Ontario
Division of Mines

Geoscience Report 153

Geology of the Pukaskwa River-University River Area

Districts of Algoma and Thunder Bay

By
Gerald Bennett and P.C. Thurston

1977

Ministry of Natural Resources

Ontario
Division of Mines

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Bennett, Gerald, and Thurston, P.C.
1977: Geology of the Pukaskwa River-University River Area, Districts of Algoma and Thunder Bay; Ontario Div. Mines, GR153, 60p. Accompanied by Maps 2332 and 2333, scale 1:63,360 or 1 inch to 1 mile; and chart.

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Scale 1:63,360 or 1 inch to 1 mile.

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(back pocket)

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ABSTRACT

During the summer of 1968 geological mapping at a scale 1:63,360 or 1 inch to 1 mile was carried out over an area of 2,760 km² (1,065 square miles) on the north shore of Lake Superior between Wawa and Marathon. Nine hundred and thirty square kilometres (360 square miles) of the map-area is underlain by Early Precambrian (Archean) metavolcanics and metasediments, most of which are contained within two generally synclinal belts. The northern belt, named the 'Kabenung Lake belt', trends west-southwest for 50 km (30 miles) with an average width of about 8 km (5 miles). It forms the western end of the much larger Michipicoten metavolcanic-metasedimentary belt. The southern belt, the 'Mishibishu Lake belt', forms an arc, convex to the north, with an overall length of 55 km (35 miles) and an average width of about 16 km (10 miles).

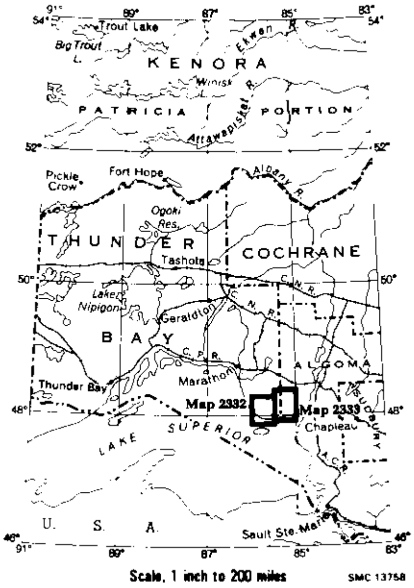

Figure 1–Key map showing location of the Pukaskwa River and University River area. Scale 1:3,168,000 or 1 inch to 50 miles.

In order of decreasing areal distribution, the most important rock types in the Kabenung Lake belt are mafic metavolcanics and early mafic intrusive rocks (68 percent of total); greywacke, argillite, siltstone, and iron formation (23 percent); conglomerate and arkose (6 percent); felsic to intermediate metavolcanics (3 percent).

The oldest rocks of the Kabenung Lake belt are basaltic flows with equivalent gabbroic to dioritic sills and some intercalated dacitic to rhyodacitic pyroclastic rocks, flows, and intrusions. Overlying the metavolcanic assemblage is up to 2,000 m (7,000 feet) of metasediments, mainly greywacke, argillite, siltstone, and extensive deposits of Algoma-type iron formation. A persistent zone of polymictic conglomerate and arkose is the youngest rock unit in the metavolcanic-metasedimentary assemblage.

The rock types of the Mishibishu Lake belt are mafic to intermediate metavolcanics and related mafic intrusive rocks (64 percent); greywacke, siltstone, argillite, and iron formation (24 percent); felsic to intermediate metavolcanics (8 percent); porphyritic dacite (3 percent); and conglomerate

(2 percent). The stratigraphy of both metavolcanic-metasedimentary belts is essentially the same, although the Mishibishu Lake belt is more complex structurally and lithologically.

The granitic rocks surrounding the metavolcanic-metasedimentary belts consist mainly of trondhjemite and quartz monzonite with dioritic and granodioritic phases. Migmatitic zones and hybrid facies are common. A stock of quartz monzonite and quartz-bearing monzonite intrudes the Kabenung Lake belt at Kabenung Lake. A similar but more synenitic stock intrudes the Mishibishu Lake belt at Mishibishu Lake.

Olivine diabase and quartz-bearing diabase dikes of diverse trends intrude all the major lithologic units.

A few erosional remnants of Keweenawan lavas occupy topographically low areas near the shore of Lake Superior.

In spite of difficulties imposed by the generally rugged topography, mineral exploration has been conducted in the area since the late 1800s.

The report describes six iron prospects, six gold prospects, one tungsten prospect, and ten properties or prospects where exploration has been carried out for base metals.

Geology

of the

Pukaskwa River–University River Area

Districts of Algoma and Thunder Bay

by

Gerald Bennett[1] and P.C. Thurston[2]

INTRODUCTION

The mapping of the Pukaskwa River–University River area is the third helicopter-supported reconnaissance geological mapping project undertaken by the Division of Mines, Ontario Ministry of Natural Resources (formerly the Ontario Department of Mines and Northern Affairs). The field work was completed during the summer of 1968. Two preliminary uncoloured geological maps at a scale 1:63,360 or 1 inch to 1 mile, with marginal notes (Bennett, Thurston, and Giguere 1969a, b) were published in February, 1969. There was a simultaneous publication of six preliminary maps (Wolfe and Wright 1969a,b,c,d,e,f) showing the distribution of cold extractable heavy metals, copper, zinc, manganese, nickel, and cobalt in stream, and spring sediments of the Pukaskwa River–University River map-area. The geochemical survey was under the direction of W.J. Wolfe, formerly of the Ontario Division of Mines.

Location and Access

The area mapped lies on the shore of Lake Superior between Wawa and Marathon. The boundary between the District of Algoma and the District of Thunder Bay passes through the map-area. The area covered by the geological and geochemical surveys consists of two adjoining rectangular areas. The eastern rectangle comprises the University River Sheet bounded by Latitudes 47°52′30″ and 48°22′30″ North and by Longitudes 85°00′00″ and 85°30′00″ West. The western rectangle is shown on the Pukaskwa River Sheet which is

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Manuscript approved for publication by the Chief Geologist, 29 December 1971.

bounded by Latitudes 47°52′30″ and 48°15′00″ North and by Longitudes 85°30′00″ and 86°00′00″ West.

Highway 17 passes through the northeastern corner of the University River map-area, and much of the northern part of the area is made accessible by a gravel road which extends south-southwest from Highway 17 at Kabenung Lake as far as the western boundary of Keating Township[1].

A power transmission line of The Hydro Electric Power Commission of Ontario extends northwestward across the University River area from about Latitude 48°03′ North at the east edge of the area to Latitude 48°15′ North on the western edge. A winter road extends along most of the length of the power line. There are no roads or power transmission lines in the Pukaskwa River area.

Most of the rivers of the area are fast flowing and filled with boulders, particularly within 8 to 16 km (5 to 10 miles) of the shore of Lake Superior, and make very poor canoe routes over most of their length.

Parts of the shore of Lake Superior in the map-area may best be reached by boat from Michipicoten Harbour, about 25 km (15 miles) east of the map-area or from Marathon about 65 km (40 miles) north of the northern boundary of the Pukaskwa River area. It must be borne in mind, however, that there are few good harbours which provide shelter from strong southwest winds. The best of these are Dog Harbour, located just west of the University River, and Richardson Arm in Homer Township.

Where lakes of suitable size exist, fixed-wing aircraft provide the most efficient means of gaining access to many parts of the area. Where the hills are high and the lakes small, a helicopter provides the only means of access other than on foot.

Present Survey

The field work commenced on May 21, 1968 and continued until September 12, 1968. The party consisted of three Division of Mines geologists, five senior assistants, five junior assistants, one cook, and a helicopter air-crew consisting of a

[1]The townships in the area have been renamed as follows:
Tp. 31, Rge.23 - Bostwick Tp.
Tp. 31, Rge. 24 - André Tp.
Tp. 31, Rge 25 - Macaskill Tp.
Tp.31, Rge.26 - Knicely Tp.
Tp.31, Rge. 27 - Dahl Tp.
Tp.32, Rge. 23 - Franchère Tp.
Tp. 32, Rge. 24 - Warpula Tp.
Tp.32, Rge. 25 - Levesque Tp.
Tp.32, Rge 26 - Killins Tp.
Tp.32, Rge. 27 - Chapais Tp.
Tp. 33, Rge. 23 - Groseilliers Tp.
Tp. 33, Rge 24 - St. Germain Tp.
Tp. 33, Rge 25 - Legarde Tp.
Tp. 33 Additional, Rge 25 - Legarde Additional
Tp. 33, Rge. 26- Keating Tp.
Tp. 33 Additional,Rge. 26 - Keating Additional
Tp. 33, Rge 27 - Charbonneau Tp.

pilot and a mechanic. A four-man geochemical party shared the camp facilities.

A base camp was maintained at the northeast arm of Iron Lake in Keating Township. In addition a temporary camp was set up for about a week at the abandoned village of Pukaskwa Depot in Homer Township.

The geological mapping was of a reconnaissance nature. Traverses were made perpendicular to the strike of the metasediments and metavolcanics at intervals of about 1.6 km (1 mile). Only a few traverses were carried out on the granite areas. Data were recorded on aerial photographs at a scale of 1:15,840 or 1 inch to ¼ mile and transferred to base maps at the same scale. The aerial photographs were supplied by the Silviculture Section, Timber Branch, Division of Forests, Ontario Ministry of Natural Resources. The base maps were supplied by the Cartography Section, Division of Lands. After the field season the maps were redrafted and reduced by a photographic method to 1:63,360 or 1 mile to 1 inch for publication at that scale.

Of the 430 hours of helicopter flying time used, about 60 percent was utilized for transporting traversing teams, 30 percent for rapid geological reconnaissance by one geologist, and 10 percent for moving temporary two-man camps. The speed and efficiency of the mapping was hampered by the unusually wet weather of the summer of 1968. Canada Department of Transport statistics show that the rainfall at White River in June 1968 was over twice the average and that of July was over three times the average. High winds and fog added to the problems of carrying out helicopter operations.

Previous Work

Brief descriptions of the physiographic features, natural resources, and geology of the north shore of Lake Superior were made by L. Agassiz *et al.* (1850) and W.E. Logan (1863). The first geological map of the areas mapped in this report-area was prepared by A.P. Coleman (1899) and shows in a very general way the distribution of 'greenstone' and notes the iron deposits at Iron Lake. More detailed descriptions of some of the iron formations are given by A.P. Coleman and A.B. Willmott (1899). In the summer of 1904, J.M. Bell (1905) mapped an area of about 4,100 km^2 (1600 square miles), including the areas of the present survey as well as much of the Wawa area. Bell's map and comprehensive report are tributes to the work of the early geologists.

E.L. Evans (1940) mapped much of the area between Mishibishu Lake and the East Pukaskwa River.

A.M. Goodwin (1954) did detailed geological mapping in the Kabenung Lake area.

Natural Resources

The area under study lies within the Boreal Forest region of Canada (Hosie 1969). The dominant species of forest trees are black spruce, white spruce, balsam fir, white birch, and trembling aspen. Jack pine grows on well drained sandy areas with arbor vitae and tamarack being restricted to poorly drained swampy areas.

During the 1968 field season logging was being carried out around Iron Lake and southwest of Highway 17 around Obatanga Lake. The remains of log dams on many of the creeks in the southwestern part of the map-area are evidence of logging operations between 30 and 50 years ago.

Speckled trout are reported to be plentiful in the Pukaskwa River and in many of the small streams flowing into Lake Superior. Pike and pickerel are common in the larger lakes. Commercial fishing is carried out on Lake Superior but not on any of the inland lakes of the area. Sport fisherman and tourists were rarely encountered during the field season. The relative inaccessibility and scarcity of large lakes suitable for the establishment of tourist lodges have no doubt hindered the development of a tourist industry.

The only large game sighted during the field season were moose and black bear. The former seemed to be more abundant near the shore of Lake Superior, and the black bear were a continuing nuisance at the base camp of the field party at Iron Lake.

Small game sighted during the field season included rabbit, fox, beaver, martin, muskrat, and grouse.

The deep valleys and steep gradients of the Pukaskwa and University Rivers may possibly support small hydro electric generating stations.

Topography

The map-area lies within the Abitibi Uplands region of the Canadian Shield (Bostock 1970).

The topography is characterized by steep sided hills and ridges rising from 30 m (100 feet) to as much as 180 m (600 feet) from the valley floor. The lower 16 to 32 km (10 to 20 miles) of the Pukaskwa River, the East Pukaskwa River, and the University River occupy deeply incised valleys commonly 120 to 180 m (400 to 600 feet) deep (Photo 1). Except near the shore of Lake Superior (Photo 2), the relief over the metavolcanic-metasedimentary belts is less extreme and the topography is typified by rolling hills generally less that 60 m (200 feet) high.

The runoff water of the map-area flows southward into Lake Superior through the drainage basins of the Pukaskwa, University, and Makwa Rivers. The drainage pattern is largely bedrock controlled and essentially a trellis type, except over areas of thick glacial outwash deposits, where a modified dendritic drainage pattern has developed. The main rivers such as the Pukaskwa, the East Pukaskwa, and the University Rivers are very fast flowing, particularly in their lower reaches. The University River drops a total of about 200 m (650 feet) over many rapids and cascades between the outlet of Eaglet Lake and the shore of Lake Superior, a straight line distance of about 25 km (15 miles). Within 20 to 25 km (12 to 15 miles) of their mouths, the gradients of the Pukaskwa and the Makwa Rivers are similar.

ODM 9481

Photo 1–The East Pukaskwa River.

ODM9482

Photo 2–Typical Lake Superior shoreline near Dog Harbour.

Acknowledgments

L.A. Bell, L.B. Cochrane, K.D. Choudari, and V.J. Sopuck acted as senior assistants and did independent geological mapping for the entire field season. H. Bowen acted as a senior assistant for July and August. W.D. Ewert, F.A. Hung, E.K. Langtry, W.R.Troup, and R.L. Wright acted as junior assistants. K.Bardua was employed as cook and was a great asset to the party. The authors would like to thank the personnel of Pegasus Airlifts for their co-operation throughout the summer. White River Air Service provided fixed-wing aircraft on a charter basis.

GENERAL GEOLOGY

Of the 2,690 km^2 (1,065 square miles) mapped at a scale 1:63,360 or 1 inch to 1 mile, about 980 km^2 (360 square miles) are underlain by metavolcanics and metasediments. The remaining 1,700 km^2 (640 square miles) are underlain by granitic rocks (Table 2).

The metavolcanics and metasediments form two belts each with an area of about 390 to 520 km^2 (150 to 200 square miles). The most northerly belt is the Kabenung Lake belt which extends west from Kabenung Lake at the eastern border of the University River map-area in a west-southwest direction for a distance of about 50 km (30 miles), and has an average width of about 8 km (5 miles). The Kabenung Lake belt is only the westward extension of a much larger belt which continues east of Kabenung Lake for a distance of over 80 km (50 miles) (Goodwin 1962).

A second major metavolcanic-metasedimentary belt, the Mishibishu Lake belt, forms an arc which extends from Dog Harbour on the shore of Lake Superior in the east, northwestward through Mishibishu Lake and then continues westward to the mouth of the Pukaskwa River for a distance of about 55 km (35 miles). Three stocks of granitic rocks intrude the Mishibishu Lake belt and the average thickness of the belt, including the stocks, is about 16 km (10 miles).

A small belt of metavolcanics is located in the northwestern part of Homer Township, and narrow remnants of metavolcanic-metasedimentary belts occur in the northwestern part of the University River map-area, and on Marjory Lake in Warpula Township.

Early Precambrian (Archean)

METAVOLCANICS

A simple twofold classification of metavolcanics was used in the field. Volcanic rocks with a content of mafic minerals greater than 35 percent were classified mafic to intermediate and those with a content of mafic minerals less than 25 percent were classified felsic to intermediate. Where rocks were too fine

TABLE 1 | TABLE OF LITHOLOGIC UNITS FOR THE PUKASKWA RIVER AND UNIVERSITY RIVER AREA.

PHANEROZOIC

CENOZOIC

QUATERNARY

RECENT

Swamp and stream deposits

PLEISTOCENE

Till, sand and gravel (moraines, eskers)

UNCONFORMITY

PRECAMBRIAN

LATE PRECAMBRIAN

KEWEENAWAN

Dacite

UNCONFORMITY

EARLY TO LATE PRECAMBRIAN

LATE MAFIC INTRUSIVE ROCKS

Diabase, olivine diabase, quartz diabase, gabbro

INTRUSIVE CONTACT

EARLY PRECAMBRIAN (ARCHEAN)

INTERMEDIATE TO FELSIC INTRUSIVE ROCKS

KABENUNG LAKE STOCK AND MISHIBISHU LAKE STOCK

Porphyritic monzonite, porphyritic quartz monzonite, porphyritic quartz-bearing monzonite

BATHOLITHIC GRANITIC ROCKS

Biotite quartz monzonite, biotite trondhjemite, quartz monzonite, hornblende trondhjemite, hornblende-quartz monzonite, porphyritic granite, hybrid granite, migmatite, pegmatitic muscovite granite, pegmatite, aplite, hornblende diorite-gneiss, biotite granite-gneiss

INTRUSIVE CONTACT

WILDER LAKE COMPLEX

Hornblende diorite, quartz diorite, hornblende porphyry (diorite), gneissic granite, hybrid granite, genissic diorite, gneissic granite-diorite, minor gabbro

INTRUSIVE CONTACT

METASEDIMENTS

Conglomerate, polymictic conglomerate, greywacke, arkose, sandstone arkose, argillite, slate, iron formation and ferruginous sandstone

METAVOLCANICS

FELSIC TO INTERMEDIATE METAVOLCANICS

Dacite to rhyolite flows, felsic to intermediate tuff and volcanic breccia, felsic to intermediate agglomerate, porphyritic dacite (intrusive), quartz-feldspar porphyry (flows and sills)

MAFIC TO INTERMEDIATE METAVOLCANICS AND RELATED INTRUSIVE ROCKS

Basalt, andesite, amygdaloidal basalts, pillow basalt to andesite, porphyritic basalt, gneissic amphibolite, amphibolite, chlorite schist, chlorite-biotite schist, gabbro, porphyritic gabbro

IRON FORMATION

TABLE 2 Planimeter survey of Geological Maps 2332 and 2333, (back pocket) showing the areal extent of major rock types.

	Rock Type	Area (in square miles[1])	Percent of total less granitic rocks
KABENUNG LAKE BELT	Mafic metavolcanics and early mafic intrusions	105	70
	Felsic metavolcanics	1.6[2]	1
	Greywacke, slate, Iron Formation	34.9	23
	Conglomerate	8.7	6
	Wilder Lake Complex	9.6	
	Kabenung Lake Stock	9.8	
	Total area less late intrusions	160.6	
MISHIBISHU LAKE BELT	Mafic metavolcanics and early mafic intrusions	139	64
	Greywacke, slate, Iron Formation	54.3	24
	Conglomerate	3.6	2
	Felsic to intermediate metavolcanics	16.6	8
	Mishibishu Stock	9.6	
	Porphyritic dacite	5.9	3
	Total area less late intrusions	229.0	

[1]To convert square miles to square kilometers multiply by 2.6.
[2]A minimum value as only units outlined on the map are included. The actual percentage is probably between 2 and 4 percent.

grained to allow an estimation of the mineral content, more subjective characteristics such as colour and hardness were used as a basis of classification.

