteristic of "Superior-Type Iron-Formations" (Gross 1965) such as gran-

ules, intraclasts, oolites, oncolites, and stromatolites. Ironstones in rock associations of typical Algoma type Iron Formation are associated with volcanic rocks, wackes, or slates (Gross 1965).

In the current map-area, the ironstones are associated with mafic metavolcanics and form the southeastern end of a long northwesterly trending zone of a metavolcanic-ironstone assemblage that can be traced through Parkin, Hutton, Kitchener, Roberts, Emo, Rhodes, and Botha Townships (*see*: Card and Meyn 1969; Dressler 1980; Meyn 1970 and 1971). At the Moose Mountain Mine in Hutton Township, iron ore mining has proceeded with interruptions since 1908.

In the current map-area, the ironstones consist of quartz, magnetite, hematite, carbonate, minnesotaite, and stilpnomelane. Quartz is recrystallized, polygonal, and ranges from about 0.007 mm to 0.07 mm maximum dimension. Magnetite is also recrystallized, is commonly hypidiomorphic, and makes up an estimated 25 percent of the ironstone. The rocks, however, commonly are rather poor in iron and could be called "ferruginous chert". Hematite occurs as a very fine dust within quartz grains and causes the brick red colour of the jasper interbands. The carbonate is siderite. In a few interbands siderite makes up an estimated 5 percent of the rock. Minnesotaite and stilpnomelane form only traces in the rock.

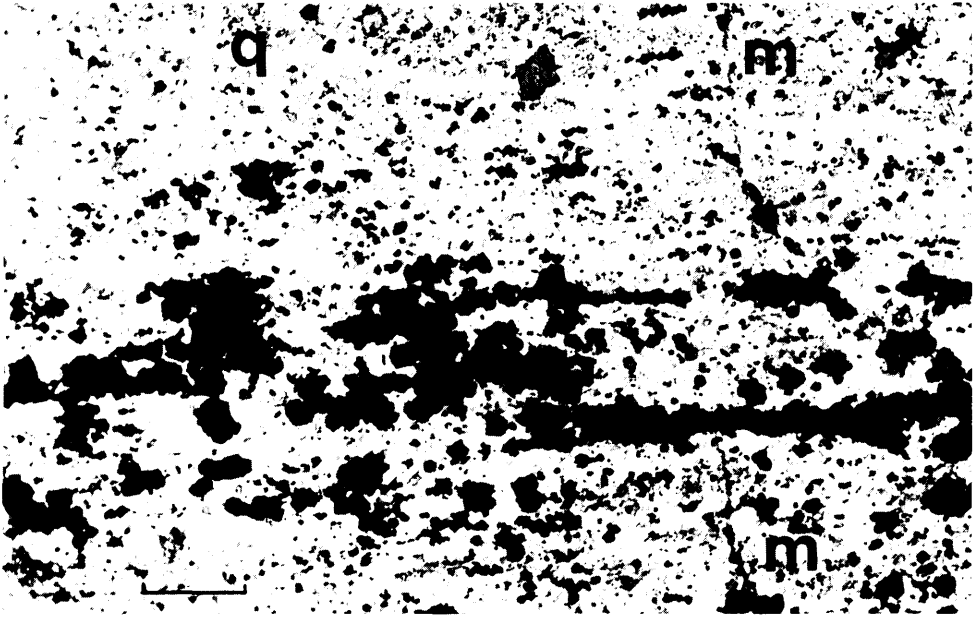
Within the long northwesterly trending zone of metavolcanics and ironstones, the ironstones probably were iron-rich in one place, and iron-poor in another. This difference reflects variations present from the time of sedimentation. Diagenetic or low grade metamorphic processes such as the migration of quartz and iron, however, may have played an important role in enriching or depleting the ores. Diagenetic features, illustrated in Photo 1, show quartz and iron oxides migrating oblique to the banding of the ironstone.

Gneiss

The Early Precambrian wacke, arkose, and siltstone metasediments are mainly exposed near the western edge of Lake Wanapitei. Gneisses are exposed west of these generally trending north-south metasediments. The gneiss does not appear to have a definite trend in the direction of strike. The rock is commonly somewhat migmatized and is exposed closer to the Nickel Irruptive than the other metasediments and is therefore brecciated in places. For these reasons, the author could not prove that gneiss in the west is a higher rank metamorphic equivalent of the metasediments in the east, or that the gneiss is older and was metamorphosed before the metasediments were deposited.

The gneiss varies from being fine to medium grained and varies from pinkish grey to grey and dark grey. The gneiss is thinly banded, laminated, or is more or less homogeneous. *Lit-par-lit* mobilizate or patches or dikes of granitic mobilizate are common and most abundant near granitic bodies where the gneiss grades into migmatites.

In thin section, the rock is seen to consist of plagioclase (An_{20-30}), quartz, biotite, garnet, hornblende, apatite, and opaque minerals. Garnet and hornblende were observed only in a few places. A diaphthoritic alteration is indi-



OGS 10 311

Photo 1—Cherty ironstone. Note migration of quartz (q) and magnetite (m). Northwestern Rathbun Township. Scale 0.3 mm. Plane polarized light.

cated by the presence of chlorite, epidote, and sericite. The epidote and sericite replace plagioclase. Two chlorites were observed in thin section. One type is common light greenish chlorite showing the characteristic anomalous brownish birefringence of a magnesium-iron chlorite and the other type is isotropic between crossed polarizers. The first type replaces biotite; the second isotropic type, probably a Fe-ripidolite, replaces garnet.

The gneiss is panxenomorphic and granoblastic. Recrystallized biotite forms an open or closed fabric depending on the amount of biotite present.

FELSIC PLUTONIC ROCKS AND MIGMATITES

Granitic Rocks

Early Precambrian granitic rocks are exposed¹ in the southwestern part of the map-area, and were emplaced about 2500 m.y. or more ago (Van Schmus

¹The granitic rocks near Skead and Bowlands Bay are possibly post-Nipissing and of the same age as the Murray and Creighton granites near Sudbury.

TABLE 3 | MODAL ANALYSES IN VOLUME PERCENT OF EARLY
PRECAMBRIAN GRANITIC ROCKS, WANAPITEI LAKE AREA.

Specimen Number	53G1	62G2	81G2	81G3	75G2	40G9B	49G9
Quartz	30.7	25.4	5.9	21.4	30.4	35.5	<1.0
Microcline	11.2	20.4		12.0	20.9	43.1	
Plagioclase	57.5	50.8	64.2	65.2	46.7	15.7	43.5
Anorthite	An25-	An25-	An30±	An25-	An25-	An25±	saus-
content	30	30	5	28	30	5	surite
Epidote			1.2				10.9
Biotite						5.7	
Muscovite	0.2						
Chlorite	0.2	2.6	1.2	0.2	1.5		
Hornblende			23.6				44.0
Apatite	tr	tr					tr
Zircon				tr			
Opaque minerals	0.2	0.8	3.9	1.2	0.5		0.6
IUGS classification (after Streckeisen 1974)	Grano- diorite	Grano- diorite	Diorite	Grano- diorite	Grano- diorite	Granite	Diorite

Abbreviation
tr — trace amount

1965). These rocks and the Early Precambrian metasediments, metavolcanics, and diabase constitute the basement on which the supracrustal rocks of the Huronian Supergroup were deposited. The granitic rocks are younger than the metasediments and metavolcanics. Inclusions of these rocks are contained in the granitic rocks. Nebulitic relicts of almost completely assimilated inclusions within the granitic rocks were noted in a few places. In other places, the inclusions exhibit sharp contacts with the granites. Gradations from granitic rocks into migmatites are common. Larger masses of more or less homogeneous "granites" are exposed in only one place, in northeastern Norman Township. All these observations suggest an anatectic origin for the granitic rocks of the current map-area.

The granitic rocks are medium to coarse grained and commonly are equigranular. The rocks vary from red through pink to pinkish grey due to various degrees of rock alteration. Strongly altered "granite" appears to contain more fine, dustlike hematite staining altered feldspar. Gneissic granitic rocks also occur, but are not common.

In thin section, the rocks exhibit an igneous texture. Quartz, plagioclase (An_{25±5}), microcline, chloritized biotite, muscovite, epidote, and opaque minerals are the major rock forming components. Greenish hornblende is present in a few sections. Accessory minerals are apatite and zircon. Several modal analyses are presented in Table 3. The rocks are granodiorite and diorite according to the IUGS classification of plutonic rocks (Streckeisen 1974, 1976).

Migmatites

A migmatite (Mehnert 1971, p.355) is a "megascopically composite rock consisting of two or more petrographically different parts, one is the country rock in a more or less metamorphic stage, the other is of pegmatitic, aplitic, granitic, or generally plutonic appearance". In the map-area, rocks containing more than 40-50 percent mobilizate were mapped as migmatites.

Mobilizates in the map-area have a granitic to granodioritic modal composition. The mobilizates are medium grained, coarse grained, or pegmatitic, and range from red to pink and white. *Lit-par-lit* mobilizate exudations, patchy, dike-like, and schlieric mobilizates were observed. Ptygmatic structures are common. Mobilizate masses larger than these bodies contain appreciable amounts of country rocks, which are mainly biotite-plagioclase gneisses, in the form of sharply defined rafts to nebulitic schlieren.

The migmatization is older than the intrusion of the Early Precambrian diabase dikes. The diabases show sharp contacts with the migmatites and were not affected by the mobilization.

MAFIC INTRUSIVE ROCKS

Three types of post-granitic, mafic dike rocks occur in the area west and south of Lake Wanapitei underlain by Early Precambrian basement rocks. The most common type is fine- to medium-grained diabase. Glomeroporphyritic diabase dikes, the second type, are scarce. The third type consists of porphyritic diabase dikelets, composed of mafic intrusive dike rock, and have been observed at only two localities.

Diabase

Many diabase dikes intrude the Early Precambrian granitic and older rocks. These rocks do not intrude the supracrustal rocks of the Huronian Supergroup, and are therefore considered to be Early Precambrian in age. The dikes are some decimetres to several metres thick. They strike northwest, northeast, north, and in many other directions. The most prominent strike direction in the map-area, however, is northwest. An intense megabrecciation close to the Sudbury Structure is possibly responsible for the great variety of strike directions. The dikes cannot be traced for long distances along strike. The dikes commonly dip steeply and intrude along pre-existing faults and joints.

Diabase is a fine- to medium-grained, dark greenish grey rock. Examination of thin sections reveal diabase shows the normal greenschist facies mineralogy of mafic rocks; saussuritized plagioclase, actinolite, chloritized pyroxene, and leucoxene. Opaque minerals and carbonate are present in minor amounts.

Glomeroporphyritic Diabase

Less than 5 percent of the Early Precambrian diabase dikes are glomeroporphyritic; the rocks are porphyritic showing plagioclase phenocrysts gathered into distinct clusters. The glomeroporphyritic diabases form dikes that are up to 8 m thick, and commonly only 1 to 3 m thick.

The plagioclase clusters are up to 5 cm in diameter, individual hypidiomorphic crystals are as much as 1.5 cm long. The groundmass in which the clusters are embedded are fine grained and dark greenish grey.

Plagioclase phenocrysts are completely replaced by epidote and a little chlorite. The groundmass is made up of small saussuritized plagioclase laths, actinolite, chlorite, opaque minerals, leucoxene, and a very small amount of quartz. Actinolite probably replaced pyroxene and forms together with the saussuritized plagioclase, a subophitic rock texture.

Porphyritic Diabase

Fine-grained to aphanitic, dark grey, and porphyritic diabase forms thin dikes and are exposed at two locations in the southwestern part of the map-area. One occurrence is on the western shore of Bowland's Bay of Lake Wanapitei, the other is 1.2 km north of the Canadian National railroad tracks on the road that leads to the Nickel Rim Mine.

The dikes are a few cm to about 30 cm thick and show idiomorphic plagioclase phenocrysts in the centre of the dikes up to 1.5 cm by 2 cm in length. At the Bowland's Bay occurrence, one dike appears to intrude another (Photo 2). At both occurrences, the dikes do not appear to be affected by the Sudbury-type brecciation which is obvious throughout the area.

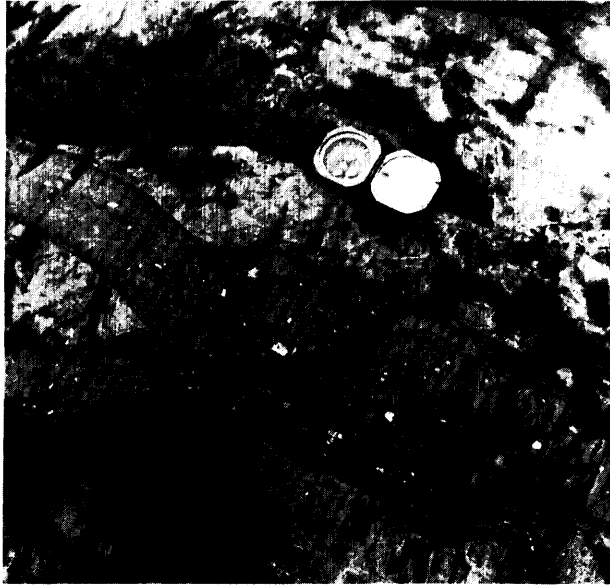
In thin section, the rocks appear to consist of small, about 0.02 to 0.5 mm in length, completely saussuritized plagioclase laths set in a very fine grained groundmass of dust-like iron oxide and actinolitic hornblende pseudomorphs which were probably clinopyroxene. The plagioclase phenocrysts (An₅₀₋₅) are also almost completely saussuritized.

A chemical analysis of Specimen 57G29A (see Figure 27) is presented:

SiO₂ (46.20) Al₂O₃ (16.90) Fe₂O₃ (4.90) FeO (9.68) MgO (3.69) CaO (6.32) Na₂O (3.51) K₂O (2.68) TiO₂ (2.30) P₂O₅ (1.10) MnO (0.22) H₂O⁺ (2.11) H₂O⁻ (0.58) CO₂ (0.29) S (0.23).

The classification of the dike rocks as diabase is based on this chemical analysis.

J.E. Thomson (1961, p.26) described diabase dikes that cut the ore bodies of the Nickel Rim Mine. Some of these dikes have large feldspar phenocrysts. The porphyritic dikes herein classified as Early Precambrian, are possibly of the same kind as the dikes described by Thomson. Such dikes are probably younger than the Nickel Irruptive.



OGS 10 312

Photo 2—Porphyritic diabase. Western shore of Bowlands Bay.

Middle Precambrian

HURONIAN SUPERGROUP

The rocks of the Huronian Supergroup were deposited between 2500 m.y. ago, the age of the Early Precambrian felsic plutonic rocks, and 2160 m.y. ago, the age of the Nipissing Intrusions. The Huronian Supergroup consists of clastic sedimentary rocks namely wackes, arenites, and arkoses, and minor carbonate-bearing rocks. The clastic material was derived from the granitic terrane to the north. Volcanic rocks are known to occur in the lower Huronian succession south and west of Sudbury, but appear to be absent in the map-area.

Hough Lake Group

The Mississagi Formation of the Hough Lake Group only is exposed in the map-area. The Ramsay Lake and Pecors Formations appear to be absent.

MISSISSAGI FORMATION

The Mississagi Formation (Winchell 1888) is the oldest formation of the Huronian Supergroup in the map-area. It overlies the Early Precambrian basement rocks west of Massey Bay, Lake Wanapitei. At Ashigami Lake, Scadding Township, the formation is overlain by pebbly wacke and paraconglomerate of the Bruce Formation.

The Mississagi Formation is a thick unit. A reliable estimate of the thickness, however, is not possible in the map-area because of discontinuous outcrop and faulting in critical areas. Southwest of Sudbury, K.D. Card *et al.* (1977), stated that the formation is approximately 760 to 900 m thick. An estimated minimum thickness of the formation in the map-area, based on the more extensive outcrop areas from Howie Island to Redrock Point of Lake Wanapitei, is 1050 m. This assumes an average dip of 55° and that no fault occurs between the mainland and Howie Island.

In the map-area, the Mississagi Formation is composed of units of arkose, and subarkose with a minor amount of conglomerate and wacke. P.A. Palonen (1971) and Card *et al.* (1977) described the formation as a sequence of coarsening upward sedimentary cycles consisting mainly of sandstone and subordinate siltstone. Individual cycles are lensoid and vary in thickness from 3 m to 76 m (Card *et al.* 1977). The limited information available from the map-area suggests the presence of coarsening upward and fining upward sedimentary cycles.

Conglomerates of the Mississagi Formation in the map-area are clast- or matrix-supported quartz-pebble conglomerates (Photo 3). Polymictic conglomerate also occurs, but is not common. Conglomerate occurs at Massey Bay of Lake Wanapitei, east of the Village of Skead, and south of Ashigami Lake in Scadding Township.

The pebbles in the conglomerate range in maximum dimension from 0.5 cm to about 5 cm and are set in a medium-grained arkosic matrix or in a wacke matrix. The matrix commonly is pyritiferous, and, in places is radioactive. Pyrite appears to be finely disseminated or mantles quartz pebbles. The conglomerate beds are up to 2 m thick and are interbedded with silty wacke or arkosic sandstone.

Sandstones form most of the Mississagi Formation, and are exposed mainly south of Ashigami Lake, in Scadding Township, and at Massey Bay, Lake Wanapitei. These rocks commonly are grey on fresh and weathered surfaces. Pink, buff or red varieties are subordinate in amount. In the triangular diagram (Figure 2) the modal analyses (Table 4) of 13 randomly selected specimens are shown. Opaque minerals can constitute as much as 10 percent of the rock and mainly consist of pyrite. The matrix is dominated by chlorite and sericite. Isolated quartz or granite pebbles up to 5 cm in maximum dimensions were observed in the sandstones in a few places.

Sedimentary structures of the sandstones are; bedding, crossbedding, ripple-marks and grading. Individual beds and crossbeds are commonly 0.3 m to 2 m thick. Ripple marks have wavelengths which vary from 3 cm to about 10 cm and have amplitudes of up to 3 cm.

Interbeds of grey to greenish grey wacke within the sandstone are 2 cm to 30 m thick. Wacke beds up to about 1 m thick were also observed in the conglomerate. Wacke is finely laminated or massive and in a few places contains



OGS 10 313

Photo 3—Quartz-pebble conglomerate. Mississagi Formation. Massey Bay.

subangular to rounded granite or quartz fragments as much as 5 cm in size. Thick beds of wacke may contain interbeds of medium-grained arkose.

The metasediments of the Mississagi Formation are; arkose, subarkose, arkosic wacke, subarkosic wacke, and lithwacke (Young 1967; Casshyap 1971).

Quirke Lake Group

The Quirke Lake Group consists of the Bruce Formation, Espanola Formation, and Serpent Formation. The contact with the underlying rocks of the Hough Lake Group appears to be conformable and abrupt. The contact with the overlying Cobalt Group is a tectonic unconformity in one place and conformable in another.

BRUCE FORMATION

The Bruce Formation (Collins 1914b) is exposed in Scadding, MacLennan, Rathbun, and Aylmer Townships; however, only in Scadding Township does it underlie large areas. In most places, the formation appears to conformably

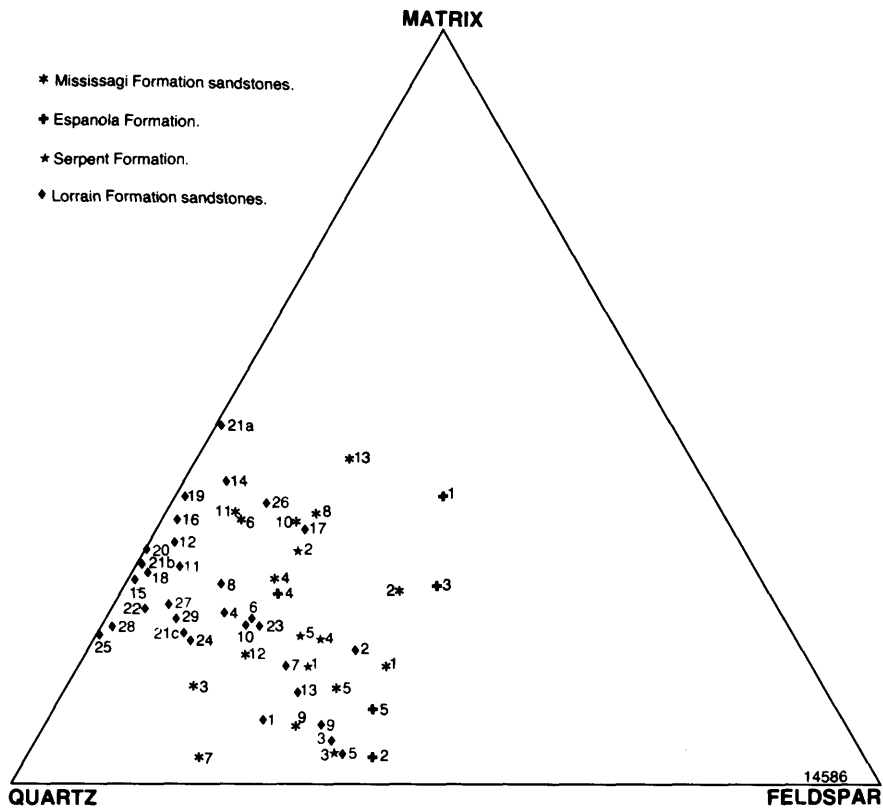


Figure 2—Mineralogical composition of rocks in the Mississagi, Serpent, and Lorrain Formations.

overlie the rocks of the Mississagi Formation, and is in turn conformably overlain by calcareous sedimentary rocks of the Espanola Formation.

Southwest of Sudbury, the formation varies in thickness from a few metres to as much as 460 m (Card *et al.* 1977), and between Sault Ste. Marie and Blind River (Frarey 1977) it is 15 m to 100 m thick. At Ashigami Lake in the map-area, the Bruce Formation is approximately 200 m thick. Reliable estimates of the formation's thickness cannot be made in other parts of the map-area.

The Bruce Formation is made up almost completely of paraconglomerate and pebbly wacke. Granitic clasts predominate in these rocks. Metasedimentary, metavolcanic, gabbroic, and quartzite fragments also occur, but are not very common. Most clasts are in the pebble to cobble size range, but boulder size clasts up to 40 cm in diameter and granules 2 to 4 mm in diameter were also observed. Pebble size fragments are the most common. The clasts are subangular to rounded. Very small clasts are commonly angular.

The matrix of the paraconglomerate is a very fine grained, dark grey or black wacke or a fine- to medium-grained, grey or greenish grey arkosic wacke. The matrix consists of very fine grained chlorite, sericite, and epidote and a

TABLE 4 MODAL ANALYSES OF SANDSTONES, MISSISSAGI FORMATION, WANAPITEI LAKE AREA.

Specimen Number	20E13	74E15A	74E15B	4G6	4G12	7G7	15G5	26G6	35G1A	35G1B	39G14	58G7	59G1	81G6
Number on Figure 2	3	1	2	13	12	11		10	9	8	5	4	6	7
Quartz	72.1	48.8	42.4	39.4	64.6	56.9	17.3	50.2	63.0	47.0	55.8	56.0	56.0	76.0
Feldspar	15.0	36.7	32.4	17.3	18.4	8.2		15.8	29.3	17.5	31.4	17.0	8.3	20.3
Matrix	12.9	14.5	25.2	43.3	17.0	34.9	59.8	34.0	7.6	35.5	12.8	27.0	34.7	3.7
Biotite					7.1	6.7		5.1						
Sericite	0.2													
Chlorite											0.4			
Carbonate														
Magnetite														
Pyrite	1.2	0.1								9.9	0.4		1.0	
Rock fragments							22.9							
Classification	Sub-arkose	Arkose	Arkosic wacke	Sub-arkosic wacke	Sub-arkosic wacke	Sub-arkosic wacke	Lith-wacke	Sub-arkosic wacke	Arkose	Sub-arkosic wacke	Arkose	Sub-arkosic wacke	Sub-arkosic wacke	Sub-arkosic wacke

fine-grained fraction of quartz and feldspar. In places it is calcareous. Pyrite and iron oxides are commonly present and give rise to the rusty weathering characteristic of the rock. Just south of the first rapids of the Wanapitei River, about 1.3 km downriver from the Wanapitei dam, the paraconglomerate matrix is rich (± 10 percent) in metamorphic biotite.

Near the base of the Bruce Formation, close to western Ashigami Lake, the formation contains interbeds of arkose. The arkose beds are up to 5 m thick, fine grained, and pink.

The Bruce Formation paraconglomerate resembles the paraconglomerate of the Gowganda Formation. A glacial origin for the rocks of the Bruce Formation has been discussed by several authors; such as Collins (1925), Young and Chandler (1968), and Frarey and Roscoe (1970).

ESPANOLA FORMATION

The Espanola Formation was formally introduced by Collins in 1925 and includes the Bruce limestone (Winchell 1888), Espanola greywacke, and Espanola limestone (Collins 1913b). Between Sault Ste. Marie and Blind River, the formation is between 160 and 200 m thick (Frarey 1977). Southwest of Sudbury, Card *et al.* (1977) described the lowest member of the Espanola Formation as an interbedded sequence of limestone, dolostone, calcareous siltstone, and sandstone having a thickness of 15 to 30 m. The second member according to Card *et al.* (1977) consists of interbedded calcareous and non-calcareous siltstone and greywacke, dolostone, limestone, and quartz arenite 120 to 300 m in thickness, and a third member of calcareous and non-calcareous quartz arenite having interbeds of siltstone and greywacke. This third member varies from 60 to 200 m in thickness.

In the map-area, rocks of the Espanola Formation are exposed in Aylmer, Maclellan, Rathbun, and Scadding Townships. In northern Aylmer Township, the formation is at least 250 m thick. At Ashigami Lake in Scadding Township, the formation is as much as 100 m thick. Elsewhere in the map-area folding, faulting, and lack of outcrop do not allow reliable estimates to be made of the thickness. The attempt to subdivide the formation into various members turned out to be impossible for the same reasons.

The most common rocks of the Espanola Formation are calcareous siltstone, limestone, and calcareous wacke. The central thick sandstone member (Card 1978a) of the Sudbury-Manitoulin area appears to be absent in the map-area.

In Hutton and Parkin Townships, Meyn (1970) described an upper Espanola Formation member consisting of "fine-grained siltstone to sandstone with greywacke composition". This member appears to be absent from the map-area.

Rocks of the Espanola Formation are characterized by alternating layers of grey, buff or white, in places, dark brown weathering limestone and dark grey calcareous siltstone and calcareous wacke. The limestone beds weather more rapidly than the other rocks, and the siltstone and wacke form ridges. The differential weathering and the strong colour contrast between beds make the Espanola Formation an excellent marker horizon.

Geology of the Lake Wanapitei Area

The thickness of the limestone interbeds ranges from a few mm to about 1.5 m. The limestone appears to be fine grained and homogeneous, or it can exhibit a fine parallel lamination. Minor amounts of quartz, feldspar, and iron oxides are present in places.

The calcareous siltstone and wacke beds (Table 5, and Figure 2) range in thickness from a few mm to about 50 cm, and are rarely as thick as 1 or 2 m. The siltstone is homogeneous and can have a fine internal lamination similar to the limestone. It is composed of angular quartz and feldspar set in a matrix of chlorite, mica, and carbonate.

The wacke beds are less common than the siltstone interbeds. The wacke beds are dark grey-green and commonly are very fine grained. In places, these rocks are composed mainly of chlorite and mica with a minor, very fine grained fraction of quartz and feldspar, and could be termed "argillite".

In southern Scadding Township, about 0.5 km east of the Wanapitei River and 1.75 km north of the southern limit of the map-area, rocks of the Espanola Formation appear to be weakly metamorphosed. This is indicated by the presence of scapolite and biotite-phlogopite in the limestone. Scapolite is up to 1 by 4 mm in size, idiomorphic, and poikiloblastic containing inclusions of feldspar, quartz, carbonate, and biotite-phlogopite. The latter mineral makes up an estimated 5 percent of the matrix and grains are up to 0.1 by 0.3 mm in size.

Also near the outlet of Lake Wanapitei, Espanola Formation rocks are weakly metamorphosed. Limestone is recrystallized and wacke exhibits metamorphic minerals such as albite, actinolite-tremolite, and epidote. Here, the metamorphism is caused by the intrusion of a Nipissing gabbro body.

SERPENT FORMATION

In the northern part of the map-area, rocks of the Serpent Formation (Collins 1913b) are exposed just east of the Wanapitei River. In the south, these rocks underlie a large area in central Scadding Township, and extend from just west of Ashigami Lake, Scadding Township, to Wanapitei Island in Maclellan Township.

In the map-area, the Serpent Formation consists of arkose that is calcareous in a few places and also contains subordinate amounts of wacke. A small amount of conglomeratic rocks were observed in the map-area.

The classification of the arkose and wacke as Serpent Formation is based on stratigraphic-structural evidence and on diamond-drill records by Gulf Minerals Canada Limited and D.R. Watt. In northern Aylmer Township, the formation overlies Espanola Formation limestone, and is in turn overlain by typical Gowganda Formation rocks. Also in central Scadding Township, structural evidence indicates that the arkose is part of the Serpent Formation. This is substantiated by diamond-drill records by Gulf Minerals Canada Limited and D.R. Watt. Their results show that the arkose is underlain by Espanola Formation limestone.

In northern Aylmer Township, the formation is approximately 380 m thick. In Scadding Township, it is at least 60 m thick, and is very probably much thicker than this.

TABLE 5 | MODAL ANALYSES IN VOLUME PERCENT OF SEDIMENTARY ROCKS, ESPANOLA AND SERPENT FORMATIONS, WANAPITEI LAKE AREA.

Specimen Number	Espanola Formation					Serpent Formation				
	17E7	17E8	29E4	6G3B	6G4	6F7	4G22	6G5	6G24	29G15B
Number in Figure 3	1	2	3	4	5	1	2	3	4	5
Quartz	32.0	57.0	38.9	56.9	53.9	58.4	52.3	61.5	55.6	57.4
Feldspar	30.5	39.1	35.8	18.6	36.6	25.5	17.6	34.1	25.5	23.2
Matrix	37.5	3.9	25.3	24.5	9.5	15.2	30.1	4.4	18.9	19.4
Biotite				0.5			7.0		tr	7.6
Sericite							0.5			
Chlorite	7.7	0.4		6.8		0.7	9.8			
Carbonate	tr	1.6	tr	10.1	0.7		1.8			
Opaque minerals	0.9	0.5	0.4	1.9						
Rock fragments						0.9				
Abbreviation										
tr — trace amounts										

Geology of the Lake Wanapitei Area

The dominant type of sandstone of the Serpent Formation is fine- to medium-grained, grey, pinkish, in a few places, red arkose. Bedding thickness ranges from less than 1 cm to over 6 m. Many beds are crossbedded, and have crossbeds as thick as 6 m.

In thin section, the arkose is revealed to be composed of 40 to 70 percent quartz, 25 to 40 percent feldspar, and 1 to 30 percent fine-grained sericitic matrix (Table 5 and Figure 2). Carbonate has been observed in only a few thin sections and never makes up more than 3 percent. Accessory detrital minerals are opaque minerals. Dolomite porphyroblasts up to 3 cm in size occur in the arkose close to the contact of the formation with the underlying rocks of the Espanola Formation (see Map 2451, back pocket).

The Serpent Formation arkosic wacke is a fine-grained grey rock, and forms interbeds within the arkoses that commonly are only a few cm thick. In diamond-drill records, Gulf Minerals Canada Limited reported wacke beds that are more than 1 m thick (Assessment Files Research Office, Ontario Geological Survey, Toronto).

The wackes contain quartz, feldspar, and minor rock fragments set in a chloritic-sericitic matrix.

Paraconglomerate beds are not common in the Serpent Formation of the map-area, and were observed only in the Southeast Bay of Lake Wanapitei. The beds consist of subrounded pebbles that are up to 5 cm in size and are set in a medium-grained arkose matrix. The pebbles consist of arkose, and small amounts of granite and quartz. The conglomeratic beds are up to about 20 cm thick.

The sandstones of the Serpent Formation are arkose, arkosic wacke, and calcareous arkose (Young 1967; Casshyap 1971).

Cobalt Group

The Cobalt Group (Miller and Knight 1906) consists of the Gowganda, Lorrain, Gordon Lake, and Bar River Formations. The two upper formations, the Gordon Lake and the Bar River, appear to be absent from the map-area. Nevertheless, the Cobalt Group is the thickest Huronian group in the area.

GOWGANDA FORMATION

The Gowganda Formation (Collins 1917) is the basal formation of the Cobalt Group and is a heterogeneous sequence of conglomerate, arkose, and wacke. It is a thick and extensive unit and is exposed from Sault Ste. Marie to the Cobalt area.

In the map-area, the formation covers a large amount of terrain extending from Ashigami Lake in Scadding Township to the northwestern and northeastern boundaries of the area. No contacts with underlying rocks have been observed in the area, but from strike and dip measurements in northern Aylmer Township, the formation appears to conformably overlie the Serpent Formation (see Figure 3). In central Scadding Township, where the Serpent and Gow-

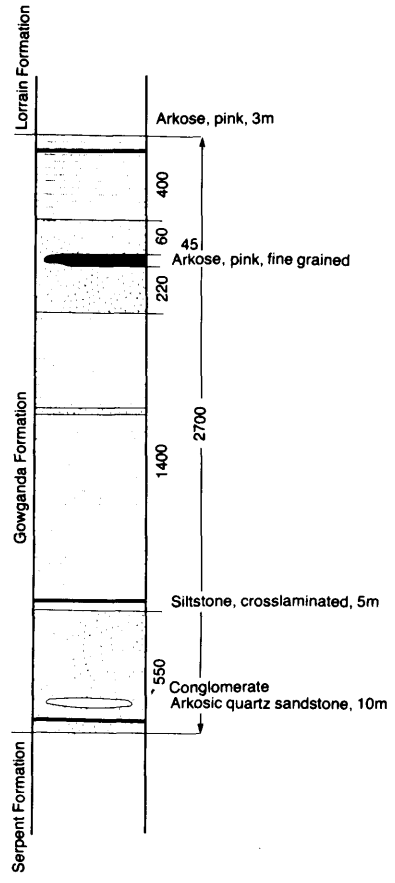
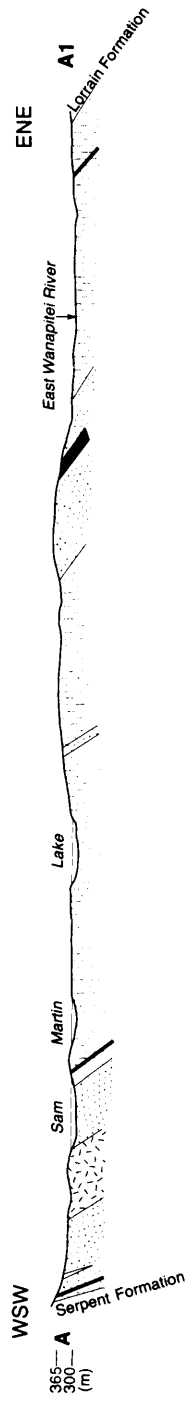


Figure 3—Cross-section and stratigraphic section. Gowganda Formation, Northern Aylmer Township.

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ganda Formations are exposed in close juxtaposition, the geological information is suggestive of a transgressional unconformity between the two formations. Post Huronian folding and faulting in this part of the map-area, however, make these observations inconclusive. The contact of the Gowganda Formation with the overlying Lorrain Formation appears to be conformable and rather abrupt.

In the Sudbury-Espanola area, Card *et al.* (1977) subdivided the Gowganda Formation into two units; a lower unit of cyclically repeated conglomeratic and pelitic members, and an upper unit of interbedded sandstone and pelitic rocks. Also, these two units were subdivided into a number of lithostratigraphic members. In the map-area, however, the stratigraphy of the Gowganda Formation is distinct from the one described by Card *et al.* (1977). Nevertheless, as in the Sudbury-Espanola area, the formation is characterized by vertical and lateral facies changes. Conglomerate and sandstone are not common in the map-area compared with the area southwest of Sudbury (Card *et al.* 1977). Figure 3 shows a section across the formation in northern Aylmer Township and a stratigraphic column derived from this section. The stratigraphy is similar to that described by Card *et al.* (1973) from the Maple Mountain area which lies north of the map-area. In the Maple Mountain area, these authors describe a lower conglomerate-mudstone-wacke and sandstone member and an upper argillite member comparable to the Gowganda Formation rocks of the map-area. However, in the Wanapitei Lake area only small amounts of conglomerate occur in the lower members. "Dropstones", as indicated in the stratigraphic column of Figure 3, are not very common.

The stratigraphic column of Figure 3 is not representative of the whole Gowganda Formation in the map-area. In detail, the stratigraphy differs a little from place to place. For instance, in eastern Mackelcan Township, massive wacke, not the laminated variety, forms the very top of the formation.

Petrography

Conglomerate

Paraconglomerates and orthoconglomerates occur here and there within the Gowganda Formation. These rocks are not very common and form discontinuous layers commonly up to about 10 m thick which occur mainly near the base of the formation. The only thicker conglomerate bed observed in the area is exposed just west of Rathbun Lake in Rathbun Township, and is possibly 50 to 100 m thick.

The clasts in paraconglomerates and orthoconglomerates range in size from smaller than 1 cm to about 50 cm. The clasts are angular to rounded and, in the following order of decreasing abundance, consist of granitic rocks, gabbroic rocks, quartzite, metasediments, and metavolcanics. The granitic clasts commonly make up more than 90 percent of the clasts present. No clast sorting has been observed. The matrix consists of a greenish grey wacke that is very similar to the ordinary massive Gowganda Formation wacke and consists of quartz, feldspars, rock fragments, chlorite, epidote, mica, and opaque minerals.

Sandstone

The Gowganda Formation sandstones are pink to grey, fine- to medium-grained arkose, and arkosic wacke. Bedding thicknesses average 1 to 50 cm, with crossbeds occurring here and there. The sandstone members commonly are only a few metres thick. The only thicker unit is exposed in northern Aylmer Township. It is approximately 45 m thick.

