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Report 238

Geology of the

Marble Lake Area

Counties of Frontenac and Lennox and Addington

1986

Ontario

Ministry of
Northern Development
and Mines

Ontario Geological Survey
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J.M. Moore, Jr., and R.L. Morton

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FOREWORD

MARBLE LAKE AREA

The Marble Lake map area includes a thick volcanic-sedimentary succession which hosts a variety of mineral occurrences and small former mines. In relation to most of the Grenville Province, primary structures in the rocks are well preserved, inasmuch as metamorphic grade and deformation are moderate. Accordingly, the area presented an unusual opportunity to determine the sequence of deposition, igneous intrusion and metamorphism, and the controls on mineralization. The authors of the report have drawn not only on one field season's observations, but also compiled the results of several detailed university studies, in order to deduce a stratigraphy and propose geological guides to prospecting for base and precious metals in the area.

V.G. Milne
Director
Ontario Geological Survey

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Scale 1:31 680.

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(back pocket)

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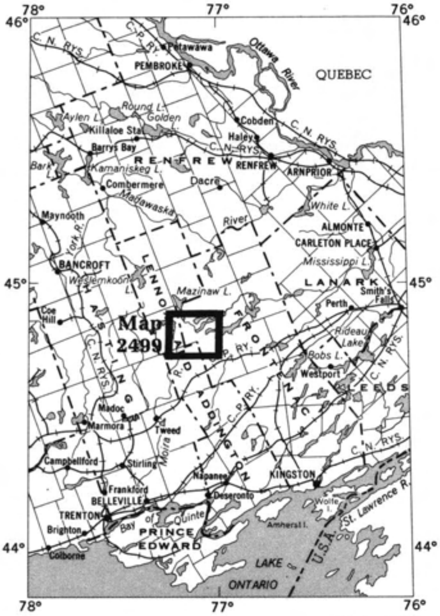

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Figure 1–Key map showing location of the Marble Lake area. Scale 1:3 168 000 or 1 inch to 50 miles.

ABSTRACT

The Marble Lake map area includes parts of Anglesea, Barrie, Kaladar, Kennebec, and Clarendon Townships. The area was mapped in order to better understand the stratigraphy, the volcanic and related rock associations, and the genetic affiliations of the mineral occurrences.

All the bedrock of the area is of Late Precambrian age, and all units, including igneous rocks, have been regionally metamorphosed and deformed during the "Grenvillian Orogeny". The oldest unit comprises submarine tholeiites correlative with the Tudor Formation of the Grenville Supergroup. These flows are succeeded by tholeiitic andesite and rhyolite, and by high-alumina basalt flows, andesite and dacite pyroclastic rocks and flows. Two major silicic volcanic centres, with a variety of associated shallow intrusions, have been identified. Between these centres are accumulations of mafic and silicic volcaniclastic and dolomitic sedimentary rocks, capped by calc-alkalic volcanic rocks. Younger thick carbonate metasediments overlie with minor unconformity the metavolcanic succession.

Granodiorite batholiths, and smaller intrusions ranging from peridotite and gabbro to granite and syenite, have intruded the volcanic-sedimentary succession; there is evidence of local metamorphism and deformation associated with the major plutons. Subsequently, the succession was eroded and the Flinton Group deposited on a surface of angular unconformity. Sedimentation began with oxidized pelites and coarse, quartz-rich clastics and progressed to reduced and carbonate-rich facies. No igneous activity is associated with this sedimentary succession. Two major phases of deformation and one major regional metamorphism occurred after the Flinton Group; The Group is restricted to narrow northeast-trending synclinal infolds in the pre-Flinton rocks. Metamorphic grade increases from west to east, from upper greenschist facies to mid-amphibolite facies.

Small copper occurrences are related to volcanic rocks, volcanic sedimentary rocks, and shallow intrusions. Lead-zinc-arsenic-gold occurrences are found in basaltic sedimentary rocks and in carbonate rocks, mainly close above the volcanic rocks. Lead-zinc deposits in Flinton dolostone may result from erosion of pre-Flinton volcanic rocks. Although the area has been thoroughly prospected for gold, the base-metal potential (particularly copper) has received relatively little attention and a number of occurrences warrant further investigation.