Mafic to Intermediate Metavolcanics and Related Intrusive Rocks

The mafic to intermediate metavolcanics consist almost entirely of mafic flows; mafic to intermediate pyroclastic rocks were not recognized within the map-area.

The mafic metavolcanics are typically fine to medium grained, massive to well foliated, and are pale grey to greenish grey, brownish grey and almost black on the fresh surfaces. Weathered surfaces are generally medium grey to brownish grey.

Of the 30 specimens studied in thin sections, 25 had been metamorphosed under greenschist facies conditions of regional metamorphism or under albite-epidote facies conditions of contact metamorphism. The most common mineral assemblages are as follows: (a) albite + chlorite + pale green amphibole ± quartz + epidote + carbonate; (b) pale green amphibole + epidote ± quartz + carbonate + albite. Biotite is rare in these greenschist facies mafic metavolcanics. Near the edges of the metavolcanic-metasedimentray belts and adjacent to the granitic batholiths and stocks, the volcanics have been metamorphosed under hornblende-hornfels facies conditions of contact metamorphism. These rocks commonly show a faint to pronounced gneissic layering brought about by alternating variations in the content of the mafic and felsic minerals. The layers range in thickness from less than 0.6 cm (¼ inch) to 7 cm

TABLE 3 Modes of Mafic Metavolcanics and Early Mafic Intrusive Rocks (Values in percent)

	P113-12	GB11-2	BD2-3	AE4-6A	LB5-3	GB7-1	CA13-2
Quartz	trace	4	-	5	-	2	trace
Plagioclase	18	25	19	24	47	13	18
Actinolite	50	21	1	-	-	41	53
Hornblende	-	-	57	66	-	5	-
Chlorite	5	29	-	-	31	8	6
Epidote	24	16	23	4	7	29	23
Carbonate	1	5	trace	1	19	trace	-
Opaques	2	trace	trace	trace	-	trace	trace
Others	trace	trace	-	-	trace	1	trace

Location of Specimens

P113-12	Basalt, greenschist facies, 3 km (2 miles) southeast of Maple Lake, Mishibishu Lake belt.
GB11-2	Basalt, greenschist facies, North shore of Lake Superior, 10 km (6 miles) west of the University River.
BD2-3	Basalt, albite-epidote-hornfels facies, 0.4 km (¼ mile) northwest of Wilder Lake, Kabenung Lake belt.
AE4-6A	Basalt, hornblende-hornfels facies, 3 km (2 miles) west of Nichols Lake, Kabenung Lake belt.
LB5-3	Carbonatized basalt, greenschist facies, 16 km (10 miles) west of Mishibishu Lake, Mishibishu Lake belt.
GB7-1	Gabbro, greenschist facies, 11 km (7 miles) south of Katzenbach Lake, Mishibishu Lake belt.
CA13-2	Gabbro or coarse-grained basalt, greenschist facies, 1.6 km (1 mile) west of Iron Lake.

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Photo 3–Gneissic amphibolite; northeast of Crayfish Lake, Chapais Township.

(3 inches). Gneissic mafic metavolcanics are best developed and exposed along the northern edge of the Kabenung Lake belt, particularly in the vicinity of Heart Lake (Photo 3).

The greenschist facies mafic metavolcanics consist essentially of finely granular equant grains of untwinned albite and stubby, subhedral prisms of albite displaying albite and pericline twins and rarely combined Carlsbad albite twins. Granular epidote or clinozoisite are distributed throughout the plagioclase grains. The predominant mafic minerals are scaly grains or clots of chlorite or poorly crystallized pale green to bluish green amphibole. Accessory minerals are sphene, carbonate, biotite, iron-titanium oxides, quartz, and zircon.

Flow contacts were rarely observed but several good exposures of flow breccias, pillow breccias, and pillow structures were observed in both the Kabenung Lake and Mishibishu Lake belts.

The following characteristics of flow breccia were useful in their identification:

(1) fragments and matrix of similar composition;
(2) incomplete separation and rotation of some fragments;
(3) breccia can be traced to the unbrecciated central part of the flow (Photo 4).

Pillow structures are present in many localities throughout the metavolcanic belts and are useful as an aid to structural interpretation. Pillows range from 15 cm (6 inches) to 1.2 m (4 feet) long and from 10 cm (4 inches) to 0.6 m (2 feet) thick. A chilled selvage of black cherty rock is commonly present and ranges from about 0.6 cm to 5 cm (¼ inch to 2 inches) thick. A zone of amygdules is

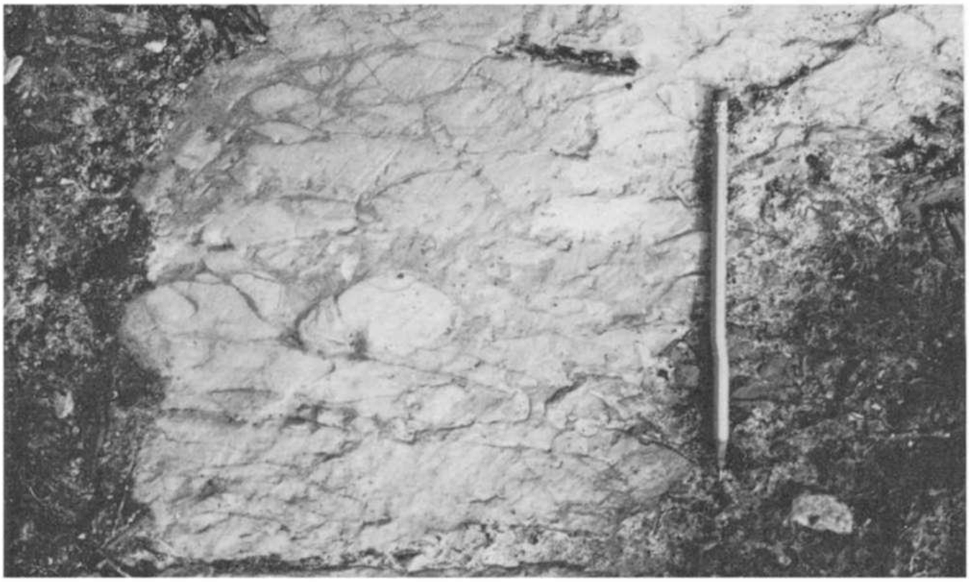

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Photo 4–Flow breccia in basalt; north of road, Keating Township. Note fracturing and incomplete separation of some fragments.

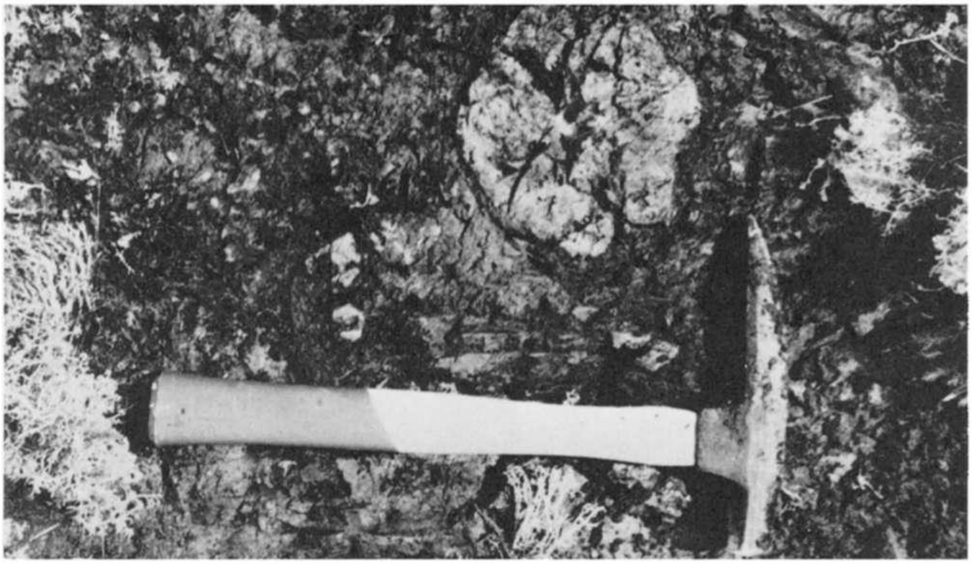
locally present 2.5 to 5 cm (1 to 2 inches) from the pillow selvage and parallels the selvage. Less commonly, pillows have amygdaloidal cores or cores of more feldspathic composition than the edges.

Amgydules do not appear to be widespread within the metavolcanics, but an area of amygdaloidal mafic metavolcanics is located about 3 km (2 miles) northeast of Iron Lake. The amygdules are ellipsoidal to almost perfectly spherical and range in size from 0.2 to 1.9 cm (0.1 to 0.75 inch) across the greatest dimension. The amygdules consist of coarsely granular quartz or calcite or both. The larger specimens have a core of coarse calcite crystals surrounded by stout prisms of quartz which grew radially inward from the walls.

Apple green clots consisting entirely of finely granular quartz and epidote are common in the metavolcanics north of Iron Lake in the Kabenung Lake belt. These clots range from less than 2.5 cm (1 inch) to at least 15 cm (6 inches) across; many are irregular in shape or rounded, but a significant number show an hexagonal outline (Photo 5).

Porphyritic basalt is widespread throughout the mafic metavolcanic units of the map-area, although it probably forms less than 1 percent of the total volume of mafic metavolcanics. The rock typically displays pale yellow to pale green feldspar phenocrysts up to 7.6 cm (3 inches) across, set in a dark green, fine-grained massive, groundmass. The phenocrysts commonly form 10 to 30 percent of the rock, but an exposure about 0.8 km (½ mile) southeast of Heart Lake contains up to 90 percent saussuritized plagioclase phenocrysts.

The extrusive origin of at least some of this porphyritic basalt is shown by



ODM9485
Photo 5–Quartz-epidote clot in mafic metavolcanics; east of Nichols Lake, Keating Township. Note crude hexagonal form.

the occurrence of deformed but identifiable pillow structures in an outcrop of porphyritic basalt about 5 km (3 miles) south of Mishibishu Lake.

Metamorphosed, medium- to coarse-grained, faintly foliated to massive, mafic rocks are common among the finer grained mafic metavolcanics of the area. Commonly there are insufficient criteria to classify these coarse-grained rocks as either mafic intrusive rocks or as the central parts of thick mafic flows. However, several early mafic sills are well exposed about 3 km (2 miles) northwest of Iron Lake and also near the southern border of the Kabenung Lake belt. The intrusions observed are sills about 5 to 6 m (15 to 20 feet) thick. Although many thicker sills undoubtedly exist, none were found to be exposed across their entire width. Although none exhibited any evidence of chilled contacts, their intrusive nature is shown by some or all of the following criteria:

(1) shearing in the country rock within 2.5 to 5 cm (1 to 2 inches) of both contacts of the intrusion;

(2) the intrusive rock is invariably more massive and homogeneous in texture and colour than the surrounding rocks;

(3) many sills display blocky jointing similar to that of post-granite diabase;

(4) rarely are inclusions of the surrounding rocks found within the sills; narrow apophyses of the sills are noted to extend for a few feet into the surrounding rocks.

When studied in thin section, the mineralogy of early mafic intrusive rocks is found to be essentially the same as that of greenschist facies mafic metavolcan-

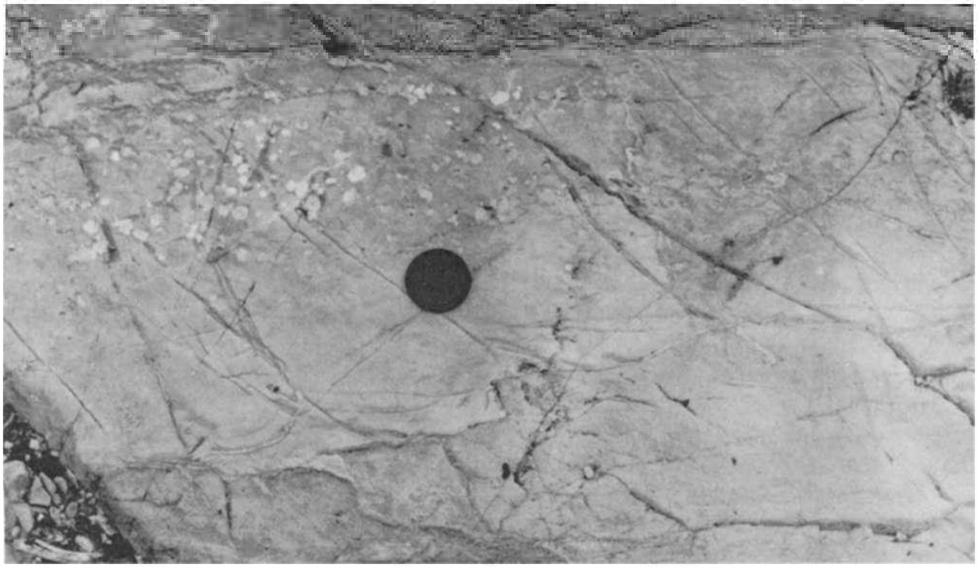


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Photo 6–Basalt porphyry dike; near road in Keating Township. Note concentration of altered plagioclase phenocrysts on one side of dike.

ics. The texture is largely modified by growth of secondary actinolite and chlorite, but relict diabasic and gabbroic textures can be discerned.

The early age of these mafic intrusions is shown by their close association with thick sequences of mafic flows and the fact that they have undergone greenschist facies metamorphism. The lack of chilled contacts supports the view that they were intruded as sheets into a subvolcanic setting where thermal gradients were very high. Additional evidence for a volcanic association is the lack of early mafic intrusions cutting the conglomerate units although rarely gabbro sills have been identified within the lower parts of the greywacke assemblage.

In addition to the relatively thin mafic sills described above, there are extensive areas which are believed to be underlain largely by coarse-grained, massive gabbroic rocks. The largest such area lies along the southern edge of the Kabenung Lake belt between the University River and the western boundary of Knicely Township. Another such area extends eastward from the east boundary of Homer Township which can be seen on the south-central Pukaskwa River Sheet (see Map 2332, back pocket). These areas probably represent laccolithic bodies of gabbro of volcanic association.

Several minor mafic dikes or sills containing abundant phenocrysts of highly saussuritized plagioclase occur within the Kabenung Lake belt and the eastern half of the Mishibishu Lake belt (Photo 6). These sills or dikes are generally no more than a few feet wide and are identical in texture and composition to the porphyritic basalt previously described.

Felsic to Intermediate Metavolcanics

Although widely distributed throughout the Kabenung Lake belt, felsic to intermediate metavolcanics comprise only about 2 to 4 percent of the total metavolcanic-metasedimentary assemblage of that belt. The thickest sections of felsic metavolcanics are found about 1.6 km (1 mile) west of Kabenung Lake, and north and west of Iron Lake. Many occurrences of pale grey, massive, porphyritic felsic flows or sills occur within the mafic flows of the Kabenung Lake belt but these appear to be too thin and discontinuous for delineation at the scale 1:63,360 or 1 inch to 1 mile.

A lens-shaped unit of felsic metavolcanics occurs at the nose of an anticline about 1.6 km (1 mile) west of Kabenung Lake. The exposed rocks consist of pale grey to white weathering, massive quartz-feldspar porphyry and some crudely banded tuff and coarse volcanic breccia of similar composition.

The quartz-feldspar porphyry has a composition of about quartz latite and contains from 30 to 50 percent phenocrysts of albite and quartz, about 5 mm across. The massive and uniform texture of this rock indicates that it may be intrusive.

A unit of felsic pyroclastic rocks 60 to 150 m (200 to 500 feet) thick and about 3 km (2 miles) long, extends west-southwest from the north shore of Iron Lake. The rocks include medium to pale grey tuff-breccia containing about 15 percent greenish grey to dark grey, wispy fragments less than 1.2 cm (½ inch) thick and from 2.5 to 15 cm (1 to 6 inches) long. These fragments are probably collapsed pumice fragments and are in a matrix of foliated, grey quartz-feldspar porphyry. The remainder of the metavolcanics in this unit are foliated porphyritic dacite to rhyodacite. Three specimens were examined in thin section and were found to contain 5 to 15 percent rounded, corroded, and embayed quartz phenocrysts 0.5 to 3 mm across and 15 to 45 percent euhedral and unzoned albite phenocrysts from 0.5 to 5 mm long. Accessory minerals include wisps of white mica, chlorite, carbonate, opaque minerals, and biotite. The matrix is a very fine grained quartz-feldspar mosaic.

The largest area of felsic to intermediate metavolcanics in the Kabenung Lake belt extends southwestward for a distance of 7 km (4½ miles) from the west boundary of Keating Township. It has a maximum thickness of about 450 m (1,500 feet) and is made up largely of rhyodacitic quartz-feldspar porphyry flows and pyroclastic rocks similar to those described above. Also prominent are brownish weathering, dark grey, strongly foliated, dacitic, feldspar porphyry flows and pyroclastic rocks containing 25 percent albite phenocrysts 1 to 5 mm long in a groundmass of very fine grained plagioclase, quartz, biotite, white mica, and accessory carbonate (Table 4).

The felsic to intermediate metavolcanics are widely distributed throughout the Mishibishu Lake belt, but are most common in the western part of the belt where the low dips of these rocks have exaggerated their true abundance in the metavolcanic assemblage. The northern and eastern parts of the belt appear to be particularly poor in felsic to intermediate metavolcanics.

The felsic to intermediate metavolcanics of the Mishibishu Lake belt tend to show a greater variety in colour, texture, and composition than those of the Kabenung Lake belt. In the western part of the Mishibishu Lake belt the most

TABLE 4 — Modes of Felsic to Intermediate Metavolcanics (Values in percent)

	CB8-4	GB8-17B	Ph7-15	CC2-2	CA9-3
Plagioclase phenocrysts	19	27	19	36	32
Quartz phenocrysts	8	5	2	-	7
Biotite	5	-	3	-	-
Muscovite	4	14	-	11	19
Carbonate	4	6	trace	2	5
Chlorite	trace	3	9	10	trace
Actinolite	-	-	17	-	-
Epidote, clinozoisite	trace	trace	2	-	-
Groundmass (quartz-feldspar)	60	45	47	41	37
Others	1	trace	1	trace	trace
Total	101	100	100	100	100

Location of Specimens

CB8-4	Dacitic tuff, 5 km (3 miles) west of Iron Lake, Kabenung Lake belt.
GB8-17B	Porphyritic rhyodacite, 11 km (7 miles) south of Katzenbach Lake, Mishibishu Lake belt.
Ph7-15	Dacite, east boundary of Homer Township, Mishibishu Lake belt.
CC2-2	Dacitic feldspar porphyry, 5.8 km (3½ miles) west of Abbie Lake, Kabenung Lake belt.
CA9-3	Rhyodacite, 2.4 km (1½ miles) northwest of Iron Lake, Kabenung Lake belt.

common type appears to be grey to brownish grey or pinkish weathering feldspar porphyry displaying white or pink albite or oligoclase phenocrysts 0.5 to 5 mm long in a fine-grained grey groundmass of 10 to 15 percent quartz, 10 percent amphibole, 75 percent plagioclase, and minor amounts of carbonate, white mica, biotite, and epidote. Rhyodacitic quartz-feldspar porphyry occurs locally as does fine-grained equigranular rhyodacite, but these more felsic varieties appear to be subordinate to dacite.