Petrographic study shows that the sandstones consist of; quartz, feldspar, a chloritic matrix, opaque minerals, and, in places, minor small amounts of rock fragments or carbonate. Feldspar is mainly plagioclase. The plagioclase, microcline ratio varies from 20:1 to 50:1.

Wacke

Two types of wacke occur in the area: these are; 1) a massive and 2) a laminated variety. In general, the massive variety appears to be more abundant in the lower part of the formation. Both rock types commonly are very fine grained and grey to greenish grey. The laminae are coloured in various shades of grey and green, rarely in shades of pink and dark grey. The varve-like laminae are continuous or discontinuous over the size of an outcrop.

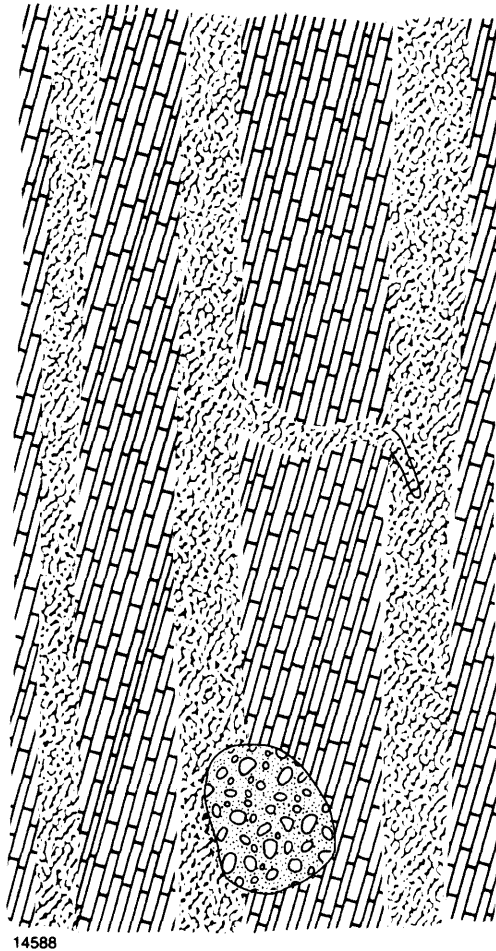
Rafted pebbles, cobbles, and boulders, called "dropstones", were observed in both types of wackes, but appear to be more abundant in the massive wackes. These "dropstones" are commonly subangular, but all shapes from angular to rounded were observed by the field party. Most clasts are granitic in composition, but other rock types, such as gabbros, metasediments and metavolcanics also occur in the map-area. The clast size ranges from a few mm to about 1 m.

Sedimentary features observed within the wacke units, besides the varve-like lamination and bedding that is commonly 20 cm to over 1 m thick in the massive wackes, are; ball and pillow structures, convolute lamination, graded lamination, cross-lamination and small clastic dikes (Figure 4).

In thin section, the wackes are seen to consist of angular to subrounded grains of quartz and feldspar ranging from less than 0.03 mm to about 0.5 mm in size. These grains are set in a very fine grained matrix of chlorite, epidote, opaque minerals, and, in a few places, of little carbonate. The lamination in the laminated wackes is caused by an interlayering of silty quartz- and feldspar-rich layers on a fine scale and an interlayering of argillitic beds rich in chlorite and mica on a yet finer scale.

Origin of the Gowganda Formation Sedimentary Rocks

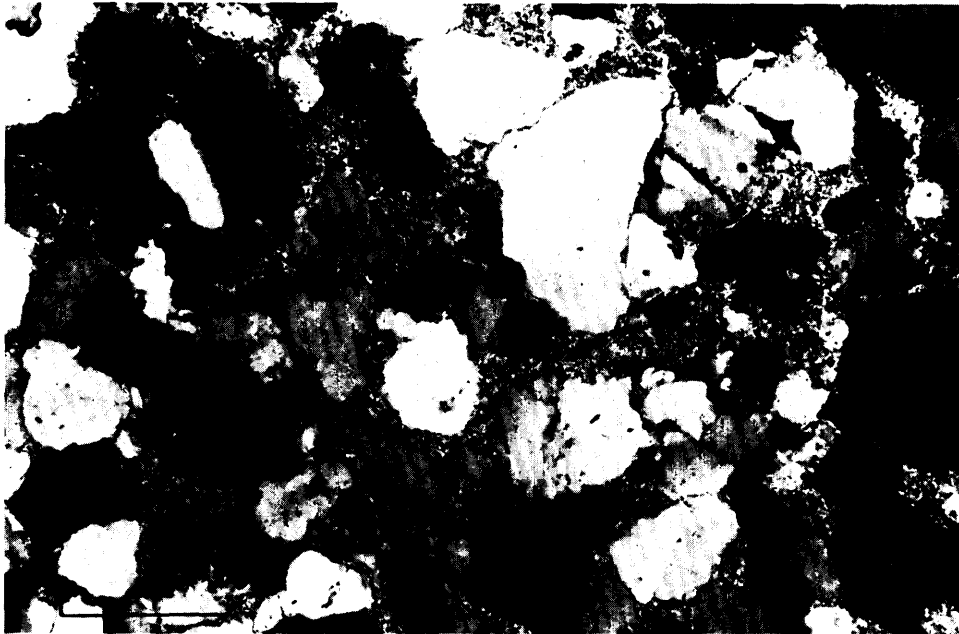
D.A. Lindsey (1969) and Card *et al.* (1973) studied the petrography and paleogeography of the rocks of the Gowganda Formation. Their studies indicated that the source of the Gowganda sedimentary rocks were the granites and greenstones north of the Cobalt region. Lindsey (1969) followed the lead of Collins (1917) and many others by classifying the rocks of the Gowganda Forma-



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Figure 4—Clastic dike in Gowganda Formation wacke. Scadding Township.

tion as glacial sediments. Card *et al.* (1973) stated that not all sedimentary features can be explained by glaciation. These authors postulated that the rocks were derived from Early Precambrian rocks under vigorous climatic conditions, and were deposited by south-flowing depositional media. They believed that glaciation was the main process of sediment transportation and deposition, whereas turbidity currents, slumping, and erosion along fault scarps, however, played a less widespread role. The sediments were possibly deposited in a transitional zone between glacial continental and marine conditions.



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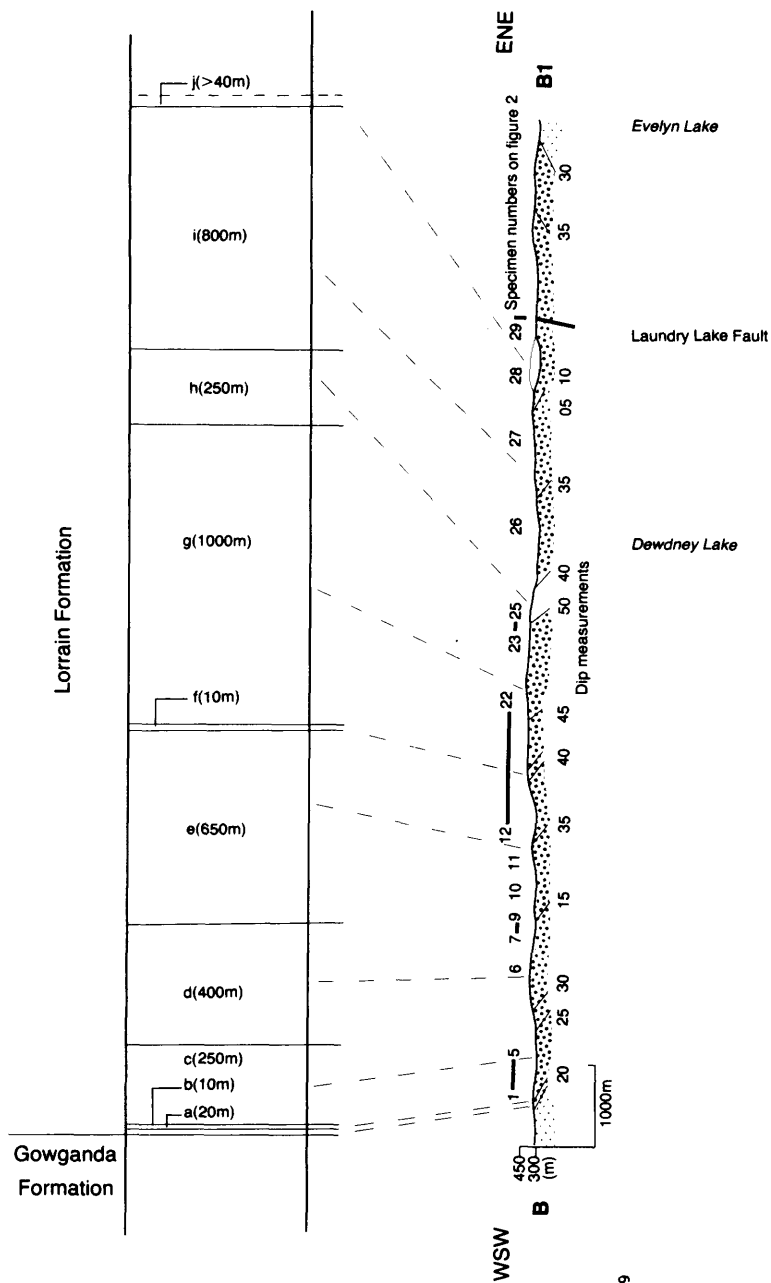
Photo 4—Lorrain Formation sandstone. Mackelcan Township. Scale 0.2 mm. Crossed polarizers.

LORRAIN FORMATION

Rocks of the Lorrain Formation (Miller and Knight 1906) are exposed in the northern part of the report-area. These rocks consist almost completely of sandstone. Minor siltstone occurs in the lower parts of the formation. Thin quartz-pebble paraconglomerate beds occur here and there, and are too thin to be shown on the maps that accompany this report.

The detrital quartz and feldspar grains are subangular to subrounded (Photo 4) and the grain size ranges from 0.1 mm to 2 mm. No obvious upward decrease in grain size and no well-marked increase of roundness of quartz and feldspar grains, as observed by Card *et al.* (1977) south of Sudbury, have been noticed in the map-area. For instance, the subarkosic wacke that underlies the uppermost preserved quartz-wacke member near Dewdney Lake in Mackelcan Township, is coarser grained than the underlying rocks, has a grain size as large as 5 mm, and contains many thin paraconglomerate beds.

The Lorrain Formation has an approximate preserved thickness 3400 m (Figure 5) in the map-area. Figure 5 is a section across the Lorrain Formation in northern Aylmer and Mackelcan Townships. A pink or greyish pink arkose forms the lowermost member of the formation. It is exposed at these locations; at the base of a large syncline in northern Aylmer and Mackelcan Township, at Bassfin Lake, and at Matagamasi Lake in Rathbun Township. A grey arkose



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Figure 5—Cross-section and stratigraphic section. Lorrain Formation.

overlies the pink arkose and is in turn overlain by greenish grey arkose (see Figure 5).

Thirty-one thin sections of the lower two thirds of the preserved Lorrain Formation sandstones were modally analysed. The analyses in the triangular diagram of Figure 2 are numbered and the numbers correspond stratigraphically to the locations shown in the cross-section of Figure 5. Figure 2 shows a general decrease in feldspar content upward, and in the upper preserved parts of the formation, the feldspar disappears completely. The feldspar was replaced by a sericitic matrix or it was not deposited at all. Hematite is sporadically distributed, but occurs mainly in the arkose at Bassfin Lake and in the northern part of Matagamasi Lake in Rathbun Township, and in the quartz arenite exposed just west of Dewdney Lake in central Mackelcan Township. Hematite is commonly concentrated in the foresets of small scale crossbeds. A pyritiferous arkose is exposed at Wolf and Jones Lakes in central Mackelcan Township. Sedimentary textures observed in the sandstones of the Lorrain Formation include bedding and crossbedding on a large and small scale. Bedding thickness ranges from about 5 cm to over 3 m. Dolomite porphyroblasts up to 2 cm in size were observed by the author in a pinkish arkose on the eastern shore of the southern part of McCarthy Bay, Matagamasi Lake.

Wacke occurs near the base of the Lorrain Formation. The wacke is grey, massive, and resembles the massive wacke of the underlying Gowganda Formation. The wacke members are as much as 10 m thick, are discontinuous along strike, and were observed only at the western limit of the large syncline in the Lorrain Formation in northern Aylmer Township. They were not observed at the eastern limit of outcrop in Mackelcan Township.

Paraconglomerate beds within the Lorrain Formation rocks are lenslike, discontinuous, and are as much as 1 m thick. Most, beds, however, are much thinner, are about 5 cm to 20 cm thick, and many beds are only one pebble layer thick (lag gravel). The pebbles range from about 1 to 3 cm in diameter, are rarely 5 cm in size, are rounded or subrounded, and consist of quartz, quartzite, and, less commonly, of jasper, metasiltstone, and granitic rocks. The matrix of the paraconglomerate consists of a normal Lorrain Formation sandstone.

MAFIC INTRUSIVE ROCKS

Nipissing Intrusive Rocks

The Nipissing Intrusive Rocks intrude the sedimentary rocks of the Huronian Supergroup and older rocks of the Southern Structural Province of the Canadian Shield in a region extending from Cobalt to Sault Ste. Marie. The radiometric ages of the Nipissing rocks have been determined by the Rb/Sr whole rock method as 2160 ± 60 m.y. in the Gowganda area (Fairbairn *et al.* 1969), and as 2150 ± 50 m.y. in the Blind River area (Van Schmus 1965).

In the map-area the Nipissing Intrusive Rocks are gabbro, granodiorite, granitic dike rocks, quartz-plagioclase porphyry, and pegmatites. The gabbros predominate, but the remaining rock types are not common and make up less

than 1 percent of the Nipissing Intrusive Rocks. The gabbros occur throughout the map-area. The more felsic differentiates were observed mainly near the Portage Bay of Lake Wanapitei, at central Matagamasi Lake, and at the southern shore of Lake Wanapitei. The rocks have been regionally metamorphosed under lower greenschist facies conditions. The gabbro is commonly altered to metagabbro due to an addition of water during the regional metamorphism.

GENERAL GEOLOGY

Gabbro

The Nipissing gabbro forms sills, dikes, and irregularly-shaped bodies. An open ring-shaped body, the "Lake Wanapitei Nipissing Gabbro Intrusion", occurs east of Lake Wanapitei.

The emplacement of the gabbro intrusions was controlled by pre-Nipissing faults, folds, and by lithologic features, such as the bedding and competency of the host rocks. In general, the distribution of the intrusions is controlled by the less competent rocks of the Gowganda Formation. Little or no Nipissing gabbro intrusions occur in areas underlain by competent rocks, such as sandstone of the Lorrain Formation.

The contacts of Nipissing gabbro with rocks older than it are exposed in only a few places. The fine-grained marginal parts of the gabbro intrusions commonly contain inclusions of the host rock.

Granophyre

Granophyre forms massive segregations in the upper parts of some Nipissing gabbro intrusions. In the map-area, the size of these segregations within a gabbro body varies from a few metres to several tens of metres. Granophyre was observed: near the Crystal Gold Mine; Portage Bay, Lake Wanapitei; at central Matagamasi Lake, and in minor amounts, in several other places in the map-area.

Granodiorite

Granodiorite differentiates of the Nipissing magma form mappable units along the southern shore of Lake Wanapitei and in southern Scadding Township. Like the granophyres, these rocks are probably located near the top of Nipissing intrusions.

Granitic Rocks

Granitic rocks associated with the Nipissing gabbro intrusions form dikes that are up to 1.5 m thick. The dikes exhibit sharp contacts with the host rocks which are commonly Nipissing gabbro, or in a few places are rocks of the Huronian Supergroup. The granitic rocks do not show any preferred geographic orientation and were observed mainly in Portage Bay, Lake Wanapitei, and in the central part of Matagamasi Lake.

Quartz-Plagioclase Porphyry

Quartz-plagioclase porphyry is exposed at two locations in northwestern Rathbun Township north of the Lake Wanapitei Indian Reserve. At one location it is in contact with wacke of the Gowganda Formation wacke, at the other, it forms an isolated outcrop in an area underlain by Huronian sedimentary rocks and Nipissing gabbro.

Pegmatite

A monzodioritic pegmatite dike was observed on an island in central Matagamasi Lake where it appears to be in contact with Nipissing gabbro and Gowganda Formation wacke. It is about 1 to 2 m thick.

PETROGRAPHY

Gabbro and Pegmatitic Gabbro

The normal Nipissing gabbro is an equigranular, fine- to medium-grained, grey, dark greenish grey weathering rock. Orthopyroxene-rich varieties weather brown. Subophitic gabbro occurs here and there. The gabbro is fine grained where it is in contact with the host rocks.

Pegmatitic gabbro forms small, decimetre-sized bodies, or larger schlieren, up to several metres in size, within the common equigranular gabbro. Pegmatitic gabbro is characterized by dark green to black hornblende laths set in a white to pinkish white feldspar groundmass. The hornblende crystals vary in length from 1 cm to 5 cm.

Granophyric gabbro occurs in minor amounts in the upper parts of some gabbro bodies. It is medium grained and somewhat lighter coloured than the normal equigranular gabbro.

In thin section, the normal, equigranular gabbro, is revealed to be composed of 39 to 56, commonly 45 to 53 volume percent of idiomorphic to xenomorphic plagioclase, 15 to 35, commonly 15 to 20 volume percent of xeno

TABLE 6 MODAL ANALYSES OF NIPISSING INTRUSIVE ROCKS, GABBROS, WANAPITEI LAKE AREA.

Specimen Number	16E6*	20E12*	38E8A*	38E8B*	38E16A*	38E17*	41E9A	41E9B	49E1	49E2	49E7
Quartz	3.8	0.7	7.6	3.6	2.2	11.7	2.9	9.5	tr	8.7	1.4
Plagioclase	49.5	39.6	52.1	52.8	11.6	21.9	47.8	36.6	45.1	25.5	51.9
Othopyroxene	0.8	7.5	6.0	6.1			5.6		17.9		5.4
Clinopyroxene	16.4	19.6	16.9	17.7			19.3		35.5		14.5
Granophyre		tr									
Amphibole	18.7	30.8	14.7	16.2	41.4	25.1	21.0		0.2	34.3	21.9
Biotite	5.2	0.5	0.7	0.2			1.3	0.4	tr		1.3
Chlorite					4.1	15.9		9.2		2.6	1.8
Epidote		tr			29.1	20.4		1.9		28.0	
Apatite					tr		0.1				
Sphene										0.9	
Leucoxene						4.8					
Carbonate					0.2						
Sericite Orthoclase, and Muscovite											
Opaque minerals	5.6	1.3	2.0	3.4	10.1	0.2	2.0	42.4	1.3		1.8
Plagioclase rim			An ⁴⁷⁻⁵⁵	An ⁶²	An ⁰⁻⁵	An ⁰⁻⁵	An ⁴⁷⁻⁵⁴	An ⁴⁵	An ⁵⁵	An ⁰⁻⁵	An ⁵⁵
composition core	An ⁴⁴⁻⁴⁷	An ⁵⁷⁻⁶³	An ⁵⁸⁻⁶¹				An ⁵⁵⁻⁶²				
Alteration index	20.6	31.4	16.2	17.4	100	100	22.1	61.0	0.2	100	24.5

Notes:

* All other specimens from "Lake Wanapitei Nipissing Gabbro Intrusion."

Abbreviation

tr — trace amounts.

TABLE 6 | Continued

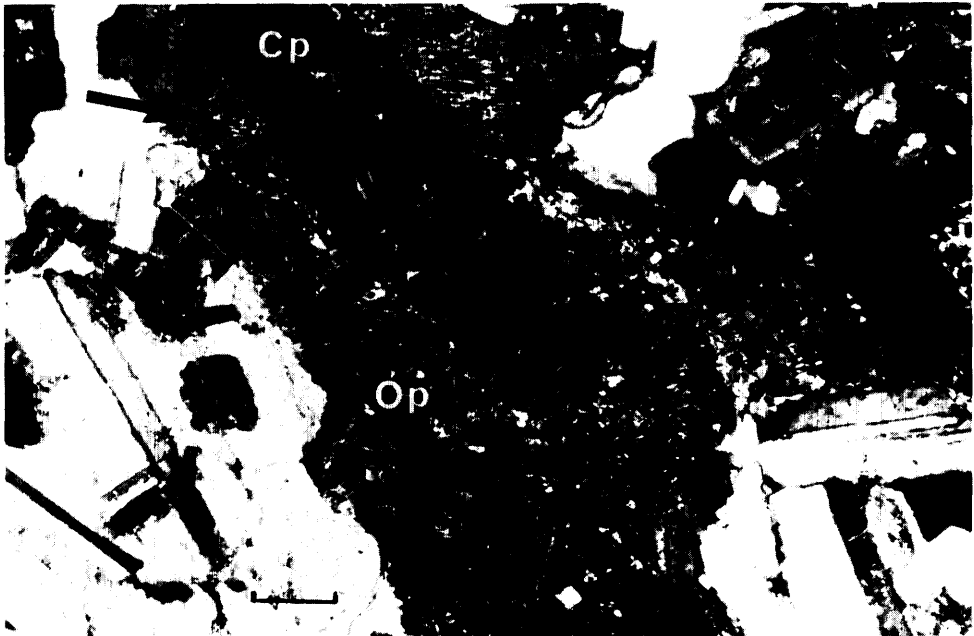
Specimen Number	47F1	47F2	47F3	47F4	47F5	47F11	47F12	M1	M2	M3	M4
	Modal Analyses in Volume Percent										
Quartz	23.8	20.2	5.4	4.5	1.1	8.5	3.0	5.5	7.2	17.2	3.5
Plagioclase	15.4	10.1	50.9	24.6	39.8	38.8	6.2	9.4	7.1	14.7	2.9
Orthopyroxene			9.7		1.6	1.1					
Clinopyroxene			12.8	tr	15.5	15.3		9.0			
Granophyre											
Amphibole	11.6	21.4	16.2	40.2	38.7	22.1	43.6	33.5	28.0	18.7	38.9
Biotite	16.9	7.0	1.4	3.3	1.1	0.4		0.3	4.0		
Chlorite		12.7	0.5	0.9		2.2	14.0	1.0	8.3	10.7	2.4
Epidote	25.9	24.4	0.9	22.9	1.8	10.3	32.8	34.8	42.7	37.4	36.9
Apatite	tr										
Sphene										0.5	
Leucoxene	1.8	2.0									
Carbonate		1.3									
Sericite, Orthoclase and Muscovite											
Opaque minerals	2.3	0.9	2.2	3.6	0.4	1.3	0.4	5.3	0.6	0.8	15.0
Plagioclase rim					An ₄₇			1.2	2.1		0.4
composition core	An ₀₋₅	An ₀₋₅	An ₅₄	An _{58, 0-5}	An ₅₄	An ₅₈	An ₀₋₅	An ₀₋₅	An ₀₋₅	An ₀₋₅	An ₀₋₅
Alteration index	100	100	19.0	83.0	41.1	38.3	100	90	95.6	100	100

TABLE 6 | Continued

Specimen Number	75E2	38F3	41F1	41F2	41F3	41F5	41F7	41F9	41F10	45F1
	Modal Analyses in Volume Percent									
Quartz	1.4	4.1	5.0	2.4	5.9	3.1	5.6	3.9	1.6	3.6
Plagioclase	29.3	24.5	31.3	25.7	20.3	5.5	47.6	51.7	55.3	2.2
Orthopyroxene			0.4				4.9	8.6	12.0	
Clinopyroxene		4.1	4.5	0.9	0.4		13.1	17.1	19.4	1.2
Granophyre										
Amphibole	48.6	44.4	38.8	38.1	39.3	49.9	22.4	11.6	10.2	39.9
Biotite		0.9	3.6	7.8	0.4		0.2	3.2	0.9	
Chlorite	3.8	1.8		0.7	3.5		1.4	0.7		7.8
Epidote	16.1	15.4	12.7	22.2	25.5	38.9	3.6	0.9		36.5
Apatite	tr									
Sphene	0.6									
Leucoxene										
Carbonate										
Sericite, Orthoclase, and Muscovite		3.4			4.0	1.3				5.8
Opaque minerals	0.2	1.9	3.7	2.2	0.7	1.3	1.2	2.3	0.6	3.0
Plagioclase rim									An ₄₀	
composition core	An ₀₋₅	An ₅₃₋₅₈	An ₄₇	An ₅₀	An _{53,0-5}	An ₀₋₅	An ₄₈	An ₅₅	An ₅₈	An ₀₋₅
Alteration index	100	68.8	56.4	63.9	88.2	100	29.4	14.0	10.4	98.7

TABLE 6 | Continued

Specimen Number	M5	M6	M7	M8	M9	M10
	Modal Analyses in Volume Percent					
Quartz	14.0	6.2	9.5	7.4	8.8	9.1
Plagioclase	46.8	42.3	48.2	42.4	5.4	5.3
Orthopyroxene					3.6	
Clinopyroxene						
Granophyre						
Amphibole					34.0	40.6
Biotite	0.4	1.5				1.3
Chlorite	<u>38.5</u>	<u>48.5</u>	<u>34.6</u>	<u>47.5</u>	8.3	6.5
Epidote					35.1	30.7
Apatite					0.4	
Sphene						
Leucoxene					0.8	0.7
Carbonate			4.5		0.4	
Sericite, Orthoclase and Muscovite					2.5	4.2
Opaque minerals	0.3	1.5	3.2	2.7	0.7	1.6
Plagioclase rim composition core	An ₀₋₅	An ₀₋₅	An ₀₋₅	An ₀₋₅	An ₀₋₅	An ₀₋₅
Alteration index	100	100	100	100	96.0	98.1



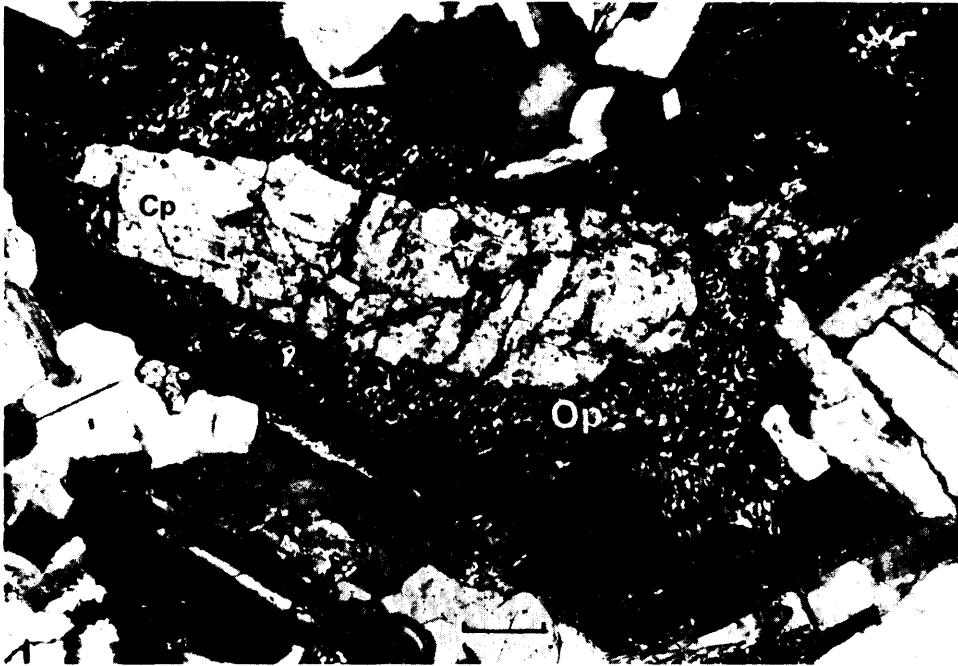
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Photo 5—Clinopyroxene (Cp) included in orthopyroxene (Op). The orthopyroxene shows a set of fine exsolution lamellae (arrows) parallel to the (100) plane of the host orthopyroxene. Nipissing gabbro. Lake Wanapitei Gabbro Intrusion. Scale 0.2 mm. Crossed polarizers.

morphic to hypidiomorphic clinopyroxene, and 15 to 25, commonly 17 to 21 volume percent of xenomorphic orthopyroxene. Other primary minerals: are green hornblende rimming pyroxene, biotite, apatite, sphene, opaque minerals, and quartz. The quartz content ranges from being absent to as much as 25 volume percent. Most modally analyzed specimens (Table 6, and see Table 9), however, contain only 0.5 to 5.0 percent quartz.

Plagioclase ranges in composition from An₄₅ to An₇₀. The cores of zoned plagioclase crystals have an An content of An₁₀ to An₁₅ higher than the rims. Clinopyroxene is a very light green augite and commonly exhibits thin exsolution lamellae. Photos 5 and 6 show a clinopyroxene included in orthopyroxene. The orthopyroxene contains a set of exsolution lamellae parallel to the (100) plane of the host orthopyroxene and small myrmekite-like clinopyroxene showing the same extinction as the central clinopyroxene inclusion; this indicates that the orthopyroxene replaced the clinopyroxene. The angle, 2vZ of the augite, ranges from 45° to 52°. Orthopyroxene is a colourless or very light greenish hypersthene-bronzite, and its 2Vx ranges from 65° to 75°. A 2vX of 75-80° was measured in a Mg-rich core of a zoned orthopyroxene.

Secondary minerals are actinolite, epidote, sericite, carbonate, chlorite, and leucoxene. In many places these secondary minerals have replaced all primary plagioclase, pyroxene, hornblende, biotite, and sphene.



OGS 10316

Photo 6—Clinopyroxene (Cp) included in orthopyroxene (Op). The orthopyroxene includes myrmekite-like clinopyroxene showing the same extinction as the central clinopyroxene. Same crystals as in Photo 5. Scale 0.2 mm. Crossed polarizers.

Several modal analyses of Nipissing gabbro are presented in Table 6 and Table 9.

Thin sections of pegmatitic gabbro exhibit long needles of actinolitic hornblende. These needles are generally 0.3 cm to 2.0 cm wide in places and 1 cm to 5 cm in length, set in a medium-grained, matrix of plagioclase, quartz, muscovite, and biotite.

Granophyre

Granophyre is characterized by an irregular, eutectoid intergrowth of quartz and feldspar. There are transitions from Nipissing-type gabbro to granophyric gabbro and granophyre.

Typical granophyres are medium to coarse grained, pinkish grey, pink weathering rocks.

In thin section, a typical granophyre is seen to consist of plagioclase (An_{30-35}), quartz, biotite, sphene, apatite, zircon, opaque minerals, and an eutectoid intergrowth ("granophyre") of plagioclase and quartz. Secondary min-

Geology of the Lake Wanapitei Area

erals are chlorite, epidote, carbonate, and leucoxene. A modal analysis of a granophyre from near the Crystal Gold Mine is presented in Table 7.

Granodiorite

The granodiorite is light grey, in places weathers a pinkish colour, and is medium grained and equigranular. These rocks consist of hypidiomorphic plagioclase laths, xenomorphic microcline, quartz, and biotite. Accessory minerals are apatite, zircon, sphene, and opaque minerals. In places, the rocks are somewhat altered and exhibit minerals such as epidote, chlorite, and carbonate. The anorthite content of plagioclase ranges from about An_{25} to An_{30} . Two modal analyses of Nipissing granodiorite are in Table 7. In Specimen 55G31A, plagioclase is strongly zoned, and the central zone, making up about two thirds of the plagioclase grain, is replaced by epidote. The anorthite content of the rims of these zoned feldspars is about $An_{25\pm3}$. The rocks are classified as granodiorite-tonalite, according to the IUGS classification of plutonic rocks (Streckeisen 1974). The triangular diagram of Figure 6 in this report should also be seen.

Granitic Rocks

The granitic dike rocks are fine to medium grained, grey pinkish and weather pink. These rocks are composed of quartz, microcline, plagioclase ($An_{30\pm5}$), muscovite, and accessory apatite, sphene, and opaque minerals. Secondary minerals are chlorite after biotite, epidote, and carbonate. The rock texture is equigranular igneous.

Three modal analyses of granitic rocks are shown in Table 7. In the IUGS classification of plutonic rocks, the granitic rocks are granite and granodiorite (Streckeisen 1974, see the triangular diagram of Figure 6).

Quartz-Plagioclase Porphyry

The rock is composed of partly saussuritized, idiomorphic to hypidiomorphic plagioclase ($An_{30\pm3}$) phenocrysts and hypidiomorphic quartz phenocrysts set in a fine-grained panxenomorphic groundmass of quartz, plagioclase, possibly microcline, carbonate, sericite, biotite, chlorite, and leucoxene. The plagioclase phenocrysts are as much as 8 by 10 mm in size, and the quartz grains up to as much as 3 mm in maximum dimension.

Pegmatite

The pegmatite is a pink, coarse-grained rock containing hypidiomorphic plagioclase ($An_{30\pm5}$) and microcline, carbonate, and small amounts of quartz,

TABLE 7 MODAL ANALYSES OF NIPissing INTRUSIVE ROCKS GRANOPHYRE, GRANITIC ROCKS, GRANODIORITE, AND PEGMATITE, WANAPITEI LAKE AREA.

Rock and Field Name	Granite	Granite	Granite	Granite	Granodiorite	Granodiorite	Granodiorite	Granophyre	Pegmatite
Sample Number	36E13	37E4B1	37E4B2	11G18	55G31	49E9A	65E13		
Quartz	35.0	21.9	20.6	38.0	41.6	26.5	1.4		
Microcline	21.5	5.8	10.5	9.2	0.9	11.1**	10.0		
Plagioclase	29.6	44.6	35.9	41.6	23.8	40.9	69.2		
Biotite					16.5	3.5			
Muscovite	6.7								
Chlorite*	5.1	20.4	27.4	7.5	tr	12.3			
Epidote*					16.7	1.2			
Sphene			0.4	tr	tr	0.3			
Apatite	tr	tr			tr	tr	0.4		
Zircon					tr				
Carbonate*	0.5	7.0	3.9	2.7	tr	3.3	17.4		
Opaque minerals	1.6	0.3	1.3	1.0	0.3	0.9	1.6		
Anorthite Content	An _{30±5}	An _{30±5}	An _{30±5}		rim An ₂₅₋₂₈	An ₃₀₋₃₅	An _{30±5}		
IUGS-Classification (after Streckeisen 1974)	Granite	Granodiorite	Granodiorite	Granodiorite	Granodiorite	Tonalite	Monzodiorite		

Notes

* Secondary mineral

** Granophyre (Quartz and plagioclase)

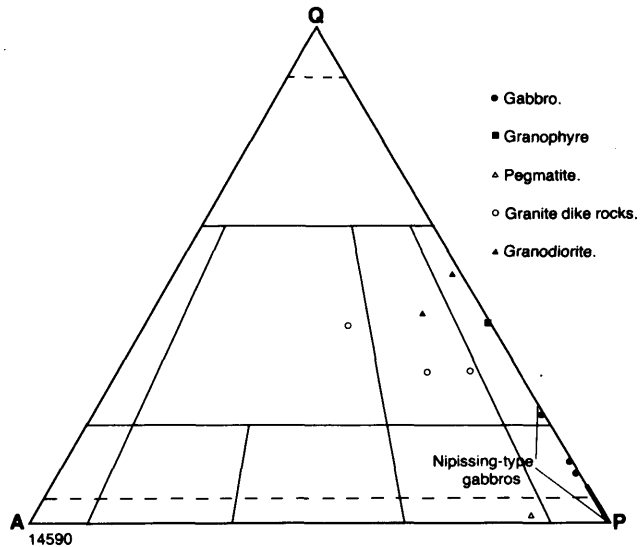


Figure 6—Streckeisen (1976) diagram to show mineralogical composition of Nipissing intrusive rocks. See Tables 6 and 7 for modal analyses.

apatite, and opaque ore minerals. A modal analysis of this rock is given in Table 7. In the IUGS classification of plutonic rocks, the pegmatite is a monzodiorite (Streckeisen 1974; see the triangular diagram in Figure 6).

Quartz, Quartz-Carbonate, and Carbonate Veins

Hydrothermal quartz, quartz-carbonate, and carbonate veins are common in almost the whole of the area (see Figure 27 and Photo 17). In most cases, the hydrothermal activity is clearly related to the Nipissing intrusions because the quartz, quartz-carbonate, and carbonate veins occur within the gabbros, or in the country rocks near the contact with the gabbros. In a few other cases, however, no clear relation to the Nipissing intrusions can be demonstrated. For instance, in central Matagamasi Lake and at McCarthy Bay of Matagamasi Lake, quartz veins and stockworks appear to be related to faulting and hydrothermal activity along the faults. In southwestern Aylmer Township, calcite veins, stockworks, and dikes are as much as 2 m thick. These rocks probably originated through a strong remobilization of Espanola Formation carbonate minerals caused by the intrusion of the Nipissing gabbro.

GEOCHEMISTRY

Gabbro

A Nipissing gabbro intrusion northeast of Lake Wanapitei was geochemically studied by the author in some detail (see section "Lake Wanapitei Nipissing Gabbro Intrusion"). Chemical analyses are presented in Tables 10 to 14 inclusive.

The Nipissing gabbros are tholeiitic and show chemical differentiation trends across thicker sills. In general, it appears that gravity settling of early formed pyroxene led to MgO, Ni, Cr, Cu, and Co enrichment in the basal parts of the magma and an enrichment in Fe₂O₃, Na₂O, and K₂O in the higher parts of the gabbro body.

Granophyre, Granodiorite, Granitic Rocks, Quartz-Plagioclase Porphyry, and Pegmatite

Table 8 shows some chemical analyses of the more felsic differentiates of the Nipissing intrusions. In general, MgO and CaO show a decrease in amount compared with the gabbros; Na₂O and K₂O show an increase in amount.

All chemical analyses, namely the analyses of gabbros and of the felsic differentiates, are plotted in a cation plot (Figure 7). The diagram shows the normal differentiation trend of a tholeiitic magma.

LAKE WANAPITEI NIPISSING GABBRO INTRUSION

The Lake Wanapitei Nipissing Gabbro Intrusion is open, ring-shaped, and located east of Lake Wanapitei in Rathbun and Scadding Townships.