There is presently a small production of marble for industrial purposes, and local use of Pleistocene sand and gravel.

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If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used:

CONVERSION FROM SI TO IMPERIAL			**CONVERSION FROM IMPERIAL TO SI**		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm²	0.155 0	square inches	1 square inch	**6.451 6**	cm²
1 m²	10.763 9	square feet	1 square foot	**0.092 903 04**	m²
1 km²	0.386 10	square miles	1 square mile	2.589 988	km²
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm³	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm³
1 m³	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m³
1 m³	1.308 0	cubic yards	1 cubic yard	0.764 555	m³
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

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

NOTE–Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in co-operation with the Coal Association of Canada.

Geology of the

Marble Lake Area

Counties of Frontenac and Lennox and Addington

by

J.M. Moore, Jr.[1] and R.L. Morton[2]

INTRODUCTION

This report presents the results of a detailed geological survey of about 275 km^2 in Frontenac and Lennox and Addington Counties, southeastern Ontario, including the southern parts of Anglesea and Barrie, the western extremity of Clarendon, and the extreme northern parts of Kaladar and Kennebec Townships (see Figure 1). The village of Cloyne is the main centre of population, and the settlements of Harlowe, Bishop Corners, and Myer Cave lie within the map area.

At present most of the area, except the northern parts of both Barrie and Anglesea Townships, and the eastern parts of Barrie Township is accessible by road. Highways 41 and 506 pass through the area. From these major highways a good system of township and private cottage and farm roads provides adequate access for most foot and canoe traverses.

Mineral exploration and some mining have been carried out in the area during the past one hundred years. Mining activity has been largely confined to Barrie Township where small amounts of gold were produced during the early part of the present century. Mineral exploration has been directed towards the search of gold, lead, and zinc; the small occurrences of copper have received little or no attention.

---

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Present Geological Survey

Metavolcanics in the Grenville Province are largely confined to zones of greenschist and lower amphibolite metamorphic facies, centred between Madoc and Bancroft, Ontario (see Figure 2, Chart A, back pocket). Although the geology of the region has been extensively studied prior to the authors' work in 1976, relatively little attention had been paid to the stratigraphy, petrology, and economic importance of the metavolcanics and their synvolcanic intrusive equivalents.

In the eastern part of Anglesea and the southern part of Barrie Township a program of detailed mapping was undertaken to determine the presence and abundance of primary volcanic textures and structures and to demonstrate that moderate grade metavolcanics could be reliably classified in the field as to their origin. The field program was successful in achieving both of these ends.

Geological mapping was carried out by the authors and their assistants during the summer of 1976. Mapping was done by pace-and-compass traverses run perpendicular to the strike of the metavolcanic and sedimentary rock units, and by direct location in open areas. The geological data were plotted directly on acetate sheets fitted over 4 inch to 1 mile air photographs, and transferred to a 4 inch to 1 mile topographic base map prepared by the Cartographic Section, Ontario Division of Lands, Ministry of Natural Resources. During the present study, the metavolcanic and plutonic rocks, as well as much of the area south of the Harlowe road and Big Gull Lake (see Geological Map, back pocket), were completely remapped. Geology of the remainder of the Flinton Group, and of the carbonate rocks between Marble, Mississagagon, and Kashwakamak Lakes and east of Bishop Corners, has been compiled from J.M. Moore, Jr. (personal files, 1961-1968); K. Sethuraman (1970); P.H. Thompson (1972); J.M. Moore, Jr. and P.H. Thompson (1972); I.E. Hutcheon (1972); and J.F. Chappell (Graduate Student, Carleton University, personal communication, 1976, 1977).

Over 1000 hand specimens were collected for petrographic and chemical examination. From these 150 thin sections were prepared and studied by standard petrographic methods. Sodium cobaltinitrite stain for the identification of potassic feldspar (Chayes 1952) was used in the study of 45 thin sections and 70 rock specimens, partly in the field.

Fifty-two samples were chemically analyzed for eleven major and nine trace elements (see Table 3).