A unit of porphyritic dacite underlies an area of about 15 km^2 (6 square miles) about 5 km (3 miles) north of Ganley Harbour. The dacite is medium to dark grey on fresh surfaces with phenocrysts of plagioclase, and hornblende 3 to 10 mm long. A deep red stain, apparently hematite, covers joint surfaces and fractures in the porphyritic dacite, and less commonly, fractures in other felsic to intermediate and mafic to intermediate metavolcanics of the area. The origin of this staining was not determined.

In thin section the porphyritic rock is seen to consist of about 15 percent oligoclase phenocrysts, 10 to 15 percent hornblende phenocrysts, 5 to 10 percent biotite, in a groundmass of quartz and plagioclase. Primary textures or structures characteristic of either flows or pyroclastic rocks were not identified in the body and the general massive character indicates an intrusive origin; however, the possibility of a thick sequence of shallow dipping flows cannot be ruled out.

In the western part of the Mishibishu Lake belt, intermediate lapilli-tuff and volcanic breccia occur locally, but are subordinate to flow rocks in terms of areal extent. A unit of intermediate volcanic breccia and tuff extends eastward from Maple Lake to a short distance beyond Missing Lake in the south-central part of the Mishibishu Lake belt. The rock consists of angular to ellipsoidal blocks and lapilli of light to dark grey, porphyritic and massive fragments in a fine-grained grey to pale brown matrix.

Felsic to intermediate metavolcanics are also important about 13 km (8 miles) south of Mishibishu Lake where they form two units, the largest of which is 5 km (3 miles) long and about 150 m (500 feet) thick.

Fine-grained, bedded tuff and lapilli-tuff are prominent in the northern unit, whereas the southern unit contains a striking yellowish pink, strongly foliated rhyolite porphyry containing pale pink euhedral phenocrysts of albite about 1cm long, and rounded and embayed phenocrysts of quartz about 2mm across in a matrix of granular albite and quartz traversed by subparallel wisps of white mica.

METASEDIMENTS (DORÉ SERIES[1])

The central, synclinal parts of both the Kabenung Lake belt and the Mishibishu Lake belt are underlain by thick, metasedimentary sequences consisting of greywacke, conglomerate, arkose, siltstone, slate, iron formation, and minor chert and quartzite. Metasediments form about 30 percent of each of the two major metavolcanic-metavolcanic belts. In addition, thin beds of greywacke, siltstone, and slate form rare interflow beds within the metavolcanics. Greywacke is commonly interbedded with metavolcanics along the boundaries of the major metasedimentary belts.

Approximately 3700 m (12,000 feet) of metasediments with minor mafic metavolcanics are exposed along the shore of Lake Superior at the eastern end of the Mishibishu Lake belt, and there appears to be about 1800 to 2400 m (6,000 to 8,000 feet) of metasediments in the western half of the Mishibishu Lake belt. Goodwin (1954) estimated from 900 to 2100 m (3,000 to 7,000 feet) of metasediments are present along the north and west sides of Kabenung Lake, and he estimated the original thickness of sediments in the area to have been about 3000 m (10,000 feet). At Iron Lake, the metasediments appear to be about 2400 m (8,000 feet) thick, but this thickness may be greatly exaggerated by folding.

[1]A thick conglomerate unit at the mouth of the Doré River was first mentioned by Logan *et al.* (1863). W.H. Collins and T.T. Quirke (1926) and Goodwin (1962) included within the Doré Series all metasediments lying above the lowermost metavolcanic group and below any younger metavolcanic successions. By the latter usage all metasediments of the map-area belong to the Doré Series.

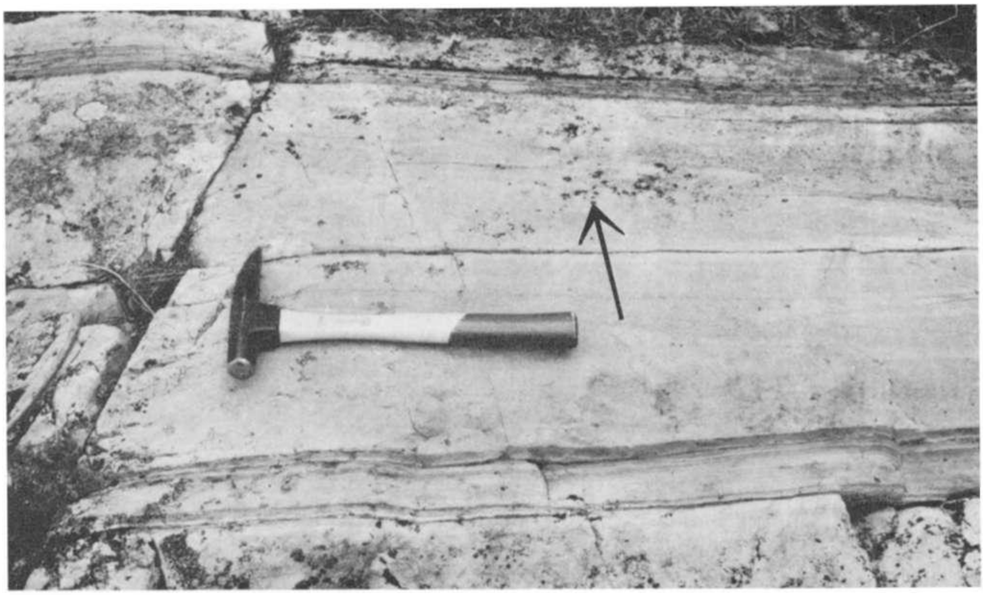

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Photo 7–Interbedded greywacke and argillite; northwest of Crayfish Lake, Chapais Township. Arrow indicates direction of younger bed as determined by grain gradation.

Greywacke and Siltstone

Greywacke,interbedded siltstone, and subordinate slate form about 75 percent of all the metasediments of the map-area. The greywacke and siltstone commonly display bedding from less than 0.6 cm (¼ inch) to at least 1 m (3 feet) in thickness. Locally, bedding may be very faint and a cursory examination may fail to reveal bedding over several hundred feet across strike. Beds showing a gradational change in grain size from a medium to coarse sand base to a fine siltstone top are common and provide useful stratigraphic information (Photo 7).

The greywacke is medium to dark grey and rarely greenish grey on fresh surfaces, and is pale to dark grey and locally reddish or brownish grey on weathered surfaces. Individual beds of greywacke and siltstone may appear massive in hand specimen, but in thin section an alignment of platy minerals is generally visible.

The greywacke consists of a disrupted framework of medium to fine sand-size, subrounded to angular quartz, plagioclase, and rock fragments set in a matrix of fine silt-size quartz, albite, muscovite or biotite, and carbonate. Rarely, epidote and actinolite are present in essential amounts. Accessory minerals include epidote, chlorite, actinolite, stilpnomelane, zircon, pyrite, and iron-titanium oxides (Table 5). With decreasing size of the clasts, the greywacke grades into siltstone.

TABLE 5 Modes of Metasediments (Values in percent)

	BD8-5	LC3-2	GB9-6	DA3-2	BE10-13D	CB11-12
Sand-size Plagioclase	27	9	15	11	21	14
Sand-size Quartz	12	27	25	9	25	27
Chlorite	3	trace	2	-	-	-
Epidote, Clinozoisite	1	-	trace	-	7	-
Muscovite	1	23	trace	11	7	14
Carbonate	1	-	trace	17	-	trace
Biotite	3	-	-	trace	-	-
Matrix (Silt-size quartz and feldspar)	52	38	43	42	38	45
Rock fragments	1	2	1	10	2	trace
K-feldspar	-	1	-	-	trace	-
Actinolite	-	-	13	-	-	-
Opaques	-	-	2	trace	-	trace
Total	101	100	101	100	100	100

Location of Specimens

BD8-5	Greywacke, 0.8 km (½ mile) northwest of Crayfish Lake, Kabenung Lake belt.
LC3-2	Greywacke, 16 km (10 miles) east of Homer Township, Mishibishu Lake belt.
GB9-6	Greywacke, 3 km (2 miles) north of Dog Harbour, Mishibishu Lake belt.
DA3-2	Calcareous greywacke, 1.6 km (1 mile) south of Iron Lake, Kabenung Lake belt.
BE10-13D	Greywacke, west end of Paint Lake, Kabenung Lake belt.
CB11-12	Greywacke, 2.4 km (1½ miles) south of Iron Lake, Kabenung Lake belt.

Slate and Argillite

Slate and argillite are commonly found at the tops of thick graded beds of greywacke and also as individual beds up to 1 m (3 feet) thick within predominantly greywacke sequences (Photo 8). The most extensive unit of slate and argillite within the map-area occurs at the top of the greywacke sequence and underlying the conglomerate unit in the central part of Killins Township. This unit of grey to black slate and argillite is about 90 m (300 feet) thick at its eastern end near Paint Lake and can be traced westward at least as far as Iron Lake, a distance of about 13 km (8 miles).

ODM9488
Photo 8—Laminated argillite, siltstone, and greywacke; the shore of Lake Superior near Dog Harbour.

Grey slate, minor graphitic slate, and argillite appear to form a significant part of the tightly folded metasedimentary unit south of Mishibishu Lake.

Conglomerate and Arkose

Persistent units and lenses of polymictic conglomerate and interbedded arkose are found near or at the top of the major metasedimentary sections in the map-area, except in the Mishibishu Lake belt east of Mishibishu Lake. However, thin, discontinuous beds of pebble and cobble conglomerate are present within the greywacke sequence near the shore of Lake Superior about 16 km (10 miles) southeast of Katzenbach Lake. Around Kabenung Lake interfingering lenses of conglomerate and arkose form units from 150 to 900 m (500 to 3,000 feet) thick and up to 6 km (4 miles) long, and a zone of conglomerate and arkose up to 600 m (2,000) feet thick occurs along the axis of the Iron Lake Syncline. In the Mishibishu Lake belt conglomerate units rarely exceed a thickness of 150 m (500 feet), but a unit west of Mishibishu Lake appears to be continuous over a distance of 20 km (12 miles) along strike.

The conglomerate rarely displays regular and continuous bedding. Lenses of greywacke and arkose from less than 0.2 cm (0.1 inch) to over 1 m (4 feet) in thickness and grow less than 0.3 m (1 foot) to over 10 m (30 feet) long are common in most exposures of conglomerate.

The conglomerate generally consists of subrounded to well rounded pebbles,

ODM9489

Photo 9–Doré Conglomerate; near Paint Lake.

cobbles, and boulders set in an arkosic matrix of sand-size quartz and feldspar (Photo 9). In most localities the predominant type of greater than sand-size clasts are grey equigranular and porphyritic felsite, similar to the felsic to intermediate metavolcanics of the surrounding metavolcanic sequence. Iron formation and mafic metavolcanic are common clasts in conglomerate exposures of the Kabenung Lake belt (Table 6).

Five specimens of granite from granite cobbles and boulders from the conglomerate were examined in thin section by L.D. Ayres and classified as albite trondhjemite (Table 7). The lithology of these granite clasts does not appear to differ significantly from some of the granitic rocks of the surrounding granitic batholiths.

Conglomerate consisting largely of iron formation cobbles in a greywacke matrix occurs adjacent to, and stratigraphically above, the Morse Mountain iron deposit and is probably an intraformational breccia or conglomerate.

In areas where cross folding is evident, such as around Kabenung Lake and northwest of Mishibishu Lake, the individual fragments of the conglomerate are locally severely flattened. Near the northwest shore of Paint Lake felsite cobbles in the conglomerate have a length to width ratio as high as 10 to 1. Goodwin (1954) pointed out that the occurrence of beds of relatively undeformed rock among zones of such highly flattened fragments indicates that the flattening was produced by shearing, rather than compressional stresses.

TABLE 6 Measured and estimated populations of pebbles, cobbles, and boulders in the Doré Conglomerate

Sample Number	1	2	3	4	5	6	7	8	9
				PERCENT OF TOTAL					
Equigranular felsite	16	14	10	10	34	48	43	55	51
Porphyritic felsite	40	49	30	-	36	40	35	23	17
Mafic metavolcanic	-	-	1	-	22	-	10	10	28
Iron formation	-	-	1	90	2	2	12	12	3
Granite	32	32	57	-	-	-	-	-	-
Quartz	10	2	1	-	-	-	-	-	-
Metasediment	2	3	-	-	12	10	-	-	-
Total	100	100	100	100	106	100	100	100	99
Total clasts counted	34	59	E^1	E^1	105	148	166	182	191

E^1 = Estimated populations.

Location of Specimens

1. 9.6 km (10 miles) west of Mishibishu Lake, Mishibishu Lake belt.
2. 150 m (500 feet) north of Sample No. 1.
3. 8 km (5 miles) east of east boundary of Homer Township, Mishibishu Lake belt.
4. 0.8 km (½ mile) northwest of Paint Lake, Kabenung Lake belt.
5. North shore of Paint Lake, Kabenung Lake belt.
6. 120 m (400 feet) north of Sample No.5.
7. 0.8 km (½ mile) east of Iron Lake, Kabenung Lake belt.
8. 150 m (500 feet) south of Sample No.7.
9. East shore of Paint Lake, Kabenung Lake belt.

Provenance of the Metasediments

Goodwin (1962, p.582) considered the metasediments of the Michipicoten area (the Doré sediments) as 'representing contemporary volcanic erosional products'. He visualized a nearby volcanic highland undergoing rapid erosion and shedding relatively unweathered, poorly sorted, debris into an adjacent basin or basins. The conglomerates are seen as alluvial fan deposits which were near their source, whereas the finer volcanic ash and debris were swept farther out into the basin and widely distributed as thin muds and impure sands. The granitic boulders of the conglomerate are considered to be derived from subvolcanic granitic intrusions and need not imply the presence of a pre-existing granitic terrain (Goodwin 1962, p. 582). M.N. Bass (1961) studied granitic boulders

TABLE 7 Modes of Granite Clasts from Doré Conglomerate (Values in percent)

	DA8-2	CC10-3	EB4-5	LC3-3	PL
Plagioclase	58.0	57.8	64.7	60.1	56.9
Quartz	31.2	32.4	34.0	23.6	30.2
K-spar	-	7.1	-	-	-
Chlorite	1.4	0.6	1.1	5.6	1.9
Epidote	3.4	1.5	-	0.1	0.9
Muscovite	5.6	0.5	-	-	-
Carbonate	0.3	-	-	6.1	9.4
Opaque	0.1	0.1	0.2	0.2	0.4
Biotite	-	-	-	trace	trace
Zircon	trace	trace	-	trace	-
Apatite	trace	trace	-	0.1	0.1
Hornblende (altered)	-	-	-	4.1	0.1
Total	100	100	100	99.9	99.9

Location of Specimens

DA8-2	Albite trondhjemite, west end of Paint Lake, Kabenung Lake belt.
CC10-3	Albite trondhjemite, 5 km (3 miles) southwest of Iron Lake, Kabenung Lake belt.
EB4-5	Albite trondhjemite, 1.6 km (1 mile) north of Mishibishu Lake, Mishibishu Lake belt.
LC3-3	Albite trondhjemite, 16 km (10 miles) east of Homer Township, Mishibishu Lake belt.
PL	Albite trondhjemite, west end of Paint Lake, Kabenung Lake belt.

from the Doré Conglomerate (although not from the present map-area) as part of a wider study and concluded that they could have been derived from small subvolcanic stocks. Ayres (1969, p.19) suggested that metasediments on the east shore of Lake Superior, tentatively correlated with the Doré Series, have been derived from a "quartz rich, potassic-poor plutonic-metamorphic terrane", which he proposed existed south of the Pukaskwa River-University River map-area and provided material for much of the metasediments of the Michipicoten region. Ayres (1969, p.19) also states that the presence of conglomerate with trondhjemite cobbles and boulders probably reflects tectonic uplift within the plutonic-metamorphic source area.

The present study adds little positive evidence to support either a volcanic or plutonic-metamorphic source area for the metasediments. As previously noted the five granitic clasts studied from the conglomerate of the map-area differ little from those of the surrounding granitic terrain and were found to contain no granophyric textures characteristic of subvolcanic granitic intrusions.

Goodwin, however, pointed out that high geothermal gradients may have existed in the Archean volcanic area which would produce slower cooling and textures in keeping with plutonic granites. Granite boulders appear to be less abundant in conglomerate in the eastern part of the map-area and might reflect increasing distance from a plutonic-metamorphic source. However, a much more detailed study should be required to determine the statistical validity of this apparent trend.

Iron Formation and Related Rocks

The Michipicoten area of Ontario, of which the present map-area is a part, has long been noted for the widespread distribution of iron formation. At present the only producing mine is the MacLeod Mine of The Algoma Steel Corporation Limited, located at Wawa about 16 km (10 miles) east of the map-area. However, some of the iron formations within the map-area may form significant reserves which could be utilized, following improved market conditions and more efficient beneficiation methods.

Collins and Quirke (1926) set forth the classic concept of the Michipicoten-type iron formation. They noted that the thicker sections commonly contain a stratigraphic sequence which they summarized as: (1) mafic metavolcanics which form a cover over the iron formation; (2) a sharp contact which separates these mafic metavolcanics from the underlying banded chert-magnetite iron formation; (3) a sharp partly alternating contact which separates the chert-magnetite member from an underlying pyrite member; (4) the pyrite member which grades downward into a siderite member; (5) the carbonate member which grades downward into a felsic volcanic formation which forms the footwall of the iron formation.

More recent work by Goodwin (1962, p.573) indicates that this stratigraphic sequence is found only in thick iron formations of volcanic association; iron formations of sedimentary association show less variation and generally consist of alternating beds and lamellae of chert and magnetite or hematite.

Most of the significant deposits of iron formation in the map-area are found within the Kabenung Lake belt. An almost continuous unit of iron formation extends around the north and west sides of Kabenung Lake and continues westward through the entire length of the metavolcanic-metasedimentary belt. There are two major gaps in the iron formation unit where it either pinches out completely or is too thin to be detected. One is a gap of about 6 km (4 miles) between Paint Lake and Iron Lake, and another 6 km (4 mile) break occurs about 1.6 km (1 mile) southwest of Abbie Lake. The thickness of this iron formation unit varies considerably; the thickest parts occur west of Kabenung Lake 60 to 120 m (200 to 400 feet) and at Iron Lake 60 to 360 m (200 to 1,200 feet). Throughout most of its length the iron formation occurs within a thick sequence of greywacke.