At Rathbun Lake, the intrusive shows impressive sulphide mineralization and at Boucher Lake (now part of Portage Bay) and at Matagamasi Lake, gold-bearing quartz and quartz-carbonate veins appear to be associated with the gabbro (see section in "Economic Geology" on "Gold"). The intrusion, therefore, is of economic interest. Results of geological, petrographical, and geochemical investigations are given on the following pages. These investigations were undertaken to aid mineral exploration, and to test a combined geological-petrographical-geochemical approach in locating an area where mineral exploration should be concentrated.

Petrography

The Lake Wanapitei Nipissing Intrusion is a two-pyroxene gabbro. The mineralogy of this intrusion does not differ from the other Nipissing intrusions in the area (see section on "Petrography; Gabbro and Pegmatitic Gabbro").

TABLE 8 CHEMICAL ANALYSES OF NIPISSING INTRUSIVE ROCKS GRANOPHYRE, GRANODIORITE, QUARTZ-PLAGIOCLASE PORPHYRY, GRANITIC ROCKS AND PEGMATITE, WANAPITEI LAKE AREA.*

Rock Type	Granophyre		Quartz-plagio- clase porphyry	Granodiorite	Granitic Dike Rock	Pegmatite
Sample Number	49E9B	49E9A	20E7	55G31	12G8	37E4B
Major Components in Weight Percent						
SiO ₂	69.20	68.70	68.20	70.90	68.00	61.90
Al ₂ O ₃	13.50	12.50	16.30	13.30	17.20	17.80
Fe ₂ O ₃	1.86	1.65	1.61	1.56	total	0.04
FeO	3.49	4.10	1.54	3.15		5.18
MgO	1.44	1.63	1.09	1.67	1.38	0.40
CaO	1.54	1.24	1.61	2.74	0.55	1.89
Na ₂ O	3.45	3.00	6.52	2.83	8.34	3.07
K ₂ O	2.61	2.59	2.08	2.24	0.51	7.77
TiO ₂	0.76	0.74	0.34	0.53	0.70	0.73
P ₂ O ₅	0.12	0.10	0.13	0.10	0.13	0.71
MnO	0.06	0.07	0.04	0.05	0.01	0.13
H ₂ O+	1.16	1.36	0.63	0.44	0.33	0.06
H ₂ O-	0.26	0.51	0.29	0.36	0.32	1.22
CO ₂	0.38	0.42	0.78	0.20	0.32	0.67
S	0.02	0.03	0.02	0.02	0.25	0.01
Total	99.85	98.64	100.18	100.09	99.25	99.83

Notes

* Chemical analyses performed by Geoscience Laboratories, Ontario Geological Survey, Toronto.

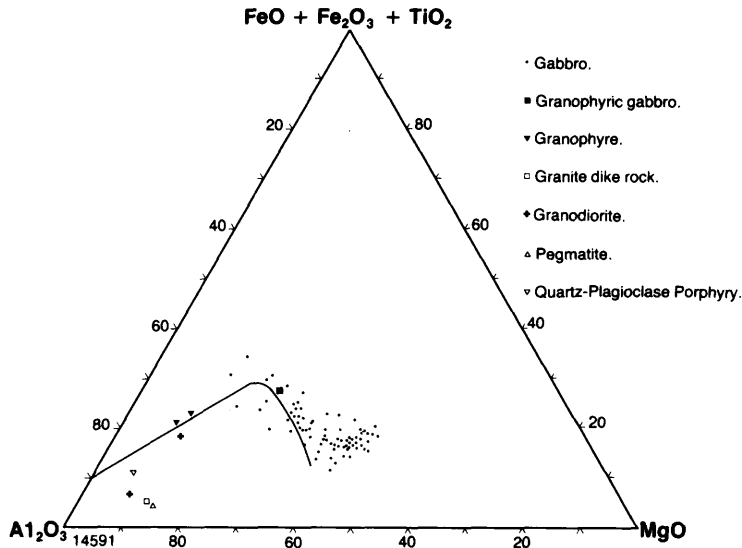


Figure 7—Jensen cation plot. Nipissing Intrusive Rocks. See Table 8 for chemical analyses.

Figure 8 is a sketch map showing the location of post-gabbro quartz veins and granophyric differentiates, the regional distribution of secondary alterations of the gabbro, and of the regional variation of the anorthite content within the gabbro. To obtain quantitative results illustrating the alteration of the gabbro, the author used an “alteration index (AI)”. This index is based on modal analyses and relates the amount of altered minerals within the rock to the amount of minerals (100-B) which are characterized by a potential to show alterations in thin sections.

The alteration index is given by the following equation:

$$AI = \frac{100A}{100-B}$$

A is the percentage of alteration products, the sum of modal percents of albite, epidote group minerals, chlorite, sericite, actinolite-tremolite, carbonate, leucoxene, and so on, and B is the sum of minerals that do not appear altered in thin section (quartz, apatite, opaque minerals). An unaltered, fresh rock has an AI of 0, a completely altered gabbro an AI of 100.

More than 30 thin sections were studied to show the distribution of mineral alterations within the gabbro body, that is the distribution of the change in the mineralogical composition of the gabbro brought about by the action of hydrothermal solutions and deuteric processes. The spatial distribution of the alterations within the gabbro (Figure 8), and of the occurrences of granophyric veins and quartz or quartz-carbonate veins and dikes, suggest that the mineral alterations and the granophyric and hydrothermal dike rocks are genetically related. The hydrothermal solutions that altered the gabbro also formed the quartz dikes and veins that, in places, are gold bearing. The hydrothermal ac-

tivity probably is a deuteric process related to the gabbro intrusion itself and not related to another, post-gabbro hydrothermal process. This is indicated by the regional distribution of the hydrothermal veins in and near the intrusion where the gabbro minerals are strongly altered. Quartz veins and quartz stockworks, however, also occur elsewhere in the map-area where they appear to be related to hydrothermal activity along faults.

The modal analyses on which Figure 8 is based are given in Table 10 (see also Table 6). The reader should refer to the sample location map (see Figure 27).

The mineralogy of the Lake Wanapitei Nipissing Gabbro Intrusion does not differ from other gabbro bodies in the map-area. Mineralogical sections that occur across two extensive rock exposures are presented in Table 9. The clinopyroxene content appears to increase upward in the sections. No other clear differentiation trends can be deduced from the modal analyses. In Section III, however, a weak differentiation trend is indicated by the optically determined composition of orthopyroxenes (Tröger 1959). These pyroxenes appear to have a somewhat lower magnesium content in the lower parts than in the upper parts of the cliff (see Table 9, and Figure 10).

The upward Mg-increase in magnesium is confirmed by the results of chemical investigations which follow this section.

Geochemistry

Tables 10 to 13 show chemical analyses of samples taken from four sections across a steep to vertical cliff on the northeastern shore of Lake Wanapitei.

Section III (Table 12) is about 70 m high; and 13 samples were taken at intervals of about 6 m. Sections I, II, and IV are 25, 50, and 35 m high and ten, 11, and 8 samples, respectively (see Tables 10, 11, and 13), were taken at about equal distances across the outcrops. In Figures 9 to 12, the chemical analyses obtained from these samples are plotted on variation diagrams for most major elements and for some trace elements. In general, MgO, Cu, Ni, and Co contents increase, but, Na₂O and K₂O contents decrease with an increase in height. Gold commonly is lower than about 10 ppb in most samples. Only the samples 2, 3, and 4 of Section III and some samples in Sections II and IV show values well above 10 p.p.b. In Figure 13, the "gold rich" zone in Section III is connected with the zones in Section I, II, and IV where traces or higher ppb values of gold were detected. More detailed geochemical investigations are required to substantiate the preliminary results of a "gold reef" within the gabbro.¹ It is to be noted that in Section III, palladium appears to be enriched in the gold-rich layer.

MgO, Cu, Ni, and Co increase with height in three sections. This behaviour seems to be in contrast to the normal differentiation trends in a gabbro sill. However, an initial increase in the content of these elements near the base of a sill is quite normal and has been observed in other gabbro bodies (Professor Naldrett, University of Toronto, personal communication, September 1978).

¹At the time of writing, a geochemical study was in progress at the University of Western Ontario, London, Ontario).

TABLE 9 MODAL ANALYSES OF NIPISSING GABBRO (LAKE WANAPITEI NIPISSING GABBRO INTRUSION), WANAPITEI LAKE AREA.

Specimen Number	SECTION III							SECTION I								
	1	3	5	8	1	2	4	5	9	10	1	2	4	5	9	10
Quartz	1.4	0.5	0.8	0.5	tr	1.3										
Plagioclase	55.5	53.8	48.8	50.8	40.8	6.2	35.2	50.6	47.9	50.0						
Orthopyroxene	24.5	21.8	24.0	20.9		0.4	21.0	17.8	19.9	19.1						
Clinopyroxene	15.1	22.0	23.8	25.9	2.8	4.0	16.6	27.7	28.0	28.9						
Primary Hornblende	1.1	0.6	0.5	0.3					1.3							
Biotite	1.3	0.9	1.9	1.4					1.9	1.1						
Actinolite	0.4	0.1			32.0	45.1	18.3	2.0								
Epidote	0.2				18.0	28.9	0.2	0.1								tr
Sericite					0.3	3.1	8.3								tr	
Carbonate					tr											
Chlorite					5.7	10.7										
Opaque minerals	0.5	0.3	0.2	0.2	0.4	0.3	0.4	0.2	0.6	0.2						0.2
Plagioclase rim	An ₅₄	An ₄₇		An ₄₇₋₅₅						An ₅₃						
composition core	An ₆₇	An ₆₃	An ₆₂	An ₆₀₋₆₅	An ₅₋₁₅	An ₀₋₅	An ₅₄	An ₆₂	An ₇₀	An ₆₅						
2VX Orthopyroxene	65°-66°	67°	65°-75°	72°-74°			72°	75°	70°-72°	Rim 65°						Core 78°-80°
2VZ Clinopyroxene	50°	46°-50°	48°	45°-48°			52°	52°	50°	46°						
Alteration index	1.7	0.7	0.5	0.3	56.1	95.5	26.9	2.1	0.0	0.0						

Notes:

For locations of samples in Sections I and III see Figure 13.

Abbreviation

tr — trace amounts.

TABLE 10 CHEMICAL ANALYSES OF LAKE WANAPITEI NIPISSING GABBRO INTRUSION, NORTHEASTERN LAKE WANAPITEI, SECTION I, WANAPITEI LAKE AREA.*

Sample Number	1	2	3	4	5	6	7	8	9	10
	Major Components in Weight Percent									
SiO ₂	51.1	51.0	46.0	49.9	50.8	51.1	51.6	51.0	51.3	51.4
Al ₂ O ₃	14.8	13.8	12.8	15.0	14.3	14.6	14.2	13.8	13.9	13.7
Fe ₂ O ₃	1.94	1.66	0.68	0.96	1.09	0.85	1.02	1.06	1.14	0.99
FeO	6.07	6.32	6.82	5.15	6.57	6.65	6.57	6.82	6.57	6.82
MgO	9.59	11.80	10.30	12.10	11.40	11.10	11.40	11.80	11.50	11.90
CaO	11.3	9.88	8.17	11.10	12.20	12.10	12.30	12.00	12.20	11.30
Na ₂ O	1.25	0.76	0.70	0.60	0.93	1.01	0.85	1.13	0.94	1.09
K ₂ O	0.50	0.77	0.76	1.29	0.34	0.38	0.27	0.30	0.37	0.26
TiO ₂	0.48	0.38	0.35	0.20	0.34	0.35	0.36	0.36	0.36	0.36
P ₂ O ₅	0.04	0.04	0.04	0.01	0.04	0.04	0.05	0.03	0.03	0.04
MnO	0.16	0.17	0.14	0.18	0.16	0.16	0.16	0.16	0.16	0.16
L.O.I.	2.70	3.60	11.8	1.60	0.40	0.40	0.40	0.40	0.80	0.30
TOTAL	99.93	100.18	98.56	99.09	98.57	98.74	99.18	98.86	99.27	98.32
	Trace Elements in Parts Per Million (PPM)									
Ag	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Au (ppb)	<10	<10	<10	<10	<10	10	10	10	10	<10
Co	40	38	38	43	44	43	44	45	46	46
Cr	387	600	540	640	680	580	640	660	600	540
Cu	128	104	39	144	148	144	136	150	162	162
Ni	141	186	172	187	198	185	188	199	200	200
Pd					trace, (<0.001 oz/ton)					
Pt					not detected (<0.005 oz/ton)					

Notes:

* Chemical analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Abbreviation

L.O.I. — Loss on ignition.

For location of samples, see Figure 13.

TABLE 11 CHEMICAL ANALYSES OF LAKE WANAPITEI NIPISSING GABBRO INTRUSION, NORTHEASTERN LAKE WANAPITEI, SECTION II, WANAPITEI LAKE AREA.*

Sample Number	1	2	3	4	5	6	7	8	9	10	11
	Major Components in Weight Percent										
SiO ₂	48.00	48.70	50.10	47.70	49.60	50.80	49.80	50.20	51.20	50.50	50.80
Al ₂ O ₃	16.50	14.00	15.30	15.40	14.80	15.00	14.90	15.00	14.80	14.80	14.10
Fe ₂ O ₃ total	9.00	9.09	8.64	8.32	8.71	8.62	8.39	8.29	7.80	8.07	8.86
MgO	8.99	10.40	10.50	10.90	10.70	10.80	10.70	11.20	11.60	11.60	12.00
CaO	10.60	11.70	12.50	11.50	12.40	12.30	12.80	12.20	12.60	12.00	12.30
Na ₂ O	1.22	1.22	1.17	0.71	1.10	1.02	0.91	0.86	0.95	0.76	0.78
K ₂ O	0.19	0.12	0.34	1.08	0.39	0.29	0.44	0.50	0.35	0.52	0.45
TiO ₂	0.32	0.36	0.33	0.22	0.37	0.38	0.38	0.35	0.35	0.33	0.36
P ₂ O ₅	0.02	0.02	0.01	0.00	0.02	0.01	0.01	0.01	0.01	0.01	0.00
MnO	0.16	0.18	0.17	0.18	0.16	0.17	0.17	0.17	0.17	0.17	0.19
CO ₂	0.09	0.16	0.09	0.26	0.18	0.08	0.26	0.11	0.05	0.22	0.05
S	0.04	0.04	0.06	0.03	0.08	0.05	0.05	0.04	0.04	0.05	0.09
H ₂ O [±]	3.37	2.70	0.35	2.01	0.84	0.07	0.99	0.25	0.21	0.83	0.66
TOTAL	98.50	98.69	99.56	98.31	99.35	99.59	99.80	99.18	100.13	99.86	100.64
	Trace Elements in Parts Per Million (PPM)										
Ag	140	40	<10	40	20	not detected	not detected	10	10	30	40
Au (ppb)	33	39	43	41	43	44	43	41	43	43	48
Co	264	600	590	610	660	670	690	750	750	740	740
Cr	104	126	130	174	129	130	136	123	145	174	205
Cu	115	162	163	170	177	174	175	178	192	194	216
Ni	<10	10	<10	<10	16	<10	<10	<10	<10	<10	<10
Pb	60	64	62	60	62	61	68	58	59	57	72
Zn						not detected	not detected				
Pd and Pt											

Notes:

* Chemical analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto. See Figure 13 for location of samples.

TABLE 12 CHEMICAL ANALYSES OF LAKE WANAPITEI NIPissing GABBRO INTRUSION, NORTHEASTERN LAKE WANAPITEI, SECTION III, WANAPITEI LAKE AREA.*

Sample Number	1	2	3	4	5	6	7	8	9	10	11	12	13
SiO ₂	51.5	49.4	50.5	50.4	50.6	50.0	50.5	51.2	50.8	50.5	50.3	50.6	50.7
Al ₂ O ₃	16.7	15.7	16.9	16.5	15.3	16.7	15.1	14.9	14.7	16.1	15.8	13.7	13.9
Fe ₂ O ₃ (total)	8.31	9.72	7.93	8.06	8.46	7.53	8.47	8.65	8.92	8.40	7.95	8.46	8.68
MgO	9.11	10.10	9.90	9.99	10.40	10.20	10.50	10.90	11.00	11.40	11.80	12.00	11.80
CaO	11.80	10.30	12.80	12.50	12.30	13.10	12.10	12.10	12.00	12.10	12.20	12.10	12.20
Na ₂ O	1.61	2.27	1.33	1.26	1.16	1.23	1.29	1.21	1.17	1.23	1.02	1.01	1.01
K ₂ O	0.58	0.45	0.29	0.37	0.40	0.13	0.42	0.30	0.28	0.25	0.26	0.26	0.26
TiO ₂	0.47	0.37	0.35	0.35	0.40	0.25	0.37	0.38	0.41	0.36	0.30	0.34	0.35
P ₂ O ₅	0.07	0.06	0.06	0.06	0.06	0.04	0.05	0.06	0.05	0.05	0.06	0.05	0.05
MnO	0.15	0.14	0.15	0.15	0.16	0.15	0.16	0.17	0.17	0.16	0.16	0.17	0.17
L.O.I.	0.50	2.40	0.40	1.10	0.50	0.10	1.00	0.40	0.30	0.20	0.30	0.90	0.20
TOTAL	100.80	100.91	100.61	100.74	99.74	99.43	99.96	100.27	99.80	100.75	100.15	99.59	99.32

Ag	Trace Elements in Parts Per Million (PPM)												
	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Au (ppb)	10	230	40	130	<3	<3	<3	<3	<3	<3	<3	<3	<3
Co	33	34	40	39	42	41	41	44	51	51	40	45	43
Cr	440	760	860	800	760	292	660	580	680	720	620	720	600
Cu	100	92	108	116	93	126	126	112	126	137	132	163	142
Ni	129	146	157	155	159	145	172	170	176	188	188	217	193
Pb	70	25	31	17	11	45	38	28	20	<10	27	12	44
Zn	60	54	60	66	59	50	62	60	63	60	56	62	60
Pt	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr
Pd	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr

Notes:

* Chemical analyses performed by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Abbreviation

L.O.I. - Loss on ignition.

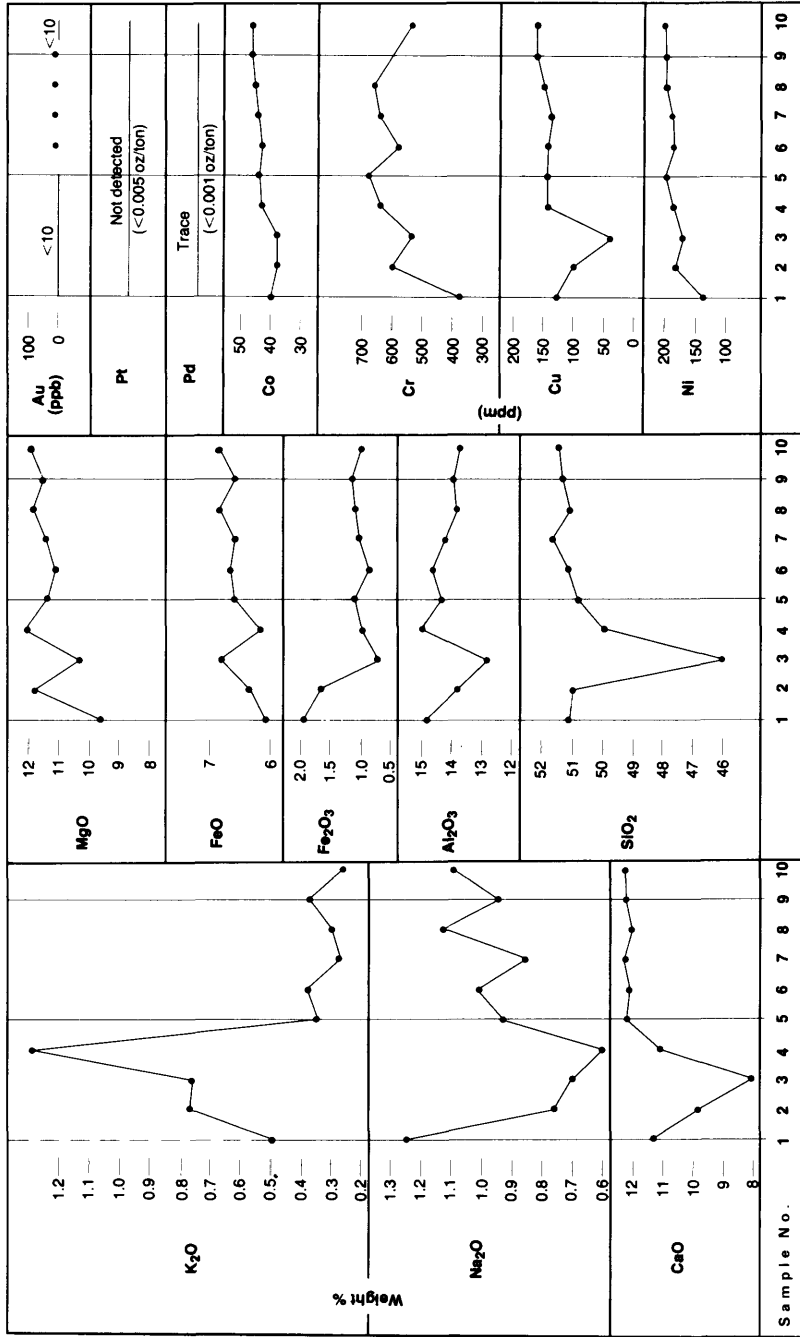
For the location of these samples, see Figure 13.

TABLE 13 CHEMICAL ANALYSES OF LAKE WANAPITEI NIPISSING GABBRO INTRUSION, NORTHEASTERN LAKE WANAPITEI, SECTION IV, WANAPITEI LAKE AREA. *

Sample Number	1	2	3	4	5	6	7	8
	Major Components in Weight Present							
SiO ₂	50.50	50.90	50.50	49.90	49.90	50.40	50.90	50.80
Al ₂ O ₃	15.20	15.70	15.30	14.40	15.70	15.40	15.20	15.60
Fe ₂ O ₃ total	9.37	9.40	9.42	10.00	8.20	9.69	10.60	10.80
MgO	8.98	8.79	8.85	9.33	8.74	7.83	7.71	7.50
CaO	12.10	11.70	11.90	10.90	13.10	11.40	11.00	11.10
Na ₂ O	1.36	1.34	1.07	2.01	1.57	1.73	1.97	1.75
K ₂ O	0.47	0.56	0.56	0.57	0.54	0.57	0.42	0.44
TiO ₂	0.50	0.51	0.50	0.49	0.52	0.58	0.65	0.63
P ₂ O ₅	0.04	0.03	0.02	0.03	0.03	0.04	0.03	0.03
MnO	0.18	0.18	0.17	0.19	0.17	0.18	0.19	0.18
CO ₂	0.08	0.12	0.09	0.58	0.09	0.08	0.15	0.08
S	0.07	0.04	0.06	0.04	0.07	0.07	0.06	0.05
H ₂ O [±]	0.85	0.34	0.00	1.98	1.24	0.95	1.19	0.45
Total	99.70	99.61	98.44	100.42	99.87	98.92	100.07	99.41
	Trace Elements in Parts Per Million (PPM)							
Ag	<10	10	30	30	not detected	20	<10	10
Au (ppb)	41	41	40	40	37	37	36	41
Co	500	480	460	520	580	162	151	166
Cr	90	85	82	113	86	116	77	110
Cu	129	131	125	142	130	101	93	115
Ni	13	10	10	22	11	12	19	<10
Pb	82	74	64	92	67	73	95	82
Zn					not detected			
Pd and Pt								

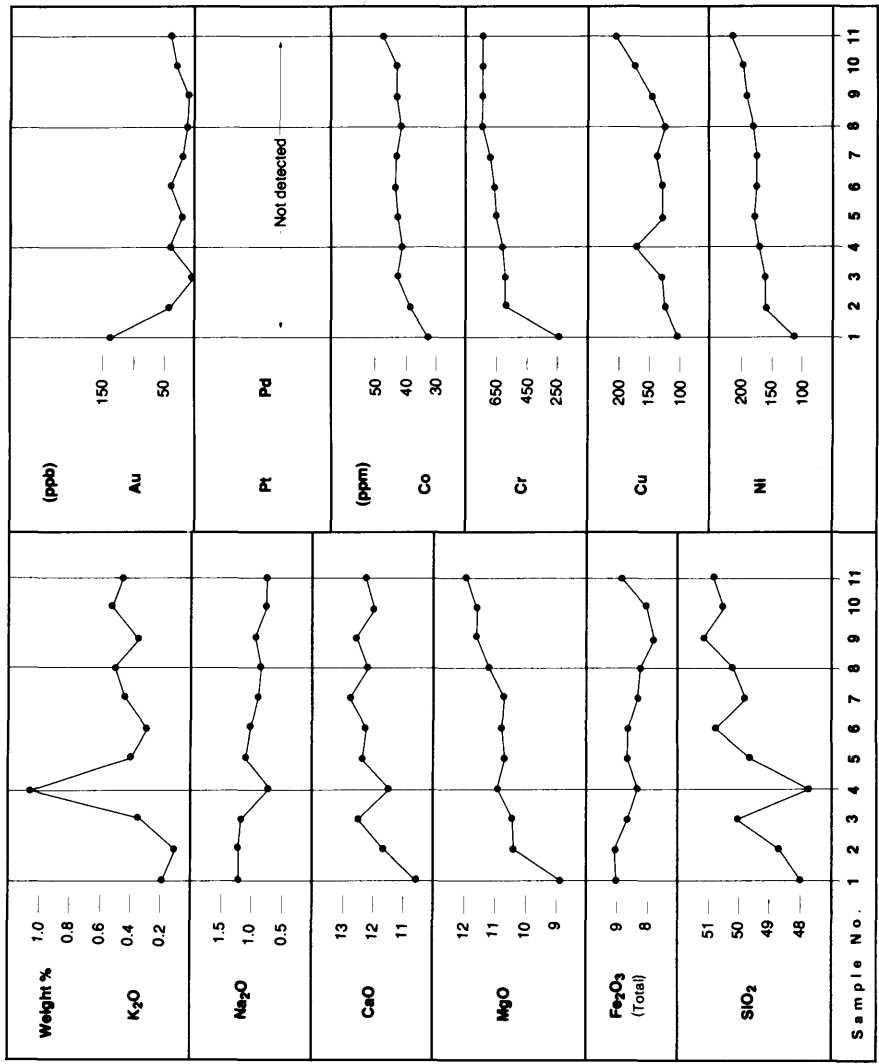
Notes:

* Chemical analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.



14593

Figure 9-Variation diagram for some major elements and some trace elements. Lake Wanapitei Nipissing Gabbro Intrusion. Section I. See Table 10 for chemical analyses.



14594

Figure 10—Variation diagram for some major elements and some trace elements. Lake Wanapitei Nipissing Gabbro intrusion. Section II. See Table 11 for chemical analyses.

Geology of the Lake Wanapitei Area

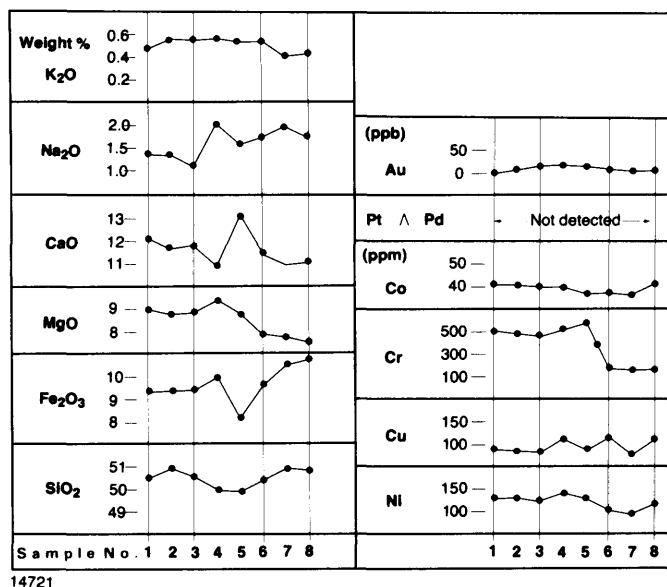


Figure 12—Variation diagram for some major elements and some trace elements. Lake Wanapitei Nipissing Gabbro Intrusion. Section IV. See Table 13 for chemical analyses.

Further eastward, in the Lake Wanapitei Nipissing Intrusion and in Section IV, the rocks behave normally; the content of the above-mentioned elements decreases. Figures 14 to 16, in general, show clear differentiation trends within the gabbro body. Ni, Cu, Co, and MgO contents decrease, Fe₂O₃, K₂O, and Na₂O increase eastward. Using the available laboratory techniques it was not possible to delineate zones enriched in precious metals. The chemical analyses, on which Figures 14 to 16 are based, are presented in Tables 14 and 15.

In the specimens M5, M6, M7, and M8, (see Table 6), which were all taken from outcrops in Matagamasi Lake, the alteration products of plagioclase are albite and chlorite; the pyroxenes are completely replaced by chlorite. This is in contrast to the alteration of gabbro to epidote, chlorite, and actinolite that is common elsewhere. Chemically, this alteration is reflected by a strong CaO depletion of the rocks (see Table 15). Also, the copper and zinc ppm values are well below average. The chloritization and Ca-Cu-Zn depletion probably are due to an increase in the amount of water that was locally available during regional metamorphism or hydrothermal activity. The chloritized gabbros are commonly cut by many thin hydrothermal quartz veins. In other locations, however, where quartz veins occur in the gabbro, the strong chloritization has not been observed.

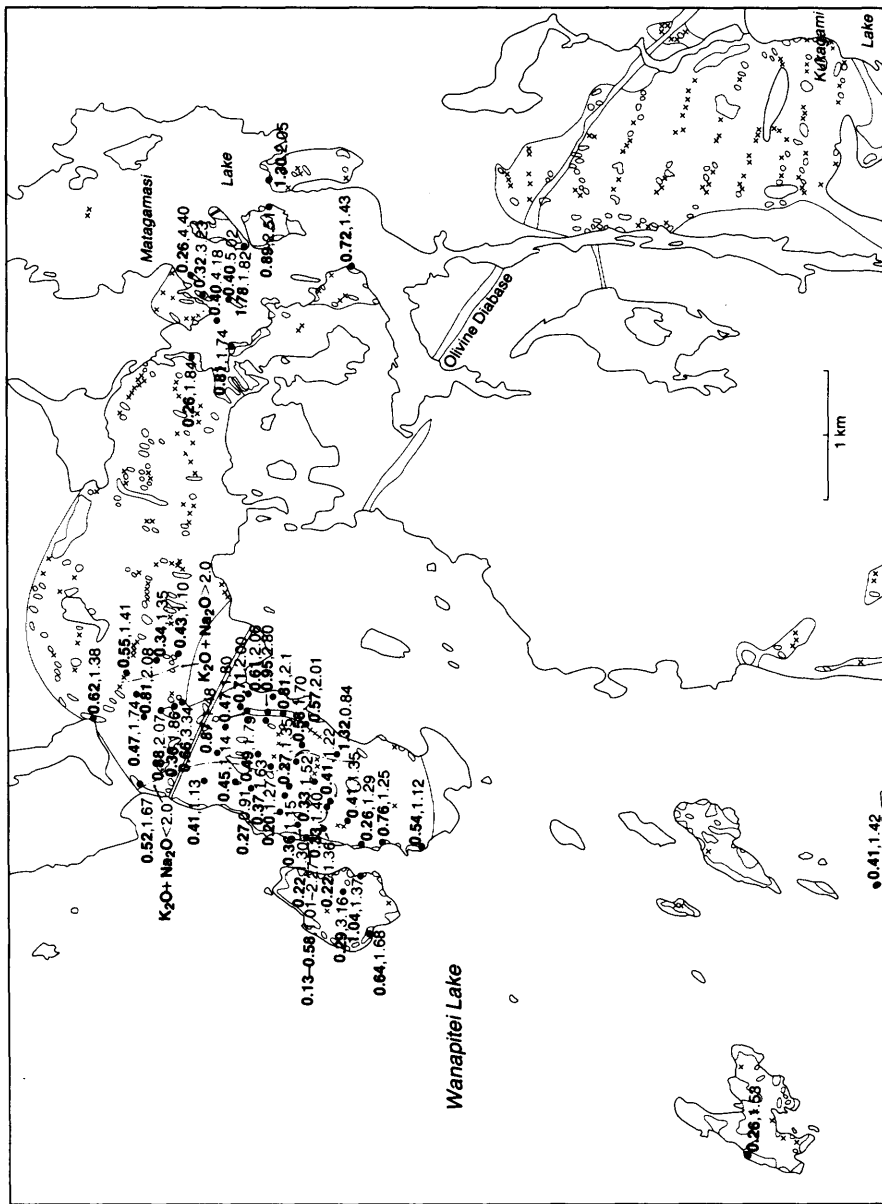


14596

Figure 13—Zone enriched in gold. Lake Wanapitei Nipissing Gabbro Intrusion.

Conclusion

Gold-bearing quartz and quartz-carbonate veins occur near the upper parts of the gabbro intrusion. Copper, nickel, cobalt, and precious metals are enriched near the base of it. The highest gold, copper, and nickel values (40 ppb, 590 and 361 ppm) were obtained about 0.6 km southwest of the occurrence of Cu, Ni, Ag, Au, Pd, Pt in massive sulphides at Rathbun Lake. Along the lower western contact, the gabbro in general appears to be enriched in these metals. The massive sulphide occurrence also lies at this contact. At the time of writing, an extrapolation of the results obtained from the northwestern part to the rest of the open-ring shaped gabbro intrusion is not possible. More detailed studies are in progress by G. Finn at the University of Western Ontario; London, Ontario.



14598

Figure 15-Variation of MgO (first number) and Fe₂O₃ (total) (second number) (in weight percent) within the Lake Wanapitei Nipissing Gabbro Intrusion.

TABLE 14 | CHEMICAL ANALYSES OF LAKE WANAPITEI NIPISSING GABBRO INTRUSION, WANAPITEI LAKE AREA. *

Sample Number	45E2	45E3	45E4	45E4	45E4	45E6	45E7	74E13	74E14	75E2
Major Components in Weight Percent										
SiO ₂	51.20	50.00	50.00	52.10	51.80	51.70	50.70	50.70	50.70	51.60
Al ₂ O ₃	14.90	15.00	17.20	17.50	14.20	14.20	15.10	16.10	16.10	15.70
Fe ₂ O ₃ total	11.30	9.23	9.81	11.30	9.42	10.10	8.63	8.80	8.80	11.20
MgO	7.10	11.30	7.78	5.91	10.90	10.40	9.97	10.10	10.10	5.43
CaO	10.60	11.30	11.30	9.56	11.60	11.30	12.40	12.50	12.50	9.67
Na ₂ O	1.80	1.14	1.63	2.10	1.40	1.35	1.42	1.53	1.53	3.16
K ₂ O	0.47	0.45	0.37	0.81	0.33	0.41	0.41	0.26	0.26	0.29
TiO ₂	0.62	0.39	0.47	0.84	0.42	0.46	0.44	0.42	0.42	0.80
P ₂ O ₅	0.08	0.05	0.07	0.10	0.05	0.07	0.06	0.06	0.06	0.12
MnO	0.20	0.18	0.18	0.18	0.17	0.19	0.15	0.16	0.16	0.15
L.O.I.	0.30	0.40	0.40	0.60	0.80	0.40	0.80	0.50	0.50	1.60
Total	98.57	99.44	99.21	101.00	101.09	100.58	100.08	101.13	101.13	99.72
Trace Elements in Parts Per Million (PPM)										
Ag						<3				
Au (ppb)						<10				
Co	50	53	44	43	52	51	47	48	48	36
Cr	68	314	57	25	239	186	335	305	305	26
Cu	118	132	102	97	150	140	102	136	136	88
Ni	65	168	83	49	153	128	163	169	169	39
Pb	71	47	47	41	113	82	73	27	27	22
Zn	99	68	76	92	74	80	66	70	70	70
Pd and Pt						not detected				

TABLE 14 | Continued

Sample Number	3I1	3I2	3I3	3I4	3I5	3I6	3I7	3I8	3I9	3I10	57H1
Major Components in Weight Percent											
SiO ₂	51.40	51.70	57.60	51.60	51.40	50.50	51.20	50.50	52.10	52.20	49.90
Al ₂ O ₃	14.80	17.30	13.30	16.10	12.90	13.40	15.20	15.40	15.30	15.40	12.10
Fe ₂ O ₃ total	11.80	10.90	13.20	9.90	9.52	9.94	9.84	11.30	11.00	10.90	10.40
MgO	7.12	4.38	3.12	8.18	12.20	12.20	8.69	6.84	7.00	7.49	12.00
CaO	10.90	9.96	6.90	11.80	11.80	12.20	11.20	10.70	10.90	10.90	11.00
Na ₂ O	2.42	2.80	3.08	1.79	0.91	1.13	1.48	2.21	2.00	2.06	0.84
K ₂ O	0.55	0.95	1.04	0.49	0.27	0.41	0.87	0.62	0.71	0.61	1.32
TiO ₂	0.61	0.74	1.12	0.47	0.40	0.29	0.48	0.65	0.58	0.56	0.41
P ₂ O ₅	0.08	0.09	0.17	0.06	0.06	0.04	0.06	0.08	0.07	0.05	0.05
MnO	0.21	0.17	0.17	0.19	0.18	0.19	0.18	0.18	0.19	0.19	0.22
CO ₂	0.13	0.32	0.31	0.11	0.08	0.11	0.12	0.08	0.23	0.06	0.14
S	0.05	0.13	0.08	0.06	0.10	0.09	0.06	0.03	0.09	0.07	0.09
H ₂ O [±]	n.d.	n.d.	0.11	0.23	0.32	0.10	0.52	0.99	0.68	0.47	1.67
Total	100.07	99.44	100.20	100.98	100.14	100.60	99.90	99.58	100.85	100.96	100.14
Trace Elements in Parts Per Million (PPM)											
Ag	50	<10	<10	<10	<10	not detected	<10	<10	<10	<10	<10
Au (ppb)	42	40	33	46	48	20	<10	39	47	44	50
Co	35	21	8	69	450	470	103	39	39	43	229
Cr	112	82	52	128	202	240	135	118	115	119	172
Cu	59	38	16	89	200	200	108	61	66	72	153
Ni	12	<10	14	<10	<10	<10	11	<10	<10	<10	<10
Pb	100	88	83	78	65	66	73	80	80	82	68
Zn						not detected					
Pd and Pt											

Geology of the Lake Wanapitei Area

TABLE 14 | Continued

Sample No.	57H2	57H3	57H4	57H5	57H6	57H7	57H8	57H9	57H10	57H11	54G3
	Major Components in Weight Percent										
SiO ₂	51.70	50.70	51.50	50.80	51.60	51.00	50.70	51.20	51.10	49.30	49.30
Al ₂ O ₃	13.40	13.10	13.30	13.90	13.70	12.70	13.20	16.00	15.60	14.20	15.50
Fe ₂ O ₃ total	8.96	9.32	9.86	9.44	8.90	10.00	9.73	9.04	9.73	11.50	9.46
MgO	11.80	12.10	11.40	11.70	12.00	12.70	11.70	9.04	8.69	9.22	8.47
CaO	11.80	12.20	12.10	12.20	12.40	12.20	12.10	12.20	11.70	11.10	12.10
Na ₂ O	1.22	1.28	1.36	1.30	1.27	1.15	1.35	1.52	1.70	2.01	0.97
K ₂ O	0.41	0.26	0.22	0.22	0.20	0.36	0.27	0.33	0.58	0.57	0.43
TiO ₂	0.39	0.37	0.41	0.39	0.34	0.35	0.40	0.42	0.46	0.48	0.48
P ₂ O ₅	0.06	0.05	0.06	0.06	0.05	0.05	0.06	0.06	0.06	0.06	0.06
MnO	0.17	0.18	0.18	0.18	0.17	0.19	0.18	0.16	0.18	0.19	0.18
CO ₂	0.13	0.08	0.07	0.05	0.32	0.12	0.05	0.12	0.13	0.16	0.41
S	0.08	0.08	0.07	0.02	0.04	0.10	0.06	0.03	0.06	0.07	0.07
H ₂ O [±]	0.79	0.04	0.06	0.13	n.d.	0.28	0.19	0.35	0.51	1.37	1.52
Total	100.91	99.76	100.59	100.39	100.99	101.20	99.99	100.47	100.50	100.23	98.95
	Trace Elements in Parts Per Million (PPM)										
Ag						not detected					
Au (ppb)	10	10	10	10	10	10	10	10	10	10	10
Co	43	48	52	45	47	52	46	47	45	52	38
Cr	450	410	280	398	420	430	268	113	88	107	402
Cu	193	208	250	168	190	240	158	142	140	118	90
Ni	212	200	186	178	200	207	157	110	99	110	117
Pb	10	10	10	10	10	10	10	10	10	21	10
Zn	62	64	70	62	58	62	64	62	75	85	61
Pd and Pt						not detected					

Notes:

* Chemical analyses performed by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Abbreviation

n.d. — not detected.

TABLE 15 | CHEMICAL ANALYSES OF LAKE WANAPITEI NIPISSING GABBRO INTRUSION, MATAGAMASI LAKE, WANAPITEI LAKE AREA.

Sample Number	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
Major Components in Weight Percent										
SiO ₂	51.9	53.9	53.4	51.3	57.0	53.6	53.8	53.0	52.3	52.2
Al ₂ O ₃	15.9	14.9	14.8	15.6	15.9	15.8	16.4	17.2	14.1	14.8
Fe ₂ O ₃ total	10.3	12.7	12.2	10.2	6.59	8.63	5.74	7.08	12.8	13.7
MgO	7.14	4.85	5.82	7.76	10.9	13.0	11.6	12.3	7.27	5.20
CaO	9.99	8.19	8.73	9.29	0.17	0.24	1.10	0.22	9.02	8.36
Na ₂ O	2.05	2.51	1.43	1.82	4.40	3.23	5.02	4.18	1.84	1.74
K ₂ O	1.30	0.89	0.72	1.78	0.26	0.32	0.40	0.40	0.26	0.81
TiO ₂	0.63	0.95	1.07	0.46	1.22	1.04	0.99	0.82	0.71	1.07
P ₂ O ₅	0.08	0.12	0.11	0.07	0.11	0.10	0.09	0.08	0.09	0.09
MnO	0.18	0.17	0.21	0.14	0.02	0.02	0.03	0.02	0.21	0.21
L.O.I.	1.80	2.00	2.70	2.30	4.90	5.80	6.20	5.50	2.50	2.20
Trace Elements in Parts Per Million (PPM)										
Ag	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
An (ppb)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Co	39	35	46	47	25	31	23	17	46	43
Cr	66	19	139	33	17	21	26	36	32	33
Cu	122	74	68	116	7	8	6	6	116	64
Ni	80	36	59	66	73	62	96	83	57	29
Pb	67	16	41	16	<10	10	10	74	93	110
Zn	66	58	128	52	10	12	12	10	87	89
Pd and Pt					not detected					

Note:
 * Chemical analyses performed by Geoscience Laboratories, Ontario Geological Survey, Toronto.

SUDBURY BASIN ROCKS, BRECCIAS, AND NICKEL IRRUPTIVE

Whitewater Group

The Whitewater Group comprises the Onaping, Onwatin, and Chelmsford Formations, and is only found within the Sudbury Basin. The group is at least 1800 m.y. old and slightly older than the Nickel Irruptive (Fairbairn *et al.* 1969).

The Onaping Formation is the only formation of the Whitewater Group present in the map-area. The carbonaceous and pyritic siltstone of the Onwatin Formation and the wacke of the Chelmsford Formation appear to be absent.

ONAPING FORMATION

The Onaping Formation of the map-area can be subdivided into two members, the "Quartzite Breccia" (Stevenson 1961) at the base of the formation and the "Onaping Tuff" (Coleman 1905) overlying the breccia.

Quartzite Breccia

A quartzite breccia forms the base of the Onaping Formation in the area. The overlying tuff of the Onaping Formation and the underlying Nickel Irruptive micropegmatite include quartzite clasts¹. The breccia forms a 0.4 km wide band between the tuff and the micropegmatite.

The quartzite is a fine- to medium-grained, light grey to cream coloured rock. Clast sizes range from over 30 m to less than 1 cm. The matrix is very fine grained, grey, contains small mineral and quartzite fragments, and resembles the matrix of the Sudbury-type breccias or the fine-grained groundmass of the Onaping tuff. Photo 7 illustrates a typical quartzite breccia in the area.

Only a few thin sections of the quartzite breccia were studied during the present investigations. The quartzite is composed of quartz, albite, and small amounts of chlorite and iron oxide minerals. Quartz is strongly strained and commonly fractured in places, however, it is recrystallized. It forms grains 0.03 mm to 1.5 mm in maximum dimension. A strong feldspathization is evident in all thin sections studied. The feldspar is albite and forms xenomorphic grains grown interstitially between grains of quartz or forms rosette-like hypidiomorphic laths. Strongly and very weakly feldspathized quartz was observed in one thin section. Hand specimens of strongly feldspathized quartzite resemble granite.

¹At two locations, the same quartzite forms inclusions up to about 60 cm in-size within the sublayer near the footwall of the Nickel Irruptive. The locations are about 500 m south of the Nickel Rim Mine and about 350 m east-southeast of the Victor Mine.



OGS 10 317

Photo 7—Quartzite Breccia. Southeastern Capreol Township.

The fine-grained grey matrix of the breccia consists of quartz, feldspar, chlorite, and almost completely chloritized biotite.

Origin of the Quartzite Breccia

The breccia at the base of the Onaping Formation was originally referred to as the Trout Lake conglomerate (Coleman 1905). A.G. Burrows and H.C. Rickaby (1929), E.S. Moore (1930), W.H. Collins and E.D. Kindle (1935), and H.C. Cooke (1946) described the rocks as breccias and agglomerates of pyroclastic origin. J.E. Thomson (1956a,b), J.E. Thomson and H. Williams (1956, 1959), and H. Williams (1956) referred to these rocks as rhyolite and rhyolite breccias. More recently, J.S. Stevenson (1961) termed the rock "Quartzite Breccia".

The Quartzite Breccia is stratigraphically equivalent to the Basal Breccia of W.V. Peredery (1972). Peredery described the basal breccia as containing mainly metasedimentary, granitic, or gneissic fragments. He compared the breccia with the Bunte Breccie (Gümbel 1870), a fall-back breccia in the Ries meteorite impact crater in southern Germany. As in the Ries crater, the basal breccia of the Sudbury structure consists mainly of stratigraphically younger rocks affected by the crater forming event. The stratigraphically older brecci-

ated rocks are mainly found in the overlying tuffs, part of the Onaping Formation and the suevite, part of the Ries crater. The main differences between the "Bunte Breccie" and the "Quartzite Breccia" is that in the map-area, the breccia is not "bunt", that is multicoloured, but consists only of one rock type, namely quartzite, and that no feldspathization affected the Ries "Bunte Breccie". In the Ries crater, the breccia is composed of Tertiary to Triassic sedimentary rocks and a great variety of igneous and metamorphic basement rocks (Dressler *et al.* 1969).

It is beyond the scope of this report to theorize on the origin of the Sudbury structure. However, the stratigraphic position and resemblance of the "Bunte Breccie" in a well established meteorite impact crater and the basal breccia, namely the Quartzite Breccia, of the Sudbury Basin is striking.

Onaping Tuff

The very southwestern part only of the map-area is underlain by the Onaping tuff. Only the lower third of the tuff sequence is exposed there.

The tuff lacks bedding and other sedimentary features. Bomb-like and contorted fladen-like bodies were observed at a few places. The tuff is grey or dark grey, and consists of country rock fragments set in a commonly lapilli-sized tuff matrix.

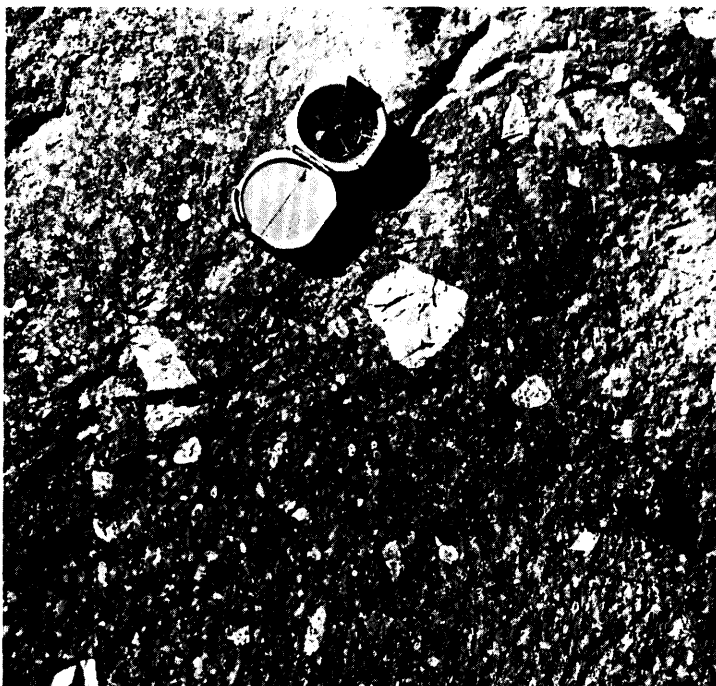
The tuff shows a size grading of fragments within the 0.8 km wide section of the Onaping tuff that is exposed in the area. Close to the underlying Quartzite Breccia, the tuff is made up of lapilli-size clasts and blocks and boulders of quartzite and Early Precambrian granitic rocks (Photo 8). The large fragments are angular, as much as 1.5 m in length, and commonly 20 to 50 cm in size near the base of the tuff: a gradual decrease takes place in fragment size upward in the section. In the uppermost part of the tuff exposed in the area, the quartzite fragments are only 1 to 2 cm, rarely 3 or 4 cm, in length. Also, the tuff matrix itself appears to become finer grained towards the top of the formation.

The country rock fragments show shock-metamorphic mineral deformation such as deformation lamellae in quartz (Carter 1968) and plagioclase (Photo 9). A strong recrystallization, however, has apparently destroyed most shock metamorphic features. This deduction was made after studying five Onaping tuff thin sections. No volcanic rock fragments were observed.

The tuff itself consists of recrystallized glass fragments that are commonly shard-like and composed of, mineral and rock fragments, and a fine-grained recrystallized matrix. The matrix consists of fragments of quartz, feldspar, glass shards, and a submicroscopic material. Eutaxitic textures are quite common.

Origin of the Onaping Tuff

It is beyond the scope of this report to speculate on the origin of the Onaping tuff, and by implication the origin of the Sudbury Basin. The reader is referred to the accounts given by K.D. Card (1978a), J.S. Stevenson (1972), and Peredery (1972) for a more detailed petrological description of the tuff and for a



OGS 10 318

Photo 8—Lower Onaping Tuff. Southeastern Capreol Township.

discussion of the origin of the rocks. Stevenson interpreted the Onaping tuff to be a volcanic ash-flow sheet, whereas Peredery advocated a meteorite impact origin of the Sudbury Basin and described the Onaping tuff as a sheet of fall-back breccia.

Footwall Megabreccia, Sudbury-Type Breccia, and Pseudotachylites

Footwall megabreccia, Sudbury-type breccia, and pseudotachylite are older than the intrusion of the Sudbury Nickel Irruptive. The age relations of these rocks with respect to the Onaping Formation are not known. If the Sudbury structure originated by an impact of a meteorite the assumption would be made that all the breccias and the Onaping tuff originated simultaneously.

Footwall Megabreccia

On the geological map that accompanies this report (Map 2451, back pocket) an attempt has been made to illustrate the complex mode of occurrence of



OGS 10 319

Photo 9—Deformation lamellae in plagioclase. Onaping Tuff. Southeastern Capreol Township. Scale 0.1 mm. Crossed polarizers.

the geological formations in two localities, one is near the village of Skead, and the other is between the western shore of Massey Bay of Lake Wanapitei and the Nickel Irruption. The result, however, is only an approximation of the actual conditions. In places, the rock types are so intimately mixed that only the most detailed investigations could clarify the geological picture presented on the geological map. Thomson (1961, p.9) stated that units northwest of Massey Bay could be best described as a "chaos complex".

The "chaos complex" forms the footwall of the Sudbury Nickel Irruption. In the map-area it consists mainly of; (a) Early Precambrian gneisses, metasediments, metavolcanics, and granites, (b) minor Huronian sedimentary rocks, and (c) Nipissing gabbro. The chaotic mode of occurrence, shown by the brecciation and fracturing of the rocks, probably accompanied by minor movement and rotation of some megaclasts, was caused by the Sudbury Event. The distortion of the primary geological structure was not severe enough to obliterate the primary northwest trend of numerous Early Precambrian diabase dikes.

The size and shape of the footwall megabreccia clasts are not easily perceived. Transitions from sublayer leucocratic breccia (see section on sublayer) to footwall megabreccias apparently occur, and the difference between the two breccia types is probably only the size of the clasts. Megaclasts possibly range from 50 to 400 m in maximum dimension. Near the Sudbury Nickel Irruptive, the geological situation is still more complicated by the intrusion of sublayer (see under "Sublayer") leucocratic breccia between footwall megaclasts (megabreccia of Pattison 1979). Detailed observations are limited by the size of rock exposures. The author, however, observed outcrop areas in the "chaos complex" that are up to 400 m in size and that do not show any signs of severe brecciation or fracturing.

On the geological map that accompanies this report (Map 2451, back pocket), the geological boundaries within the megabreccia zone are in places arbitrary. The reasons for this are obvious after the reader has obtained a comprehensive understanding of the description of the breccia zone.

Sudbury-Type Breccia

Sudbury-type breccias are abundant in the surrounding area and for some 15 km beyond the boundary of the Nickel Irruptive. K.D. Card (1978a, p.194-195) presented evidence that the distribution and trends of the breccia bodies are irregular, but a suggestion of radial and concentric patterns exists about the Sudbury Nickel Irruptive. The author of this report makes the observation that the breccias quite commonly occur at the contacts of rock formations or appear to be associated with major faulting. For instance, the breccias were quite commonly observed at the contacts of Nipissing gabbro with older rocks or at the contacts of Gowganda Formation wackes with the overlying sandstone of the Lorrain Formation at Bassfin Lake. The Laundry Lake Fault in Mackelcan Township is characterized by many breccia and pseudotachylite occurrences. The breccias are most abundant close to the Sudbury Basin and are less abundant further away from it.

The Sudbury-type breccia bodies consist mostly of locally derived subangular to rounded rock fragments in a fine-grained dark grey rock flour matrix. The bodies form large breccia zones, smaller patches, and dikes. The contacts with the host rocks are sharp. Microscopically, the matrix consists of rounded and angular mineral fragments, mostly quartz and feldspar, in an extremely fine-grained rock powder.

The breccia fragments and the matrix were not chemically investigated by the author. Card (1978a, p.193) stated that "the bulk chemical composition of the matrix materials corresponds closely to the average composition of the contained rock fragments indicating that the breccias were formed primarily by an "in situ" milling process (Card 1968; Speers 1957)". Apparently, the only significant additions were water and carbon.

Pseudotachylite

Pseudotachylites (Shand 1916) are rocks that look like tachylites. All transitions occur between typical Sudbury-type breccias and pseudotachylites. The author therefore believes that the pseudotachylites and breccias originated by the same deformational process. The pseudotachylites, in contrast to the breccias, macroscopically resemble igneous injections that penetrate the host rocks in a very irregular pattern. Pseudotachylites form discontinuous dikes, veinlets, apophyses, and very thin seams, and are aphanitic, black or dark grey, and glassy looking in places. They may or may not include fragments of the country rock.

Pseudotachylites and the host rocks are of about the same chemical composition. Pseudotachylites originated from the host rocks by strong tectonic forces, and are known to occur along major faults and in meteorite impact craters. Pseudotachylites associated with faults were described from the Alps (Masch 1970), from Scotland ("flinty crush rocks"; Park 1961) and from some other localities. Pseudotachylites in meteorite craters were described among other craters from several Canadian localities (Dence 1964; Dressler 1970; Murtaugh 1976) and from the Ries crater in southern Germany (Dressler and Graup 1969). S.J. Shand (1916) explained the origin of the Vredefort structure pseudotachylites as follows: "the pseudotachylite has originated from the granite itself through melting, caused (as I have shown) not by shearing but by shock, or alternatively, by gas-fluxing". French (1968, p.409) stressed the strong similarity between the character of the Vredefort pseudotachylite and the Sudbury breccia.

Sudbury Nickel Irruptive

The Sudbury Nickel Irruptive has a radiometric age of 1844 ± 3 m.y. (Krogh and Davis 1975) and forms a northeast-trending elliptical ring that is approximately 60 km long and 27 km wide. The intrusion is tholeiitic and consists of a lower (outer) part of "norite" and an upper (inner part) part of granitic rock, commonly termed "micropegmatite". The rocks dip westerly (Mamen 1955) in the map-area.

Rocks of the Nickel Irruptive outcrop in the southwestern part of the map-area. For mapping purposes, the Nickel Irruptive was subdivided into four units: sublayer, norite, transition zone norite, and micropegmatite.

Sublayer

The copper-nickel ores of the Sudbury Nickel Irruptive are associated with an inclusion-bearing rock unit, the so-called sublayer, that occurs as flat lenses and sheets along the lower contact of the Nickel Irruptive. It also forms offset dikes that radiate outward from the Nickel Irruptive. The sublayer is pre-main Sudbury Nickel Irruptive.

Two variants of sublayer rocks can be recognized (Pattison 1979); the "leucocratic breccia" and the "igneous sublayer". The leucocratic breccia, generally speaking, consists of fragments of footwall rocks and of mafic and ultramafic rocks, set in a fine-grained, light grey to pinkish grey matrix. The matrix is described by E.F. Pattison (1979) as being mosaic-granoblastic metamorphic. The igneous sublayer, commonly lying between the main Nickel Irruptive and the leucocratic breccia, is characterized by a great variety of mafic and ultramafic rock fragments and minor footwall rock fragments interbedded in a medium-grained gabbroic matrix. D.R. Rae (1975), in a study of the igneous sublayer from the Strathcona Mine in Levack Township, described fragments of wehrlite, clinopyroxenite, websterite, lherzolite, dunite, harzburgite, orthopyroxenite, norite, gabbro, and footwall hornfels.

In the map-area, sublayer rocks occur from the Nickel Rim Mine to north of Capre Lake. Outcrops of the igneous sublayer are scarce and were observed mainly at Blue Lake and Capre Lake. These outcrops contain mainly mafic and ultramafic rock fragments. The leucocratic breccia is well exposed at Capre Lake. Fragments within it range in size from a few millimetres to several metres and consist of granite, hornblende gneiss, diabase, gabbro, anorthosite, banded magnetite ironstone, and amphibolite. All these rock types except ironstone and anorthosite are known to occur relatively close to the sublayer occurrences in the map-area. The nearest ironstones occur northwest of Wanapitei Lake. The nearest anorthosite occurs in Falconbridge Township, about 8 km south of the map-area.

Norite and Micropegmatite

The typical norite is a medium-grained, grey to dark grey, equigranular rock. The transition zone norite is very similar, but contains some pinkish, macroscopically visible granophyric intergrowths. The micropegmatite is a pink, medium- to coarse-grained, granitic-looking rock.

A 0.5 m wide northeast-striking granitic dike was observed by the author intruding the norite about 0.8 km southeast of the southeast end of Blue Lake. The dike outcrops over a length of about 10 m. The granitic rock is pink, very fine grained, and equigranular. Just west of the MacLennan Mine near Skead another granitic dike occurs within the norite.

Under the microscope, the Sudbury Nickel Irruptive rocks are seen to be composed of quartz, plagioclase, augite, hypersthene, biotite, chlorite, opaque oxides, and apatite. Photos 10 to 12 inclusive show a typical norite, a transition zone norite, and a typical micropegmatite respectively.

In a detailed study of the Sudbury Nickel Irruptive, A.J. Naldrett *et al.* (1970) sampled a section across the East Range norite and micropegmatite ("MacLennan Traverse"). Their petrographical investigations are based on studying and modally analyzing 460 thin sections. Their results are shown in Figure 17. Naldrett *et al.* (1970) emphasized the similarity of the East Range rocks with those of the North Range. Secondary alteration, however, appears to be stronger in the East Range than in the North Range of the Sudbury Nickel Irruptive. The following petrographic description is based on the investigations of Naldrett *et al.* (1970) investigations.

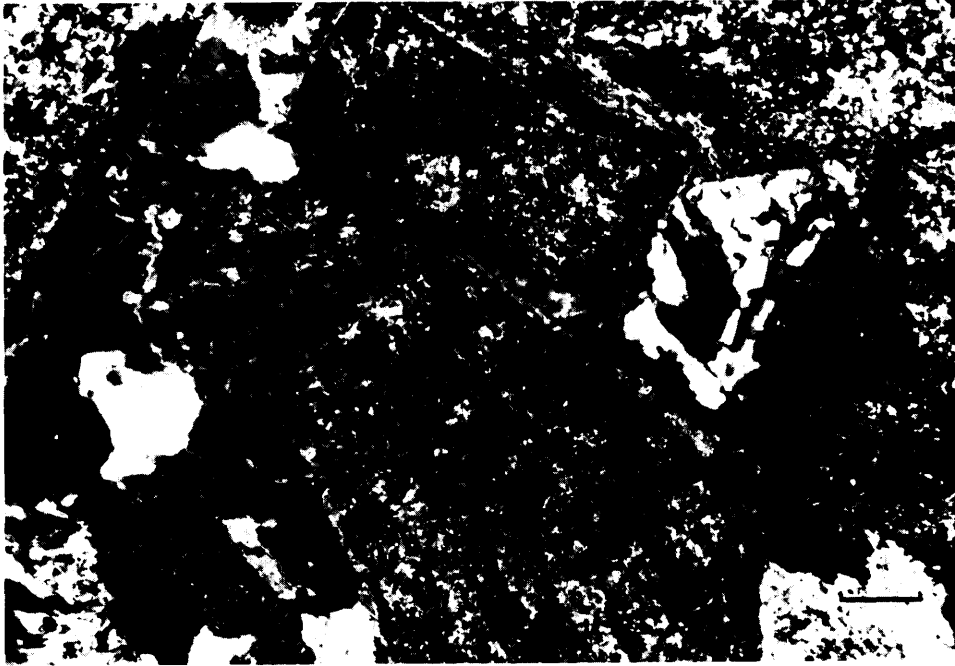


OGS 10 320

Photo 10—Norite, very little granophyric intergrowth and quartz. Sudbury Nickel Irruptive near the Nickel Rim Mine. Scale 0.25 mm. Crossed polarizers.

Plagioclase is commonly intensely altered, and Naldrett *et al.* (1970) were only able to obtain analyses from samples within the central parts of the “felsic norite”, one near the outer margin of the “oxide-rich gabbro” and another from near the outer margin of the micropegmatite. In the felsic norite, the anorthite content of the plagioclase in general decreases upward within the section from about An₅₉ to about An₅₁. Within the oxide-rich gabbro zone, plagioclase changes abruptly from An₅₀ in the felsic norite to about An_{3.5}. This abrupt change, as Naldrett *et al.* (1970) stated, “is associated with the equally abrupt appearance of numerous epidote inclusions in the plagioclase, indicating that the change is the result of a secondary reaction”. The Fe: (Fe + Mg) ratio of augite in the MacLennan traverse shows little change “in the outer two thirds of the felsic norite, but continuing inward there appears to be a progressive increase in the ratio that extends well into the oxide-rich gabbro” (Naldrett *et al.* 1970). In the felsic norite the Fe: (Fe + Mg) atomic ratio of augite is about 0.25 to 0.37, in the oxide-rich gabbro this ratio is about 0.33 to 0.50. No fresh hypersthene was observed by Naldrett *et al.* (1970) in the MacLennan traverse.

The Sudbury Nickel Irruptive is a differentiated, tholeiitic intrusion. This is shown by the investigations of Naldrett *et al.* (1970) and, among other studies, by a geochemical study published by C.W. Knight in 1923. Knight chemi-



OGS 10321

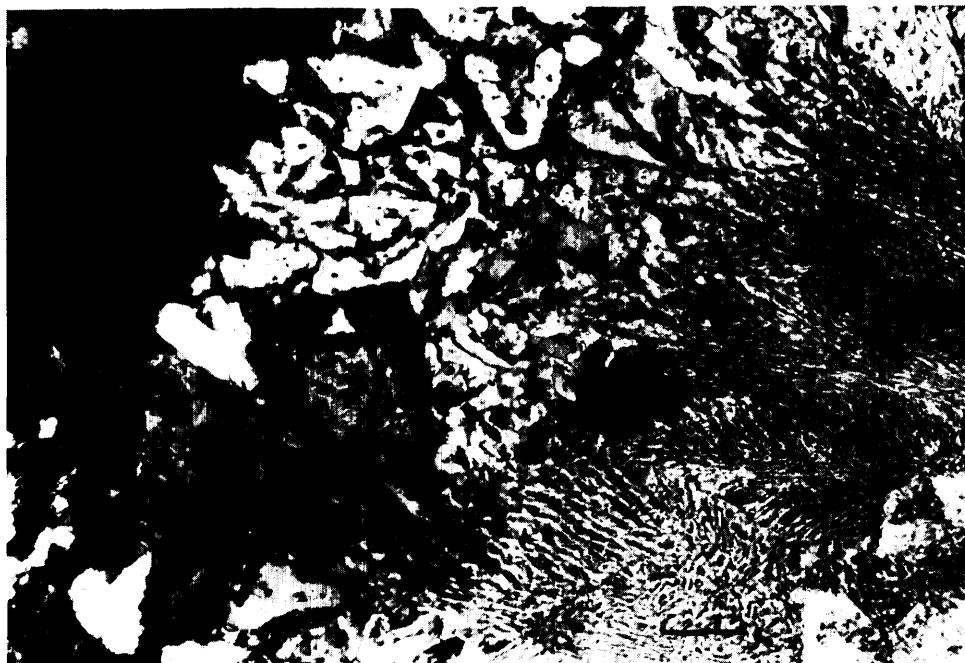
Photo 11—Transition zone norite, little granophyric intergrowth. Sudbury Nickel Irruptive near Blue Lake. Scale 0.25 mm. Crossed polairzers.

cally analyzed 17 specimens from a 2530 m long section across the Sudbury Nickel Irruptive in MacLennan Township. The mean values of his 17 analyses are presented in Table 16.

Late Precambrian

Olivine Diabase

Several olivine diabase dikes occur in the map-area. These dikes belong to the northwest-trending "Sudbury Swarm". Different radiometric ages have been reported for the dike rocks. According to W.R. Van Schmus (1965) their age is 1280 m.y. More recently, T.M. Gates and P.M. Hurley (1973) obtained a Rb-Sr isochron age of 1460 ± 130 m.y. on dikes in the Sudbury area. W.H. Fahrig and R.K. Wanless (1963) reported K-Ar whole rock ages of 431 ± 80 and 416 ± 76 million years from specimens which were taken from diabase dikes that extend across the Grenville Front Tectonic Zone to the south of the map-area



OGS 10 322

Photo 12—Micropegmatite, abundant granophyric intergrowth. Sudbury Nickel Irruptive near Blue Lake. Scale 0.25 mm. Crossed polarizers.

into the Grenville Structural Province. These ages and the rather constant geographic orientation of most dikes implies that intrusion of the dikes occurred under regional tensional stress over a long period of time. The tensional stress responsible for the emplacement of the Sudbury Swarm appears to have been a large scale tectonic feature because the Sudbury dikes are similar in trend, paleomagnetic properties, and age to the Mackenzie Swarm in the northern Canadian Shield (Fahrig and Jones 1969).

The olivine diabase dikes are the youngest pre-Cenozoic rocks in the area. A dike up to 250 m wide extends in a northwesterly direction from west-central Kelly Township, and across Rathbun Township to central Aylmer Township. Several thinner dikes were observed in most other townships of the map-area. The dikes commonly are several kilometres long. The 250 m wide dike is about 34 km long and extends from central Janes Township (Dressler 1979) to central Aylmer Township. Many dikes are marked by linear valleys.

The olivine diabase is commonly medium grained, in places coarse grained to pegmatitic. Very fine grained, almost aphanitic and porphyritic dikes were also observed. These are about 1 to 3 m thick. The medium-grained rocks are dark, somewhat bluish grey on a fresh surface and weather brown. The aphanitic dikes are black and weather dark grey or rusty. These dikes commonly occur close to thicker, coarser-grained dikes and trend more or less parallel to them.

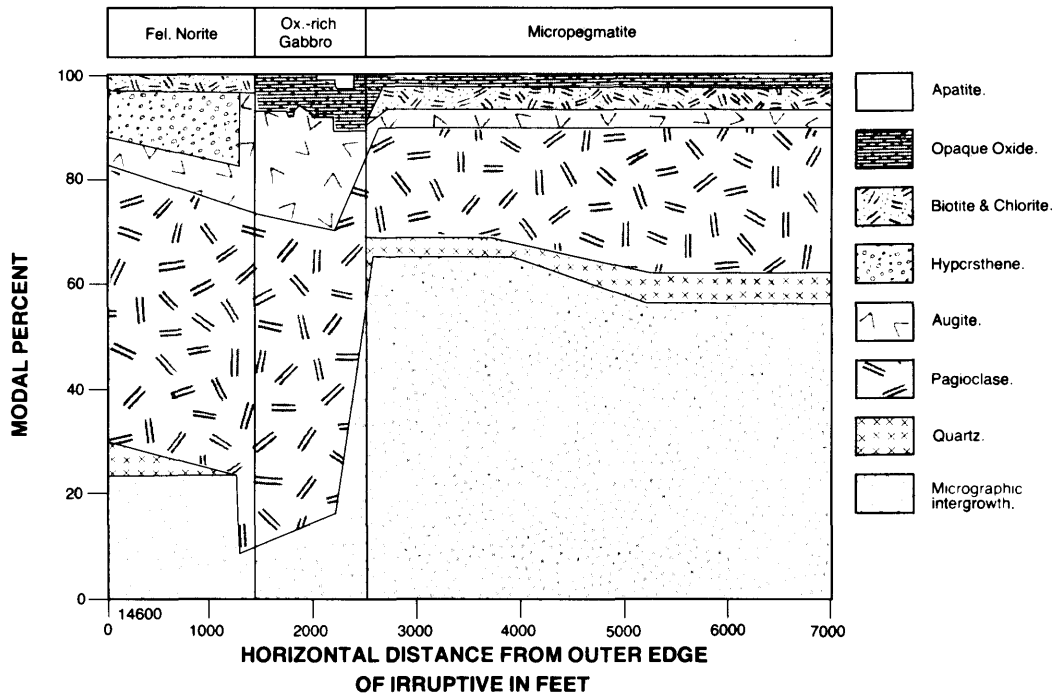


Figure 17—Modal variation over the Macleannan traverse. Data from 460 thin sections (from Naldrett *et al.* 1970). See Table 16 for chemical analyses.

TABLE 16 | CHEMICAL ANALYSES (MEAN VALUES) OF THE MACLENNAN TOWNSHIP NORITE AND MICROPEGMATITE (AFTER KNIGHT, 1923), WANAPITEI LAKE AREA.

	Norite (6 samples, between 0 and 640 m)	Micropegmatite (11 samples, between 640 and 2530 m)
SiO ₂	55.87	67.60
Al ₂ O ₃	19.81	13.39
Fe ₂ O ₃	2.47	3.67
FeO	5.96	4.13
CaO	5.44	1.89
MgO	2.73	1.07
Na ₂ O	3.67	3.46
K ₂ O	1.91	3.25
H ₂ O	2.20	1.53
CO ₂	0.20	0.20



OGS 10 323

Photo 13—Aphanitic, porphyritic olivine diabase. Plagioclase laths and little olivine in an almost opaque groundmass. Westshore of Portage Bay. Scale 0.4 mm. Crossed polarizers.

In places they appear to be apophyses of thicker dikes.

Plagioclase and pinkish, brownish augite of the medium-grained diabase form a subophitic texture. Olivine (Fo₅₅₋₇₀; Fa₄₅₋₃₀) is xenomorphic. Dark brown biotite makes up 0.4 to 2.5 percent, and titaniferous magnetite 2.7 to 8, rarely to 22 percent of the rock. Apatite is an accessory mineral.

Very fine grained to aphanitic and porphyritic olivine diabase (Photo 13) consists of idiomorphic plagioclase phenocrysts that are up to about 0.15 by 1.3 mm in length, and xenomorphic to hypidiomorphic olivine up to 0.37 mm in size set in a very fine grained almost opaque groundmass of opaque ore minerals, pyroxene, and fine plagioclase laths that are up to about 0.01 by 0.13 mm in length. These fine plagioclase needles in places show shapes that are typical of a rapidly cooled rock (Photo 14).

Table 17 presents modal analyses, and Table 18 presents chemical analyses of olivine diabase.



OGS 10 324

Photo 14—Quench plagioclase in olivine diabase, west shore of Portage Bay. Scale 0.03 mm. Plane polarized light.

Hydrothermal Activities

Quartz, Quartz-Carbonate, and Carbonate Veins

Hydrothermal quartz, quartz-carbonate, and carbonate veins are common in almost all the area (see Figure 27, and Photo 17). In most cases, the hydrothermal activity is clearly related to Nipissing intrusions because the quartz, quartz-carbonate, and carbonate veins occur within the gabbros or in the country rocks near the contact with the gabbros. In a few other cases, however, no clear relation can be shown between hydrothermal activity and Nipissing intrusions. In central Matagamasi Lake and in McCarthy Bay, Matagamasi Lake, quartz veins and stockworks appear to be related to faulting and hydrothermal activity along the faults. In southwestern Aylmer Township, calcite veins, stockworks, and dikes up to 2 m thick occur. These probably originated through a strong remobilization of Espanola Formation carbonate minerals caused by the intrusion of Nipissing gabbro.

TABLE 17 | MODAL ANALYSES OF OLIVINE DIABASE, WANAPITEI LAKE AREA.

Sample Number	18E13	38E18	38E19	47F8	64F3	59G8	37E4A
Olivine	3.2	16.5	18.0	15.9	22.7	9.4	3.6
2VX of Olivine**	n.d.	n.d.	78°-80°	76°-78°	80°-82°	n.d.	83°-85°
Olivine***			Fo65-61	Fo61-55	Fo70-65		Fo77-72
composition	n.d.	n.d.	Fa35-39	Fa39-45	Fa30-35	n.d.	Fa23-28
Augite	22.0	10.8	13.1	15.9	3.6	17.9	—
2Vz of augite	48°-50°	n.d.	n.d.	48°	n.d.	n.d.	—
Plagioclase	48.7	63.9	59.3	62.6	64.4	54.8	11.0
							Pheno- crysts Small thin laths
Plagioclase composition	An62-64	An64-68	An65	An65-70	An65	An65	An60-65 An40-48
Biotite	0.4	2.4	1.1	2.2	2.5	4.2	—
Apatite	tr	0.3	1.1	0.2	0.3	tr	—
Actionolite	4.0	—	—	0.5	—	4.2	—
Carbonate	0.1	—	—	—	—	—	—
Opaque minerals	21.6	6.1	7.4	2.7	6.5	9.4	69.5
							Fine ground mass

Notes:

** Two to four determinations.

*** Optical determinations (Tröger 1959; p. 37).

Abbreviation

n.d. — not detected.

TABLE 18 | CHEMICAL ANALYSES OF OLIVINE DIABASE, WANAPITEI LAKE AREA.