What may represent the southern limb of the above iron formation has been traced from Jimmy Kash Lake westward for a distance of about 10 km (7 miles). Beyond that the iron formation is represented by rusty weathering sandstone or chert.

The thick lenses of iron formation known as the Frances mine prospect (3) and Brotherton Hill deposit (2) are of uncertain stratigraphic position and may represent isolated fault blocks (Goodwin 1954). The tightly folded Betty Lake deposit, near the eastern edge of the University River map-area is considered by Goodwin (1962) to lie stratigraphically above the metasediments.

In the Mishibishu Lake belt, iron formation occurs mainly as discontinuous units in two broad zones about 150 m (500 feet) wide. One of these extends from eastern Homer Township and continues eastward about 1.6 km (1 mile) south of the East Pukaskwa River for a distance of about 13 km (8 miles) where it is truncated by a granitic batholith.

Another zone of iron formation extends eastward from Maple Lake, north of Missing Lake and on through Cameron Lake to the batholith beyond.

Less important zones of iron formation are found in central Homer Township, on the shore of Lake Superior about 6 km (4 miles) southeast of the mouth of the Pukaskwa River, and about 6 km (4 miles) west of the mouth of the University River. The latter continues northwestward and may be an extension of the Cameron Lake zone.

All four facies of Michipicoten-type iron formation have been identified within the map-area. Oxide-facies iron formation is the most abundant and probably constitutes about 90 percent of all the iron formation. It consists of alternating beds and lamellae of magnetite-hematite and chert forming units from less than 2.5 cm (1 inch) to 60 m (200 feet) thick (Photo 10). The chert layers are generally pale to dark grey, yellow or red jasper, and consist of a mosaic of equigranular quartz grains about 0.02 mm across. The darker varieties of chert generally contain minute grains of an opaque mineral, presumably magnetite. The magnetite-rich layers are commonly dark grey to black, and those with a significant amount of hematite in addition to magnetite, are commonly reddish. The iron-rich layers locally contain much quartz as well as silicate minerals such as stilpnomelane, chlorite, grunerite, and actinolite.

The oxide facies of iron formation locally grades into carbonate facies. The latter is generally highly stained with limonite and a deep brownish weathered zone may be as much as 0.6 cm (¼ inch) deep.

The fresh carbonate is siderite and is deep grey to bluish grey. Secondary veinlets of siderite which are present locally around Iron Lake are a golden brown or dark brown. The siderite commonly occurs as beds and lamellae intercalated with chert and as tiny equant grains disseminated throughout the chert and occurring between the individual quartz grains. Scattered cubes of pyrite are very common in the carbonate facies of the iron formation.

The carbonate facies is best developed around Betty Lake near the edge of the University River map-area, but it also occurs in minor amounts throughout the iron formation of the Kabenung Lake belt.

Locally sulphide-rich sections up to several feet thick are present in association with carbonate-rich iron formation. In the Mount Raymond deposit near the western end of Paint Lake, beds of massive pyrite 2.5 to 7.5 cm (1 to 3 inches) thick, alternate with very pale grey to white chert. The original bedded nature of these beds may be obscured because of subsequent intense brecciation. Most of the pyrite and pyrrhotite in the iron formation occurs as disseminated grains in siderite and chert and also as thin lenses and lamellae less than 2.5 cm (1 inch) thick within siderite and chert beds. Closely associated chert, carbonate, and sulphide minerals are found southwest of Abbie Lake. Goodwin (1954) noted

ODM9490

Photo 10–Folded iron formation; road to Makwa River, Killins Township.

the occurrence of graphitic slate in association with sulphide iron formation at Mount Raymond.

The silicate-facies iron formation makes up a minor amount of most of the oxide-facies iron formation throughout the map-area. Silicate iron formation generally forms thin beds and lamellae within oxide-facies iron formation. The iron silicates are generally dark green to greenish brown, and generally display a strong foliation. The most common iron silicates are chlorite, biotite, actinolite, grunerite, and stilpnomelane. In only a few occurrences did these silicates form greater than 75 percent of an individual bed. In most occurrences considerable magnetite and quartz occur with the silicates.

INTERMEDIATE TO FELSIC INTRUSIVE ROCKS

Wilder Lake Complex

A broad but well defined, positive aeromagnetic anomaly is present on Aeromagnetic Map 2177G (ODM-GSC 1963f) and extends from Wilder Lake to within a few hundred feet of the south shore of Obatanga Lake. The anomalous area appears to be underlain largely by varieties of diorite, ranging from dark green to black meladiorite and gabbro (which may in part represent recrystallized and hybridized metavolcanics) to leucocratic hornblends diorite and quartz diorite. Inclusions of amphibolite are common in the latter. Cutting all phases of the dioritic rocks and inclusions are dikes of what may be roughly classified as a "hornblende porphyry". This is a dioritic rock consisting of euhedral phenocrysts of dark green to black hornblende from 1.5 to 5 cm (½ to 2 inches) long and up to 1.3 cm (½ inch) across. The groundmass consists of medium-grained to coarse-grained, pink plagioclase, which in thin section is seen to consist largely of fine micaceous alteration products rimmed by albite or oligoclase. Interstitial quartz is present in accessory amounts. The abundance of boulders of this rock in the drift around Iron Lake indicates that it may form a significant part of the complex. All the dioritic rocks and the "hornblende porphyry" are intruded by numerous dikes, veins, and irregular bodies of granitic rocks ranging from massive to gneissic, grey granodiorite and quartz diorite to pale pink or white trondhjemite and quartz monzonite.

In general the Wilder Lake complex can be said to consist of early dioritic phases of the granitic batholiths intruded by hornblende porphyry (a hybrid rock) and lastly by granitic rocks in various stages of contamination.

Batholithic Granitic Rocks

Only a limited amount of time was available for the study of the granitic rocks because of the poor weather conditions during the 1968 field season. As a result only a few ground traverses were done over the granitic batholiths; most of the data was collected by brief helicopter stops from 1.6 to 6.4 km (1 to 4 miles) apart. Because of the reconnaissance nature of the survey, the individual batholiths could not be outlined except where they occur within the boundaries of the major metavolcanic-metasedimentary belts.

Granitic rocks underlie about 70 percent of the map-area. Of this about 30 percent may be considered contaminated granite and migmatite.

The migmatitic zones show a spatial association to the major metavolcanic-metasedimentary belts. Extensive migmatitic zones extend westward from the west end of the Kabenung Lake belt and along the northwestern edge of the Mishibishu Lake belt. These zones are 1.6 to 5 km (1 to 3 miles) across and can be traced for 16 km (10 miles) to the west. They apparently represent the extensions of the metavolcanic-metasedimentary belts which have been only partly assimilated by the surrounding granitic batholiths.

For the most part these migmatitic zones are characterized by rapid variation both across strike and along strike in the proportion of granitic material to metamorphosed volcanic material.

The migmatitic rocks generally contain from 5 to 80 percent amphibolite, either as angular fragments or as distorted, wispy semi-digested lenses (Photos 11, 12). An amphibolite-rich zone up to 60 m (200 feet) wide and almost 1.6 km (1 mile) long occurs within a migmatite zone along the north-central part of the Kabenung Lake belt. Gneissic layering is prominent in the migmatitic zones. Amphibole-rich and biotite-rich layers from less than 2.5 cm (1 inch) to several metres or more (several feet) alternate with grey, massive to foliated quartz diorite. In general, the migmatite areas pass outward through a zone of gneissic and contaminated granitic rocks into what may be classed as nonmigmatitic or normal granitic rocks.

ODM9491

Photo 11–Migmatitic hybrid granitic rocks with amphibolite inclusions; near west end of the Kabenung Lake belt. Note minor displacement.

ODM9492

Photo 12–Migmatitic amphibolite; south edge of Kabenung Lake belt in Keating Township.

The "normal" or nonmigmatitic rocks can be classed as either trondhjemite or quartz monzonite in composition. Chemical analyses of granitic rocks of the area indicate that the granitic rocks which lie to the north and northwest of the major metavolcanic-metasedimentary belts tend to be richer in potassium (quartz monzonite) than those which lie south and southeast of the major greenstone belts (W.J. Wolfe 1970, personal communication). Thin section examination of the limited number of specimens available tends to bear out this finding.

The megascopic appearance of the quartz monzonite and trondhjemite is similar. Both weather pale grey and the predominant feldspar may be white to deep red or pink. In fact it was found that feldspar colour was a particularly unreliable indication of feldspar composition. The predominant mafic mineral is biotite. Hornblende granite appears to be less common, except in migmatitic zones. In most areas the granitic rocks are equigranular, medium to coarse grained, and massive to faintly foliated. Local zones of foliated and gneissic granite are common and may represent batholith borders. Porphyritic textures are developed locally.

In thin section the trondhjemite rocks are seen to consist of 40 to 71 percent subhedral oligoclase tablets averaging about 5 mm long with interstitial quartz anhedra forming about 10 to 35 percent. Clear microcline and microcline-microperthite generally partially replace oligoclase. Biotite is the predominant mafic mineral but hornblende and actinolite are generally present in contaminated varieties. Epidote and chlorite are widespread and locally form up to 10 percent of the rock. Sphene, magnetite, zircon, apatite, and allanite are present in very minor amounts. In the quartz monzonite, microcline-microperthite forms from 20 to 40 percent of the rock at the expense of oligoclase; otherwise the mineral assemblage is essentially similar to that of the trondhjemite (Table 8).

Small lenses and irregular patches of common granitic pegmatite are plentiful within the granitic areas, but no extensive bodies of pegmatite or rare mineral pegmatite were observed.

Garnet-bearing muscovite granite occurs in the northwestern part of the University River map-area (see Map 2333, back pocket). The weathered surface of the muscovite granite is white, whereas the freshly broken surfaces are pale buff. The rock has a variable texture consisting predominantly of fine- to medium-grained aplitic granite containing coarse-grained pegmatitic stringers. The essential minerals are oligoclase, quartz, muscovite, and microcline. Red garnet forms less than 1 percent of the rock. The total area underlain by the muscovite granite is unknown but it does not appear to be large and may only represent a pegmatitic phase of the granitic batholith.

Kabenung Lake Stock

The Kabenung Lake Stock was intruded along the axis of the Kabenung Lake belt at the northeastern edge of the map-area. The stock is roughly trapezoidal in plan and has an area of about 25 km^2 (10 square miles). It consists predominantly of massive, porphyritic quartz monzonite to porphyritic quartz-bearing monzonite. On weathered surfaces the rock is generally pale pink to pale

TABLE 8 Modes of Granitic Rocks
(Values in percent)

	P114-2	P113-10	PD13-3	PC10-2A	PC10-2A	PG10-25	PG19-3	PG10-1A	EB6-2
Plagioclase	71	51	40	49	56	33	58	27	48
Quartz	18	32	33	22	25	23	31	25	trace
Microcline	-	-	21	29	9	40	-	38	38
Chlorite	4	trace	2	trace	-	1	trace	trace	1
Amphibole	-	2	-	-	-	-	-	trace	trace
Muscovite	-	-	1	-	-	1	-	trace	-
Biotite	-	12	4	-	8	-	8	7	-
Sphene	trace	trace	1	trace	1	1	trace	trace	trace
Opaques	trace	trace	trace	1	trace	trace	1	1	1
Epidote	6	3	-	-	2	2	3	2	1
Apatite	trace	trace	-	trace	trace	trace	1	1	trace
Others	1	1	trace	1	trace	1	1	trace	1
Clinopyroxene	-	-	-	-	-	-	-	-	12
Total	100	101	102	102	101	102	103	101	102

Location of Specimens

P114-2	Trondhjemite, 5 km (3 miles) west of Point Isacor, north shore of Lake Superior.
P113-10	Biotite trondhjemite, 13 km (8 miles) south of Mishibishu Lake.
PD13-3	Quartz monzonite, 1.6 km (1 mile) east of Gibson Lake.
PC10-2A	Quartz monzonite, 8 km (5 miles) west of Gibson Lake.
PG18-2	Biotite trondhjemite, 5 km (3 miles) northwest of Marjory Lake.
PG10-25	Quartz monzonite, 3 km (2 miles) south of west tip of Kabenung Lake belt.
PG19-3	Biotite trondhjemite, central Levesque Township.
PG10-1A	Biotite-quartz monzonite, 3 km (2 miles) southwest of Mishibishu Lake.
EB6-2	Pyroxene syenite, Mishibishu Lake stock.

grey, but on fresh surfaces it is seen to consist of pale pink to deep red euhedral phenocrysts of microcline set in a groundmass of white to pale pink euhedral oligoclase tablets with interstitial dark green clinopyroxene or hornblende and quartz. Locally bright green epidote forms as much as 15 percent of the rock, making a striking contrast with the red microcline.

Although the rock appears massive in most surface exposures, some specimens show a slight but definite primary foliation caused by the subparallel alignment of tabular crystals of microcline.

The microcline occurs as anhedral to subhedral grains about 3 to 10 mm across or as phenocrysts up to 20 mm long, which commonly include euhedral plagioclase crystals 0.2 to 0.5 mm long. Exsolved plagioclase generally forms 10 to 15 percent of the microcline and commonly occurs as thin, serrated layers of the crystal, giving the illusion of oscillatory zoning. The oligoclase forms anhedral to subhedral grains about 2 to 5 mm which commonly display more albitic edges. The clinopyroxene is colourless in thin section and forms subhedral crystals about 1 to 3 mm across. Quartz is interstitial. Biotite or hornblende replace clinopyroxene in some specimens.

Mishibishu Lake Stock

A body of massive to porphyritic, pyroxene monzonite and quartz-bearing monzonite intruded the metasedimentary and metavolcanic assemblage around Mishibishu Lake, Mishi Lake, and Katzenbach Lake. This stock is roughly oval in outline with a maximum dimension of 9 km (5 ½ miles) and an area of about 28 km^2 (11 square miles). The rock weathers pale pink to pale grey and is pale to bright pink on fresh surfaces. The essential minerals are microcline-microperthite, oligoclase, and clinopyroxene. Accessory minerals include quartz, epidote, carbonates, sphene, zircon, apatite, and iron-titanium oxides. The content of iron-titanium oxides is particularly low (less than 1 percent in the three specimens examined in thin section) in view of the rather distinct magnetic anomaly the body exhibits on Aeromagnetic Map 2176G (ODM-GSC 1963e).

Early to Late Precambrian

LATE MAFIC INTRUSIVE ROCKS

Diabase

Post-granite diabase dikes from several centimetres (a few inches) to at least 60 m (200 feet) wide are abundant throughout the map-area. The trends of the diabase dikes mapped during the 1968 field season are shown on Maps 2332 and 2333 (back pocket) along with data from other sources. The apparent scarcity of diabase dikes within the granitic terrain reflects the relatively fewer ground trav-

ODM9493

Photo 13—Northeast-dipping Keweenawan (?) olivine diabase dike; north shore of Lake Superior, Homer Township. Note columnar jointing perpendicular to walls.

erses over the granite.

There are three preferred strike directions of diabase dikes in the map-area. These are about N30E, N40W, and N-S. The diabase dikes may be conveniently subdivided into quartz-bearing and olivine-bearing varieties.

The central parts of some dikes over 30 m (100 feet) thick tend to be more gabbroic and chilled border zones of fine-grained to cherty black diabase are present at the contact of the dike against the older rocks.

The reconnaissance mapping and preliminary study of the diabase dikes undertaken indicates that northeast-trending dikes are for the most part the quartz-bearing diabase, whereas north-striking and northwest-striking dikes are commonly olivine-bearing or olivine-rich diabase.

The quartz-bearing diabase dikes are dark brown to orange-brown on weathered surfaces and on fresh surfaces laths of pale green to white or grey plagioclase are easily visible against a black background of pyroxene and amphibole. Pale green to grey or buff phenocrysts of plagioclase up to 2.5cm (1 inch) long are locally present forming porphyritic zones a metre or more (a few feet) across and parallel to the sides of the dike.

Two types of olivine diabase (possibly of Late Precambrian age) have been identified. The first type generally occurs as relatively thick, north-striking dikes which display textures varying from ophitic to gabbroic within the same body. This type may generally be distinguished from the quartz-bearing diabase by the paler coloured and more abundant plagioclase.

The second type of olivine diabase forms a northwest-trending swarm of dikes dipping about 50 degrees northeast in the vicinity of the mouth of the Pukaskwa River (Photo 13). These dikes are reddish brown weathering and are generally black on fresh surfaces. In thin section the two specimens studied contain about 45 percent labradorite, 10 to 20 percent iddingsite (after olivine), 1 to 5 percent olivine, and about 20 percent clinopyroxene with the remainder being mainly iron-titanium oxides with accessory chlorite. The high magnetite content of these dikes is reflected in a strong aeromagnetic anomaly on Aeromagnetic Maps 2164G and 2165G (ODM-GSC 1963a,b). The relationship between the two types of olivine diabase is unknown. It should be borne in mind, however, that more than one age of all types of diabase may be present and that dikes of differing trends may be of the same geological age.

In the southwestern part of the map-area, it was found that at two locations the quartz-bearing diabase is intruded by northwest-trending olivine diabase.

The only rock within the map-area for which an absolute age has been determined, is a northwest-trending diabase near Pukaskwa Depot, which yielded a K-Ar age of 1,030 m.y.
(Wanless 1970).

Gabbro

A roughly equidimensional body of unmetamorphosed gabbro about 1.3 km^2 (2½ square miles) in area lies at the southwest end of the Kabenung Lake belt. On fresh surfaces the gabbro is black to dark greenish grey and weathers brown to grey. The essential minerals are labradorite, hypersthene (inverted pigeonite), clinopyroxene, and hornblende. Quartz and biotite are present as accessory minerals. Iron-titanium oxide ranges from 5 to 15 percent and accounts for the distinct aeromagnetic anomaly over the body (see ODM-GSC 1963b). The mineralogy and texture of the body indicate that it may be related to one of the periods of diabase intrusion.

Late Precambrian

KEWEENAWAN ROCKS

Erosional remnants of Keweenawan lavas occur on and near the shore of Lake Superior between Point Isacor and the University River. The predominant rock type observed is deep red to reddish brown aphanite containing abundant amygdules 0.6 cm (¼ inch) across. The matrix is very fine grained (about 0.02 mm) and consists largely of kaolinized (?) feldspar, fine scaly chlorite, and quartz. Because of the highly altered state and fine-grained nature of the rock a precise classification is not possible but the rock is probably a dacite.