Sample Number	37E4A	38E18
SiO ₂	43.60	45.20
Al ₂ O ₃	14.50	17.00
Fe ₂ O ₃	5.89	1.76
FeO	10.80	12.10
MgO	5.55	6.42
CaO	8.01	8.92
Na ₂ O	2.97	3.07
K ₂ O	1.07	0.89
TiO ₂	3.57	2.26
P ₂ O ₅	0.82	0.41
MnO	0.24	0.20
CO ₂	0.74	0.26
S	0.20	0.03
H ₂ O ⁺	0.56	0.44
H ₂ O ⁻		0.39
Total	98.52	99.35

Notes:

* All chemical analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Dolomite Porphyroblastesis

At a few locations in Scadding Township, and at one place in Rathbun Township, dolomite porphyroblasts occur in arkose of the Serpent and Lorrain Formations. Dolomite is¹ hypidiomorphic to idiomorphic, and up to 3 cm in size. The grey, rusty weathering crystals make up 5 to 30 percent of the rock. The porphyroblastic arkoses seem to be stratigraphically controlled because they appear to occur in strike parallel bands. The porphyroblasts, however, also occur in dike-like features perpendicular to the bedding of the host rocks. The shape, extent, and thickness of the porphyroblastic arkose zones having a parallel strike is not known. A maximum thickness of about 2 m has been observed by the author.

Figure 18 illustrates a porphyroblastic, dike-like rock observed west of central Bugg Lake in Scadding Township. Bedding planes of the host rock can be traced through the "dike".

Thin section examination reveals that the dolomite crystals contain up to ten percent minute feldspar and quartz grains. Some porphyroblasts, however, are devoid of any inclusions. The dike rock in Figure 18 contains about 15 per-

¹Dolomite was determined by X-ray diffractometry.

cent more carbonate than the host rock (1-3 percent, Table 19). Both the host rock (Specimen number 13G12A, Table 19), taken very close to the contact of the dike, and the dike rock itself (Specimen 13G12B, Table 19), contain minor amounts of xenomorphic apatite. Apatite was not observed elsewhere in arkose of the Serpent Formation and is possibly related to the dolomite porphyroblastesis. In thin sections of dolomite porphyroblastic arkose from other locations, however, no apatite was observed. The cause of the porphyroblastesis and its age are not known to the author.

Cenozoic

QUATERNARY

Pleistocene and Recent

Pleistocene glacial processes striated, grooved, and eroded the bedrock, scoured away the soil and weathered rock, and laid down a discontinuous mantle of glacial deposits. There were several major advances of glaciers, however, only evidence for the last advance, the Wisconsinan, can be documented in the map-area. The Wisconsinan ice retreated approximately 10 000 years ago (Boissonneau 1968; Prest 1969).

The unconsolidated, Pleistocene sediments can be subdivided into glacial ground moraine and moraine, glaciofluvial outwash, and eskers.

The largest and thickest unconsolidated deposits of the area are found north of Lake Wanapitei and south of the village of Skead. North of Lake Wanapitei are thick sand deposits of probably fluvial or glaciofluvial origin. Near Skead, the deposits consist of sand, boulder, and gravel. Recent sediments of the area are swamp, stream, and lake deposits.

Figure 19 is a sketch-map showing the distribution of major outcrop areas, Pleistocene deposits, and swamps. The figure also shows the direction of glacial striae, these indicate the direction of the last ice movement.

THE LAKE WANAPITEI CRATER

Dence and Popelar (1972) presented topographic, geophysical, and petrographic evidence for a meteorite impact origin of Lake Wanapitei. Topographic indications of this are the shape of the lake and the predominantly concentric pattern of the streams and smaller lakes within 5 km of the lake. Geophysical evidence is a local, almost circular gravity depression over the circular part of the lake with a horizontal gradient of more than 4 mgal/km outward from the centre. This suggests a superficial mass deficiency with a circular plan. Petrographic evidence comes from suevite pebbles and boulders first found by Dence in 1970 at several localities near Massey Bay of Lake Wanapitei. Dence and

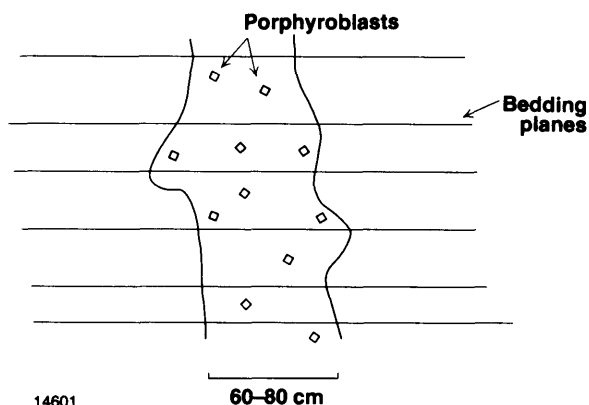


Figure 18—Dolomite porphyroblastesis in a dike-like feature in a Serpent Formation arkose. West of central Bugg Lake. See Table 19 for chemical analyses.

TABLE 19 | **CHEMICAL AND MODAL ANALYSES OF SERPENT FORMATION ARKOSE, WANAPITEI LAKE AREA.***

Specimen Number	13G12A	13G12B
Major Components in Weight Percent		
SiO ₂	79.70	70.90
Al ₂ O ₃	13.40	13.20
Fe ₂ O ₃ (total)	0.25	1.61
MgO	0.51	1.38
CaO	0.55	2.22
Na ₂ O	6.15	6.50
K ₂ O	0.37	0.22
TiO ₂	0.21	0.27
P ₂ O ₅	0.07	0.11
MnO	0.01	0.04
CO ₂	0.58	3.71
S	0.06	0.46
Total	101.86	100.62
Modal Analyses in Volume Percent		
Quartz	56.0	50.0
Feldspar	40.0	29.0
Matrix	little	4.0
Opaque minerals		1.0
Carbonate	3.0	16.0
Apatite	<1.0	tr

Notes:

* Chemical analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Specimen 13G12A unaltered, specimen 13G12B with dolomite porphyroblasts.

Geology of the Lake Wanapitei Area

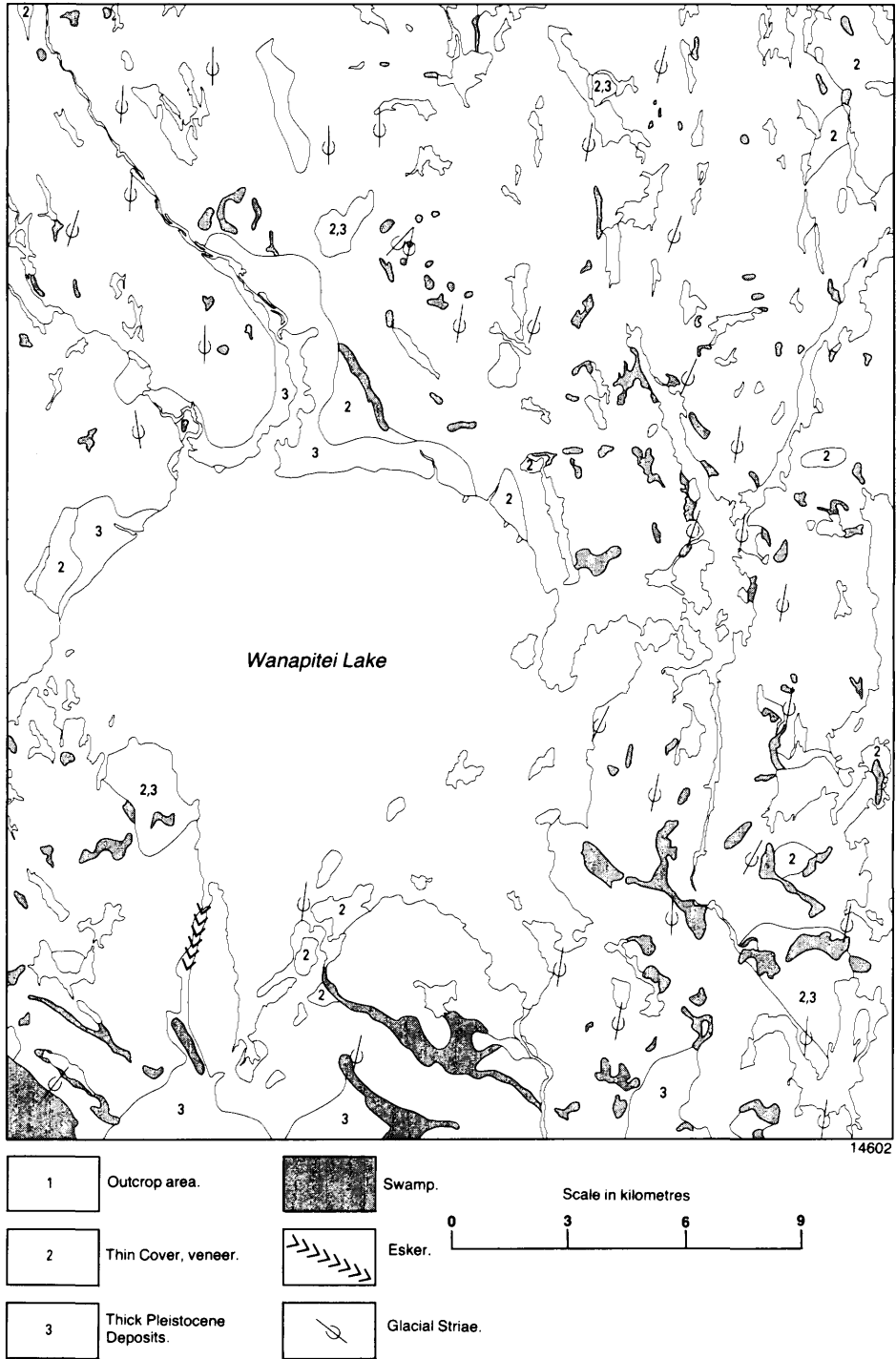
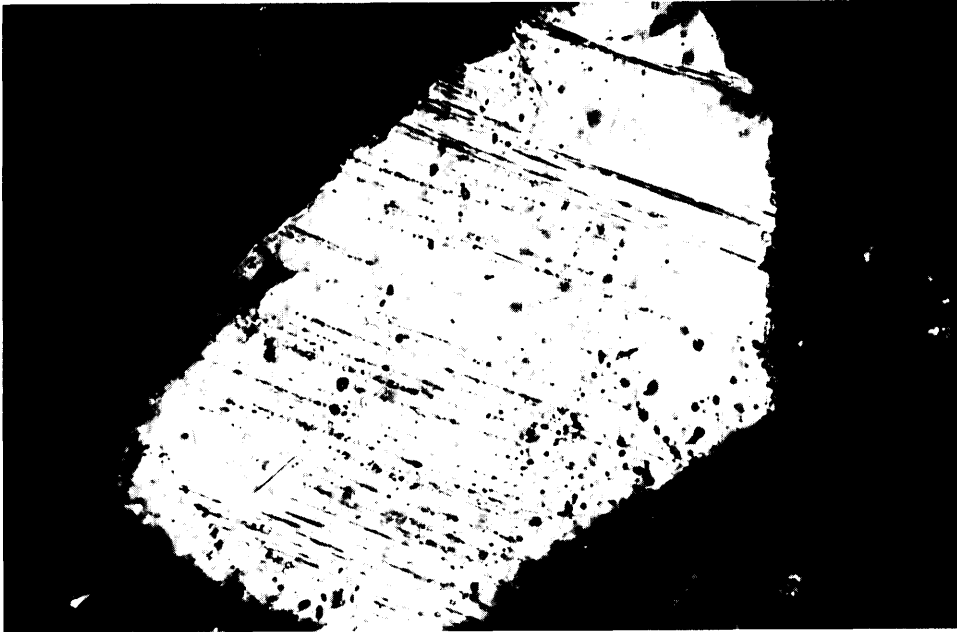


Figure 19—Sketch map of Pleistocene and Recent geology.



OGS 10 325

Photo 15—Decorated deformation lamellae in quartz. Suevite boulder, Massey Bay. Length of quartz grain 0.2 mm. Plane polarized light.

Popelar (1972) suggest that the breccias (suevite) had been scoured from the lake during the last period of glaciation. The suevite of the type location, the Nördlinger Ries in Germany, is a fall-back breccia containing fragments of shock metamorphosed rocks and diaplectic glass set in a matrix of fine-grained mineral, rock, and glass fragments. Dence and Popelar (1972) gave a description of the Lake Wanapitei suevite and also a resumé of their microscopic investigations of the breccias. These authors described the common shock-metamorphic features in the rock forming minerals of the fragments, such as deformation lamellae and diaplectic vitrification and also reported the discovery of coesite. Photo 15 shows deformation lamellae in a quartz grain in suevite.

Several shatter cone locations are indicated on the geological maps that accompany this report (Maps 2450 and 2451, back pocket). Most locations are on the shore or on the islands of Lake Wanapitei. However, shatter cones were also found by the author up to 5 km northwest of the lake. Some shatter cones northwest of the lake occur in a zone of very strong rock brecciation (Photo 16).

The author studied many thin sections of rock specimens taken from outcrops on the shoreline of Lake Wanapitei and on islands in the lake. Deformation lamellae in quartz were observed at only three locations, these are; a) on a

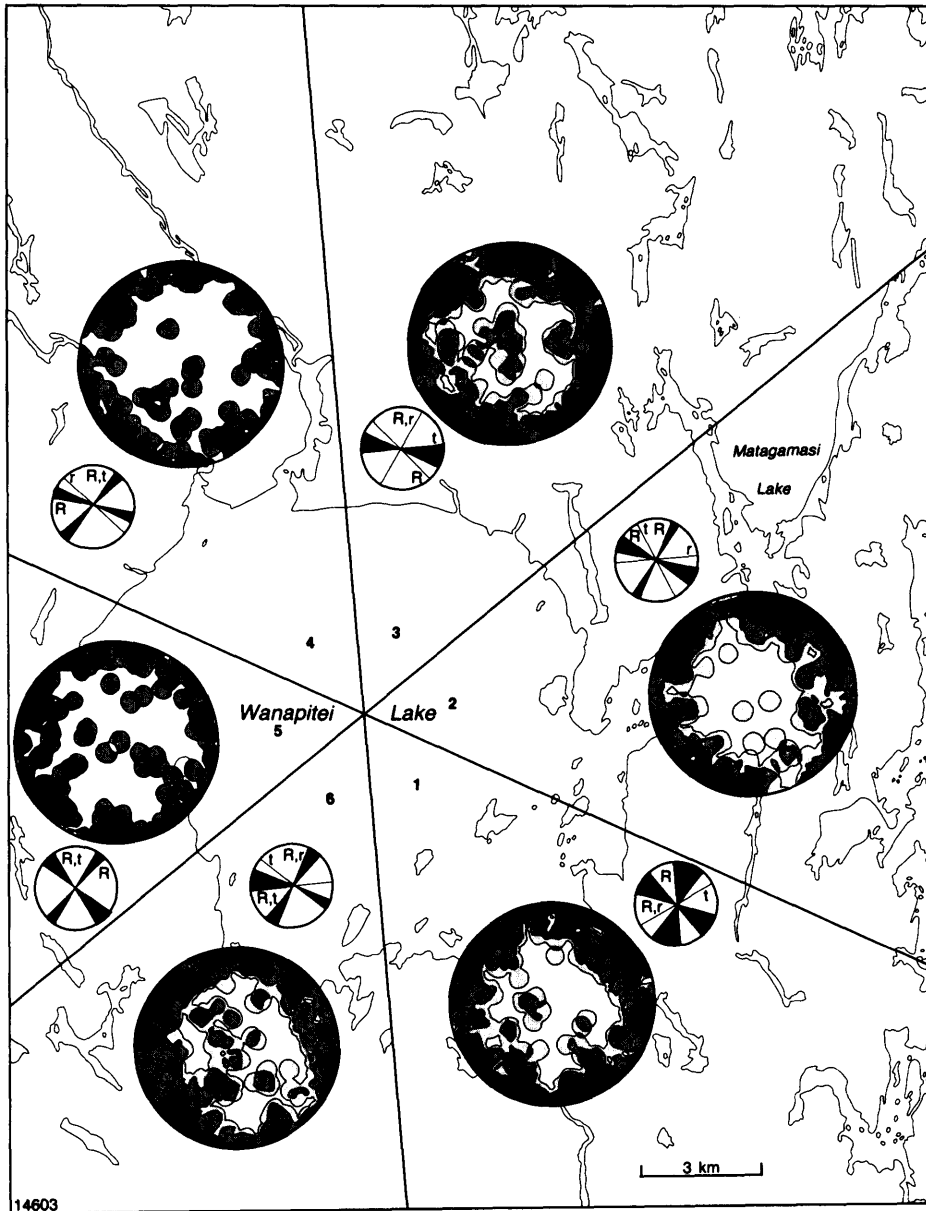


OGS 10 326

Photo 16—Brecciated Lorrain Formation arkose. Northwest of Lake Wanapitei.

tiny island about 0.6 km south of Blueberry Island in western Lake Wanapitei, b) on the western shore of Massey Bay, and c) near the Skead Station. At the two first mentioned locations, the lamellae are in sedimentary rocks of the Mississagi Formation, at the third, in a granitic rock. At all these locations the barely recognizable lamellae were noticed only in a few quartz grains of the thin sections studied by the author. No islands exist in the central part of Lake Wanapitei, where shock metamorphic effects, if present, would be strongest.

In Figure 20, 1340 joint measurements around Lake Wanapitei are plotted on six point density stereograms of six segments of an area with its centre being the approximate geographic centre of Lake Wanapitei. Most stereograms indicate steeply dipping northwest-northeast-trending joint sets. These joints



14603

Sector 1: 263 points; 1(0.4%)–2(0.75%)–4(1.5%)–8(3%)–12(4.6%).

Sector 2: 253 points; 1(0.4%)–2(0.8%)–4(1.6%)–8(3.2%)–12(4.7%).

Sector 3: 303 points; 1(0.3%)–2(0.7%)–4(1.3%)–8(2.6%)–12(4%).

Sector 4: 106 points; 1(0.9%)–2(1.9%)–4(3.8%)–6(5.7%).

Sector 5: 123 points; 1(0.8%)–2(1.6%)–4(3.2%)–8(6.5%).

Sector 6: 279 points; 1(0.4%)–2(0.7%)–4(1.4%)–8(2.9%)–12(4.3%).

R.....Regional.
 r.....Radial
 t.....Tangential.

Figure 20—Jointing around Lake Wanapitei.

are of regional character and were not formed by the crater forming event. In stereograms 1, 3, 6, and also possibly 2, tangential joints, joints tangential to the circular outline of the "crater" can be recognized. In stereograms 4 and 5, the regional northwest- and northeast-trending joints coincide with the tangential joints. Radial joint patterns are indicated in all the stereograms except for number 5. The stereograms are not conclusive, because in stereograms 1, 3, and 6, radial joints coincide with regional patterns. Also stereograms 4 and 5 are not very conclusive. This possibly is due to the strong cataclasis near the Sudbury Nickel Irruptive. Nevertheless, they show the regional trends.

The tangential joints coincide with the concentric pattern of streams and lakes around Lake Wanapitei. The joints also appear to have a radial pattern. The joint pattern around Lake Wanapitei, therefore, appears to substantiate the observation that the circular shape of Lake Wanapitei is not incidental, but was caused by a geological event, namely the impact of a meteorite or was caused by a conventional endogenic, source, namely volcanic forces.

The joint measurements around Lake Wanapitei used to make the six stereograms of Figure 20 were obtained during the field mapping programme. No efforts were undertaken to measure the joints in a statistical manner to ensure an equal distribution of measurements within the six segments or around the whole Lake Wanapitei structure. Therefore, these stereograms should be treated as qualitative statements only.

STRUCTURAL GEOLOGY

The map-area includes parts of two structural provinces of the southern Canadian Shield; the Superior, and Southern Structural Provinces. The area lies just north of the Grenville Front Tectonic Zone.

Superior Structural Province

The rocks of the Superior Structural Province outcrop west of Lake Wanapitei and consist of metavolcanics and metasediments, gneisses, migmatites, granitic rocks, and diabase dikes. The granitic rocks were emplaced during the later stages of the Kenoran Orogeny about 2500 million years ago (Stockwell *et al.* 1970). The foliations in the pre-granite rocks are probably Kenoran in age.

No clear general trend of schistosity and gneissosity exists for the Early Precambrian rocks in the map-area. Strong faulting and brecciation affected these rocks during the Sudbury Event; this was probably caused by a volcanic explosion or the impact of a meteorite. The deformation of these rocks, however, was not severe enough to disrupt the general north-northwest strike of many Early Precambrian diabase dikes. In a few places, a north-northwest trend of Early Precambrian foliations is also indicated.

Southern Structural Province

Most of the map-area lies in the southernmost part of the Cobalt Embayment which is a part of the Southern Structural Province characterized by little-deformed, commonly rather flat-lying Huronian sedimentary rocks, and is at the eastern end of the Penokean Fold Belt. The Penokean Fold Belt, a typical orogenic belt, extends from Minnesota to about the position of Sudbury, but the effects of Proterozoic orogenic events are noticeable in the region and also east and northeast of the map-area (Card *et al.* 1973, p.51).

Northern Part of Map-Area

In the northern part of the map-area, wide and open folds, north-, north-west-, and north-northwest trending faults are the main structural features. The major fold axes trend approximately north-south. The major north-northwest fault is the McLaren Lake-Wanapitei River Fault; the major north-south faults are the McLaren Creek and Laundry Lake Faults.

Southern Part of Map-Area

In the southern part of the map-area south of Lake Wanapitei, the rocks are moderately deformed and the rocks and structures in general trend west-northwest to northwest and dip to the northeast. Scarcity of outcrop did not allow a detailed structural study to be made. The limited geological information that is available, however, strongly indicates the existence of a more complex structural pattern in the southern part of the map-area than in the northern part of it. For instance, the spatial distribution of the various pre-Gowganda sedimentary rocks, mainly between Ashigami Lake and the Wanapitei River, is suggestive of large scale pre-Gowganda folding and faulting. In a few places, the Huronian rocks show fracture cleavage, and the strata of the incompetent Espanola Formation are quite commonly strongly and tightly folded.

Other Structural Domains

Other structural domains of the area are the Sudbury Structure and the Lake Wanapitei Structure. The Sudbury Structure, namely the Sudbury Nickel Irruptive and the Whitewater Group of the Sudbury Basin, underlie only a small sector of the map-area. No structural analysis therefore is given in this report and the reader is referred to K.D. Card (1978a) for a description of the Sudbury Structure. The deformation and brecciation (see Photo 16) of the footwall rocks of the Sudbury Nickel Irruptive in the map-area are described in the section "Sudbury Basin Rocks, Breccias, and Nickel Irruptive." The Lake Wanapitei Structure is dealt with in the section "The Lake Wanapitei Crater".

METAMORPHISM

In the Superior Structural Province, amphibolite facies regional metamorphism occurred before the emplacement of the Early Precambrian granitic rocks. This is indicated by the presence of fine- to medium-grained, in places, migmatitic gneisses and by the presence of typical amphibolites. Near the village of Skead and along the southwestern shore of Lake Wanapitei, the Early Precambrian rocks show only the effects of greenschist facies regional metamorphism. Diaphthoritic effects, the saussuritization of plagioclase, and the chloritization of garnet, amphibole, pyroxene, and biotite in Early Precambrian amphibolite facies rocks are probably related to Middle Precambrian metamorphism.

In the Southern Structural Province including the Sudbury Nickel Irruptive and the Whitewater Group, the rocks commonly exhibit the effects of low greenschist facies metamorphism. Typical greenschist facies mineral assemblages include chlorite, saussurite, albite, epidote, and actinolite. Minor biotite occurs in Huronian rocks southwest of the village of Skead. Higher grade greenschist facies or amphibolite facies metamorphism is indicated by an isolated occurrence of scapolite in rocks of the Espanola Formation in the southern part of the map-area. The occurrence is only 6.5 km north of the Grenville Front Boundary Fault. About 1.4 km south of the scapolite occurrence, Kennco Explorations (Canada) Limited located a garnetiferous sediment at 110 m depth of a 45° dipping diamond-drill hole. This seems to indicate an increase in metamorphic grade towards the Grenville Front Boundary Fault. Near the drilling site, at the bank of the Wanapitei River near the southern boundary of the map-area, calcareous sedimentary rocks of the Espanola Formation occur that do not show any obvious higher rank metamorphism. The scapolite and garnet occurrences therefore possibly represent a "node", or elliptical zone of higher metamorphic grade and not a continuous increase of metamorphism towards the Grenville Front Boundary Fault. Metamorphic nodes have been described by H.C. James (1955) in the very western part of the Penokean Belt and by Card (1964, 1978b) in the Sudbury Area.

ECONOMIC GEOLOGY

The Lake Wanapitei Area includes part of the Sudbury Nickel Irruptive with three past producing nickel-copper mines located at the base of the Irruptive. There are also other base metal and gold occurrences known in the area. These are associated with Nipissing gabbro intrusions. Uranium mineralization is found in rocks of the Mississagi Formation. Hydrothermal copper mineralization, associated with minor faulting, occurs in rocks of the Gowganda Formation. Early Precambrian ironstones occur in northwestern Rathbun, northeastern Norman, and southeastern Parkin Townships. Breccia stone used for ornamental building purposes, occurs in central Aylmer Township. Sand and gravel is readily available in many parts of the map-area.

On the following pages, a general description in alphabetic order of the metal occurrences and of the history of the exploration activities in the area is

TABLE 20 | UNPATENTED CLAIM HOLDERS (1978) MASSEY BAY, WANAPITEI LAKE AREA.

Name of claim holder	Number of claims	Claim number (Claim map, MacLennan Township issued August 21, 1978)	Property number on geological maps (2450 and 2451, back pocket)
Arena, A.	7	462372-462378	Not numbered on map
Burton, M.L.	14	425989-425994 462192-462196, 462337, 462555, 462556	6
Fittley, H.Z.	8	451069-451076	Not numbered on map
Viau, L.	10	470144-470153	Not numbered on map

presented. The descriptions, if not otherwise stated, are based on data obtained from assessment file reports (Assessment Files Research Office, Ontario Geological Survey, Toronto, and Resident Geologist's Office, Sudbury) or from field investigations undertaken by the author.

Copper

NOVA BEAUCAGE MINES LIMITED (31)

Exploration Activity

The Nova Beaucage Mines Limited copper deposit in central Aylmer Township is a mineralized showing that has been restaked several times over a period of years.

In 1957 Kennco Explorations (Canada) Limited agreed to option from Messrs. Barry and Gasparini 18 mining claims. In the spring of 1958, surface trenching and packsack drilling were done and the claims were included in a larger area over which Kennco Explorations (Canada) Limited did airborne magnetic and electromagnetic work. Two short diamond-drill holes 28 m and 11.7 m in length did not cut any chalcopyrite-bearing rocks. The first 4.3 m of the deeper hole is in breccia and the remainder is in bedded Gowganda Formation sedimentary rocks. In the shorter hole, the first 11 m is in breccia, the remainder is in Gowganda sedimentary rocks (Figure 21). Four chip sample assays are shown in Figure 21. The main showing is about 6 m long and is 1.3 m

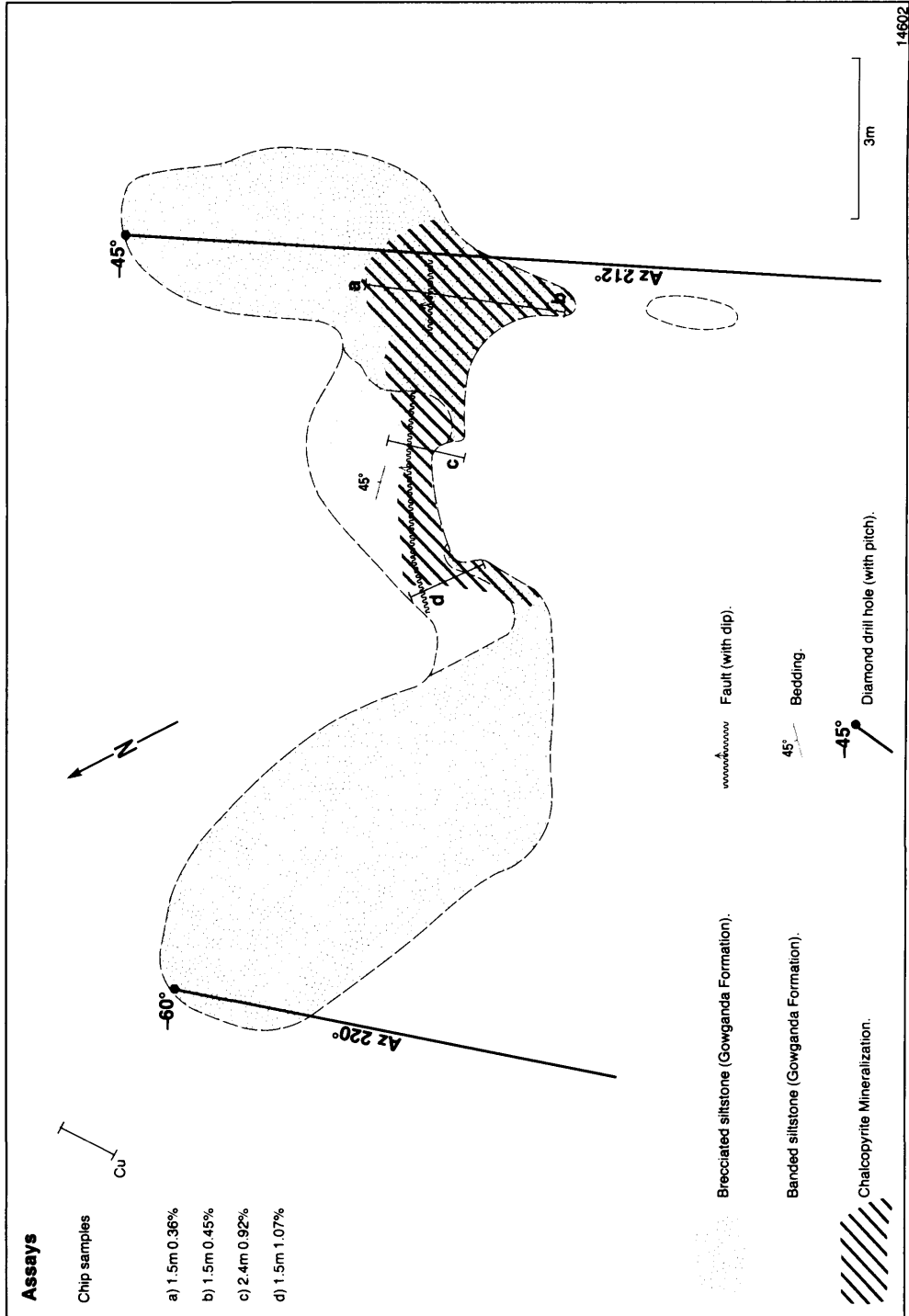


Figure 21—Nova Beaucauge Mines Limited - copper occurrence. Central Aylmer Township.

wide as indicated by a rusty zone.

In 1965, McPhar Geophysics Limited conducted an induced polarization and resistivity survey for Nova Beauceage Mines Limited. The induced polarization results did not indicate any large near-surface deposits of either massive or heavily disseminated sulphide mineralization. Two holes were diamond drilled for a total length of 280 m to determine the cause of a small induced polarization anomaly. The drill cores, however, did not show any significant mineralization.

During the summer of 1977, W. Borer held a group of claims around the Nova Beauceage Mines Limited property. He did not report any work for assessment credit and the claims were allowed to lapse.

General Geology

The mineralization and brecciation appears to be related to a minor east-west steeply dipping fault. The brecciation and hydrothermal impregnations of the breccia by quartz and carbonate are not uncommon in the vicinity of the property. These impregnations are possibly related to an intrusion of Nipissing gabbro that is not exposed at the present erosion surface. The author observed a thin gabbro dike, an apophyse of the assumed gabbro intrusion, just west of the mineralized showing. On its way upwards the gabbro had to intrude the rocks of the Huronian sequence, and probably remobilized the carbonate minerals of the Espanola Formation which impregnated the breccia. Eastward-dipping rocks of the Espanola Formation are exposed only 1.9 km west of the showing. Sulphide mineralizations are known to occur at the contact of Nipissing gabbro with Espanola Formation carbonaceous sedimentary rocks, for instance in northern Hart Township and southern Hess Township (Card and Innes 1976a, b).

Iron

Early Precambrian ironstones occur in northwestern Rathbun, northeastern Norman, and southeastern Parkin Townships. No recent exploration activity has been reported.

Rathbun Lake Occurrence (35)

The ironstone occurrences in southeastern Parkin Township and northeastern Norman Township were studied by Ironco Mining and Smelting Company Limited in the mid 1960s. Meyn (1970, p.43) described the exploration effort by Ironco as follows:

In 1966 Ironco held six unpatented mining claims in southeast Parkin Township. This property covers an area in which a number of iron formation lenses were found during the mapping program ... The iron formation is typically interbedded silica and magnetite and it occurs in three lenses that, striking in different direction, dipping nearly vertically, are about 200 to 300 feet long and

Geology of the Lake Wanapitei Area

about 50 feet thick. ...In 1964, one hole, totalling 220 feet, was drilled in a southeasterly direction on claim S124117 encountering minor pyrrhotite mineralization in "diorite"; another, totalling 197 feet, was drilled on S124118 and it encountered 50 feet of banded magnetite from 0 to 50 feet.

Ironco Mining and Smelting Company Limited did not report any further exploration activity and allowed its claims to lapse.

In the Report of the Ontario Iron Ore Committee (Ontario Department of Mines, 1924, p.207) the Rathbun Township ironstones are described as follows:

In Rathbun township iron formation outcrops occur in lots 22, 23, and 24, concession VI.

One group of outcrops lies near the east side of lot 22 not far from the shore of Wanapitei lake. The iron formation is composed principally of quartzitic silica interbanded with siliceous magnetite. It also includes areas of reddish jasper interbanded with both lustrous steely looking magnetite, and dark-coloured hematite. A few bands of ore 4 or 5 inches wide and 2 to 3 feet long were observed.

To the northwest of this on a high hill in lot 24 lies the largest exposure of iron formation. This varies in width from 125 to 600 feet, and has a length of 1,500 feet. The iron formation consists of cherty and granular silica interbanded with magnetite. Generally speaking the magnetite bands are sparingly present. Their thickness rarely exceeds 2 inches and is usually very much less.

On several of the smaller exposures between the two groups described, there is a rusty capping due to oxidation of sulphides occurring in the silica.

Several diamond-drill holes were put down on the principal exposures in 1908 and 1909, but so far as could be learned the proportion and mode of occurrence of silica and magnetite at depth is identical with that on surface.

No portion of any of the iron formation outcrops seen would make a merchantable ore.

Nickel and Copper

Nickel and copper occur in association with the Sudbury Nickel Irruptive and in Nipissing gabbro intrusions.

SUDBURY NICKEL IRRUPTIVE

The Sudbury Nickel ores were discovered in 1883 and exploration activity has gone on since the early days of mining activity at Sudbury. The activity has included geological and geophysical surveys with numerous diamond-drill holes being put down. During the 1978 field season, Inco Limited diamond drilled near Blue Lake and Falconbridge Nickel Mines Limited conducted a detailed geological mapping programme south of the village of Skead.

Three past-producing mines are located west and south of southern Lake Wanapitei: The Nickel Rim Mine of Falconbridge Nickel Mines Limited, the Victor Mine and the Maclennan Mine of Inco Limited. All the ground underlain by or bordering the Sudbury Nickel Irruptive is covered by claims. The main claim holders are Falconbridge Nickel Mines Limited (about 85 claims) and Inco Limited (about 20 claims). Several other companies and individuals hold another forty claims of which most are patented, some are leased.

FALCONBRIDGE NICKEL MINES LIMITED (8)

Nickel Rim Mine

The following description of the Nickel Rim Mine is based on the accounts of Thomson (1961) and L. Mamen (1955):

The property was originally staked by W. McVittie and G. Bennett who sold it to the Connell interests operating as McVittie-Graham and Company. This company sunk a 80 m deep shaft and later allowed the property to revert to the original owners who sold it again nine years later to the Ontario Nickel Corporation Limited which in 1943 became known as Ontario Nickel Mines Limited. In 1945, 2427 tons of ore, averaging 3.25 percent nickel and 0.64 percent copper, were shipped to Sudbury. In 1950 the mine was sold to East Rim Nickel Mines Limited. This company sank three shafts to about 220 m and opened three levels at 75 m, 120 m, and 170 m. 38 000 tons of ore averaging 1.58 percent nickel and 0.59 percent copper were sent to the Falconbridge smelter. In 1954 the company changed its name to Nickel Rim Mines Limited. By 1958, Number 2 shaft was extended to a depth of 430 m. The mine operated until May 31, 1958. It produced a total of 6 218 000 pounds of copper and 14 068 000 pounds of nickel valued at \$10 056 516. The total tonnage of ore mined was 1 276 633 tons.

Falconbridge Nickel Mines Limited purchased the property in 1964, but no further mining has been recorded since then.

General Geology

No exploration activity has been reported from the Nickel Rim property of Falconbridge Nickel Mines Limited since 1961. Therefore no additional information is available since Mamen (1955) and Thomson (1961) published their accounts on the mine. Thomson (1961, p.26) presented a geological section through a part of the mine and a geological plan of the 132 m level and gave the following geological description of the mine:

The mine is located on the east rim of the Sudbury nickel irruptive, at a place where the structure strikes west of north. A body of quartz diorite and quartz diorite breccia lies between the norite and the footwall granite. The contact between the quartz diorite and norite is gradational and arbitrarily defined. The contact of the quartz diorite with footwall granite is irregular in both plan and section. The over-all dip of this contact is steeply west towards the Sudbury Basin, but locally it may flatten on a roll or may steepen to bulge outward into the granite footwall. Granite breccia frequently forms a transition zone between the normal quartz diorite breccia and typical granite. It consists almost entirely of granite inclusions with little quartz diorite matrix. On and above the 250-foot level the quartz diorite breccia is 40-300 feet in width. This rock is similar to the quartz diorite breccia that is found at many other places around the edge of the Sudbury nickel irruptive. The ore is cut by diabase dikes, some of which have large feldspar phenocrysts.

Mineralization at the mine is confined mostly to the band of quartz diorite breccia and is concentrated in irregularly-shaped bodies. On the surface the quartz diorite band, which may be regarded as the ore zone, extends for a distance of about a mile from the north to the south end of the property. Most of the underground work has been confined to a length of about 1,200 feet in the central part of the ore zone, but a considerable amount of surface drilling has been done north and south of

Geology of the Lake Wanapitei Area

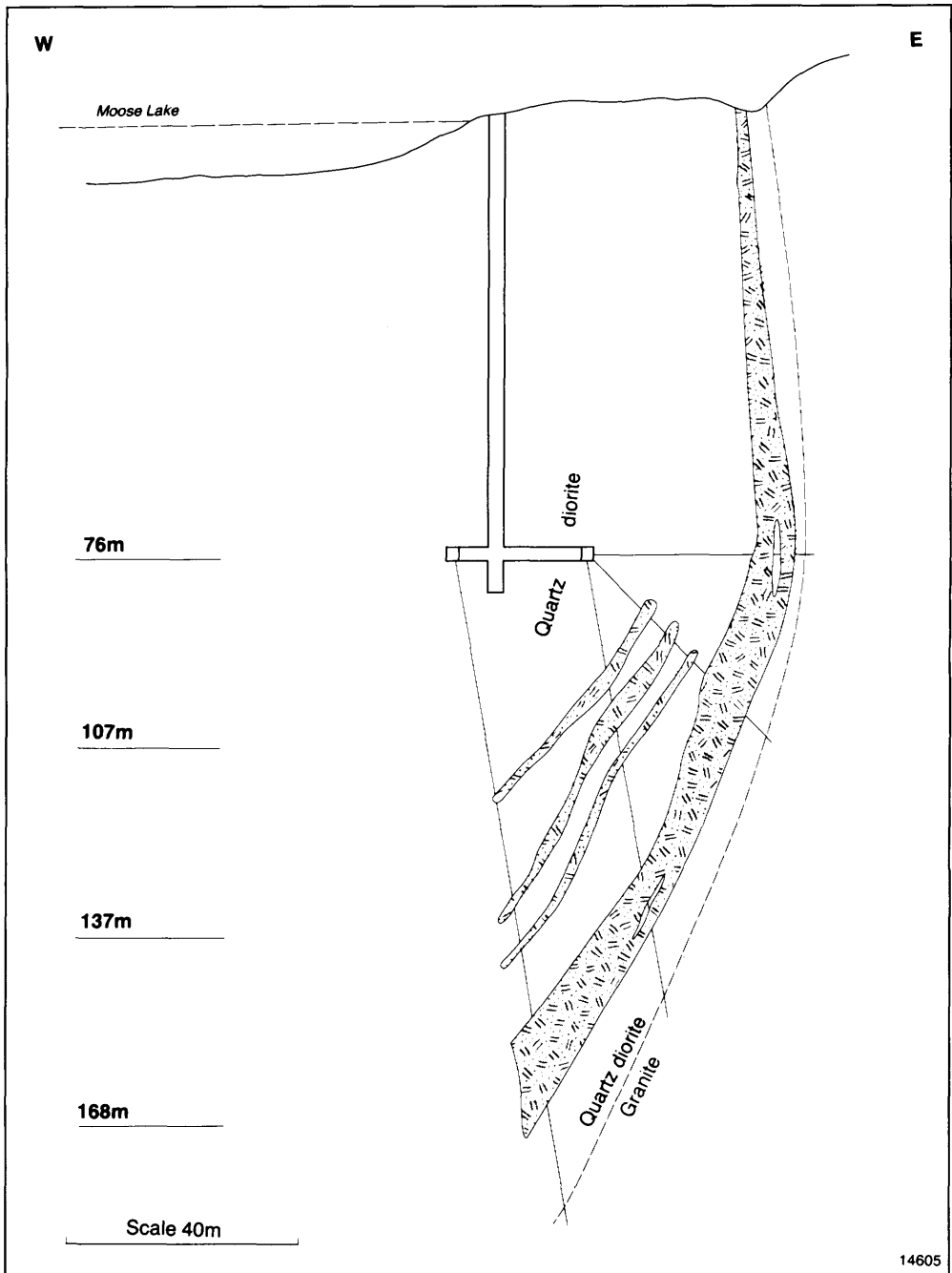


Figure 22—Generalized vertical section through the Nickel Rim Mine. Assessment file information by Ontario Nickel Mines Limited, 1949. (Pattern: ore bodies).

the mine workings. The sulphides occur in a series of irregular, disconnected bodies. Their erratic distribution required a great deal of drilling to be done to locate, outline, and evaluate the ore shoots. There does not seem to be any definite structural control in the occurrence of the sulphide bodies.

The ore shows typical Sudbury mineralization and consists of pyrrhotite, pentlandite, chalcopyrite, and lesser amounts of pyrite. It may occur as (1) massive sulphides, (2) breccia sulphides, (3) disseminated sulphides, or (4) sulphide veinlets and stringers. In mining operations these sulphides were found in all combinations within an individual ore shoot, the boundaries of which were determined by grade. It appears that the sulphides replaced, initially, the matrix of the quartzite-diorite breccia, and finally, the inclusions themselves; the latter replacement occurred where mineralization is more intense.

Figure 22 is a generalized vertical section through the Nickel Rim Mine in its early days (1949, "Moose Lake mine" of Ontario Nickel Mines Limited), modified after mine plans (assessment file information).

INCO LIMITED (18)

Maclennan Mine

The author could not obtain any detailed geological information on the Maclennan Mine, which is the property of Inco Limited. On-site investigations during the 1978 field season could not be properly made because of the lack of access to the steep-walled mine pits. Ore samples found by the author at the mine consist of common Sudbury nickel-copper ores.

The following limited information has been obtained from various Statistical Reports of the Mineral Industry of Ontario published by the Ontario Department of Mines.

In 1965, on the Maclennan property, a shaft was sunk to a depth of 282 m and six levels were established. In 1966 open pit mining was completed and the underground work proceeded. Up to about 1000 tons of ore per day were hoisted and shipped during the time the mine was in operation. Mining was completed in 1972.

Victor Mine

Operations on the Victor Mine property commenced in 1959. In 1960 a shaft was sunk to a depth of 110 m below surface, two levels were established, and a total of 134 077 tons of ore were shipped from the mine. The operations were continued to 6 December, 1960. No further information is available on the mine.

Capre Property

No company or assessment file information is available on the Capre property of Inco Limited.

During field work, the author observed rusty Sudbury sulphide mineralization-bearing sublayer and megabreccia rocks all along the east shore of Capre Lake. Many test pits, trenches, and diamond-drill sites indicate that intensive exploration activity was done by Inco Limited.

NIPISSING GABBRO INTRUSIONS

Impressive copper, nickel, and precious metals mineralization occurs in a Nipissing gabbro body exposed on the southern part of Rathbun Lake (see section on "Rathbun Lake Occurrence 35"). Minor disseminated sulphide mineralizations have been observed by the author in the Nipissing gabbros in a few places in the map-area. Only one appears to be promising, and has been tested by an exploration company, Kelly-K-Mines Limited. It is located on the east shore of the large peninsula in central Kukagami Lake (see "Kelly-K-Mines Limited (20)").

In the following section, two company surveys are briefly described that were not strictly directed to the search for base metals in Nipissing gabbros, but which were designed to look in general for base metals within the map-area.

KENNCO EXPLORATIONS (CANADA) LIMITED [1970] (21)

In 1968, Questor Surveys Limited performed a combined airborne magnetic and electromagnetic survey for Kennco Explorations (Canada) Limited over an area of approximately 673 km². This survey included almost all Scadding Township, Davis Township, and parts of Kelly, MacLennan, and Rathbun Townships. The purpose of the survey was to investigate occurrences of base-metal mineralization within the area.

The company discovered three groups of electromagnetic anomalies in the southwestern corner of Scadding Township and six weak anomalies in the southeastern part of Lake Wanapitei. In southwestern Scadding Township three 5 to 6 channel anomalies were detected very close to each other and are located northeast of the Moose Rapids which is near or at the southern border of the map-area. The two other groups of (3-channel) anomalies occur 2.1 km northwest and 1.7 km north-northeast of the Moose Rapids. Kennco Explorations (Canada) Limited stated that the 3-channel anomalies in southwestern Scadding Township may be due to small quantities of sulphide mineralization or rather deeply buried sulphide bodies. The good 5- to 6-channel response anomalies appear likely to be caused by sulphide mineralization.

The six weakest anomalies in Lake Wanapitei occur close to Bonanza Island, and between this island and the outlet of the lake. They are believed by

the company to be most likely caused by conductive overburden in the bottom of the lake.

On the basis of the airborne magnetic data, the company was able to extrapolate known geology into areas where limited or no outcrop occurs using airborne magnetic data.

In 1969 and 1970, as a result of the geophysical survey and geological field work, the company diamond drilled three holes for a total length of 3953 m in Scadding Township. One 318 m long hole is in western Kelly Township that forms part of the map-area. The northernmost drill hole in Scadding Township, intersected weathered fine-grained gneiss (12.5-15.8 m) and tuffs (15.8-121.9 m) having minor disseminations and blebs of sulphides. Also in the other two holes in Scadding Township, the drill intersected rocks which the company classified as tuffs and tuff conglomerate. The rocks occasionally contain 5 to 10 percent disseminated sulphides over a length as long as 7.5 m. A 15 cm thick garnet-rich band was encountered in one hole. In the Kelly Township drill record, the company described a length of 306 m of gabbro containing minor sulphide mineralization in places that is underlain by 9 m of quartzite and 3 m of Gowganda Formation argillite.

The company did not report any further work and the claims were allowed to lapse.

NORANDA MINES LIMITED [1955] (30)

During the summer of 1955 a group of 26 claims in Davis [outside the map-area] and Scadding Townships was surveyed by Noranda Mines Limited using an electromagnetic unit. The claims were held under option from Messrs C. Kiernan and J.J. Gatchell. The purpose of the survey was to locate electrical conductors that might represent or lead to the discovery of sulphide ore. The company discovered six weak conductors of which one is in the map-area, and is located about 270 m east of the outlet of Ashigami Lake in Davis Township in patented claim S 2809. This sector of the map-area is covered by glacial deposits and the cause of the anomaly therefore is not known.

RATHBUN LAKE OCCURRENCE (35)

Exploration Activity

An impressive showing of sulphide mineralization occurs in a Nipissing gabbro body exposed at southern Rathbun Lake in Rathbun Township (Figure 23). A 13.4 m deep prospect shaft has been excavated some sixty years ago and a limited amount (8.8 m) of crosscutting has been undertaken at the shaft bottom. No information was found on these old workings in the Assessment Files Research Office, Ontario Geological Survey, Toronto, or the Resident Geologist's Files, Ontario Ministry of Natural Resources, Sudbury.

Dolmac Mines Limited purchased a group of claims including the mineral-

Geology of the Lake Wanapitei Area

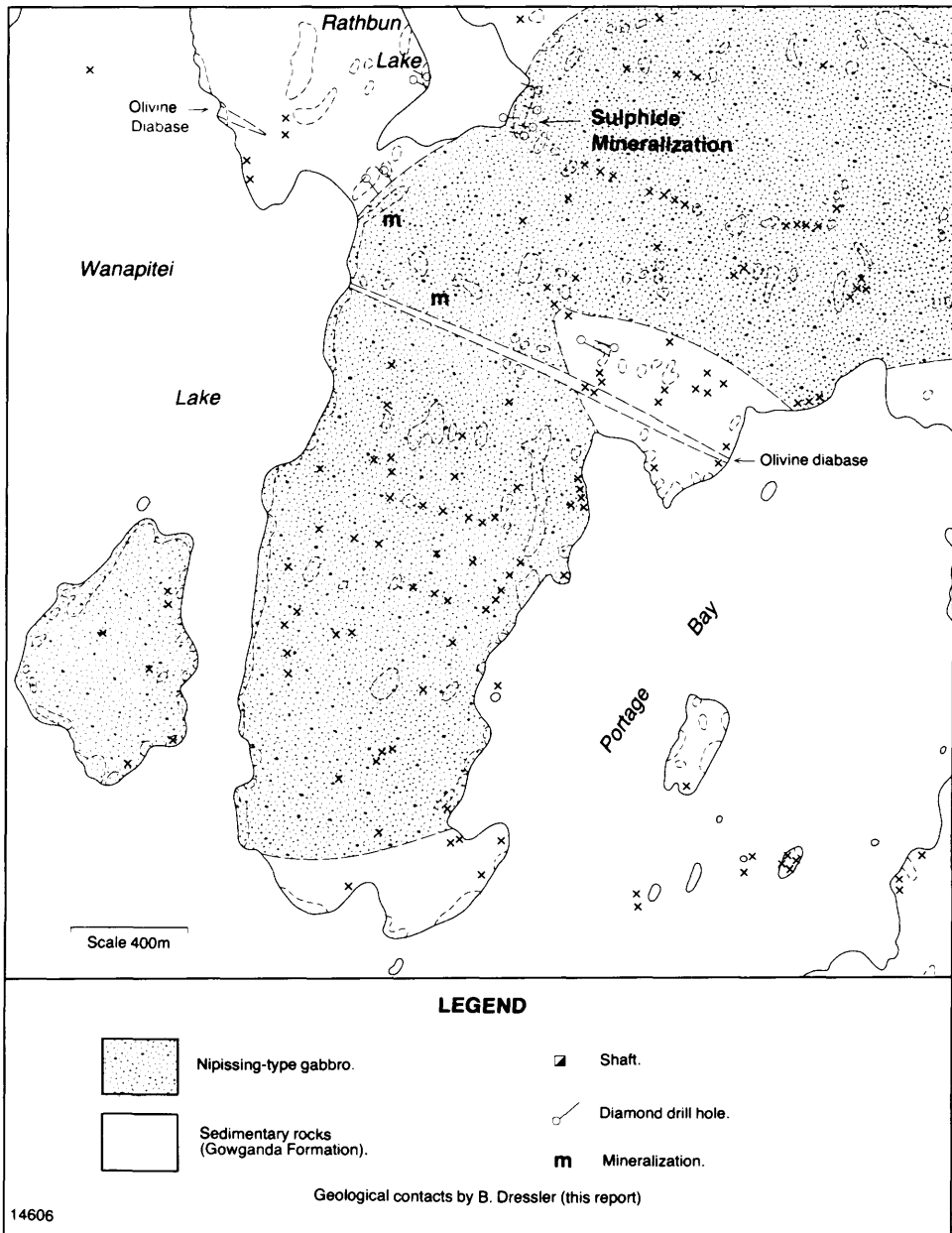


Figure 23—Location of the Rathbun Lake Occurrence (35) and the location of 11 diamond drill holes by Dolmac Mines Limited.

ized showing from local prospectors in 1953. During the spring of 1954 a combined magnetometer and electromagnetic survey was conducted over part of the property, and later the old shaft was dewatered. During the later part of 1954 and up to May 1955 eleven diamond-drill holes totalling 614.5 m in length were put down (Figure 23 and Map 2451, back pocket). These efforts failed to discover any further mineralization.

In a report dated in 1957 to Dolmac Mines Limited consulting geologist M. Ogden (see Assessment Files Research Office, Ontario Geological Survey, Toronto) described the occurrence as follows:

It seems obvious on a quick examination of the shaft area that the copper and associated base and precious metals follow the contact. However, on closer examination, and following some detailed trenching, it became clear that the mineralized zone does not follow the contact but strikes across it in an east-west direction¹. Further, the mineralization lies entirely within diabase and ceases at the sediment contact 20 feet west of the shaft. Nor does it continue into the outcrop 30 feet east of the shaft. In the previous mapping of the shaft and drifts, there is a fault zone shown about 20 feet east of the shaft in the centre of the east drift. It is quite possible that this fault zone (which probably follows the low ground running approximately 25 degrees east of north) displaces the mineralization for perhaps some hundreds of feet.

When the shaft was dewatered a few years ago, little or no evidence of mineralization could be found in the drifts at the bottom of the shaft. However, as the distance between the cut-off contact to the west and the probable cut-off fault to the east is only about 30 feet, it is quite possible that the mineralized zone after plunging to the east would not reach the bottom of the shaft before it is cut off by the fault...

Two hundred and twenty feet north-east of the shaft, an exposure was found of disseminated lumps of solid chalcopyrite with a little pyrrhotite and pyrite. It is not clear from the exposure in exactly what direction this new zone trends but there is a suggestion that it trends about 60 degrees true or perhaps between 60° and 90°. Its width is between eight and ten feet. An assay over this width would be low (less than ½ percent copper). However, the important point is not the grade but rather the possibility that this exposure may represent the fringe of the offset portion of the intense mineralization found at the shaft. That is, this new showing may be in reality the same zone as that found in the shaft, but due to the probable fault running parallel to the lakeshore, the zone has been displaced by 220 feet. If it is not the same zone as at the shaft, it could be a parallel zone.

In 1958 Dolmac Mines Limited diamond drilled another 12 holes totalling 188.5 m in length near the old shaft. The location of these drill holes are not shown on the Map 2451 (back pocket) or on Figure 23. Figure 24 shows the location of six of the 12 drill holes put down in 1958, the old shaft, the crosscuts, and the contact between the Nipissing gabbro and the Gowganda Formation wackes. The diamond drilling did not lead to the discovery of an economic ore body. M. Ogden recommended a detailed McPhar-type electromagnetic survey over the contact zone. The author of this report does not know if this recommendation has been carried out as no further information by Dolmac Mines Limited on the occurrence is available. The claims were allowed to lapse.

The original showing was so good that other individuals and mining companies re-examined the ground around southern Rathbun Lake. In 1963 Waco Petroleum Limited diamond drilled six holes totalling 335 m in length. In 1966, 1968, and 1971 Norlex Mines Limited and Burco Explorations Limited diamond drilled eight holes totalling 918 m in length. All three companies drilled near the old shaft and did not discover any promising mineralization. In 1966, Paramaque Mines Limited conducted magnetic and electromagnetic sur-

¹The estimated length of the ore zone is of at least 12 m (40 feet) (Koulomzine 1955).

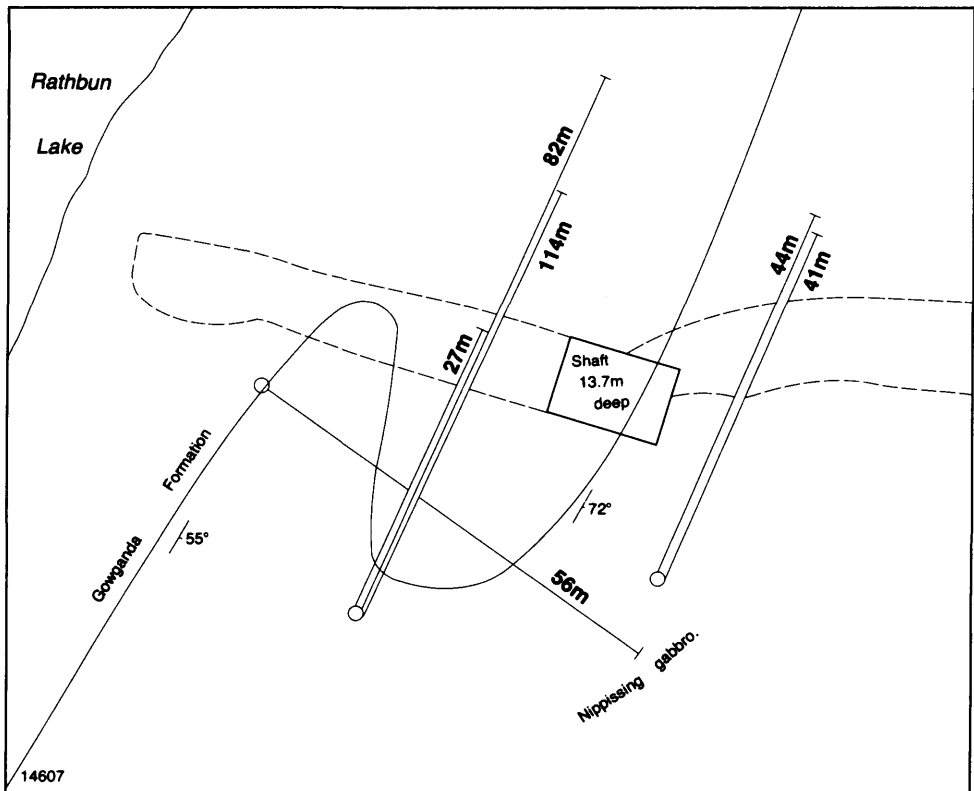


Figure 24—1958 Diamond drilling by Dolmac Mines Limited near the shaft at Rathbun Lake. Dashed line: crosscutting at the shaft bottom.

veys north and south of the original showings. The results did not provide any encouraging leads. However, the company reports two magnetic anomalies in Lake Wanapitei that are of some interest. No further work has been reported.

The following chemical assays are presented:

a) *Massive sulphides of the main showing.*

Grab samples of heavy sulphide mineralization taken by Dolmac Mines Limited from the shaft dump yielded (Koulomzine 1955; Ogden 1957):

Cu, 5.51-19.92 percent; Ag, 0.17 ounce-1.978 ounces per ton; Ni, 0.11-2.86 percent; Pt, 0.088 ounce-1.08 ounces per ton; Au, 0.002-0.36 ounce per ton; and Pd, 0.17-0.98 ounce per ton.

A selected grab sample of massive sulphide ore taken by the author of this report from the shaft dump and analyzed by the Geoscience Laboratories, On-

tario Geological Survey yielded:

Cu, 10.2 percent; Ag, 2.22 ounces per ton; Ni, 0.14 percent; Pt, 0.056 ounce per ton; Au, 0.02 ounce per ton; and Pd, 34.6 ounces per ton.

b) Low grade mineralized rock.

An assay of a grab sample of low grade mineralized rock taken by Dolmac Mines Limited southwest of the shaft gave: Cu 1.31 percent, Ni 0.29 percent, Pt 0.07 ounce per ton, Pd 0.16 ounce per ton.

General Geology

The main massive sulphide mineralization in the Nipissing gabbro near the south end of Rathbun Lake is about 12 m long and 0.3 to 0.6 m wide (Koulomzine 1955). It is near the contact of the gabbro with Gowganda Formation sedimentary rocks. Its strike is not parallel to the contact, but almost perpendicular to it, and no mineralization has been observed in the sedimentary rocks. The contact of the main mineralized body with the non-mineralized gabbro is gradational. T. Koulomzine (1955) described sparsely mineralized gabbro flanking the high grade massive sulphide body. The non-mineralized host rock is little altered. The alteration index is only 22.1 (see "Lake Wanapitei Nipissing Gabbro Intrusion").

The ore minerals are chalcopyrite, pyrrhotite, magnetite, and a small amount of covellite. Magnetite is hypidiomorphic to idiomorphic; all other ore minerals are xenomorphic. Covellite fills fractures in chalcopyrite. The gangue minerals are plagioclase, quartz, epidote, chlorite, and a small amount of biotite. Plagioclase of the mineralized zone appears to be a little more altered than the plagioclase of the host rock. The host rock (see specimen 41E9A, Table 6) contains 2.9 percent quartz, the ore gangue 9.5 percent (see specimen 41E9B, Table 6). Pyroxene appears to be absent from the mineralized rock, whereas the host rock contains about 25 percent pyroxene. The opaque mineral in the host rock is titanomagnetite. No sulphide minerals have been observed in the host rock. There is no indication that the sulphides replaced other rock forming minerals, for instance former pyroxene.

The shaft at the Rathbun Lake Occurrence is filled with water and collapsed timber and the author of the present report did not see the mineralization in place. M. Ogden (1957), in a report to Dolmac Mines Limited, described a north-northeast-trending fault 9 m east of the shaft and in 1958, the same author concluded from diamond drilling that the mineralization occurs in broad, ill-defined zones striking about 135° and deeping steeply (60°-70°) to the north. Ogden also stated that the mineralization does not necessarily improve in close proximity to the contact, it seems to be concentrated near folds or irregularities in the gabbro-sediment contact, and the original high-grade showing at the shaft was mined out during the sinking of the shaft. The mineralogical observation by the author of this report and the descriptions in the Assessment Files Research Office, Ontario Geological Survey, Toronto, indicate that the

mineralization formed schlieren within the Nipissing gabbro. These schlieren possibly were parts of a bigger sulphide body and have been separated from this bigger body during the intrusion of the gabbro into the Huronian sedimentary rocks or dislocated from it by faulting after the intrusion.

The massive sulphide mineralization is located in the continuation of a zone of higher than normal gold values (see Figure 13) within the Lake Wanapitei Nipissing gabbro intrusion.

Gold

GOLD AND GOLD-COPPER OCCURRENCES IN QUARTZ AND QUARTZ-CARBONATE VEINS

Exploration Activity

In the early 1890s many minor gold discoveries were made in quartz and quartz-carbonate veins mainly associated with Nipissing gabbro intrusions. Only one place, the Crystal Gold Mine, has reported gold production worth mentioning. In a few places, for instance near Kukagami Lake and on the northern shore of Wanapitei Lake, the quartz veins contain also pyrite and little chalcopyrite, and at Kukagami Lake the quartz veins also contain galena.

A. Slaght (1896) reported on the gold exploration and mining activity in Rathbun Township. Slaght did not give exact locations for the various occurrences which he calls "mines" and Figure 25 therefore shows only the approximate location of these "mines". The figure also shows the locations of trenches along quartz veins that were encountered by the author and his assistants during the field investigations.

The following sources of information were used to make the account which follows: part of Slaght's description; observations by the author; and additional information on the gold occurrences from reports of the Ontario Geological Survey and from the Assessment Files Research Office, Ontario Geological Survey, Toronto, and the Resident Geologist's Files, Ontario Ministry of Natural Resources, Sudbury. The locations of all but two occurrences, namely the W.S. Bennett (3) property in northwestern Rathbun Township and the G.E. McVittie (27) property at the north shore of Lake Wanapitei, are shown on Figure 25. Also shown are the locations where quartz veins and granitic dikes associated with the Nipissing gabbro were observed by the field party.

General Geology

All the gold or gold-copper occurrences described below are associated with quartz and quartz-carbonate veins or dikes that occur within rocks of the Huronian Supergroup, mostly Gowganda Formation wackes, or in Nipissing gabbro

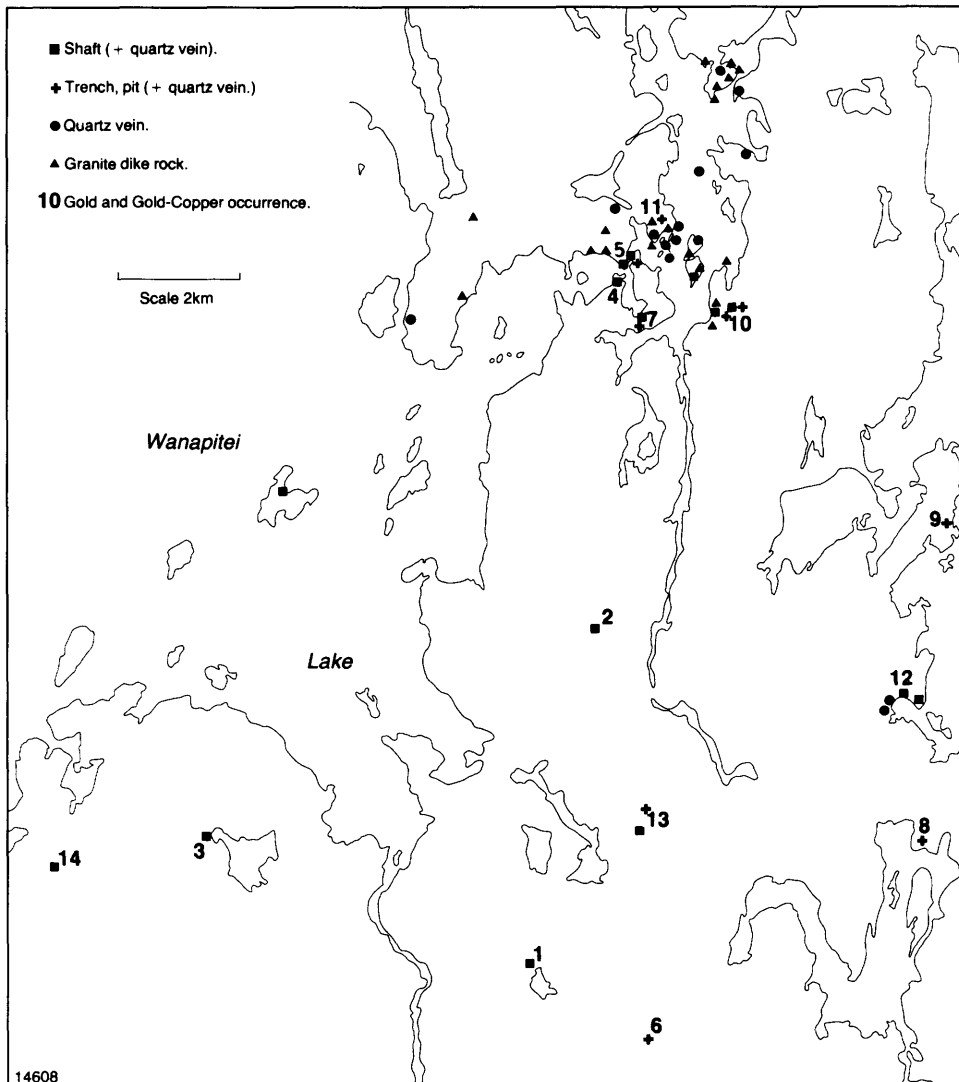


Figure 25—Gold and Gold-Copper “Occurrences” in Quartz-Carbonate Veins.

1-Alkins, G., and Alkins, J.
 2-Alwin Porcupine Occurrence
 3-Blanchard, G.
 4-Comstock Mine
 5-Crystal Gold Mine
 6-Glade Exploration Limited
 7-Gordon Mine

8-Handy, J.O.
 9-Kelly K-Mines Limited
 10-Last Chance Mine
 11-Mondoux Mine
 12-Plexman, E.J.
 13-Red Rock Mine
 14-Skead Gold Mine



OGS 10 327

Photo 17—Bonanza Mine quartz-carbonate vein. Open pit. Large idiomorphic quartz crystals in a quartz-carbonate matrix.

near or at the contact of the Huronian sedimentary rocks with the gabbro. The veins and dikes are a few centimetres to about 18 m thick and strike parallel to the contacts or cut across them (Bonanza Mine, Photo 17). Native gold occurs in the quartz or quartz-carbonate veins. A few veins also contain pyrite, chalcopyrite, and in one area, near Kukagami Lake veins contain galena.

A galena sample from Kukagami Lake supplied by the author to R. Thorpe, Geological Survey of Canada, was analyzed by the University of British Columbia under contract to the Geological Survey of Canada. The chemical data give some indication of the possible age of the lead and the model age for the lead is approximately 1500 to 1600 m.y. (R. Thorpe, personal communication, April 1979). This age is significantly younger than the age of the Nipissing gabbro intrusions (2150 m.y.).

G. ALKINS, AND J. ALKINS (1)

About 1.6 km east of the Wanapitei River in central Scadding Township lies a gold occurrence, the property of J. and G. Alkins. Fairbairn (1939) reported that after several years of inactivity, work was resumed on this property in 1939. No production and no more recent work has been reported. The old

workings, pits, and trenches were observed by the author. A quartz-carbonate vein ranging from 0.6 m to 2.5 m in width and striking north-northwesterly can be traced for about 180 m. Some pyrite is visible in the vein and a considerable amount of visible gold has been reported.

ALWYN PORCUPINE OCCURRENCE (2)

In northern Scadding Township, about 1.8 km east-southeastward of Scadding Bay (Lake Wanapitei), another gold and copper occurrence is located. In 1950, 1956, and 1959 Alwyn Porcupine Mines Limited diamond drilled 14 holes for a total of 1406 m to test the occurrence. The company reported gold assays ranging from 0 to 0.093 ounce of gold per ton and copper assays ranging from 0.18 percent to 1.22 percent. No further work was reported and the claims were allowed to lapse.

Thomson (1961) described the former Alwyn Porcupine Mines Limited property as follows:

The property is underlain by rocks of the Gowganda formation, which is cut by dikes of gabbro (Nipissing diabase). The McLaren Lake fault zone, a strong regional structure, strikes in a north-west direction across the property in the vicinity of the old workings. The rocks adjacent to the fault zone are greatly altered, brecciated, and fractured; the zone itself is marked by some sulphide mineralization and many quartz-carbonate veins. The sulphides are usually fine-grained pyrite and chalcopyrite. Several narrow diabase dikes were encountered in drilling. Practically all the mineralization and veining is in the conglomerate.

A report of E.K. Fockler, (Assessment Files Research Office, Ontario Geological Survey, Toronto, Alwyn Porcupine Mines Limited) dated January 17, 1951, summarized drilling results as follows:

The geometrical average of vein intersections to date is 0.022 ounce gold per ton and 0.42 percent copper for an average true vein width of approximately 15 feet over a drilled zone length of 600 feet. Positive vein intersections lie to the east of the shaft in holes Nos. 4, 5, 6, and 7, the north vein intersections of which average 0.038 ounce gold and 0.613 percent copper per ton for an average true width of 13 feet over a drilled length of 400 feet. Holes Nos. 4, 5, and 6 recovered the best intersections, selected sections of which average 0.085 ounce gold and 1.11 percent copper per ton for an average true width of 6 feet, 5 inches, over a vein length of 300 feet.

Hole No. 12, drilled in 1959, cut directly across the McLaren Lake fault zone, which was indicated by gouge, lost core, strong shearing, red carbonate alteration, and disseminated sulphides. On both sides of the fault, numerous narrow quartz-carbonate veins, containing very small amounts of sulphides, were intersected. In places, a narrow basic dike has been injected along the main fault.

W.S. BENNETT (3)

Free gold, occurs in northwestern Rathbun Township west of the Wanapitei River. However, no assessment file information is available on these occurrences. A group of patented claims is presently held by W.S. Bennett. Old workings, trenches, and small test pits were observed by the author along quartz veins. The writer observed visual traces of native gold in these veins.

E. BLANCHARD, (BONANZA MINE) (5)

The Bonanza Mine (Slaght 1894) is located on the west side of Bonanza Lake in Maclellan Township (Photo 17). A shaft was sunk to a depth of about 15 m and a little lateral work was done. In 1956, the occurrence was examined by Falconbridge Nickel Mines Limited as a possible source of smelter flux and two holes were drilled. Surface chip samples of the quartz vein contained 90-95 percent SiO₂ and from traces to 0.04 ounce of gold per ton. A group of four leased claims at northwestern Bonanza Lake which includes the quartz-gold occurrence is currently held by E. Blanchard.

Crystal Gold Mine

In 1892 a gold discovery was made on the mining location WD43 situated in the township of Rathbun. The mine is described as follows (Ontario Bureau of Mines 1897, p.57):

Two veins run east and west and five shafts in all have been sunk. No. 1 shaft was sunk a depth of 100 feet, cutting a vein at 85 feet which was followed several feet on both sides of the shaft and proved to be rich in free gold. At the 100 foot level a lateral drift was made and the vein again picked up at a distance of 25 feet from the main shaft. No. 2 shaft was sunk a distance of 40 feet and showed the vein to improve in size and quality of ore. No. 3 shaft or tunnel was driven on a vein showing at the base of the hill on which No. 1 shaft is sunk to a distance of 50 feet, and lateral drifts of 25 feet on each side have been made therefrom. No. 4 shaft is sunk on a vein outcropping about 500 feet from any of the other openings, and is down about 24 feet with about 15 feet of drifts. At the base of the hill near No. 3 opening a vein about 2 feet wide has been uncovered for a distance of 55 feet, and the exposed quartz is thickly studded with free gold.

In the years 1897, 1898, and 1908 the mine produced 730 tons of ore (value \$4,998) as reported in the Annual Production Statistics of Gold Mines 1897-1949 (Fifty ninth annual report of the Ontario Department of Mines, 1950, published 1951; part I, Table VI). Collins (1917) reported that the mine was operated from 1892 to 1911, however, no details or production statistics were reported by him. In 1944 Sylvanite Gold Mines Limited re-examined the ground around the Crystal Gold Mine and diamond drilled two holes for a length of 378 m near the main shaft of the mine. In the years 1963 to 1970 surface work was carried out by Little AG Mines Limited as well as diamond drilling and a geophysical survey. At the time of field work on this survey this ground was open for staking.

J. GILL (COMSTOCK MINE) (23)

Slaght (1897) described the work on this property as follows:

On WR 40, comprising 18 acres, near Boland lake and adjoining the Crystal mine property, prospecting had been done some time previous to my visit. One-half of the property I was informed is now held by Mr. W. Ross, of Toronto, assignee, and the remaining half of Messrs. Louis LaForest and T. Maloney, of Sudbury. The work done was on a vein running southeast and northwest with a dip of 80 degrees south, by a cut opening the vein for a distance of 100 and sinking a shaft fifty feet.

Another vein 17 feet from the former, which runs nearly parallel and forms a junction with it, was stripped for 75 feet and a test pit of 16 feet sunk at the junction of the two veins. In the deepest shaft the vein showed a width of 16 inches. Several surface stringers running parallel with the larger vein and stretching across a belt of nearly 100 feet have been carefully examined and apparently are feeders to them; free gold may be discovered in a number of them, as well as in the large vein. All work has been suspended, I was informed, for the want of capital.

Mining location WR40 including the gold occurrence is currently held by J. Gill.

GLADE EXPLORATION LIMITED [1973] (10)

In 1972, east of the J. and G. Alkins property, in lots 5 and 6, concession II, Scadding Township, Glade Explorations Limited, a now defunct company, carried out a geological survey on a group of 12 claims. The company reported several occurrences of visible gold in quartz veins. Grab sampling of the occurrence by the company returned 1.22 ounces of gold per ton. The quartz vein at this occurrence is at least 1.2 m wide and with its laddering structure produces an apparent width in excess of 3 m. Glade Explorations Limited reported a 1.18 ounces of gold per ton assay from a grab sample collected from an old almost completely overgrown trench dump.