Exposures of Keweenawan basalt and rhyolite occur along the sides of a stream valley about midway between Point Isacor and the University River. The thickness of Keweenawan lavas along the valley is about 6 to 9 m (20 to 30 feet) and the lavas are exposed for about 0.8 km (½ mile) along both sides of the valley. About 3 km (2 miles) east of Point Isacor a remnant of Keweenawan dacite a few hundred square feet in area exhibits a sharp contact against apparently unweathered Archean mafic metavolcanics. The contact dips about 5 to 10 degrees south. For about 0.8 km (½ mile) east of this occurrence of Keweenawan dacite, boulders of unmetamorphosed sandstone are found among the predominantly metavolcanic beach boulders. The sandstone is deep red to reddish purple with randomly distributed buff or pale brown patches and streaks. In thin section it is seen to consist predominantly of well sorted, fine sand-size, subangular to subrounded grains of quartz with subordinate felsic rock fragments and feldspar. The cement appears to be largely iron oxides and silica. The boulders may have been derived from Keweenawan deposits but they are also similar to Cambrian Jacobsville sandstone. The nearest known exposure of Jacobsville sandstone is probably that at Grindstone Point about 24 km (15 miles) south of Wawa on the east shore of Lake Superior (Ayres 1969, p.52-55). The presence of the boulders on the beach between the University River and Point Isacor indicates that outcrops of this sandstone may lie on the bottom of Lake Superior and that the boulders were thrown up as fragments on the beach by wave action.

The occurrences of Keweenawan lavas in the map-area all lie in topographically low areas such as in deep valleys or on the shore of Lake Superior. This would indicate that these areas also may represent topographic lows in the bedrock when the Keweenawan rocks were laid down.

Cenozoic

QUATERNARY

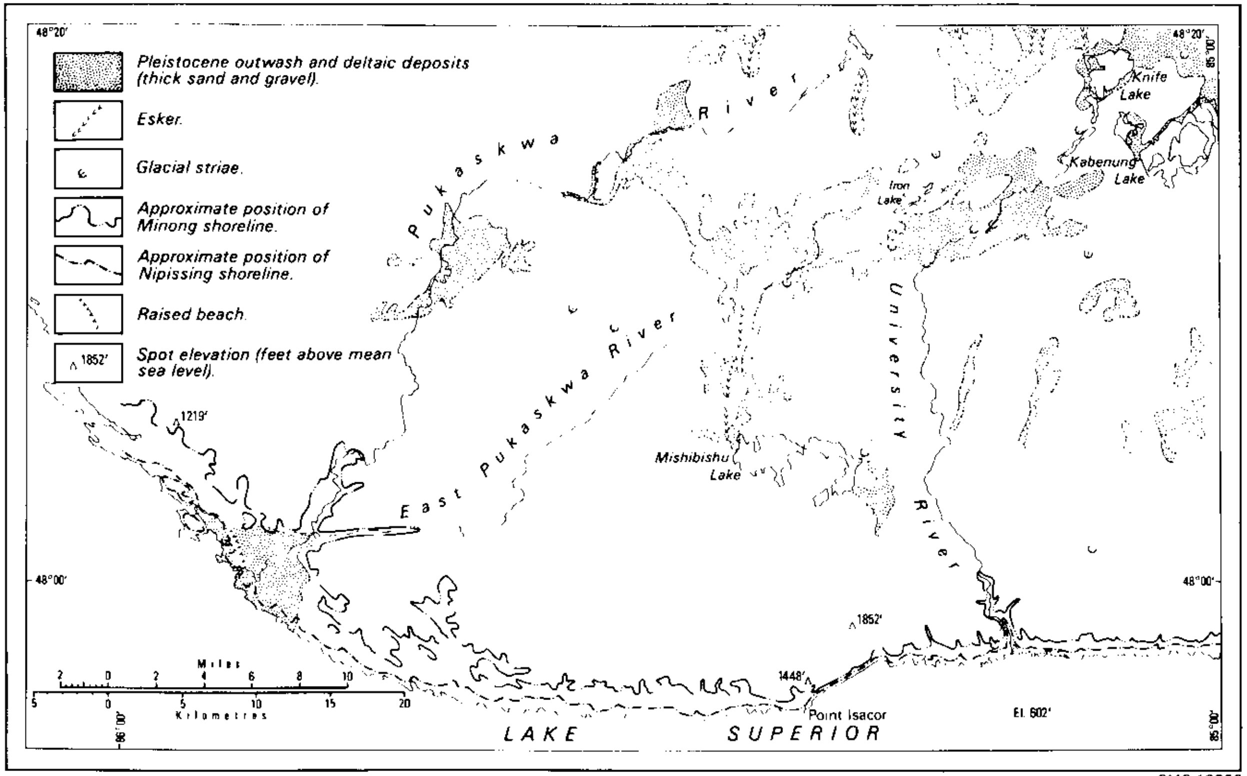
Pleistocene and Recent

GLACIAL STRIAE

Most glacial striae were measured in the eastern part of the map-area and are shown on Figure 3. Striae directions range from S10E to S45W with a general trend of about S20W which probably represents the average direction of ice movement.

DRIFT

A thin blanket of glacial till is the most common surficial deposit in the map-area. It is generally only a few feet thick except on the south slope of some hills where the thickness is probably greater than 15 m (50 feet). The summits of most hills may be covered with only a few inches of till or devoid of cover except for moss and lichen and a few small areas of till confined to depressions in the bedrock.



SMC 13759

Figure 3–Pleistocene deposits and features.

ESKERS

As shown on Figure 3 recognizable eskers are confined to the eastern part of the map-area north of Mishibishu Lake. They are generally small and discontinuous and trend either south or south-southwest.

OUTWASH DEPOSITS

As the Wisconsin ice sheet withdrew north of the shore of Lake Superior, heavily laden meltwater streams deposited large amounts of silt, sand, and gravel over the map-area.The position of these deposits is shown on Figure 3. It can be seen that these outwash deposits are particularly widespread in the northeastern part of the map-area and are for the most part restricted to a low, wide valley which roughly follows the outline of the Kabenung Lake metavolcanic-metasedimentary belt. The distribution of outwash sediments shows that the runoff from the valley was mainly through the valley of the Pukaskwa River and through streams draining directly south into Lake Superior, one apparently important route being through Mishibishu Lake. Today, this valley between Kabenung Lake and Abbie Lake is drained mainly by the University River whereas the Pukaskwa River drains an area more to the northwest.

POSTGLACIAL LAKE DEPOSITS

About 9,000 B.P. the Wisconsin ice sheet lay more or less along the north shore of Lake Superior. At this time the entire Lake Superior basin was occupied by a single continuous glacial lake known as Lake Minong, which in the region of the map-area, had an elevation of about 100 to 115 m (350 to 375 feet) above the present level of Lake Superior (Farrand 1960). The approximate position of the Lake Minong shoreline is shown on Figure 3. The level of Lake Minong closely coincides with the top of a large delta formed at the mouth of the Pukaskwa River. Downcutting by the Pukaskwa River through these deltaic sediments indicates that a minimum thickness of about 75 m (250 feet) of sediments was deposited in Lake Minong at the mouth of the Pukaskwa River.

The level of Lake Minong fell by gradual and discontinuous stages to a very low level of 109 m (360 feet) above present sea level. The new lake stage is known as Lake Houghton. As the ice front retreated farther northward, glacier unloading and subsequent rebound raised the outlet of the Great Lakes basin at the head of Lake Nipissing, resulting in a continuous rise in the level of the Great Lakes to form a single lake known as the Nipissing Great Lakes.

Around the mouth of the Pukaskwa River the Nipissing Great Lakes reached their maximum elevation of about 30 m (95 feet) above present lake level about 4,400 years ago (Farrand 1960). The Nipissing Great Lakes shoreline is outlined on Figure 3 using data from Farrand and seems to coincide with a wave-cut cliff near Pointe la Canadienne (see Map 2332 for location, back pocket) and a beach deposit near the mouth of the Pukaskwa River.

STRUCTURAL GEOLOGY

Foliation, Gneissic Structure, Cleavage

The parallel growth of platy minerals such as chlorite and mica during regional metamorphism and plutonism has imparted a very slight planar fissility (foliation) to much of the metavolcanic-metasedimentary assemblage. Where not readily visible with the naked eye, the foliation can generally be seen on suitably orientated sawed surfaces and thin sections. For the most part the foliation parallels the strike and dip of the bedding planes, except in areas of tight, complex folding such as 3 km (2 miles) west of Kabenung Lake, where a few occurrences of angular bedding-cleavage relationships occur. The foliation grades into a more highly developed schistosity in more intensely deformed areas adjacent to granitic stocks and batholiths.

Gneissic structure is locally developed in the hornblende-hornfels facies of mafic metavolcanics, but was not observed in the metasediments.

Minor Folds and Lineation

The location of minor drag folds is shown on Chart A, Figure 2 (back pocket). The plunge of these minor folds is generally greater than 45 degrees and in most cases it was not possible to relate these minor and major fold attitudes. The orientation of the minor folds may be the result of local deformation adjacent to faults.

Major Folds

The predominant structural feature of the Kabenung Lake belt is a gently plunging syncline or synclinorium, the axis of which is centred within the conglomerate unit. The main syncline is defined by several top determinations from graded bedding in the metasedimentary units and from the shape of pillows in mafic metavolcanic units. Top determinations from pillow shapes and packing indicate, but do not define closely, a northeast-trending anticline just north of Nichols Lake and a flanking synclinal structure about 2.4 km (1½ miles) south of the Iron Lake Syncline in Killins and Keating Townships. The intrusion of the Kabenung Lake Stock near the trough of the Iron Lake Syncline has greatly increased the structural complexity in the eastern part of the Kabenung Lake belt. The most important of these modifications of the original syncline is the development of steeply-plunging southeast-trending cross folds west and south of Kabenung Lake. Two flexures in the axis of the Iron Lake Syncline, one occurring 5 km (3 miles) west of Iron Lake and the other 5 km (3 miles) to the east, may also be related to this Kabenung Lake plutonism. A converse view is that the development of dilatant zones during cross folding of the syncline might have produced a locus for the emplacement of the Kabenung Lake Stock.

The Mishibishu Lake belt displays many of the structural elements of the Kabenung Lake belt. The predominantly synclinal structure of the eastern and northern parts of the Mishibishu Lake belt is reflected in the stratigraphy and by top determinations of minor primary structures in the rocks. A shallow-plunging northeast-trending syncline, probably equivalent to that of the Kabenung Lake belt, can be recognized within the metasediments in the western part of the Mishibishu Lake belt. In the eastern part of the belt, the syncline has a southeast trend. In the north-central part of the Mishibishu Lake belt the location of a major synclinal axis is obscured by the several poorly defined, subsidiary folds.

About 1.6 km (1 mile) south of Mishibishu Lake an isoclinal fold closed at the western end is outlined by a unit of argillite and greywacke, and by faint lineaments on air photographs. The data available suggest a steeply plunging anticlinal structure, plunging towards the west.

The Kink Lake anticline, in the southwestern part of the Mishibishu Lake belt is relatively well outlined by the strike of the foliation of the rocks and top determinations from pillow shapes. The crest of the fold is particularly well delineated by the bend in the Pukaskwa River near its mouth. The data indicate that the Kink Lake Anticline is a relatively open structure with a shallow plunge towards the west-northwest, and is probably synchronous with the other shallow-plunging folds of the area, rather than the young, steeply dipping cross folds.

Faults

The numerous, negative topographic lineaments visible on topographic maps and air photographs of the region indicate the presence of numerous faults and shear zones. However, it can be seen from the Maps 2332 and 2333 (see back pocket) that there are few major displacements of easily identifiable units such as conglomerate and iron formation. The displacement of rock units for several hundred feet could, however, be overlooked because of the 0.8 km (½ mile) traverse interval.

Detailed mapping by Goodwin (1954) has shown the presence of several northeast- and northwest-trending faults in the vicinity of Kabenung Lake which have an apparent horizontal displacement of as much as 750 m (2,500 feet). These faults are younger than the Kabenung Lake Stock and may represent readjustment following the intrusion of the stock.

The only major faults detected during the mapping program are three northeast-trending faults in the vicinity of Mishibishu and Katzenbach Lakes. These faults have displacement from 600 m (2,000 feet) to as much a 3000 m (10,000 feet), and although they are later than the major period of granitic intrusion, there is only limited evidence that they postdate the Mishibishu Lake Stock.

The presence of bedding plane-faults is suspected in many parts of the area, particularly in the Mishibishu Lake belt where several persistent lineaments parallel the strike of the rocks. These may represent strike-slip faults or early thrust faults which have been rotated into a near vertical dip by later folding.

Metamorphism

The number and distribution of rock specimens examined in thin section does not permit the detailed delineation of the areal extent of metamorphic facies. However, some general comments can be made. The common occurrence of albite with the calcium-bearing minerals clinozoisite and epidote indicates that, for the most part, the rocks of both the Kabenung Lake belt and the Mishibishu Lake belt were metamorphosed under greenschist facies conditions. The presence of stilpnomelane in metasediments and iron formation in the central part of the Kabenung Lake belt suggests that the rocks in this area represent the lowest temperature subfacies of the greenschist facies; the quartz-albite-muscovite-chlorite subfacies (Winkler 1967, p.95). Elsewhere the presence of biotite in metasediments and metavolcanics of both the Kabenung Lake belt and the Mishibishu Lake belt indicates that conditions of the quartz-albite-epidote-biotite subfacies of the greenschist facies had been reached locally.

In the western part of the Mishibishu Lake belt some rocks near the shore of Lake Superior contain oligoclase or sodic andesine indicative of a higher rank of metamorphism than the greenschist facies. It is believed that some rocks in this area may have undergone contact metamorphism under hornblende-hornfels facies conditions caused by the intrusion of numerous northwest-trending diabase dikes. Amphibolitic andesine-bearing metavolcanics and garnetiferous metasediments are present in the extreme western part of the Kabenung Lake belt. The metavolcanic-metasedimentary belt is here deeply embayed by fingers of granitic rocks and this higher rank of metamorphism is probably of a contact type in response to the intrusion of the granitic rocks.

Gneissic amphibolite of the hornblende-hornfels facies is most common along the northern edge of the Kabenung Lake belt.

ECONOMIC GEOLOGY

Mineral Exploration

The rugged terrain and swift, treacherous rivers make the map-area one of the most inaccessible in Ontario; yet before the turn of the century the iron deposits at Iron Lake were being assessed by the Minnesota Iron Company, and by the time of Bell's survey in 1904 (Bell 1905) almost all of the iron formation of the map-area had been discovered and thoroughly prospected. The early prospectors were seeking high-grade hematite-goethite ores of the Wawa type or residual hematite ores but their search was largely unsuccessful.

There is little record of exploration in the area from the early 1900s to the middle 1930s when prospectors obtained high gold assays from quartz veins north of Mishibishu Lake. Hollinger Consolidated Gold Mines Limited obtained an option on the most interesting section of the zone, and Macassa Mines Limited and Erie Canadian Mines Limited optioned the eastern end of the zone. About that same time, M.J. O'Brien Limited obtained a concession of Knicely, Killins, and Keating Townships. After two summers of systematic prospecting for gold with discouraging results, the project was abandoned.

The Jalore Mining Company Limited (a wholly owned subsidiary of Jones & Laughlin Steel Corporation) did prospecting and geological mapping in much of Killins Township in 1952. Presumably they were mainly interested in the iron deposits.

In 1953 Algoma Ore Properties Limited (now The Algoma Steel Corporation Limited, Algoma Ore Division) carried out airborne magnetometer surveys over most of the eastern part of the Kabenung Lake belt including the major iron deposits. The following year Goodwin (1954) did detailed geological mapping at a scale 1:15,840 or ¼ inch to 1 mile in Knicely and Killins Townships.

In 1954 Hollinger Consolidated Gold Mines Limited decided to investigate the Lorne prospect which had been known prior to 1905. Owing to an error in staking, the Hollinger claims did not include the Lorne prospect but several similar sulphide mineral deposits nearby were drilled.

In 1952 the scheelite-bearing quartz veins of the Michipicoten Tungsten deposit (12) were thoroughly mapped and described by a geologist of the Crane Company.

In the last decade base metals have become the prime target for exploration. Falconbridge Nickel Mines Limited (14) and Jonsmith Mines Limited (5) explored a copper-bearing zone south of Heart Lake in 1962, and W.B. Sutherland and Associates (23) drilled a copper-bearing zone north of Point Isacor. This general area between Mishibishu Lake and the shore of Lake Superior has recently been the subject of airborne geophysical surveys by Falconbridge Nickel Mines Limited and geochemical surveys by Broad Scope Developments Limited (11).

In 1965 International Bibis Tin Mines Limited (18) and Burrex Mines Limited (17) were active in the western end of the Kabenung Lake belt. Additional work has recently been carried out over these deposits by King Island Mines Limited.

In 1966 the Algoma Central Railway granted Acme Gas and Oil Company a three-year working option on 10 townships in the Michipicoten area. Included among these townships are Levesque, Killins, Legarde, and Keating Townships, which include most of the iron prospects and some of the more important base metal prospects in the Kabenung Lake belt. The option has been renewed and as of October 1971, these townships were still held by the Acme Gas and Oil Company Limited. Under the terms of the agreement the findings and results of exploration by Acme Gas and Oil Company Limited must be turned over to the Algoma Central Railway on the termination of the option.

In 1968 Canex Aerial Exploration Limited did prospecting over a group of claims west of Abbie Lake. Sheared iron formation in the area was examined for base metals and gold.

In 1971 that part of the area which is west of the eastern limit of the drainage basin of the Pukaskwa River was withdrawn from staking for possible use as a national park. Boundaries of the area shown on Ontario Division of Mines claim maps are tentative pending a boundary survey.

IRON

More than 70 years of intensive prospecting and mapping have failed to uncover any important deposits of direct-shipping iron ore in the map-area. The iron formations at Iron Lake, Frances Mine (3), Betty Lake (1), Brotherton Hill (2), Morse Mountain (6), and Mount Raymond (7) are at present of too low-grade to constitute ore, although as a group they form a substantial proportion of Ontario's iron reserves. The development of such deposits awaits improved mining and milling technology and improved market conditions.

GOLD

The only important gold deposits known in the area are those north of Mishibishu Lake which have been examined by Hollinger Consolidated Gold Mines Limited, Macassa Mines Limited, Erie Canadian Mines Limited, and Amichi Gold Mines Limited.

With the possible exception of the Amichi deposit, these occurrences occur within a wide shear zone along which there seems to have been considerable movement. Gold with minor sulphide mineralization occurs with quartz veins within the fault zone. The close proximity of a large syenite intrusion indicates a setting possibly similar to the Kirkland Lake gold camp.

BASE METALS

Prospecting for base metals in the area of the present study was largely ignored until about 20 years ago. Copper, as chalcopyrite, is the dominant base metal in most occurrences with zinc being the dominant metal only in the Hollinger occurrence. There are two distinct types of geological settings: the first is a typical hydrothermal type with copper mineralization introduced along a shear zone or fault which cuts across the structure of the host rocks. The Sutherland deposit and the King Island Mines deposit represent this type. The second type is strata-bound in the sense that it is more or less concordant and confined to one rock unit. The deposits south of Heart Lake and tested by Falconbridge Nickel Mines Limited and Jonsmith Mines Limited are characteristic of this type. The sulphide mineral bodies examined by Hollinger Consolidated Gold Mines Limited in migmatitic remnants of the Kabenung Lake belt probably represent sulphide facies iron formation and are also a strata-bound type.