A six-hole diamond drilling programme was carried out by the company as reported by *The Northern Miner* (January 25, 1973, p.6):

The results were mixed, with one hole giving the best assay of 6.27 oz. gold per ton across 27 cm or 1.2 oz. gold per ton across the full vein width of 1.55 m. A wildcat hole put down about 240 m from the known gold zone located a 1.5 m wide quartz vein beneath a swamp. Assays from this quartz vein yielded low gold values.

The exact locations of the Glade Explorations Limited diamond drill-holes and of the old workings are not known to the author.

GOLD NUGGET AND DEVELOPMENT COMPANY (11)

The company presently holds two claims north of the Red Rock Mine (McMillan Gold Mines Limited (Red Rock Mine) (26)) where in 1931 Mid-Continent Gold Fields Limited carried out considerable pitting and trenching to test gold mineralization in quartz and quartz-carbonate veins.

GOLD NUGGET AND DEVELOPMENT COMPANY AND L. LAFOREST (12)

The property consists of one claim located just south of the Red Rock Mine (McMillan Gold Mines Limited property (26); *see above*, Gold Nugget and Development Company property (11)).

GORDON MINE (13)

Slaght (1896) described the Gordon Mine (Figure 25) as follows:

On May 21st the Gordon mine was visited. It is situated on lot 6 on the third concession of Rathbun township, and one mile south of Boland lake, which has its outlet into lake Wahnipitae. It is near the winter road cut out by the Crystal Gold Mining Company. Four men were engaged in sinking a shaft 14 by 16 feet, and had reached a depth of 25 feet. The formation was firm, and no timbering was required. Drilling was being done by hand and the rock lifted by windlass. There was a considerable inflow of water. It was expected to reach the auriferous quartz rock at a depth of about 40 feet. A domicile 14 by 16 feet had been erected for cooking and sleeping, which, with a blacksmith shop and tent, comprised the buildings. Late in October I met Mr. Gordon in Sudbury and he informed me that the shaft had been continued to a depth of 40 feet, and the property had been further tested by the use of a diamond drill; 120 feet east of the shaft a bore had been put down at the angle of 70° on the dip of the vein, which had been tapped at the depth of 174 feet. One hundred feet further east another bore had cut the vein at about the same depth. Prospecting had been done with encouraging results on several other properties in this immediate vicinity during the summer.

No other information than the above statements by Slaght (1896) is available on the Gordon Mine. Mining location M.3, including the Gordon Mine, appears as cancelled on the 1978 Rathbun Township claim map.

J.O. HANDY (15)

L.F. Kindle (1933, p.47) described an occurrence of narrow quartz veins with visible gold in Gowganda Formation conglomerate rocks just north of Ashigami Lake. The veins strike north-south and northwesterly and have a maximum width of about 35 cm. Circa 1890, considerable pitting and trenching had been done under the direction of J.O. Handy. Kindle (1933) published a sketch map of the completed workings. Two patented claims are presently registered under the name of J.O. Handy.

W.P. HARRIS (30)

W.P. Harris presently (that is in 1978) holds one unpatented claim in southwestern Kelly Township where Kelly-K Mines Limited did some exploration in 1966 and 1967 (see section on "Kelly-K-Mines Limited (20)").

KELLY-K-MINES LIMITED (20)

In 1966 Kelly-K-Mines Limited conducted a magnetometer and a self potential survey over a group of six claims on the big peninsula in Kukagami Lake in the very southwestern corner of Kelly Township. An east-northeast striking magnetic anomaly was discovered near the west shore of the peninsula (Figure 26). It is about 240 m long, showed more than five times normal geomagnetic background, and strikes across a northwest-striking quartz-carbo-

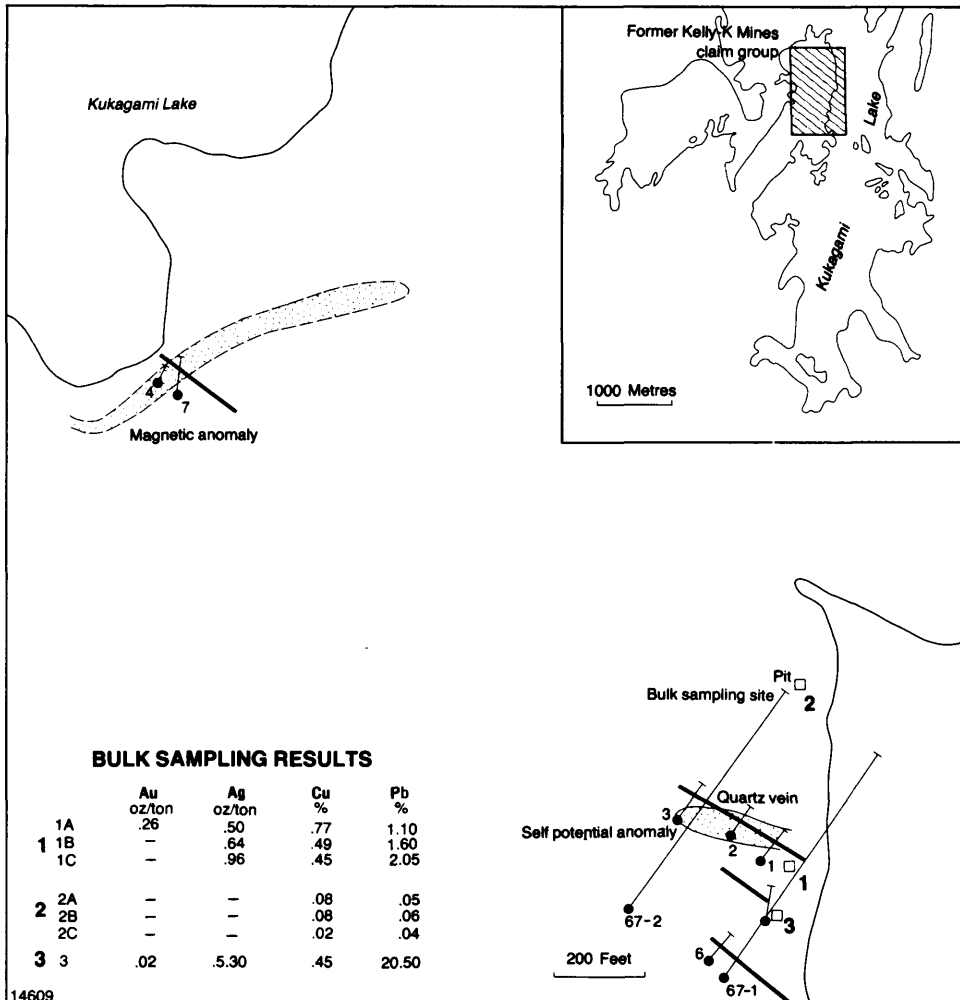


Figure 26—Exploration activity by Kelly-K-Mines Limited; Kelly Township 1966 and 1967.

nate vein. A high intensity, self potential response was recorded over another northwest-striking quartz-carbonate vein at the east shore of the peninsula. As a result of the geophysical surveys, nine holes were diamond drilled for a total length of 534 m. Seven short holes were drilled in 1966. The company reported an average assay of 0.10 ounce of gold per ton, 1.3 ounces of silver per ton, 0.90 percent copper, and 8.78 percent lead from 30 cm to 45 cm long quartz-calcite core sections in drill holes 1, 2, and 3. Similar results were obtained from hole 5 over a core length of 22 cm. From three test pits, several bulk samples were sent for chemical analyses. The results are shown in Figure 26. In 1967 the

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company diamond drilled two more holes, this time for lengths of 183.1 m and 183.4 m. Hole 67-1 (Figure 26) intersected six quartz veins that were 15 cm to 60 cm thick. Only one, a 18 cm thick vein returned a noteworthy assay of 0.24 ounce of gold per ton, 1.4 percent copper and 0.58 percent lead.

In Figure 26 bulk sampling results by the company are shown. Sample 2, a weakly mineralized gabbro, yielded up to 0.08 percent copper and up to 0.06 percent lead only. Samples 1 and 3 show encouraging results, however, the company did not report if these results were obtained from the Nipissing gabbro, as seems to be indicated on Figure 26, or if the samples included vein material.

Part of the former Kelly-K-Mines claim group was in 1978 held by W. Harris (1 claim), M. Miller (1 claim), L.L. O'Mara and N.H. Jensen (1 claim), E.J. Plexman (1 claim), and E. Wieclaw (1 claim).

LAST CHANCE MINE (22)

The only information available on this mine is from Slaght (1897).

The Last Chance mine is situated on lot 4 in the fifth concession of the township of Rathbun, which comprises 238 acres, and is about one mile east of the Crystal mine on lake Matagamasing. The property was discovered in August, 1892, by Henry Ranger and Joseph LaRose, who yet hold an interest in the mine. Mr. D. O'Connor of Sudbury has acquired an interest, and gives directions about the prospecting work. Two principal parallel veins have been discovered running east and west and a slight dip to the south, with several stringers or small veins running in the same direction. Work has been done on the two principal veins, a quarter of a mile back from the lake, and near the middle of the lot one of the veins had been traced by the outcropping quartz for a quarter of a mile, and the other for fully 300 feet. Stripping had been done in several places on the longer traced vein and a test shaft sunk twelve feet. Another shaft in which work was being done at the time of my visit was down eight feet, showing sulphide iron mixed with the quartz. The other larger vein, which was discovered near the building and hardly noticeable at the surface, has been traced for nearly a quarter of a mile, and has been opened by stripping for a few hundred feet, showing the width of the vein to be 14 inches. On the hill above the lake, say 150 feet elevation, there is a large band of mineral quartz, the small stringers running in the same direction as the other veins; some of them when opened showed liberally free gold.

No other information is available on the Last Chance Mine. The location of the Last Chance Mine is shown on Figure 25. In 1977 and 1978 the "mine" and the ground around it were unclaimed.

E. MCBRIDE (23)

Skead Mine

The Skead Mine is located just east of the village of Skead. The property (4 patented claims) is owned by E. McBride.

Thomson (1961) stated that prior to 1946 a shaft had been sunk and drifting done on the 165-foot level. The work was performed by G. Glendenning of Toronto (*circa* 1933). In 1946, Falconbridge Nickel Mines Limited dewatered

and sampled the mine. Assays from 0.088 to 0.39 ounce of gold per ton and up to 0.62 percent copper were reported.

For a more detailed description of the Skead Mine the reader is referred to Thomson (1961) who also presented a geological sketch map of the gold occurrence.

McCHESNEY GOLD MINES LIMITED (24)

Just north of the Red Rock Mine (McMillan Gold Mines Limited property (53)) McChesney Gold Mines Limited presently holds seven claims where in 1931, Mid-Continental Goldfields Limited carried out considerable trenching and pitting to test gold mineralizations.

MCMILLAN GOLD MINES LIMITED (26)

Red Rock Mine

The Red Rock Mine is located in central Scadding Township. Between 1923 and 1925 McMillan Development Company sank a shaft to a depth of about 50 m and did 340 m of drifting and crosscutting on the 30 m level (Kindle 1933). The shaft was sunk near the contact of the Gowganda Formation wacke and a Nipissing gabbro intrusion where numerous quartz and quartz-carbonate veins occur. Many of these veins were tested by trenching and pitting. McMillan Gold Mines Limited is the present owner of the property which consists of one patented claim.

G.E. MCVITTIE (27)

Only very limited information is available on this property which is located on a small peninsula in northern Lake Wanapitei. Three shafts filled with mud and water and old and rusty mining equipment give evidence of a small abandoned mining operation. Several west- to northwest-trending quartz-carbonate veins up to 1 m thick were observed by the author. At the northern shaft, strongly mineralized vein rocks containing much pyrite and sulphide-bearing gabbro were noted in the rock dumps.

J. McVittie diamond drilled five holes for a total length of 200 m and reported assays varying from 0.01 to 0.42 ounce of gold per ton. The information does not give any details whether the gold occurs solely in the quartz veins or whether it is also found in the sulphide-bearing Nipissing gabbro.

G.E. McVittie in 1978 held four patented claims including the mineralization described above¹.

¹G.E. McVittie holds another property not described in this report just west of Capre Lake.

M. MILLER (28)

M. Miller in (1978) held one unpatented claim in southwestern Kelly Township where Kelly-K-Mines did some exploration in 1966 and 1967 (see "Kelly-K-Mines Limited (20)").

MONDOUX MINE (29)

Slaght's report (1896, p.262-263) is the only information available on the Mondoux Mine:

The Mondoux property on lot 5 in the fourth concession of Rathbun had been opened about one year previous to my visit, on May 21st, by an open cut 8 by 20 feet and from 10 to 15 feet in width, with cross-cutting. Surface stripping had extended along the vein for 60 feet. The quartz, I was informed, showed a good percentage of gold.

The location of the Mondoux Mine is shown on Figure 25. In 1977 and 1978 the "mine" and the ground around it were unclaimed.

L.L. O'HARA, AND N.H. JENSEN (32)

L.L. O'Hara and N.H. Jensen in 1978 held one unpatented claim in southwestern Kelly Township where Kelly-K-Mines did some exploration in 1966 and 1967 (see "Kelly-K-Mines Limited (20)").

E.J. PLEXMAN (34)

Several copper, gold, and lead-bearing quartz veins are known to occur in the southern part of Kukagami Lake in Scadding and Davis Township. In 1960 and 1962 Midas Mining Company Limited diamond drilled 14 holes for a total length of 437 m to test the occurrence. The company reported a gold and silver rich (11.3 ounces of gold per ton, 8.7 ounces of silver per ton and 1.95 percent copper) 15 cm long core intersection in one of its drill holes.

In 1967 Kayjon Minerals Limited carried out a combined magnetic and electromagnetic survey in an area at the southwestern end of Kukagami Lake. This survey encountered three weak to strong conducting zones which strike at various angles toward an anomalous magnetic area located in the northern part of the former Kayjon Minerals Limited property, which is located about 250 m northwest of the western bay of southern Kukagami Lake, about 2.1 km north of Ashigami Lake. These three zones have indicated lengths of 90 m, 210 m, and 850 m. In 1967, the company diamond drilled two holes having a total length of 350 m. In the western hole, just west of the south end of Kukagami Lake, the drill encountered five mineralized zones containing 0 to 0.65 ounce of gold per ton, 0.04 to 0.36 ounce of silver per ton, and 0.02 to 0.07 percent copper. These assays were obtained from 1.5 m long core sections.

E.J. Plexman in 1978 held four unpatented claims (Davis and Scadding Townships) in the area formerly investigated by Kayjon Minerals Limited and by Midas Mining Company Limited. He also held one claim in Kelly Township where Kelly-K-Mines Limited did some work in 1966 and 1967 (see account of "Kelly-K-Mines Limited (20)").

TOWER FINANCIAL CORPORATION LIMITED, AND J.M. HAZLETT (36)

The property consists of two claims that are located near the Red Rock Mine of McMillan Gold Mines Limited.

E. WIECLAW (38)

E. Wieclaw in 1978 held one unpatented claim in an area where Kelly-K Mine did some exploration in 1966 and 1967 (see account of "Kelly-K-Mine Limited (20)").

GOLD IN CHLORITIZED QUARTZITE BRECCIA

P.C. MCLEAN (25)

P.C. McLean in (1978) held 25 unpatented claims in central and southern Scadding Township, where, in 1972, Gulf Minerals Canada Limited conducted an airborne geophysical survey over a group of claims (see "Gulf Minerals Canada Limited [1972] (14)"). Initially, the exploration efforts were to find uranium mineralization. Uranium, however, was not found in the investigated area, and instead gold was discovered.

P.C. McLean, in cooperation with D.R. Watt, is currently engaged in a drilling programme to value the discovery (see "D.R. Watt (37)").

D.R. WATT (37)

D.R. Watt currently holds a group of 63 claims in central and southern Scadding Township. In cooperation with P.C. McLean (see "P.C. McLean (25)") he is presently valuating a gold discovery made on ground initially investigated by Gulf Minerals Canada Limited in an uranium exploration programme (see "Gulf Minerals Canada Limited [1972] (14)").

In January 1978, D.R. Watt diamond drilled eight holes which total 492 m in length near the location where Gulf Minerals Canada Limited had diamond drilled 41 holes having a total length of 2669 m.

In the February 8, 1979 issue of the Northern Miner, page 3, some details

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on the McLean-Watt group properties were published:

The property, which is in Scadding Township 20 miles east of Sudbury, is held under option from Gulf Minerals Canada under an agreement that calls for the Watt group to spend \$200,000 over a 2-year period. Gulf retains a royalty of \$1 per ton on any ore milled.

Previous drilling by the former owners indicated some 34,000 tons of material grading .303 oz. gold per ton within an east-west trending chlorite breccia zone. But recent work carried out by the McLean-Watt group has indicated a strong new northwest trending chlorite breccia zone located some 600 feet west of the original structure. This brand new zone contains widespread gold values, and some very encouraging drill hole intersections.

The average grade of the three zones encountered in hole W-8 is 0.335 oz. per ton over a total of 15.6 ft. If taken together, the whole zone averaged 0.15 oz. per ton over 36.5 ft. The average grade of the last four zones encountered in hole W-9 was 0.33 oz. over a total width of 38.5 ft. If taken together, the whole zone averages 0.155 oz. per ton over 84.8 ft.

It is thought that holes W-8 and W-9 represent a southeasterly plunging breccia pipe within the northwest trending zone. While this structure has not yet been tested to depth, the ore intersections obtained are over true widths and thus may indicate a substantial tonnage of economic grade material, geologist McLean feels....

To date gold values have been found over a length of 1,400 ft. in surface showings and in drill holes, and there is evidence that the zone extends for a considerable distance beyond this length. There appears to be an excellent chance that other enriched pipe like structures will be found within the northwest chlorite breccia zone. Mr. McLean told The Northern Miner....

Uranium and Gold

GULF MINERALS CANADA LIMITED [1972] (14)

In 1972, Gulf Minerals Canada Limited conducted an airborne radiometric, electromagnetic, and magnetometer survey over a group of 79 claims in Scadding Township in order to: a) map the distribution of radioactive material and subsurface conductors, and b) obtain structural information on the geological formations. As a result of this work, the company diamond drilled 41 holes for a total length of 2669 m in the area 1.2 km west of the westernmost end of Ashigami Lake. Most of the diamond-drill sites were close to an outcrop area of rusty weathering pyritiferous arkose of the Serpent Formation. The diamond-drill encountered Serpent Formation quartz arenite, arkose, and wacke, Espanola Formation limestone, and Nipissing gabbro.

The company did not report the discovery of uranium; however, gold was subsequently found by P.C. McLean in the area investigated ("P.C. McLean (25)").

Uranium

In the 1950s an uranium discovery in quartz-pebble conglomerate was made on the west shore of Massey Bay of Wanapitei Lake. The ground along the western shore of this bay and the bay itself is presently (Dec. 1978) covered by about forty unsurveyed claims. The claim holders, in alphabetical order, are

listed in Table 20. No information is available on the claims held by A. Arena, H.Z. Tittley, and L. Viau.

M.L. BURTON (6)

In 1975 M.L. Burton diamond drilled a 38 m deep hole on the shore of Massey Bay, 1.6 km north of the southernmost end of Boland's Bay where he currently holds 14 unsurveyed claims.

HOLLINGER MINES LIMITED [1976] (17)

In 1976, Hollinger Mines Limited diamond drilled a 174 m deep hole near the discovery showing. The results are described in the section "Picton Uranium Mines Limited (33)". No claim was registered in the name of this company on December 31st 1978 for this occurrence.

PICTON URANIUM MINES LIMITED (33)

In 1959 Picton Uranium Mines Limited diamond drilled three holes for a total length of 162 m on the west shore of Massey Bay. The results, including some U_3O_8 assays are presented under the heading "General Geology" as follows.

General Geology

Radioactive quartz conglomerate of the Mississagi Formation is exposed at a few places along the west shore of Massey Bay of Lake Wanapitei. At the discovery site the conglomerate can be traced for a distance of about 180 m along the lakeshore. However, it is exposed at a few more places south of the discovery pit. In 1959, Picton Uranium Mines Limited encountered 2.8 m slightly radioactive quartz sandstone interlayered with siltstone that is underlain by 3.25 m radioactive, pyritiferous pebble conglomerate in one of the diamond-drill holes. Another radioactive conglomerate bed, about 8.7 m thick occurs further along in the length of the hole; from the 24.7 m to the 33.4 m length. Eight assays from the 3.25 m thick radioactive zone ranged from 0.01 to 0.04 percent U_3O_8 . Similar U_3O_8 contents were indicated in quartzite and pebble conglomerate in two other drill holes. Thomson (1961) reported an assay of 0.009 percent U_3O_8 obtained from a grab sample taken from a conglomerate occurrence opposite the Ontario Ministry of Natural Resources buildings at Bowlands Bay. Hollinger Mines Limited reported a 25 cm thick radioactive pyritic quartz pebble conglomerate bed in 124 m depth of a vertical diamond-drill hole near the discovery showing (Assessment Files Research Office, Ontario Geological Survey, Toronto).

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A general description of the quartz-pebble conglomerates is given in the section on the Mississagi Formation, this report. K.D. Card *in* Thomson 1960, p.15, has described the radioactive minerals at the base of the Huronian rocks in the District of Sudbury as follows:

Uraninite occurs in the form of small (0.05-0.1 mm) rounded to angular, fractured grains which often show a cubic habit. It is generally concentrated with other heavy minerals and with pyrite in thin seams and in the matrix as rims on quartz pebbles.

Uraninite appears to be a primary detrital mineral, as is evidenced by its close association with normal detrital minerals such as zircon and by the rounded nature of some of the grains.

A mineral which is called brannerite here, due to its similarity to the so-called brannerite of the Blind River ores, was noted in several samples. It occurs as small (0.01-0.5 mm) highly altered grains in the matrix where they are closely associated with pyrite, uraninite, zircon, and ilmenite. In polished section, brannerite grains are seen to be a mixture of two constituents, one of which is light grey and highly reflective, and another which is darker grey and less reflective. It is probable that this material is a two phase mixture of uraninite and a titanium mineral such as rutile.

Decorative Building Stone

J.J. BILLOKI (4)

In north-central Aylmer Township a breccia stone pit is currently operated by Telteck Explorations Limited on a property owned by J.J. Billoki. The breccia consists of centimetre to decimetre size angular fragments of laminated Gowganda Formation silty arkose set in hydrothermal quartz and carbonate of hydrothermal origin. The brownish to pinkish-buff breccia, in places, contains bornite and chalcopyrite.

The breccia is of the same hydrothermal origin as the nearby Nova Beaucauge Mines Limited (31) property.

Sand and Gravel

Sand and gravel is readily available in the map-area. The thickest and most extensive deposits are north of Lake Wanapitei and south and southwest of the Village of Skead. The deposits just north of Lake Wanapitei consist mainly of fine-grained quartz sand. The glacial deposits south of Skead are sand, gravel, and boulder deposits and were classified by Burwasser (1977) as outwash channel deposits. Several sand and gravel pits exist south of Skead and Bowlands Bay in Lake Wanapitei (Burwasser 1979).

GEOPHYSICAL CHARACTERISTICS OF THE AREA

The two Geological Survey of Canada aeromagnetic maps "1511G Capreol" and "1512G Milnet" show the general magnetic trends in the area. Several positive magnetic anomalies lie along the lower contact of the Sudbury Nickel Ir-

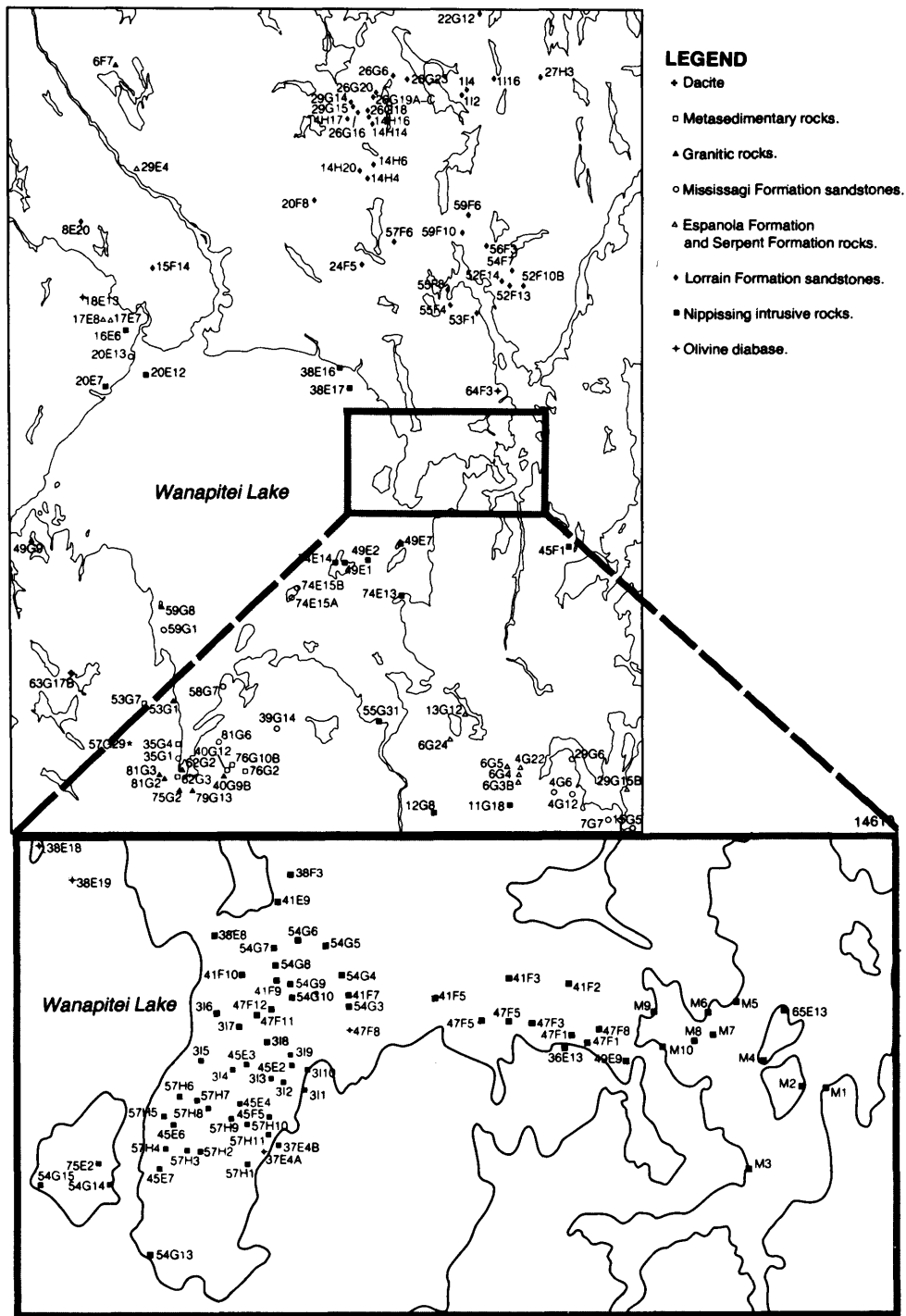


Figure 27—Sample location map for all modally and chemically analyzed specimens.

ruptive. A more or less circular positive anomaly lies over the Early Precambrian ironstone in northwestern Rathbun Township. The thick northwest-trending olivine diabase that extends from east of Kukagami Lake across Matagamasi Lake to the Wanapitei River in Aylmer Township is expressed by a strong linear positive anomaly. The Nipissing gabbro bodies have a very weak or no magnetic expression. Over Lake Wanapitei, the isomagnetic lines strike east-west and are rather widely spaced. A circular positive anomaly of about 40,000 gammas is located over Laundry Lake in Mackelcan Township. It is the westernmost part of a positive gravity-magnetic anomaly that extends from the map-area northeastward toward Temagami Lake. The origin of this anomaly is not known.

J. Popelar (1972) described positive gravity anomalies associated with the Nickel Irruptive. A weak gravity low is located over Lake Wanapitei (see section on "Lake Wanapitei Structure").

SUGGESTIONS FOR FUTURE EXPLORATION

Further detailed studies on the contact zones of the Nipissing gabbro with rocks of the Huronian Supergroup should be carried out to investigate the possibility of gold and gold-copper-quartz carbonate vein mineralization. Detailed exploration, accompanied by diamond drilling, is required on the quartz veins within the chlorite alteration zone of the Lake Wanapitei Gabbro Intrusion at Matagamasi Lake. Gold mineralization appears to be associated with a chloritization of the host rocks in the McLean and Watt properties in Scadding Township (see sections on "P.C. McLean (25) and D.R. Watt (37)").

The Rathbun Lake Occurrence (35) should be re-examined. Similar rich sulphide bodies as the one near the surface at Rathbun Lake are possibly located deeper underground within the gabbro close to the contact with the wackes of the Gowanda Formation.

Exploration of the Nipissing gabbro within the Wanapitei Lake area and on a regional basis is probably warranted in view of large tonnage, low grade, copper-nickel deposits possibly associated with the Nipissing gabbro.

Exploration of the Espanola Formation is probably warranted in view of the possibility of the occurrence of sulphide deposits in this formation, especially at the contacts with mafic intrusive rocks. The area around Sam Martin Lake in northwestern Aylmer Township appears to be a favourable target area. A Nipissing gabbro body outcrops east of easterly dipping Espanola Formation limestones and west of the Nova Beaucage Mines Limited (33) carbonaceous copper sulphide mineralization. The gabbro probably intrudes the limestones below surface.

Detailed radioactive surveys over areas underlain by rocks of the Missisagi Formation, for instance at Massey Bay, Lake Wanapitei, and south of Ashigami Lake in Scadding and Davis Townships, are needed to determine the uranium potential of the quartz-pebble conglomerate and the pyritiferous arkose found in this formation.

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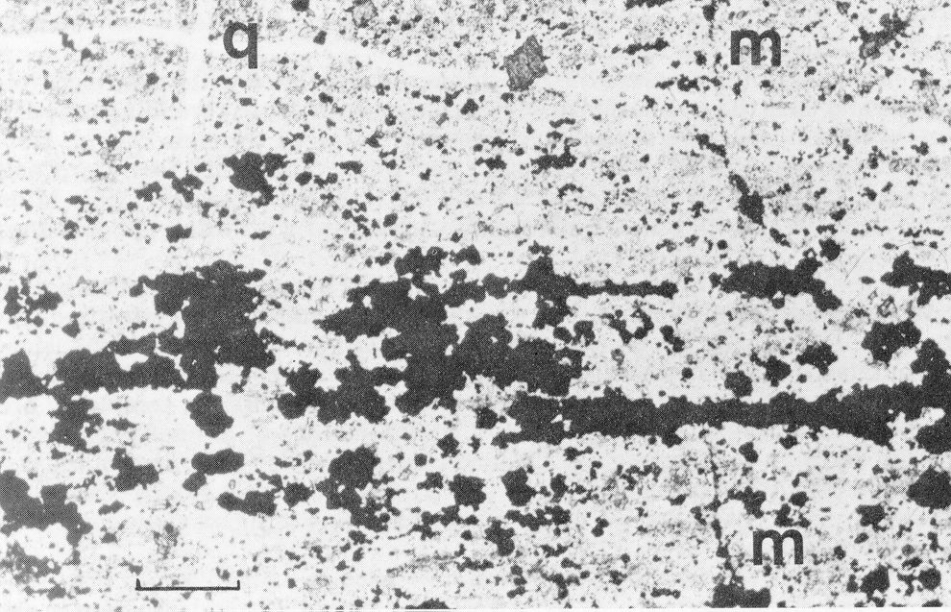
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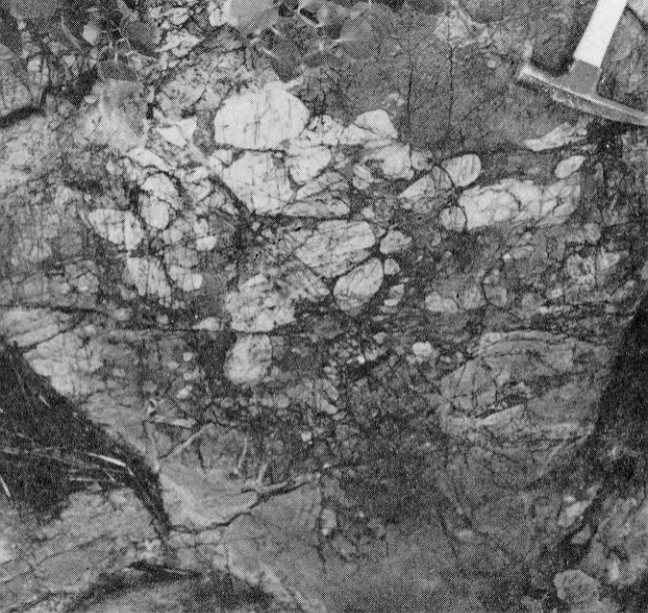
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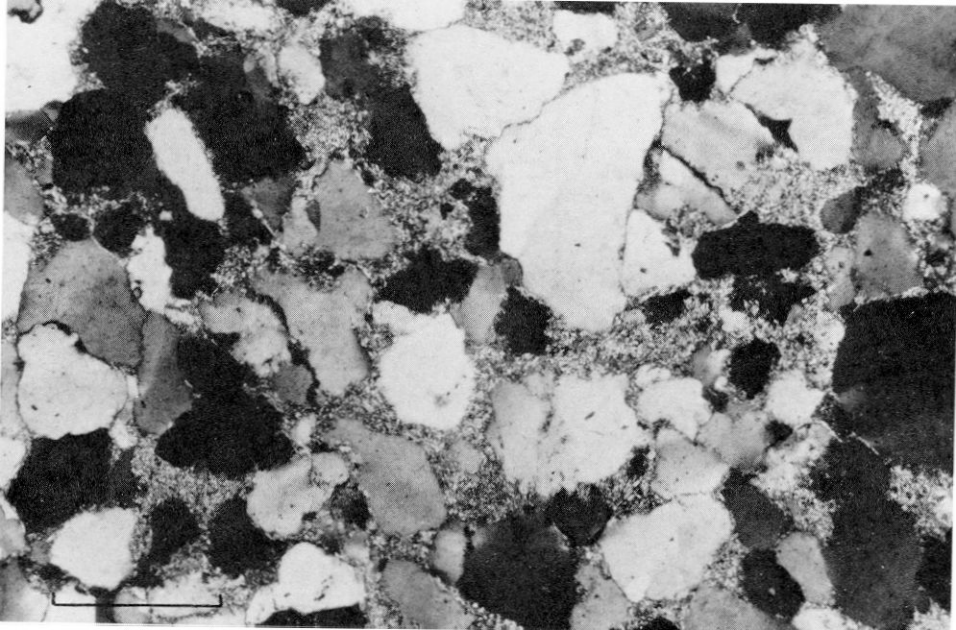
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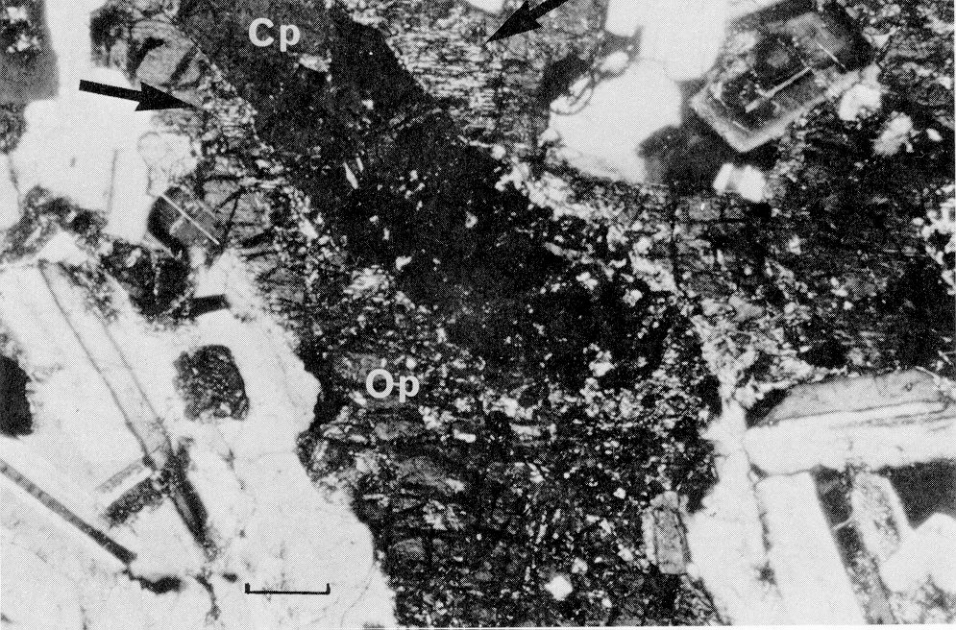