RECOMMENDATIONS FOR FUTURE MINERAL EXPLORATION

The southern part of the Mishibishu Lake belt between the University River in the east and the Pukaskwa River to the west has on the whole undergone little intensive mineral exploration (an exception being the area between

Point Isacor and the University River). The southern half of the Mishibishu Lake belt includes a wide variety of rock types which have been known to provide suitable environments for ore deposition. These include felsic to intermediate metavolcanics (particularly pyroclastic rocks), iron formation of volcanic association, gabbro, and possibly a subvolcanic dacitic intrusion. There is, however, few known mineral occurrences in this area, but this might be in part due to the lack of detailed mapping and limited prospecting for metals other than gold and iron.

The gold occurrences north of Mishibishu Lake appear to be controlled by faults and may also be related to the emplacement of the syenitic stock. Prospecting around the stock with particular attention to early strike-slip (?) faults might prove fruitful.

Descriptions of Properties and Mineral Occurrences

Acme Gas and Oil Company Limited

BETTY LAKE PROSPECT (1)

The Betty Lake prospect is located at the eastern edge of the map-area at about Latitude 48°15′ North. The following description is largely paraphrased from Goodwin (1954). The prospect consists of a tightly folded iron formation faulted along its southern boundary with a strike-length of about 820 m (2,700 feet). A 12 to 18 m (40 to 60 foot) thick, northwest-trending diabase dike crosses the iron formation about 225 m (750 feet) west of its eastern end. Contrasting thickness and composition of iron formation on either side of the dike indicates that it occupies a fault on which the movement has largely been vertical.

West of the dike the iron formation consists of sugary, dark grey to rusty chert, and rusty weathering siderite members. The chert member is 18 to 50 m (50 to 170 feet) thick with an average thickness of 40 m (140 feet) with continuous bands of siliceous magnetite and siderite. The siderite member lies south of the chert member and probably stratigraphically below it. It ranges from 3 to 25 m (10 to 80 feet) in width with an average of 15 m (50 feet). Patches and scattered grains of pyrite, pyrrhotite, and granular chert are common. A second siderite zone 9 to 12 m (30 to 40 feet) wide may exist 9 to 18 m (30 to 60 feet) north of the main siderite member.

East of the diabase dike the predominant form of iron formation is grey to brown siderite with local bands and patches of chert and scattered grains of pyrrhotite, pyrite, and magnetite. The north limb of the deposit is about 30 m (100 feet) wide and the south limb is about 40 m (130 feet) wide. They unite to form a deposit 100 by 120 m (340 by 400 feet) at the nose of the fold (Goodwin 1954).

Detailed mapping by Goodwin (1954) and 189 m (620 feet) of shallow diamond drilling indicated reserves of 13,420 tons per vertical foot averaging 39.51 percent iron and 14.53 percent silica. In 1955, The Algoma Steel Corporation Limited, Algoma Ore Division (then Algoma Ore Properties Limited) drilled eight diamond drill holes totalling 961 m (3,153 feet). (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie). The enclosing rocks are metasediments and felsic metavolcanics.

The property is held by Acme Gas and Oil Company Limited under an option agreement with the Algoma Central Railway (October 1971).

BROTHERTON HILL DEPOSIT (2)

The Brotherton Hill deposit lies about 0.4 km (¼ mile) southwest of Paint Lake in Killins Township. The iron formation is about 1,400 m (4,500 feet) long and 110 to 140 m (350 to 450 feet) thick at its midpoint. It consists mainly of banded, fractured chert with thin bands of siderite and limonite with a few seams of siliceous hematite in the central parts. There are no available analytical results and Bell (1905) pointed out that the presence of diabase dikes in the Brotherton Hill deposit would effectively lower the overall grade.

FRANCES MINE PROSPECT (3)

The Frances Mine prospect is located on Frances Hill near the centre of Killins Township, a few hundred feet west of the junction of the road to the Makwa River and the road to Iron Lake. The deposit has been known since the turn of the century and about 1902 the Algoma Commercial Company examined the occurrence, drilled six diamond drill holes, and sank a prospect shaft (Bell 1905).

Frances Hill is about 400 m (1,300 feet) long, 275 m (900 feet) wide, and about 45 m (150 feet) high. It is underlain almost entirely by iron formation consisting of an outer zone of well banded chert with intercalated siderite and pyrite surrounding a central zone of banded and brecciated chert with hematite. Two faults extend through the deposit, one trending N75E and the other N36W; both faults dip steeply to the north. It is adjacent to these faults that the iron formation is highly brecciated and secondary hematite deposits were formed. The most interesting hematite deposits occur in four seams from 15 to 30 m (50 to 100 feet) long and from 1½ to 3 m (5 to 10 feet) wide. In these zones the hematite occurs as either a hard, massive, red type or a soft yellow ore with quartz impurities. Analyses of three samples are given below.

Type	Fe	SiO_2	S	P	Source
Hard	63.10	6.34	0.09	0.27	Goodwin (1954)
Soft	50.26	19.10	0.11	0.25	Goodwin (1954)
Hard	62.46		0.02	0.02	Bell (1905, p.329)

The last recorded work done on the property is one diamond drill hole of 260 m (860 feet) by Algoma Ore Properties Limited in 1955. As of October 1971, the prospect is held by Acme Gas and Oil Company Limited.

HEART LAKE PROSPECT (4)

In 1962 Falconbridge Nickel Mines Limited conducted an electromagnetic survey, and a self-potential survey, and did geological mapping over 15 claims of a 22-claim group in Killins Township. The exploration was initiated by the discovery of a number of chalcopyrite occurrences in the vicinity of Heart Lake.

Geological maps and reports by Falconbridge Nickel Mines (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) indicate that about 22 occurrences of chalcopyrite were identified along an ill-defined 1,500 m (5,000 foot) long zone, either within a 150 m (500 feet) wide,northeast-striking unit of schistose greywacke, or within mafic metavolcanics near the contact with the greywacke. Most of these occurrences consist of only a few grains of chalcopyrite and do not deserve the rank of a "showing", but two are significant and warrant some description.

The main showing is located near the west shore of a small pond about 800 m (2,600 feet) southwest of Heart Lake. It consists of a lens of about 80 percent chalcopyrite and pryite within a narrow strip of sheared and indurated mafic metavolcanics about 5 m (15 feet) south of the main greywacke unit. The sulphide mineral lens is 8 m (25 feet) long, has a maximum width of 61 cm (24 inches), and strikes N70E with a vertical dip. There is no disseminated sulphide mineralization in the wall-rock.

A second showing occurs about 200 m (700 feet) west-southwest of the main showing. Here disseminated sulphide minerals occur sporadically along a narrow zone 150 m (500 feet) long, striking N70E, and dipping vertically. The enclosing rocks are schistose greywacke. The highest concentration of sulphide minerals is reported to be about 40 percent over a width of 15 cm (6 inches) and a length of 30 cm (12 inches). At this location pyrite and chalcopyrite are present in equal amounts. Elsewhere along the zone pyrite predominates.

Six diamond drill holes totalling 672.3 m (2,206 feet) were drilled from 60 to 200 m (200 to 700 feet) apart over a distance of 800 m (2,500 feet) along the sulphide-bearing greywacke unit, but analyses and drill logs submitted for assessment work credits indicate only narrow lenses of pyrite and chalcopyrite were intersected. The best analytical result reported was 3.56 percent copper over 0.52 m (1.7 feet). The geophysical surveys likewise failed to indicate extensions of the known surface showings.

In 1966 the prospect became the property of Acme Gas and Oil Company Limited, as part of an option agreement with the Algoma Central Railway.

JONSMITH PROSPECT (5)

In 1961 prospectors of Jonsmith Mines Limited staked a group of claims on a sulphide mineral showing 175 m (600 feet) southeast of the shore of Heart Lake in Killins Township.

Trenching, stripping, geological mapping, and an electromagnetic survey were carried out in 1962 and succeeded in delineating a mineralized zone 200 m (700 feet) long, up to 15 m (50 feet) wide, and striking N50E with a steep dip to the south. The mineralization consists predominantly of "knots", seams, and fine disseminated grains of pyrite and chalcopyrite within highly silicified, sheared dark grey to green rock of undetermined origin. The sulphide mineralization horizon lies along a contact between mafic metavolcanics on the southeast and schistose greywacke on the northwest. The Jonsmith prospect is probably a continuation of the Heart Lake prospect previously described.

Channel sampling by the company along the widest part of the zone indicated an average of 0.51 percent copper over 12 m (41 feet). Channel samples taken 6 m (20 feet) on either side of this sample averaged 0.35 percent copper over 7.54 m (24.8 feet), and 0.52 percent copper and 0.78 percent zinc over 2 m (6 feet). Three diamond drill holes through the zone failed to intersect mineralization analyzing better than 0.5 percent copper over significant widths. The company decided that the deposit was of too low a grade and tonnage to warrant further exploration (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie).

Acme Gas and Oil Company Limited held the sole right to search for minerals in Musquash, Leclaire, Menzies, Lalibert, Macaskill, Knicely, Levesque, Killins, Legarde, and Keating Townships under the terms of a working option agreement with the Algoma Central Railway. Airborne electromagnetic and magnetometer surveys were conducted over the greater part of the 10 townships and additional surface work was done on the Jonsmith prospect.

MORSE MOUNTAIN (6) AND MOUNT RAYMOND (7) OCCURRENCES

The Morse Mountain and Mount Raymond deposits together form the thicker parts of the folded iron formation of central Killins Township. That part from the trough of the syncline near Heart Lake to a small lake (Raymond Lake) about 2,000 m (6,500 feet) to the southeast is known as the Morse Mountain occurrence. The iron formation which extends south from Raymond Lake to Paint Lake is known as the Mount Raymond occurrence.

Both deposits had been prospected prior to 1905 (Bell 1905). In 1953 Algoma Ore Properties Limited conducted an airborne magnetometer survey over the area which was followed up by detailed geological mapping in 1954.

The Morse Mountain deposit is from 15 to 150 m (50 to 500 feet) thick with an average thickness of about 60 m (200 feet). The Mount Raymond deposit is between 120 to 180 m (400 to 600 feet) over most of its length of 2.8 km (1¾ miles). Both occurrences consist essentially of banded chert and siliceous magnetite with local patches of siderite and disseminated pyrite. Brecciated coarse pyrite and white chert are present in outcrop on the road at the northwestern end of Paint Lake. Minor folding, crumpling, and brecciation are common features. The average iron content is estimated by Goodwin (1954) to be between 20 and 25 percent, which when coupled with the fine grain of the magnetite has precluded any commercial development of the deposits (Goodwin, 1954, with minor additions).

The Algoma Steel Corporation Limited

Algoma Ore Division (8)

The Iron Lake iron deposit is a roughly tabular body striking N80E and dipping 80 degrees to the south. It extends from Red Pine Point on Iron Lake as far as Yaskovitch Lake, a small lake about 4 km (2½ miles) to the southwest. The iron deposit has a maximum width of about 340 m (1,100 feet) and over most of its length appears as an approximately east-trending ridge with a steep, partly talus covered southern slope and a more gently northern slope.

Between 1900 and 1903 the Minnesota Mining Company employed a party of 20 men in stripping, trenching, test pitting, and drifting. The following year the Clergue Company drilled one diamond drill hole (Goodwin 1949). In 1909 five holes totalling 1,100 m (3,500 feet) were drilled and considerable trenching done, but further information is lacking (ODM 1923, p.188). Some small pockets of high-grade hematitic ore were found as a result of this early work but none were of sufficient size to warrant further development.

In 1947 and 1948 Algoma Ore Properties Limited (now The Algoma Steel Corporation Limited, Algoma Ore Division) conducted a magnetometer survey of the property and completed a diamond drilling program.

The iron formation consists mainly of alternating layers of white chert and pale red to maroon layers of chert carrying varying amounts of hematite and magnetite. Black and deep red layers rich in magnetite and hematite respectively are rare. Siderite is present as layers and crosscutting veins but forms a minor part of the deposit. Interbedded with the iron-oxide formation are beds of soft, dark green chlorite schist and dark grey, slaty rocks which Goodwin (1949) estimated make up about one sixth of the deposit.

Sampling data are lacking but the overall grade is probably no greater than 15 percent iron.

Amichi Occurrence (9)

In 1949 Amichi Gold Mines Limited discovered gold-bearing quartz veins about 300 m (1,000 feet) north of the north shore of Mishibishu Lake.

Thirty-one claims were staked and considerable trenching, stripping, and assaying were carried in 1950. There is no report of diamond drilling.

The gold occurs in a pyrite- and ankerite-quartz vein 25 to 91 cm (10 to 36 inches) wide and in 0.3 to 1.5 m (1 to 5 feet) wide shear zones on either side of the vein. The mineralized zone strikes about N50W for a distance of as much as 300 m (1,000 feet) in metamorphosed greywacke, slate, and arkose. A company report (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) gives the following assay results:

Width		Gold	Width		Gold
cm	inches	ounces/ton	cm	inches	ounces/ton
45	18	0.23	97	38	1.48
86	34	1.92	76	30	0.26
114	45	1.07	107	42	0.19
76	30	1.39	107	42	0.27

Average width 86 cm (34 inches)
Average grade 0.87 ounces per ton

The above assay results are reported to have been obtained from a 75 m (240 feet) long section of the vein bounded by east-striking faults. Although extensions of the vein system were located, the only assays of commercial grade are those quoted above.

Aylen Occurrence (10)

In 1954 Aylen Mines Limited held 19 unsurveyed claims southwest of Mishibishu Lake. Drill logs (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) state that seven holes totalling 110 m (362 feet) were drilled in a quartz vein with minor galena and sphalerite. No analyses are available and there is no report of any further work on the showing. The Ontario charter of Aylen Mines Limited was cancelled in 1959.

Broad Scope Developments Limited (11)

Broad Scope Developments Limited hold a group of 10 unsurveyed claims about 6½ km (4 miles) west of the University River and about 2.4 km (1½ miles) north of the shore of Lake Superior. The claims were staked in April 1970, in order to explore part of an area where a geochemical survey conducted by the Ontario Division of Mines in 1968 had found anomalously high quantities of base metals in stream sediments (Wolfe and Wright 1969a,b,c,d,e,f). A report by a consulting geologist on the Broad Scope property recommended ground magnetic and electromagnetic surveys in order to assess the geochemical anomalies.

Crane (Michipicoten Tungsten) Deposit (12)

About 7.2 km (4½ miles) east of the mouth of the University River a zone of scheelite- and molybdenite-bearing quartz veins occur within a screen of highly deformed and metamorphosed conglomerate enclosed by pale pink trondhjemite. There are three main scheelite-bearing zones distributed in a linear manner in a northwest direction roughly conformable with the schistosity of the conglomerate. The main zone is about 9 m (30 feet) wide and extends from the shore of Lake Superior for about 400 m (1,300 feet) in a N34W direction. This zone is made up of a number of irregular quartz veins up to 8 m (25 feet) wide, separated by septa of schistose conglomerate. The conglomerate has been metamorphosed to dark green to black quartz-biotite schist and quartz-hornblende schist containing subrounded boulders of trondhjemite and lenses of quartzose schist.

In 1952 the property was optioned from Louis Moyd by the Crane Company who did considerable trenching, stripping, detailed geological mapping, and diamond drilling of 53 holes totalling 687.0 m (2,254 feet). Geological maps and a report by the Crane Company are in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie. The report (Nickel 1952,p.9-10) describes the mineralization as follows:

> The scheelite occurs as grains, crystals, crystal clusters, and veinlets of varying size. The largest mass of scheelite observed is about 18 inches by 12 inches....Veins of scheelite several inches in width and several feet long have been found. The scheelite is present mostly along schist septa in the quartz or at the margin of quartz veins, although scheelite is also fairly common entirely enclosed by quartz or in the schist with no immediately adjoining quartz. In fact, several of the richest portions are in the schist, with quartz several feet away. However, no scheelite has been found at a greater distance than two or three feet from quartz.
>
> The distribution of scheelite in the ore zone is very erratic, a feature tending to make sampling procedure difficult. The scheelite is cream to buff in colour and when weathered has a white dusty coating which somewhat masks the fluorescence. It is typically fractured...with the fractures almost invariably filled with clear quartz.
>
> Qualitative spectrographic analysis of a scheelite sample indicates quite high purity. Molybdenum and rare earths are practically absent. This purity is also evidenced by the color of the fluorescence...a bluish-white color. Additional elements in the scheelite, particularly molybdenum tend to modify this color.
>
> Molybdenite is fairly common. It is generally fine-grained and occurs mostly in schist septa in the quartz. In a few instances it was also observed in the quartz itself.
>
> Pyrite is common in the ore [i.e. mineralized zone] zone and extends into the schist for ten to twenty feet away from the margins of the quartz. It is present only as cubes and these increase in size with proximity to the quartz veins. The largest crystal found had an exposed area of six square inches. Pyrite may be a guide to the presence of scheelite in quartz, since pyrite was observed in the adjoining schist wherever there is scheelite in the quartz. Where the quartz is barren, however, the pyrite is usually absent.
>
> Several copper stains were observed in the northern mineralized area and these may indicate the presence of chalcopyrite, although this mineral itself was not observed.

The report gives no analytical results but an estimate of the amount of scheelite present in the southern zone is 0.35 percent or 3.9 pounds of WO_3 per ton of rock. The tonnage is estimated at 790 tons per vertical foot (Nickel 1952).

Erie Canadian Occurrence (13)

In 1937 Erie Canadian Mines Limited optioned 10 claims east of the Hollinger (Mishibishu Lake) occurrence (16) and staked an additional 22 claims. The gold-bearing quartz veins and shear zone of the Hollinger occurrence (see Property 16) were found to continue for about 240 m (800 feet) eastward on to the Erie Canadian Mines Limited ground.

Extensive stripping, trenching, and blasting were done on the extension by Erie Canadian Mines Limited, but the only significant assay obtained was 0.8 ounce of gold per ton over 1 m (3 feet) (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie). Correspondence of the company (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) states that by 1946 the claims were no longer held by Erie Canadian Mines Limited.

Falconbridge Nickel Mines Limited

In 1970 Falconbridge Nickel Mines Limited conducted airborne electromagnetic and magnetometer surveys over about 124 km^2 (48 square miles) of the southeastern part of the Mishibishu Lake belt. One hundred and sixty-one claims were staked but there is no report of any follow-up work.

Hollinger (McDougall Lake) Occurrence (15)

In 1954 Hollinger Consolidated Gold Mines Limited, in association with the Mining Corporation of Canada Limited, staked 63 claims about 6 km (4 miles) due north of the northeast corner of Homer Township. Stripping, trenching, some geological mapping, and dip needle surveys were performed over six surface showings of pyrrhotite, pyrite, and magnetite within thin screens of amphibolite. Thirteen shallow diamond drill holes totalling 113 m (371 feet) were put down to test the showings, and drill logs and analytical results (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) show that the best intersections are 0.13 percent copper over 3 m (10 feet) with trace zinc, nil gold and silver, and 0.90 percent zinc over 3.9 m (13 feet) with trace copper and nil gold and silver. Surface sampling of the Lorne prospect (Bell 1905, p.338) detected no significant amounts of base metals or precious metals.

Hollinger (Mishibishu Lake) Occurrence (16)

In 1937 Hollinger Consolidated Gold Mines Limited optioned a gold property consisting of six claims at the northwestern end of Mishi Lake, and also staked an additional 29 adjoining claims. Reports (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) indicate that Hollinger did considerable stripping and trenching as well as diamond drilling in order to assess the property. However, the results of most of this work are not available

The gold occurs in 10 to 12 east-striking quartz veins and lenses 0.6 to 1.2 m (2 to 4 feet) wide and 18 to 24 m (60 to 80 feet) long, which lie within a zone of highly sheared mafic to intermediate metavolcanics and quartz porphyry about 90 m (300 feet) wide and 600 m (2,000 feet) long[1]. This zone also strikes east, and

[1]The western 370 m (1,200 feet) is on the Hollinger ground; the eastern 240 m (800 feet) was held by Erie Canadian Mines Limited.

dips steeply to the north. Disseminated pyrite is common within the shear zone and veins, and minor chalcopyrite, galena, and sphalerite are reported. Correspondence of the Erie Canadian Mines Limited (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) state that some very high assays could be obtained from grab samples from the Hollinger showing and that a composite channel sample gave $18.00 per ton over an average length of about 2½ m (8 feet). Five selected samples were collected from old trenches on the deposit by the author's assistants in 1968, and were assayed by the Mineral Research Branch, Ontario Division of Mines. Two samples were found to contain 0.82 and 0.40 ounce of gold per ton and trace silver. The remaining samples contained only trace amounts of precious metals.

King Island Mines Limited

BURREX OCCURRENCE (17)

In 1966 Burrex Mines Prospecting Syndicate purchased a 90 percent interest in a nine-claim group adjoining the property optioned by International Bibis Tin Mines Limited. Self potential and electromagnetic surveys carried out by Burrex over the property during the summer of 1966 detected seven geophysical anomalies. Subsequent stripping of overburden and trenching at the site of an anomaly in the northwestern part of claim SSM80837 disclosed the presence of pyrite and graphite. A report of S.V. Burr (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) states that analyses of grab samples of the pyrite mineralization gave only minor amounts of precious metals and no copper. The only other anomaly on the claim group shown to be due to the presence of sulphide mineralization is located in the northwestern part of claim SSM80842. Here trenching exposed what is described in Burr's report as "heavy to massive pyrrhotite up to 35 feet in width". The best analysis of a grab sample is reported to be 0.18 percent copper and 0.03 ounce of silver.

The original claims were allowed to lapse and have been restaked by King Island Mines Limited and form part of the property described below under International Bibis Prospect (18).

INTERNATIONAL BIBIS PROSPECT (18)

In early 1966 prospectors from Thunder Bay (formerly Port Arthur-Fort William) discovered copper mineralization in a stream gulley at the outlet of a small lake in the western extension of the Kabenung Lake belt. Following trenching, stripping, and sampling by the prospectors, International Bibis Tin Mines Limited took an option on a 40 percent interest in the 54-claim group.

International Bibis Tin Mines Limited conducted a dip needle and self potential survey over the area of the showing and drilled seven holes totalling 682.1 m (2,238 feet). Six of the holes intersected the mineralized zone; the best analysis was 1.47 percent copper over 5.2 m (17 feet) of core-length (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie). The results of the remaining analyses were not encouraging and the company did not exercise its option.

In November 1969, the claim group was acquired by King Island Mines Limited who staked an additional 29 claims adjacent to the original group.

An airborne electromagnetic, magnetometer, and scintillometer survey was carried out over the group for King Island Mines Limited in December 1969. Eleven electromagnetic anomalies were detected and ground follow-up surveys were recommended. As of March 1971, the results of these ground surveys have not been submitted for assessment work credits.

The mineralized zone is 3 to 4.5 m (10 to 15 feet) wide, at least 120 m (400 feet) long, and strikes about N60W with a steep dip to the north. The mineralization consists of seams and disseminated grains of pyrite, chalcopyrite, and possibly bornite and sphalerite distributed irregularly in highly sheared, silicified, and carbonatized mafic metavolcanics. Felsic metavolcanics lie a few feet to the north of the mineralized zone and may in part be in fault contact with the mafic metavolcanics. Dikes, sills, and veins of granitic rocks have intruded the adjacent rocks.

Six grab samples were taken from the showing by the authors' assistants and were analysed by the Mineral Research Branch, Ontario Division of Mines. The results range from trace to 0.59 percent copper with one selected specimen yielding 5.58 percent copper and 0.66 ounces of silver per ton. Lead, zinc, and gold were detected in trace amounts only.

Magnacon Mines and Oils Limited (19)

A group of 21 patented claims about 1.6 km (1 mile) north of Mishibishu Lake is held by Magnacon Mines and Oils Limited.

In 1968 the authors' assistants discovered evidence of trenching and diamond drilling within the claim group about 1,800 m (6,000 feet) north of the northwest bay of Mishibishu Lake. The object of the surface work and drilling appears to have been 0.3 to 0.6 m (1 to 2 feet) thick pyrite-bearing quartz veins within a rusty weathering, northwest-striking, shear zone up to 30 m (100 feet) wide separating mafic metavolcanics from metasediments. Two selected samples were taken by the assistants and assayed by the Mineral Research Branch, Ontario Division of Mines, but were found to carry only traces of gold and silver. This showing is almost certainly part of the deposit held by Macassa Mines Limited[1] in 1937 and described by Evans (1940, p.12) as follows:

[1]Evans (1940, Map 49J) indicates the Macassa showing to be about 1.6 km (1 mile) south of the location shown on Map 2333 (see back pocket). No old workings were found at Evans' location but the description of the showing in Evans' text fits the geological picture encountered at the location on Map 2333.

Macassa Mines Limited holds a group of 9 claims north of the west end on Mishibishu Lake. A number of trenches have been cut across the schistose zone from the conglomerate into the volcanics. In this zone are intruded quartz veins parallel to the bedding or schistosity. The veins form discontinuous lenses including fragments of the country rock. Adjacent to these lenses are quartz veinlets making *lit par lit* structures with the enclosing rock. Some of the veins occur next to rusty-weathering heavily carbonated zones; others in highly carbonated and locally contorted greenstones or sediments. The vein material consists of quartz and carbonate containing varying amounts of pyrite, chalcopyrite, galena, and gold. Two kinds of quartz can be distinguished in the vein. One is a milky quartz containing visible gold associated with galena; the other is a dark, glassy variety containing pyrite, chalcopyrite, and small amounts of galena in fractures.

Between 1946 and 1952 Bishu Mines Limited did additional surface work and 3,000 m (10,000 feet) of diamond drilling on what is believed to be the same deposit. Bishu Mines' charter was cancelled in 1963 and the claims were taken over by Magnacon Mines and Oils Limited. There is no record of work on the property since 1952 (Canadian Mines Handbook, 1946, 1950, 1952, 1953, 1963).

Miro Mines Limited(20)

In January 1970 the Phelps Dodge Corporation of Canada Limited had a ground electromagnetic and magnetometer survey carried out over a group of 42 claims optioned from Miro Mines Limited. The claim group adjoins the eastern boundary of the property held by King Island Mines Limited. The geophysical survey detected two bands of coincident magnetic and electromagnetic anomalies trending east for a distance of 2.4 km (1½ miles). These anomalies coincide with units of slate, argillite, and siltstone as mapped by the field party in 1968. Although no iron formation was noted in the vicinity of the anomalies, the sulphide-facies iron formation of the Abbie Lake area is directly on strike with the anomalies. The results of follow-up geological surveys or diamond drilling are not yet available.

Rawhide 'U' Mines Limited (21)

In 1969 Rawhide 'U' Mines Limited conducted a ground electromagnetic and geochemical soil sampling survey over 26 claims of a 42-claim group in Groseilliers Township, in the eastern part of the Mishibishu Lake belt. The results of the surveys (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) show two parallel zones of electromagnetic anomalies about 300 m (1,000 feet) apart, trending north-northwest for a distance of over 3 km (2 miles). Anomalously high concentrations of copper and zinc detected in soils showed some correlation with the electromagnetic anomalies. Seven diamond drill holes, totalling 422.8 m (1,387 feet) put down to investigate coincident geochemical and geophysical anomalies, intersected mafic to intermediate metavolcanics bearing minor pyrite, pyrrhotite, and narrow zones of graphite with minor pyrite.

Sand River Deposit (22)

In 1957 the Sand River Gold Mining Company Limited carried out a dip needle survey over a group of 32 claims about 11 km (7 miles) northwest of Point Isacor. About 20 units of iron formation were delineated but most were less than 15 m (50 feet) across. Two diamond drill holes totalling 240 m (800 feet) intersected interbedded greywacke and iron formation, but grades and thicknesses were considered too low to warrant further work (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie).

W.D. Sutherland and Associates (23)

W.D. Sutherland and Associates hold a group of unsurveyed claims on the west boundary of Groseilliers Township. The claims enclose a copper prospect in a migmatite zone between the mafic metavolcanics of the Mishibishu Lake belt and a granitic pluton within the belt. Mineralization occurs for 580 m (1,900 feet) along a steeply dipping, north-striking shear zone. The strongly sheared zone, where observed by the field party is 3 to 9 m (10 to 30 feet) wide and consists of a complex of quartz veins, lenses of dark green chlorite schist from 0.6 to 6 m (2 to 20 feet) wide and highly silicified and sheared country rock. Less intense shearing and alteration extend for an undetermined distance on either side of the shear zone.

The mineralization consists predominantly of disseminated grains and blebs of pyrite and chalcopyrite within quartz veins and silicified country rock and mafic schist. A crude chip sample taken by the field party consisted of chips of roughly equal size taken at 0.3 m (1 foot) intervals along a 6 m (20 foot) trench. When analyzed by the Mineral Research Branch, Ontario Division of Mines, the sample was found to contain 0.31 percent copper but only traces of gold, silver, lead, and zinc. Two grab samples taken at the same time contained 0.62 and 0.45 percent copper but only traces of gold, silver, lead, and zinc.

W.D.Sutherland and Associates diamond drilled 14 holes totalling 1,698.6 m (5,148.7 feet) and did considerable stripping and trenching on the property in 1965. Mineralization was intersected in all of the holes which were collared from 30 to 90 m (100 to 300 feet) apart for 600 m (2,000 feet) along the copper-bearing zone. Drill logs (Resident Geologist's Files, Ontario Ministry of Natural Resources, Sault Ste. Marie) indicate that mineralization was intersected over corelengths of 1.1 to 11 m (3.5 to 38 feet) with analyses ranging from a low of 0.07 percent copper over 5.33 m (17.5 feet) to a high of 1.14 percent copper over 1.5 m (5 feet). The analyses also indicate that no economically significant amounts of gold, silver, lead, or zinc were intersected.

Copper Occurrences

Four minor copper occurrences were sampled by the 1968 field party and at that time showed no evidence of previous discovery or work.

A 15 cm (6 inch) wide quartz vein cuts mafic metavolcanics about 30 m (100 feet) north of the north shore of a small lake just north of Jimmy Kash Lake in Killins Township. The vein contains disseminated pyrite and chalcopyrite with malachite staining. A grab sample from that part of the vein showing the best mineralization was analyzed by the Mineral Research Branch, Ontario Division of Mines and was found to contain 0.15 percent copper with nil gold and silver.

Disseminated pyrite and chalcopyrite form a roughly equidimensional mineralized area about 0.3 to 0.6 m (1 to 2 feet) across in amphibolite and hybrid metavolcanics about 1,200 m (4,000 feet) northeast of Pipe Lake (see Map 2332, back pocket). A selected grab sample taken by the authors' assistants was analyzed by the Mineral Research Branch, Ontario Division of Mines, and was found to contain 0.17 percent copper and nil gold and silver.

The best apparently new occurrence sampled by the field party occurs on the shore of Lake Superior about 4 km (2½ miles) southeast of the mouth of the Pukaskwa River. At this location scattered blebs and disseminated grains of pyrite and chalcopyrite about 2.5 cm (1 inch) across form three or four mineralized areas about 0.3 m (1 foot) in diameter within pillowed mafic metavolcanics. The sulphide mineralized areas are strung out in a crude zone about 6 m (20 feet) long, extending inland under the drift cover. Two selected grab samples analyzed by the Mineral Research Branch, Ontario Division of Mines, were found to contain 3.20 and 2.35 percent copper, 0.40 and 0.88 ounces of silver per ton, and 0.02 and 0.12 ounces of gold per ton respectively.

A grab sample taken by the field party from the contact between mafic metavolcanics and pink porphyritic granite along the East Pukaskwa River at Latitude 48°02'N was found on analysis to contain 0.72 percent copper (Mineral Research Branch, Ontario Division of Mines). The contact was intruded by felsite and contains malachite-filled vugs. The zone is narrow and extends for a few feet at N50E.

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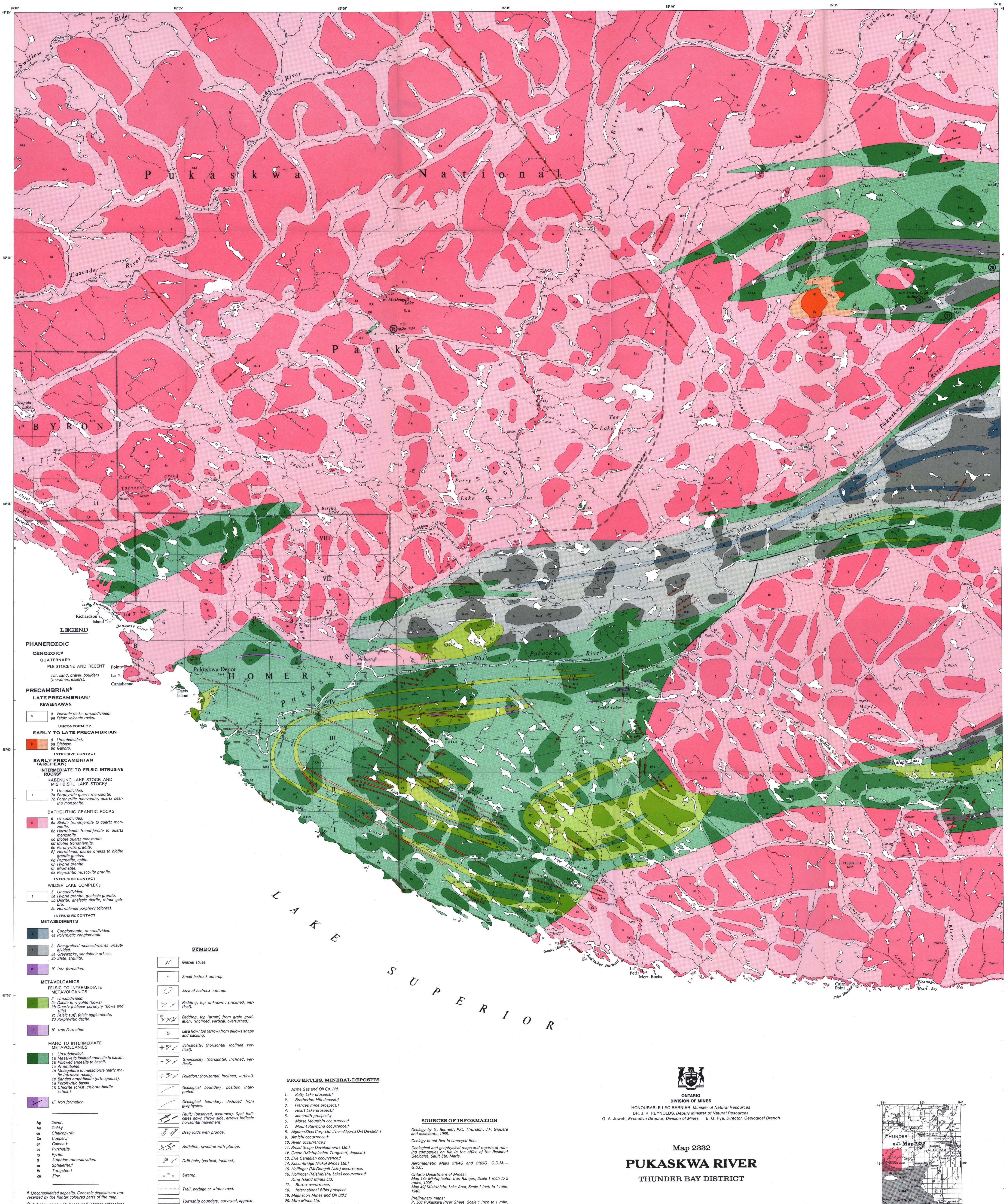
INDEX



LEGEND

PHANEROZOIC

CENOZOIC[a]

QUATERNARY

PLEISTOCENE AND RECENT

Till, sand, gravel, boulders (moraines, eskers).

PRECAMBRIAN[b]

LATE PRECAMBRIAN†

KEWEENAWAN

9 *Volcanic rocks, unsubdivided.*
9a *Felsic volcanic rocks.*

UNCONFORMITY

EARLY TO LATE PRECAMBRIAN

8 *Unsubdivided.*
8a *Diabase.*
8b *Gabbro.*

INTRUSIVE CONTACT

EARLY PRECAMBRIAN (ARCHEAN)

INTERMEDIATE TO FELSIC INTRUSIVE ROCKS[c]

KABENUNG LAKE STOCK AND MISHIBISHU LAKE STOCK†

7 *Unsubdivided.*
7a *Porphyritic quartz monzonite.*
7b *Porphyritic monzonite, quartz bearing monzonite.*

BATHOLITHIC GRANITIC ROCKS

6 *Unsubdivided.*
6a *Biotite trondhjemite to quartz monzonite.*
6b *Hornblende trondhjemite to quartz monzonite.*
6c *Biotite quartz monzonite.*
6d *Biotite trondhjemite.*
6e *Porphyritic granite.*
6f *Hornblende diorite gneiss to biotite granite gneiss.*
6g *Pegmatite, aplite.*
6h *Hybrid granite.*
6j *Migmatite.*
6k *Pegmatitic muscovite granite.*

INTRUSIVE CONTACT

WILDER LAKE COMPLEX†

5 *Unsubdivided.*
5a *Hybrid granite, gneissic granite.*
5b *Diorite, gneissic diorite, minor gabbro.*
5c *Hornblende porphyry (diorite).*

INTRUSIVE CONTACT

METASEDIMENTS

4 *Conglomerate, unsubdivided.*
4a *Polymictic conglomerate.*

3 *Fine-grained metasediments, unsubdivided.*
3a *Greywacke, sandstone arkose.*
3b *Slate, argillite.*

IF *Iron formation.*

METAVOLCANICS

FELSIC TO INTERMEDIATE METAVOLCANICS

2 *Unsubdivided.*
2a *Dacite to rhyolite (flows).*
2b *Quartz-feldspar porphyry (flows and sills).*
2c *Felsic tuff, felsic agglomerate.*
2d *Porphyritic dacite.*

IF *Iron Formation*

MAFIC TO INTERMEDIATE METAVOLCANICS

1 *Unsubdivided.*
1a *Massive to foliated andesite to basalt.*
1b *Pillowed andesite to basalt.*
1c *Amphibolite.*
1d *Metagabbro to metadiorite (early mafic intrusive rocks).*
1e *Banded amphibolite (orthogneiss).*
1g *Porphyritic basalt.*
1h *Chlorite schist, chlorite-biotite schist.†*

IF *Iron formation.*

Ag	*Silver.*
Au	*Gold.†*
cp	*Chalcopyrite.*
Cu	*Copper.†*
gn	*Galena.†*
po	*Pyrrhotite.*
py	*Pyrite.*
S	*Sulphide mineralization.*
sp	*Sphalerite.†*
W	*Tungsten.†*
Zn	*Zinc.*

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

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

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

The letter "G" preceding a rock unit number, for example "G8a" indicates interpretation from geophysical data.