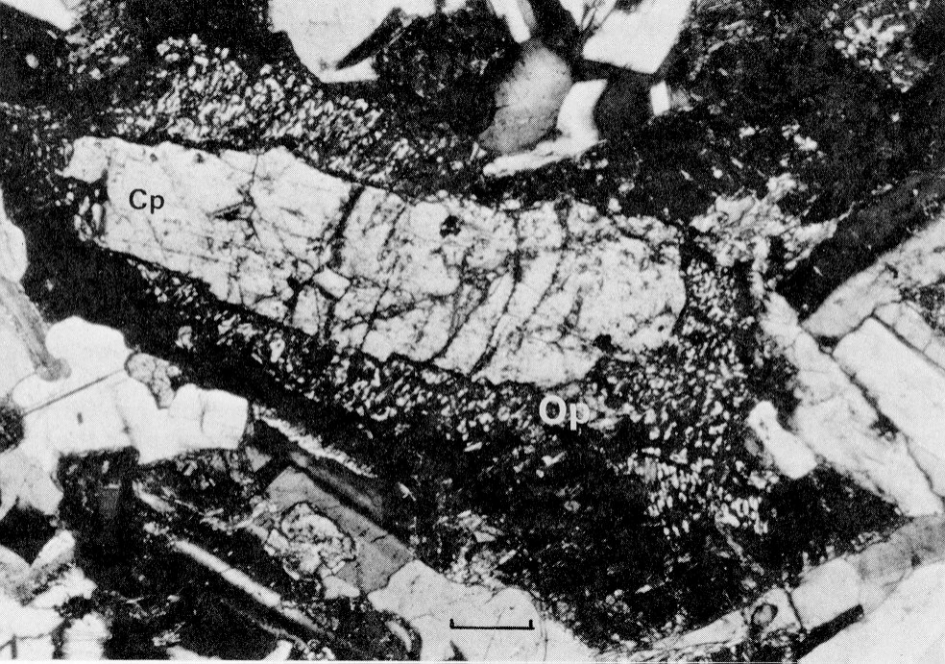












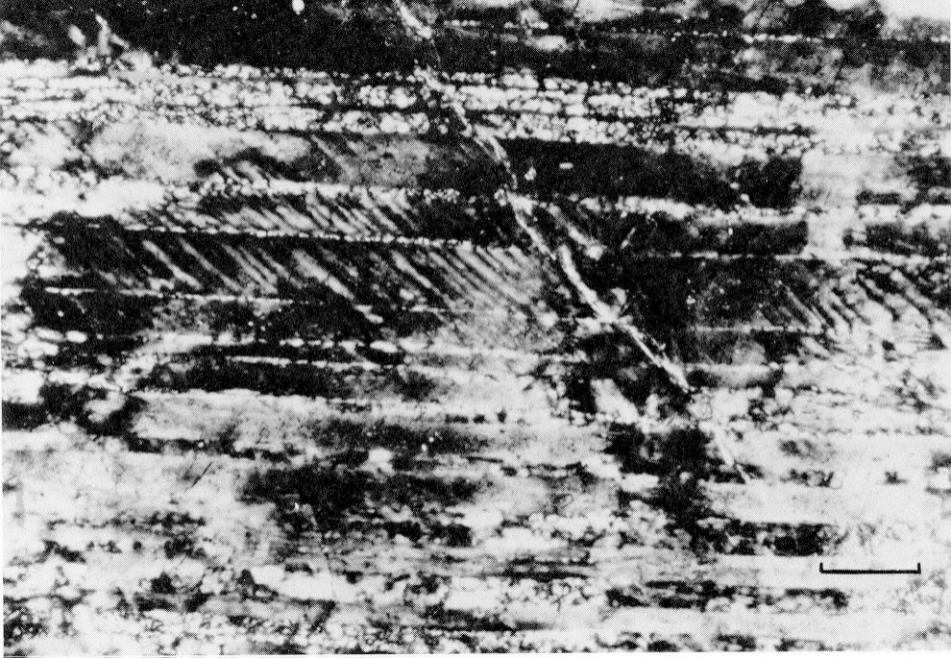
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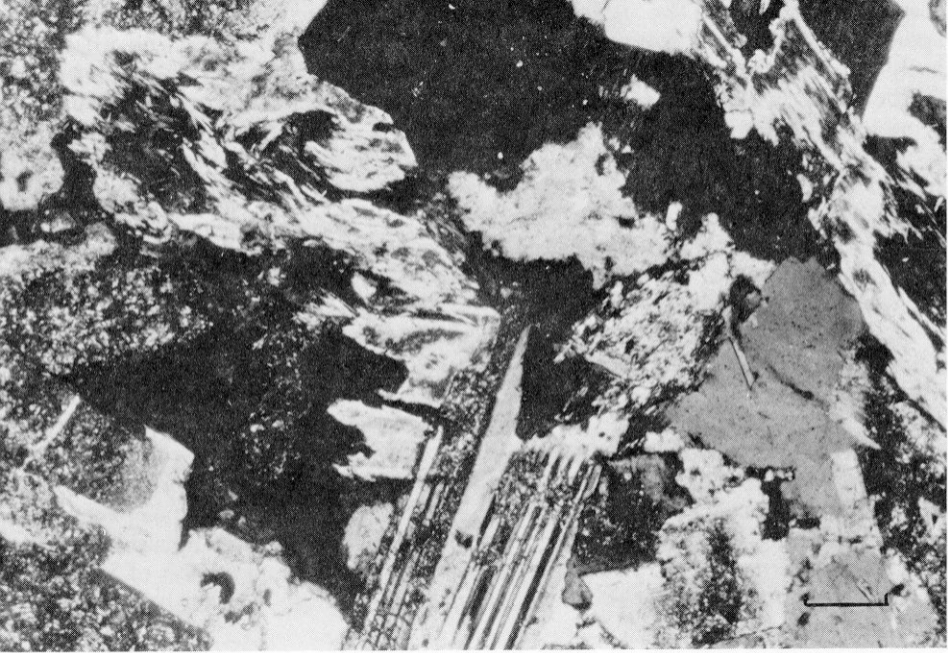
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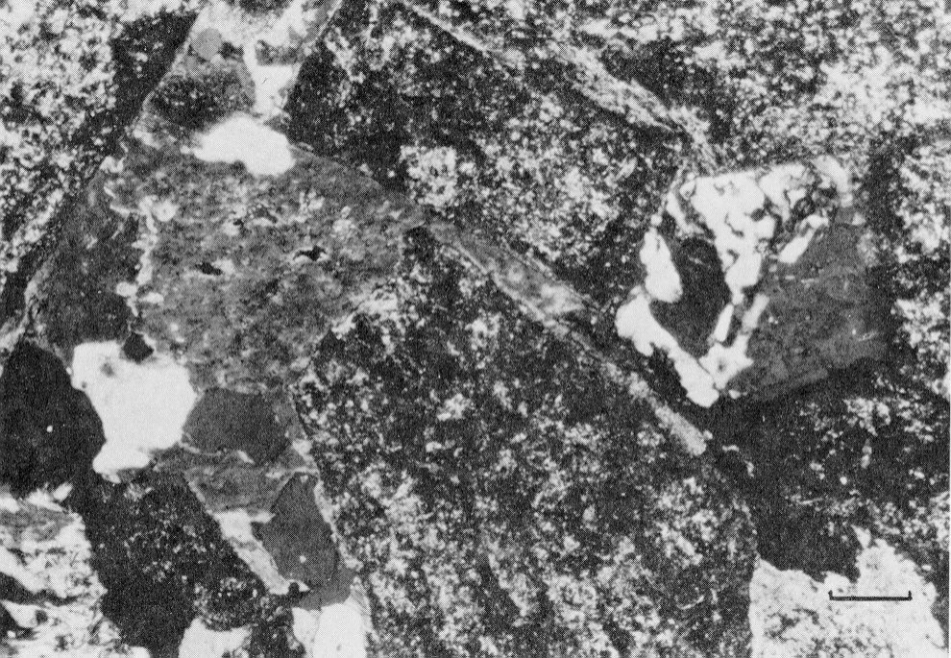


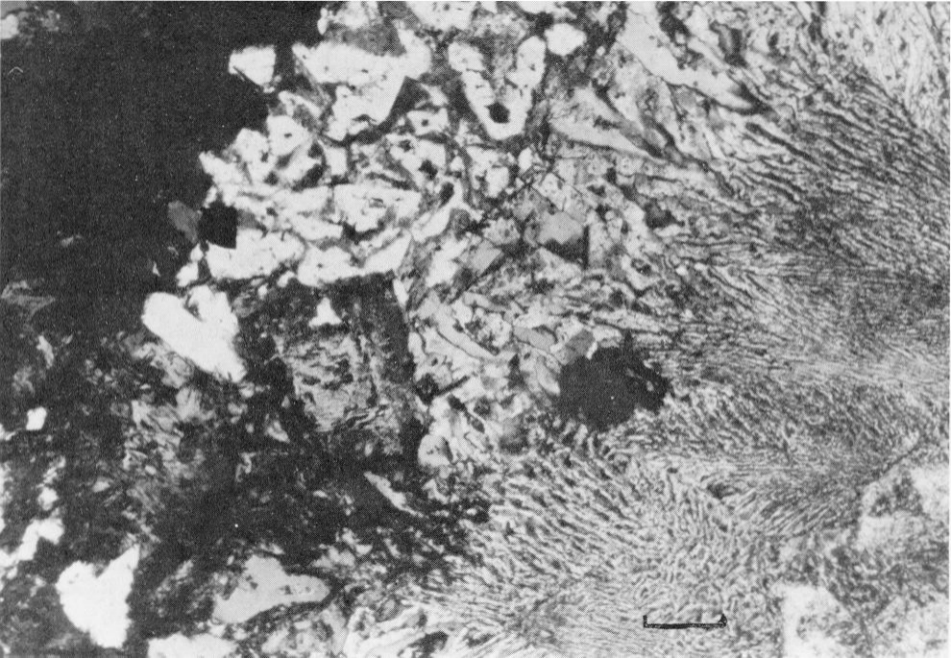






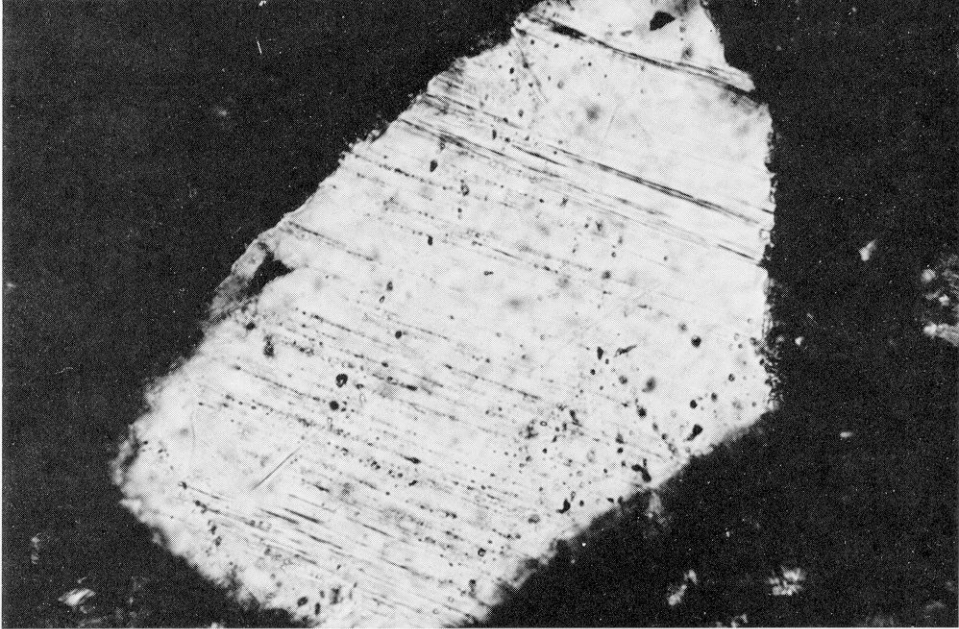














- SYMBOLS**
- Glacial striae
 - Small bedrock outcrop
 - Area of bedrock outcrop
 - Bedding, horizontal
 - Bedding, top unknown, (inclined, vertical)
 - Schistosity, (horizontal, inclined, vertical)
 - Gneissosity, (horizontal, inclined, vertical)
 - Fracture cleavage, (horizontal, inclined, vertical)
 - Geological boundary, observed
 - Geological boundary, position interpreted
 - Fault, (observed, assumed)
 - Lineament
 - Anticline, syncline, with plunge
 - Drill hole, (vertical, inclined)
 - Building
 - Highly fractured rocks
 - Contact of Pleistocene and Recent rocks
 - Section line (see report)
 - Swamp
 - Motor road
 - Trail, portage, winter road
 - Township, Indian reserve boundary, meridian or baseline, with railroads, approximate position only
 - Surveyed line
 - 27 Mining property, surveyed; boundary approximate position only
 - 27 Mineral deposit, mining property, unsurveyed, approximate position only

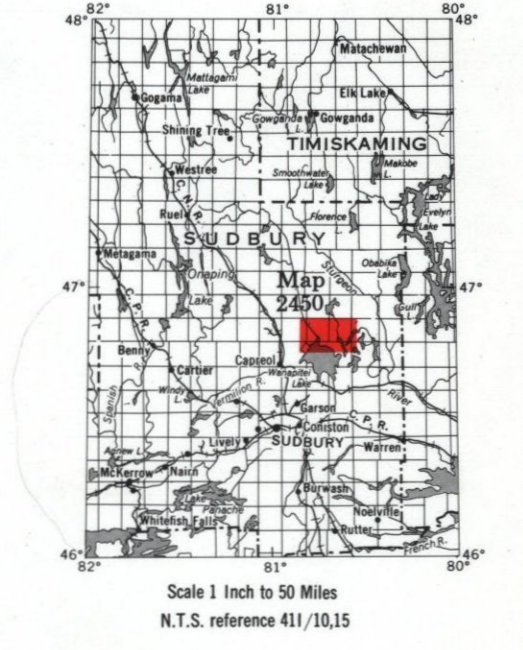
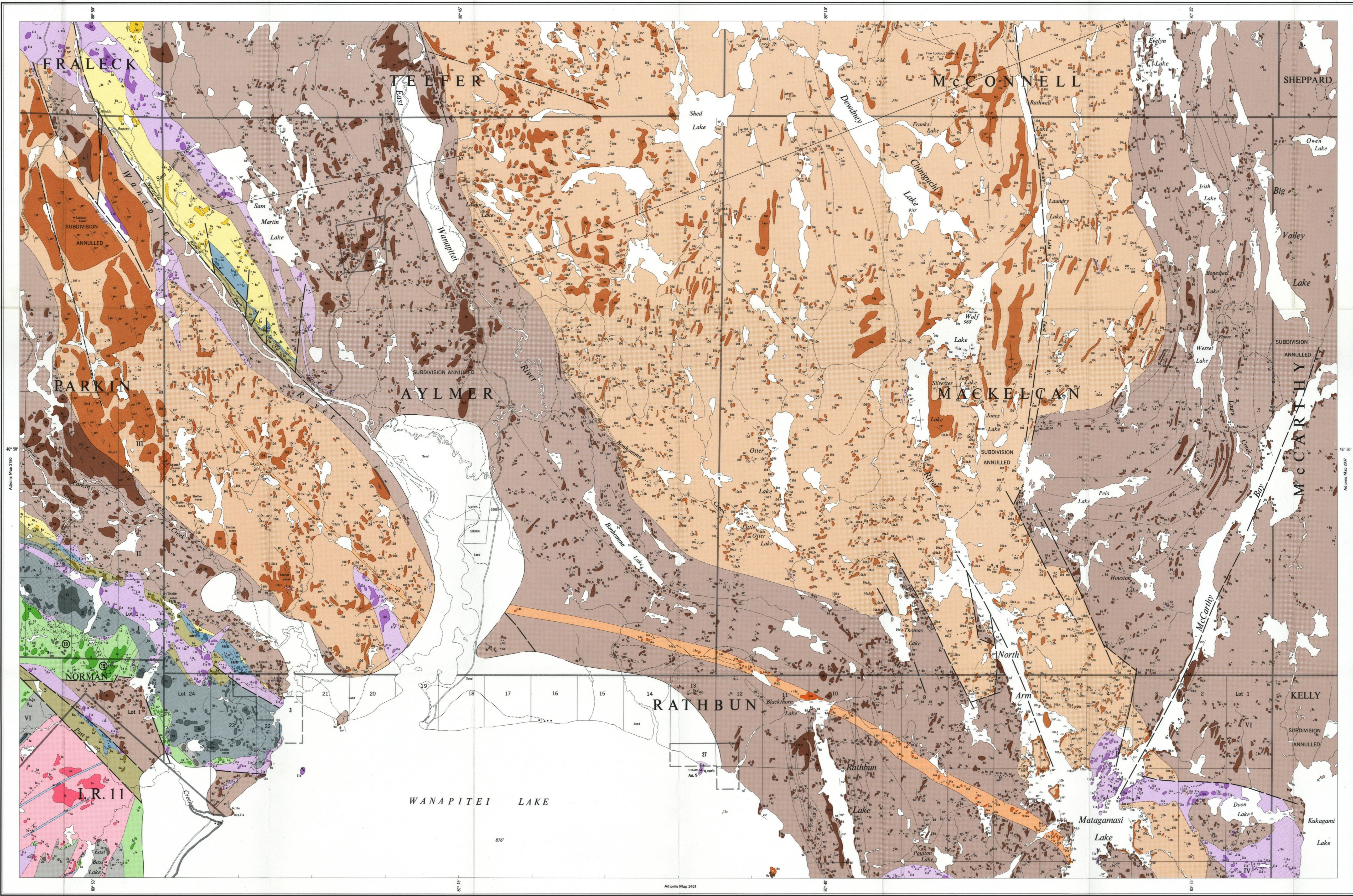
SOURCES OF INFORMATION

Geology by B. Dressler and assistants, Ontario Geological Survey, 1977, 1978.
Geology not tied to surveyed lines.
Assessment Files, Assessment Files Research Office, Ontario Geological Survey, Toronto, and Resident Geological Files, Ministry of Natural Resources, Sudbury Office.
Aeromagnetic maps 1511G, 1512G, G.S.C.
Geological Survey of Canada: Map 1948, Wanapitei Lake Area.
Ministry of Natural Resources, Ontario Geological Survey: Map 48m, Ashagam Lake Area, scale 1 inch to 1/2 mile, 1:50,000, 1959.
Map 2009, MacKenzie and Scadding Townships, scale 1 inch to 1/2 mile, 1:50,000, 1961.
Map 2037, Kelly and Davis Townships, scale 1 inch to 1/2 mile, 1:50,000, 1963.
Map 2170, Sudbury Mining Area, scale 1 inch to 1/2 mile, 1:50,000, 1965.
Map 2361, Sudbury-Cobalt, Geological Compilation Series, scale 1 inch to 4 miles, 1:253,440, 1977.
Preliminary maps, Ontario Geological Survey: P-307, Carleton, scale 1 inch to 2 miles, 1:126,720, 1966.
P-1608, Aylmer Township, scale 1 inch to 1/4 mile, 1:15,840, 1977.
P-1609, Rathbun Township, scale 1 inch to 1/4 mile, 1:15,840, 1977.
P-2226, Wanapitei Lake Area (Southern Part), scale 1 inch to 1/4 mile, 1:15,840, 1978.
P-2227, MacKeehan Township, scale 1 inch to 1/4 mile, 1:15,840, 1978.
Cartography by M.G. Sefton and assistants, Surveys and Mapping Branch, 1980.
Base maps derived from maps of the Forest Resources Inventory, Surveys and Mapping Branch.
Magnetic declination in the area was approximately 9° West, 1978.

Parts of this publication may be quoted if credit is given. It is recommended that reference to this map be made in the following form:
Dressler, B.
1981. Otter Lake. Ontario Geological Survey Map 2450, Precambrian Geology Series, Scale 1 inch to 1/2 mile, 1:31,680. Geology 1978.

- PROPERTIES, MINERAL DEPOSITS**
1. Adams, G. and Adams, J.†
 2. Allyn Porcupine occurrence†
 3. Bennett, W.S.
 4. Bilok, J. J.
 5. Blanchard, E. (Bonanza Mine)†
 6. Burton, M.†
 7. Crystal Gold Mine†
 8. Falconbridge Nickel Mines Limited†
 9. Gill, J.†
 10. Gude Exploration Limited, (1973)†
 11. Gold Nugget and Development Company†
 12. Gold Nugget and Development Company, and LaForce, L.
 13. Gordon Mine†
 14. Gulf Minerals Canada Limited, (1972)†
 15. Hardy, J. O.†
 16. Harris, W. O.†
 17. Hollinger Mines Limited, (1976)†
 18. Inco Limited†
 19. Inco Mining and Smelting Limited, (1966)†
 20. Kelly-K-Mines Limited†
 21. Keneco Explorations (Canada) Limited, (1970)†
 22. Last Chance Mine†
 23. McBride, E.†
 24. McChesney Gold Mines Limited†
 25. McLean, P. C.†
 26. McMillan Gold Mines Limited (Red Rock Mine)†
 27. Miller, G. E.
 28. Miller, M.†
 29. Mondoux Mine†
 30. Noranda Mines Limited, (1905)†
 31. Nova Beauveque Mines Limited
 32. O'Hara, L. L. and Jensen, N. H.†
 33. Pictou Uranium Mines Limited†
 34. Peonias, E. J.†
 35. Rathbun Lake occurrence†
 36. Tower Financial Corporation Limited, and Hasted, J. M.†
 37. Watt, D. R.†
 38. Wiclow, E.†

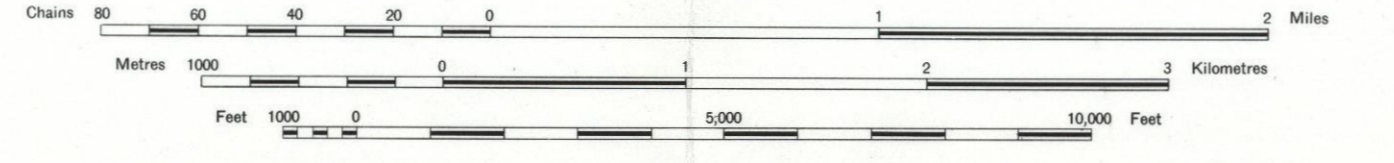
Information current to December 31, 1978. Former properties on ground now open for staking are only shown if exploration data is available—data in square brackets indicates last year of exploration activity. For further information see report.
†Appears on accompanying Map 2451, Wanapitei Lake Area report.



- LEGEND**
- PHANEROZOIC**
- CENOZOIC***
- QUATERNARY**
- PLEISTOCENE AND RECENT
- Gravel, sand, silt, swamps.
- PRECAMBRIAN***
- LATE PRECAMBRIAN**
- MAFIC INTRUSIVE ROCKS**
- 14a Olivine diabase
- MIDDLE PRECAMBRIAN**
- SUBURBY NICKEL IRRUPTIVE†**
- 13a Sublayer
13b Zone
13c Transition zone north
13d Microgranite
13e Granitic dike
- WHITewater GROUP**
- SNAPPING FORMATION†**
- 12a Quartzite breccia (basal breccia)†
12b Tuff
- MAFIC INTRUSIVE ROCKS**
- NIPISSING INTRUSIVE ROCKS**
- 11a Gabbro
11b Pegmatite gabbro
11c Granophyre †
11d Granitic dike rock, pegmatite
11e Quartz-plagioclase porphyry
- HURONIAN SUPERGROUP**
- COBALT GROUP**
- LORRAIN FORMATION**
- 10a Grey wacke
10b Arkose, subarkose, minor subarkose, wacke and quartz wacke, (10b, c, and d)
10c Pink, arkosic grey
10d Grey
10e Greenish grey, grey
10f Quartz wacke to subarkosic wacke
10g Arenites, unbedded
- GOWANDA FORMATION**
- 9a Conglomerate
9b Arkose, minor conglomerate
9c Wacke (not laminated)
9d Laminated wacke
9e Wacke unbedded
- QUIRKE LAKE GROUP**
- SERPENT FORMATION**
- 8a Arkose, arkosic wacke, calcareous arkose, minor conglomerate
8b Dolomite porphyroblastite*
- ESPANOLA FORMATION**
- 7a Calcareous siltstone, limestone, calcareous wacke
- BRUCE FORMATION**
- 6a Conglomerate, pebbly, wacke, minor arkose, wacke
- HOUGH LAKE GROUP**
- MISSISSAGI FORMATION**
- 5a Quartz-pebble conglomerate
5b Arkose, subarkose, arkosic wacke, subarkosic wacke
5c Silt wacke
- EARLY PRECAMBRIAN**
- MAFIC INTRUSIVE ROCKS**
- 4a Diabase
4b Gneissporphyritic diabase †
4c Porphyritic diabase †
- FELSIC PLUTONIC ROCKS**
- 3a Granodiorite, diorite
3b Migmatite †
- METAVOLCANICS AND METASEDIMENTS**
- METASEDIMENTS**
- 2a Wacke
2b Quartz arkosic, arkose †
2c Biotite-plagioclase gneiss, minor hornblende-plagioclase gneiss
2d Ironstone, Ferruginous chert
- METAVOLCANICS**
- 1a Mafic and intermediate metavolcanics
1b Amphibolite †
1c Dacite
1d Felsic metavolcanics
- 1a* Breccia 1a† Pseudotachylite

Ontario Geological Survey
Map 2450
OTTER LAKE
SUBURBY DISTRICT

Scale 1:31,680 or 1 Inch to 1/2 Mile



*Unconsolidated deposits. Cenozoic deposits are represented by the lighter coloured and uncoloured parts of the map.
†Bedrock geology. Outcrops and inferred extensions of each rock map unit are shown respectively in deep and light lines 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.
*Age not known, occurs also in Lorrain Formation.
†Appears on accompanying Map 2451, Wanapitei Lake Area report.

SYMBOLS

- Glacial striae.
- Small bedrock outcrop.
- Area of bedrock outcrop.
- Bedding, horizontal.
- Bedding, top unknown (inclined, vertical).
- Schistosity (horizontal, inclined, vertical).
- Gneissosity (horizontal, inclined, vertical).
- Fracture cleavage (horizontal, inclined, vertical).
- Geological boundary, observed.
- Geological boundary, position interpreted.
- Fault (observed, assumed).
- Well.
- Anticline, syncline, with plunge.
- Drill hole (vertical, inclined).
- Location of sample exhibiting deformation lamellae in quartz.
- Contact of Pleistocene and Recent rocks.
- Swamp.
- Motor road, Provincial highway number encircled where applicable.
- Other road.
- Trail, portage, winter road.
- Building.
- Township, Indian reserve boundary, meridian approximate position only.
- Surveyed line.
- Mining property, surveyed. Boundary approximate position only.
- Mineral deposit, mining property, unsurveyed, approximate position only.

NOTE

Geological boundaries east of the Sudbury Nickel Irruptive, i.e. east of Blue Lake and Capreol Lake and around Skead, commonly are megabreccia cleft boundaries.

SOURCES OF INFORMATION

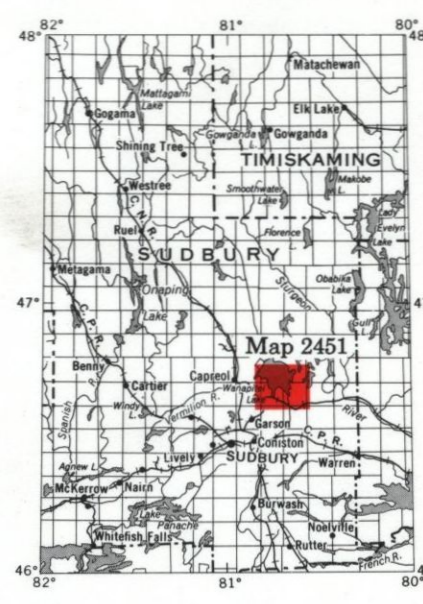
- Geology by B. Dressler and assistants, Ontario Geological Survey, 1977, 1978.
- Geology not surveyed lines.
- Assessment Files, Assessment Files Research Office, Ontario Geological Survey, Toronto, and Resident Geologist's Files.
- Ministry of Natural Resources, Sudbury Office.
- Aeromagnetic maps 1511G, 1512G, G.S.C.
- Geological Survey of Canada: Map 1948, Wanapitei Lake Area.
- Ministry of Natural Resources, Ontario Geological Survey: Map 450, Ashigami Lake Area, scale 1 inch to 1/4 mile, 1:31 680, 1970.
- Map 2009, MacLennan and Scadding Townships, scale 1 inch to 1/4 mile, 1:31 680, 1961.
- Map 2037, Kelly and Davis Townships, scale 1 inch to 1/4 mile, 1:31 680, 1963.
- Map 2170, Sudbury Mining Area, scale 1 inch to 1/4 mile, 1:31 680, 1963.
- Map 2361, Sudbury-Cobalt, Geological Compilation Series, scale 1 inch to 4 miles, 1:253 440, 1977.
- Primary maps, Ontario Geological Survey: P. 367, Capreol, scale 1 inch to 2 miles, 1:126 760, 1959.
- P. 1608, Aymer Township, scale 1 inch to 1/4 mile, 1:15 840, 1977.
- P. 1609, Rathbun, Township, scale 1 inch to 1/4 mile, 1:15 840, 1977.
- P. 2225, Wanapitei Lake Area (Southern Part), scale 1 inch to 1/4 mile, 1:15 840, 1978.
- P. 2227, MacLennan Township, scale 1 inch to 1/4 mile, 1:15 840, 1978.
- Cartography by M.G. Sutton and assistants, Surveys and Mapping Branch, 1980.
- Base map derived from maps of the Forest Resources Inventory, Surveys and Mapping Branch.
- Magnetic declination in the area is approximately 9° West, 1978.

PROPERTIES, MINERAL DEPOSITS

- 1. Atkins, G., and Atkins, J.
- 2. Alwyn Resources occurrence.
- 3. Bennett, W. S. 1
- 4. Bilski, J. J.
- 5. Blanchard, E. (Bonanza Mine)
- 6. Burton, M.
- 7. Crystal Gold Mine.
- 8. Falconbridge Nickel Mines Limited.
- 9. Gill, J.
- 10. Glade Exploration Limited (1973)
- 11. Gold Nugget and Development Company.
- 12. Gold Nugget and Development Company, and Lafarge Mine.
- 13. Gordon Mine.
- 14. Gulf Minerals Canada Limited (1972)
- 15. Hardy, J. C.
- 16. Harris, W. P.
- 17. Hollinger Mines Limited (1976)
- 18. Inco Limited.
- 19. Inco Mining and Smelting Limited (1966)†
- 20. Kelly-K Mines Limited.
- 21. Kamico Explorations (Canada) Limited (1970)†
- 22. Last Chance Mine.
- 23. McBride, E.
- 24. McChesney Gold Mines Limited†
- 25. McLean, P. C.
- 26. McMillan Gold Mines Limited (Red Rock Mine)
- 27. McVittie, G. E.†
- 28. Miller, M.
- 29. Mondou Mines.
- 30. Noranda Mines Limited (1955)
- 31. Nova Beauce Mines Limited†
- 32. O'Hara, L. L., and Jensen, N. H.
- 33. Picton Uranium Mines Limited.
- 34. Plekman, E. J.
- 35. Rathbun Lake occurrence.
- 36. Tower Financial Corporation Limited, and Hazlett, J. M.
- 37. Watt, D. R.
- 38. Wuester, E.

Information current to December 31, 1978. Former properties on ground now open for staking are only shown if exploration data is available—a date in square brackets indicates last year of exploration activity. For further information see report.

†Appears on accompanying Map 2450, Wanapitei Lake Area report.



Scale 1 inch to 50 Miles
N.T.S. reference 411/1015

LEGEND

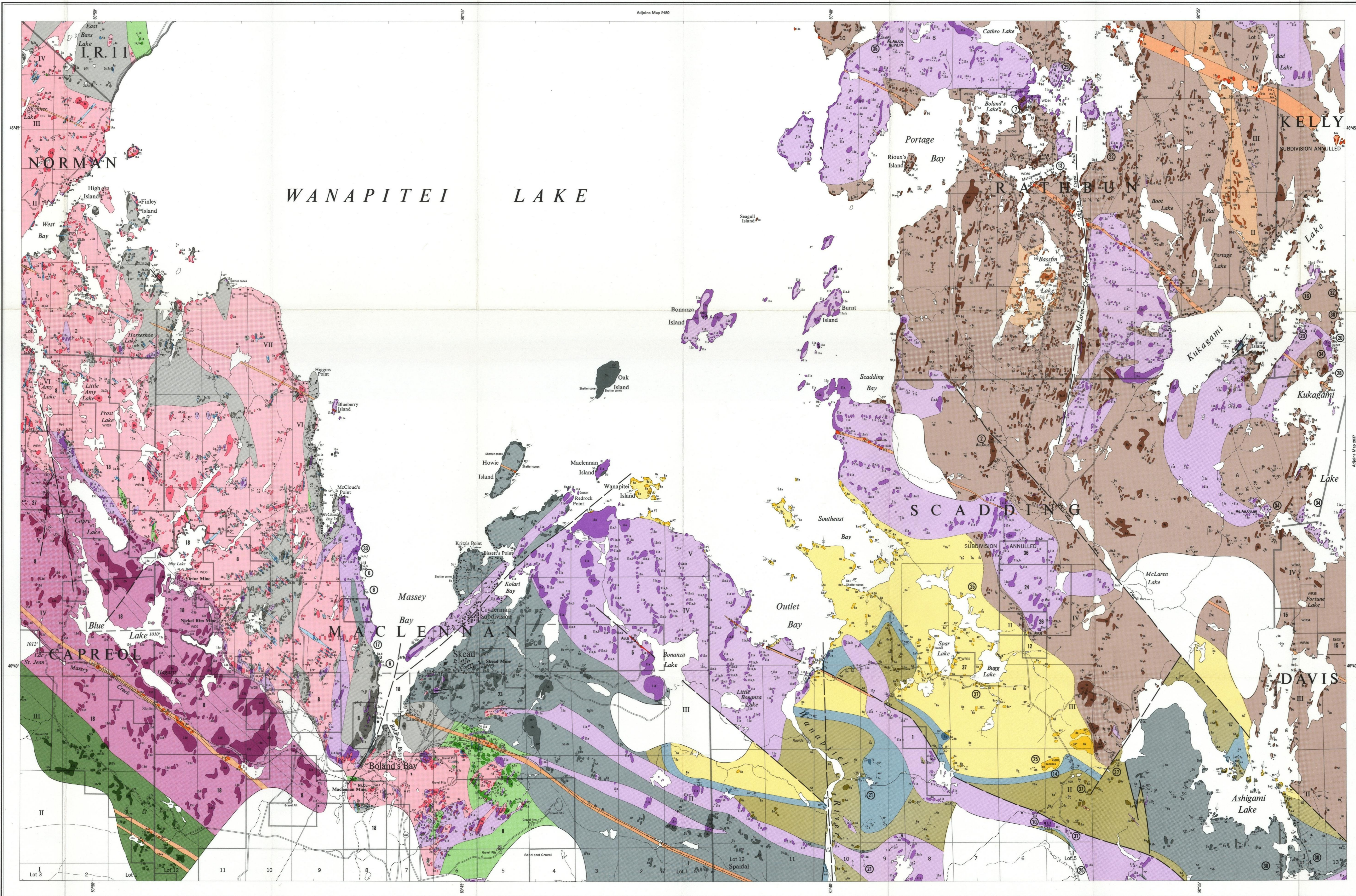
- PHANEROZOIC**
- CENOZOIC***
- QUATERNARY**
- PLEISTOCENE AND RECENT
 - Gravel, sand, silt, swamps.
- UNCONFORMITY
- PRECAMBRIAN***
- LATE PRECAMBRIAN**
- MAFIC INTRUSIVE ROCKS**
 - 14a Olivine diabase.
- INTRUSIVE CONTACT
- MIDDLE PRECAMBRIAN**
- SUDBURY NICKEL IRRUPTIVE**
 - 13a Subvolcanic.
 - 13b Norite.
 - 13c Transition zone norite.
 - 13d Microgabbro.
 - 13e Granitic dike.
- INTRUSIVE CONTACT
- WHITEWATER GROUP**
- ONAPING FORMATION**
 - 12a Quartzite breccia (basal breccia).
 - 12b Silt.
- SUBSURY EVENT
- MAFIC INTRUSIVE ROCKS**
- NIPISSING INTRUSIVE ROCKS**
 - 11a Gabbro.
 - 11b Pegmatitic gabbro.
 - 11c Granophyre.
 - 11d Granitic dike rock, pegmatite.
 - 11e Quartz-plagioclase porphyry†
- INTRUSIVE CONTACT
- HURONIAN SUPERGROUP**
- COBALT GROUP**
- LOREAN FORMATION**
 - 10a Grey wacke.
 - 10b Arkose, subarkose, minor subarkose wacke and quartz wacke, (10b, c, and d).
 - 10c Pinkish grey.
 - 10d Grey.
 - 10e Greenish grey, grey†
 - 10f Quartz wacke to subarkose wacke†
 - 10g Arkoses, unsubsided†
- GOWANDA FORMATION**
 - 9a Conglomerate.
 - 9b Arkose.
 - 9c Wacke (not laminated).
 - 9d Laminated wacke.
 - 9e Wacke (unsubsided)†
- QUIKIE LAKE GROUP**
- SERPENT FORMATION**
 - 8a Arkose, arkose wacke, calcareous arkose, minor conglomerate.
 - 8b Dolomitic porphyroblastics†
- ESPANOLA FORMATION**
 - 7a Calcareous siltstone, limestone, calcareous wacke.
- BRUCE FORMATION**
 - 6a Conglomerate, pebbly, wacke, minor arkose, wacke.
- HOUGH LAKE GROUP**
- MISSISSAUGI FORMATION**
 - 5a Quartz-pebble conglomerate.
 - 5b Arkose, subarkose, arkose wacke, subarkose wacke.
 - 5c Silt wacke.
- UNCONFORMITY
- EARLY PRECAMBRIAN**
- MAFIC INTRUSIVE ROCKS**
 - 4a Diabase.
 - 4b Gramercyporphritic diabase.
 - 4c Porphyritic diabase.
- INTRUSIVE CONTACT
- FELSIC PLUTONIC ROCKS**
 - 3a Granodiorite, diorite.
 - 3b Migmatite.
- INTRUSIVE CONTACT
- METAVOLCANICS AND METASEDIMENTS**
- METASEDIMENTS**
 - 2a Wacke.
 - 2b Quartz siltstone, arkose.
 - 2c Biotite-plagioclase gneiss, minor hornblende-plagioclase gneiss.
 - 2d Ironstone, ferruginous chert.†
- METAVOLCANICS**
 - 1a Mafic and intermediate metavolcanics.
 - 1b Amphibolite.
 - 1c Dacite.
 - 1d Felsic metavolcanics.†

- Breccia
- Pseudotachylite
- Ag Silver
- Au Gold
- carb Carbonate
- Cu Copper
- Ga Galena
- Ni Nickel
- Pd Palladium
- Pt Platinum
- q Quartz
- S Sulphide
- Gz Gneissation
- U Uranium

*Unconsolidated deposits. Cenozoic deposits are represented by the lighter coloured and uncoloured parts of the map.

†Bedrock geology. Outcrops and inferred extensions of each rock map 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.

†Appears on accompanying Map 2450, Wanapitei Lake Area report.



Ontario Geological Survey
Map 2451
MASSEY BAY
SUDBURY DISTRICT

Scale 1:31,680 or 1 inch to 1/2 Mile