†Appears on companion sheet Map 2333.

SYMBOLS

- *Glacial striae.*
- *Small bedrock outcrop.*
- *Area of bedrock outcrop.*
- *Bedding, top unknown; (inclined, vertical).*
- *Bedding, top (arrow) from grain gradation; (inclined, vertical, overturned).*
- *Lava flow; top (arrow) from pillows shape and packing.*
- *Schistosity; (horizontal, inclined, vertical).*
- *Gneissosity, (horizontal, inclined, vertical).*
- *Foliation; (horizontal, inclined, vertical).*
- *Geological boundary, position interpreted.*
- *Geological boundary, deduced from geophysics.*
- *Fault; (observed, assumed). Spot indicates down throw side, arrows indicate horizontal movement.*
- *Drag folds with plunge.*
- *Anticline, syncline with plunge.*
- *Drill hole; (vertical, inclined).*
- *Swamp.*
- *Trail, portage or winter road.*
- *Township boundary, surveyed, approximate position only.*
- *Township boundary, unsurveyed.*
- *Surveyed line, approximate position only.*
- (20) *Location of mining property, or mineral deposit. See list of properties and mineral deposits.*

PROPERTIES, MINERAL DEPOSITS

Acme Gas and Oil Co. Ltd.
1. *Betty Lake prospect.†*
2. *Brotherton Hill deposit.†*
3. *Frances mine prospect.†*
4. *Heart Lake prospect.†*
5. *Jonsmith prospect.†*
6. *Morse Mountain occurrence.†*
7. *Mount Raymond occurrence.†*
8. *Algoma Steel Corp. Ltd., The—Algoma Ore Division.†*
9. *Amichi occurrence.†*
10. *Aylen occurrence.†*
11. *Broad Scope Developments Ltd.†*
12. *Crane (Michipicoten Tungsten) deposit.†*
13. *Erie Canadian occurrence.†*
14. *Falconbridge Nickel Mines Ltd.†*
15. *Hollinger (McDougall Lake) occurrence.*
16. *Hollinger (Mishibishu Lake) occurrence.†*
King Island Mines Ltd.
17. *Burrex occurrence.*
18. *International Bibis prospect.*
19. *Magnacon Mines and Oil Ltd.†*
20. *Miro Mines Ltd.*
21. *Rawhide "U" Mines Ltd.†*
22. *Sand River deposit.†*
23. *Sutherland W.D. and associates.†*

Only current and defunct properties for which geological or related information is available are listed and located on the map face. For further information see report.

†Appears on companion sheet Map 2333.

SOURCES OF INFORMATION

Geology by G. Bennett, P.C. Thurston, J.F. Giguere and assistants, 1968.

Geology is not tied to surveyed lines.

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Magnetic declination in the area was approximately 4°W in 1970.

ONTARIO
DIVISION OF MINES
HONOURABLE LEO BERNIER, *Minister of Natural Resources*
DR. J. K. REYNOLDS, *Deputy Minister of Natural Resources*
G. A. Jewett, *Executive Director, Division of Mines* E. G. Pye, *Director, Geological Branch*

Map 2332

PUKASKWA RIVER

THUNDER BAY DISTRICT

Scale 1 : 63,360 or 1 Inch to 1 Mile

Chains 80 40 0 1 2 3 4 5 Miles
Feet 10,000 0 10,000 20,000 Feet
Metres 1000 0 1 2 3 4 5 6 Kilometres

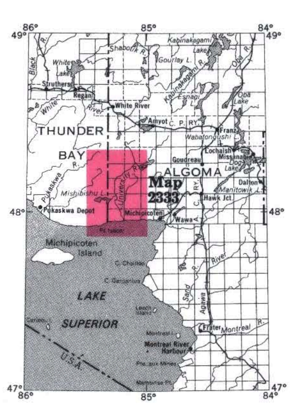
Scale 1 inch to 50 miles

NTS reference 41N/13, 42C/4.

Lambert Conformal Projection, Standard Parallels 44°30′ and 53°30′.

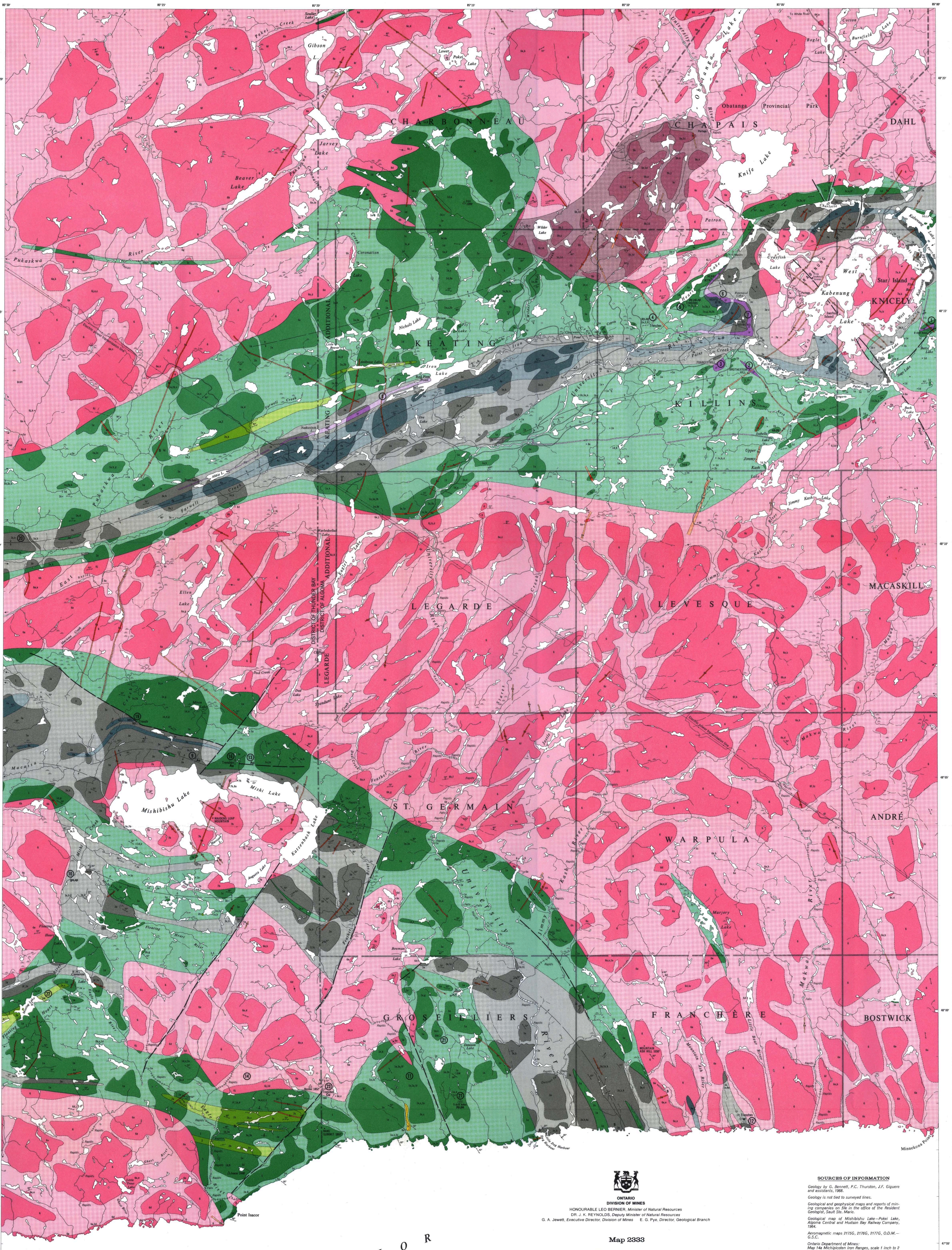
Published 1976

Map 2333
University River



Scale 1 inch to 50 miles

NTS reference 41N/14, 42C/3, 42C/6.



LEGEND

PHANEROZOIC

CENOZOIC[a]

QUATERNARY

PLEISTOCENE AND RECENT

Till, sand, gravel, boulders (moraines, eskers).

PRECAMBRIAN[b]

LATE PRECAMBRIAN

KEWEENAWAN

- 9 Volcanic rocks, unsubdivided.
- 9a Felsic volcanic rocks.

UNCONFORMITY

EARLY TO LATE PRECAMBRIAN

- 8 Unsubdivided.
- 8a Diabase.
- 8b Gabbro.†

INTRUSIVE CONTACT

EARLY PRECAMBRIAN (ARCHEAN)

INTERMEDIATE TO FELSIC INTRUSIVE ROCKS[c]

KABENUNG LAKE STOCK AND MISHIBISHU LAKE STOCK

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- 7b Porphyritic monzonite, quartz bearing monzonite.

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- 6 Unsubdivided.
- 6a Biotite trondhjemite to quartz monzonite.
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- 6c Biotite quartz monzonite.
- 6d Biotite trondhjemite.
- 6e Porphyritic granite.
- 6f Hornblende diorite gneiss to biotite granite gneiss.
- 6g Pegmatite, aplite.
- 6h Hybrid granite.
- 6j Migmatite.
- 6k Pegmatitic muscovite granite.†

INTRUSIVE CONTACT

WILDER LAKE COMPLEX

- 5 Unsubdivided.
- 5a Hybrid granite, gneissic granite.
- 5b Diorite, gneissic diorite, minor gabbro.
- 5c Hornblende porphyry (diorite).

INTRUSIVE CONTACT

METASEDIMENTS

- 4 Conglomerate, unsubdivided.
- 4a Polymictic conglomerate.

- 3 Fine-grained metasediments, unsubdivided.
- 3a Greywacke, sandstone arkose.
- 3b Slate, argillite.

- IF Iron formation.

METAVOLCANICS

FELSIC TO INTERMEDIATE METAVOLCANICS

- 2 Unsubdivided.
- 2a Dacite to rhyolite (flows).
- 2b Quartz-feldspar porphyry (flows and sills).
- 2c Felsic tuff, felsic agglomerate.
- 2d Porphyritic dacite.†

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- 1e Banded amphibolite (orthogneiss).
- 1g Porphyritic basalt.
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py	Pyrite.
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SYMBOLS

- Glacial striae.
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- Gneissosity, (horizontal, inclined, vertical).
- Foliation; (horizontal, inclined, vertical).
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- Geological boundary, deduced from geophysics.
- Fault; (observed, assumed). Spot indicates down throw side, arrows indicate horizontal movement.
- Drag folds with plunge.
- Anticline, syncline with plunge.
- Drill hole; (vertical, inclined).
- Swamp.
- Motor road. Provincial highway number encircled where applicable.
- Other road.
- Trail, portage or winter road.
- District boundary, approximate location only.
- Township boundary, surveyed, approximate position only.
- Township boundary, unsurveyed.
- Location of mining property, or mineral deposit. See list of properties and mineral deposits.

PROPERTIES, MINERAL DEPOSITS

Acme Gas and Oil Co. Ltd.
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7. Mount Raymond occurrence.
8. Algoma Steel Corp. Ltd., The—Algoma Ore Division.
9. Amichi occurrence.
10. Aylen occurrence.
11. Broad Scope Developments Ltd.
12. Crane (Michipicoten Tungsten) deposit.
13. Erie Canadian occurrence.
14. Falconbridge Nickel Mines Ltd.
15. Hollinger (McDougall Lake) occurrence.†
16. Hollinger (Mishibishu Lake) occurrence.
King Island Mines Ltd.
17. Burrex occurrence.†
18. International Bibis prospect.†
19. Magnacon Mines and Oil Ltd.
20. Miro Mines Ltd.
21. Rawhide "U" Mines Ltd.
22. Sand River deposit.
23. Sutherland W.D. and associates.

Only current and defunct properties for which geological or related information is available are listed and located on the map face. For further information see report.

†Appears on companion sheet Map 2332.

ONTARIO
DIVISION OF MINES
HONOURABLE LEO BERNIER, *Minister of Natural Resources*
DR. J. K. REYNOLDS, *Deputy Minister of Natural Resources*
G. A. Jewett, *Executive Director, Division of Mines* E. G. Pye, *Director, Geological Branch*

Map 2333

UNIVERSITY RIVER

ALGOMA and THUNDER BAY DISTRICTS

Scale 1 : 63,360 or 1 Inch to 1 Mile

Chains 80 40 0 1 2 3 4 5 Miles

Feet 10,000 0 10,000 20,000 Feet

Metres 1000 0 1 2 3 4 5 6 Kilometres

SOURCES OF INFORMATION

Geology by G. Bennett, P.C. Thurston, J.F. Giguere and assistants, 1968.

Geology is not tied to surveyed lines.

Geological and geophysical maps and reports of mining companies on file in the office of the Resident Geologist, Sault Ste. Marie.

Geological map of Mishibishu Lake—Pokei Lake, Algoma Central and Hudson Bay Railway Company, 1964.

Aeromagnetic maps 2175G, 2176G, 2177G, O.D.M.—G.S.C.

Ontario Department of Mines:
Map 14a Michipicoten Iron Ranges, scale 1 inch to 2 miles, 1905.
Map 49j Mishibishu Lake Area, scale 1 inch to 1 mile, 1940.

Preliminary maps:
P. 184 Michipicoten Sheet, scale 1 inch to 2 miles, issued 1963.
P. 507 University River Sheet, scale 1 inch to 1 mile, issued 1969.

Cartography by C.A. Love and assistants, Surveys and, Mapping Branch, 1975.

Base maps derived from maps of the Forest Resources Inventory, Ministry of Natural Resources, with additional information by the Cartography Section, Surveys and Mapping Branch, 1974.

Magnetic declination in the area was approximately 4°W in 1970.

Lambert Conformal Projection, Standard Parallels 44° 30′ and 53° 30′.

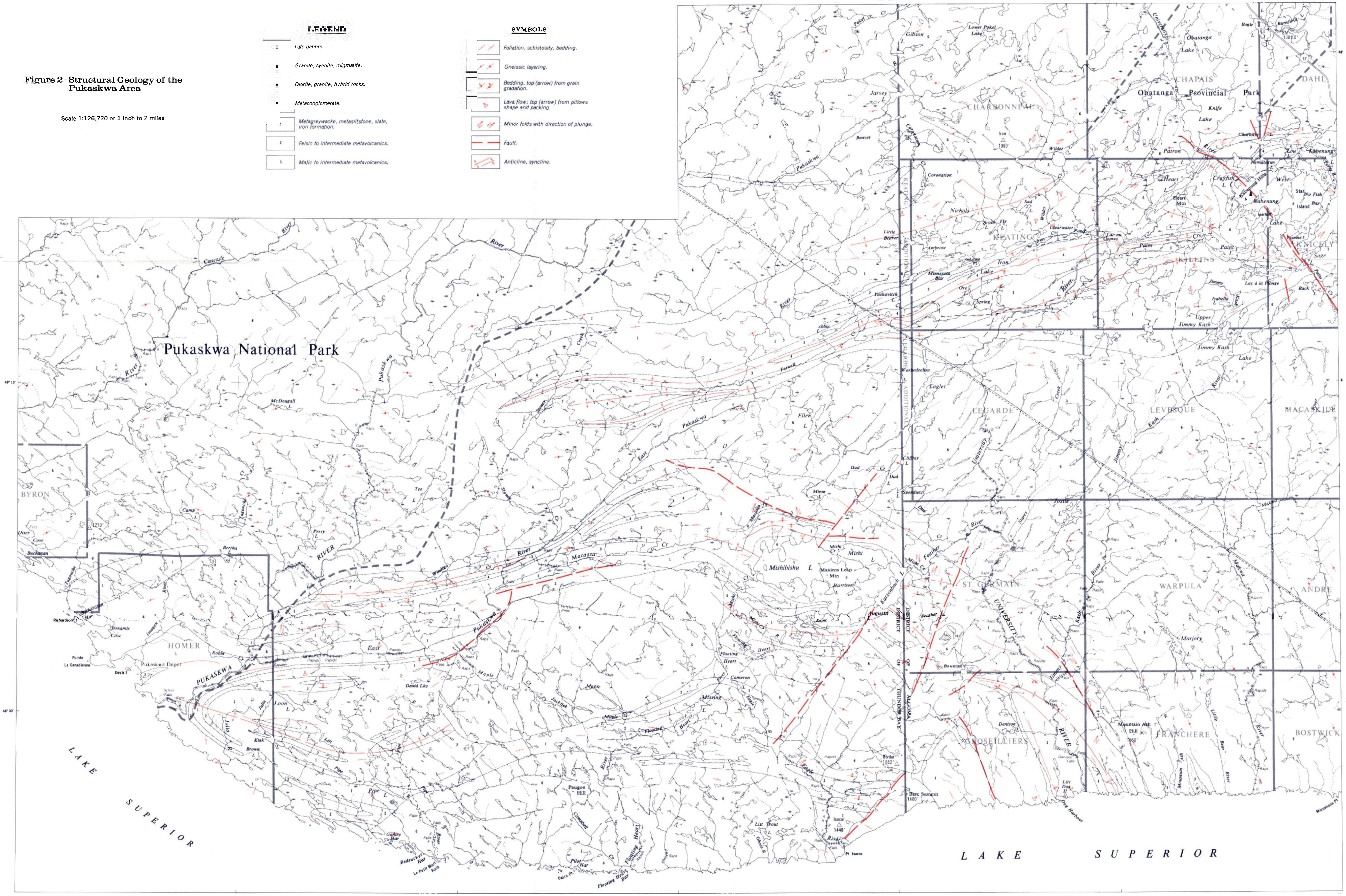

Figure 2-Structural Geology of the Pukaskwa Area

Scale 1:126,720 or 1 inch to 2 miles