This work, coupled with additional mapping of younger metasediments in Barrie Township and the northern parts of Kaladar and Kennebec Townships, has led to a more complete understanding of the regional stratigraphy and has provided the basis for an understanding of the tectonic history. As well, a number of guides for prospecting have arisen from a better understanding of the relations of volcanism, sedimentation, and mineralization.

Previous Geological Work

H.G. Vennor (1869), working in the Bancroft-Madoc area, was the first to divide the low-grade metamorphic rocks into mafic and felsic metavolcanics, metasediments, and plutonic types.

W.G. Miller and C.W. Knight (1914) mapped part of the area east of Cloyne and considered the mafic metavolcanics as the oldest rocks in southeastern Ontario. They also recognized two ages for the post-volcanic plutonic rocks.

Systematic geological mapping of Anglesea and Barrie Townships was first carried out by V.B. Meen (1944) at a scale of 1 inch to 1 mile. At the same time Kaladar and Kennebec Townships were mapped by W.D. Harding (1944).

D.F. Hewitt (1964) considered the metasediments, not the metavolcanics, to be the oldest rocks in the Bancroft-Madoc area. The low-grade metavolcanics were thought to form the upper part of the stratigraphic column.

A.W. Hounslow and J.M. Moore, Jr. (1967) described the mineral relations in a narrow belt of progressively metamorphosed pelitic schists, extending from Bishop Corners northeastward to Ardoch in Clarendon Township to the east of the map area. The rocks were found to be in the staurolite zone, to increase in grade northeastward, and to represent both oxidized and reduced shale facies.

Geological mapping in Barrie Township, by Moore (1967) and Sethuraman (1970) revealed an angular unconformity between the metavolcanics and associated marble, and the younger Flinton Group pelitic schist-conglomerate suite.

S.B. Lumbers (1967) suggested a regional stratigraphic succession consisting of an older predominantly metavolcanic group and a younger, marble-rich metasedimentary group. The metavolcanics in the area of the present study were correlated with the upper part of the Tudor metavolcanics, the oldest formation of the Grenville Supergroup in the Madoc-Bancroft area.

The name Flinton Group (Thompson 1972; Moore and Thompson 1972) was applied to conglomerate, quartzite, psammite, pelite, marble, and calcareous and graphitic schists which overlie both the metavolcanics and associated younger, marble-rich metasediments. The Flinton group was shown to postdate all major igneous activity within the map area as well as the adjacent region between Madoc to the southwest and Ardoch (Clarendon Township) to the northwest of the map area. Thompson (1972; 1973) showed that metamorphic grade, based on index minerals and assemblages in pelitic and impure carbonate rocks, increases both southwestward and northeastward from a point just west of the village of Bishop Corners, in the southwestern part of the map area.

Sethuraman (1970) and Sethuraman and Moore (1973) divided the metavolcanics in the region between Bishop Corners and Donaldson (a village approximately 5 km northeast of the map area), into five petrographic units based on colour index and presence or absence of fragments. They also established five metamorphic zones based on the geographic distribution of critical assemblages and index minerals such as biotite, chlorite, hornblende, and diopside in the mafic metavolcanics. This work supported the earlier conclusion that the metamorphic grade increased northeastward from Bishop Corners, varying from low to middle amphibolite facies.

Hutcheon (1972) mapped and sampled several areas in southern Barrie Township, underlain primarily by carbonate rocks and determined a metamorphic isograd based on the appearance of tremolite with calcite. He also (Hutcheon and Moore 1973) estimated temperatures of metamorphism from the magnesium content of calcite associated with dolomite.

J.F. Chappell (Graduate Student, Carleton University, personal communications 1976, 1977) in the course of preliminary work on a doctoral thesis study, mapped two small areas, underlain mainly by the Flinton Group, near Harlow and Myer Cave in the southern part of the map area.

The Mazinaw Lake Sheet, Aeromagnetic Map 97G (Geological Survey of Canada 1952) includes the present map area.

Acknowledgments

During the 1976 field season the authors were ably assisted by J.A. Ayer and K.M. Gochnauer. Mr. Ayer, during the latter part of the field season, did independent geological mapping and Miss Gochnauer ran one independent traverse.

Mr. Albert Banner, of Cloyne, guided the authors on the Star Gold property, and provided helpful information on several other mines and prospects. Mrs. Nadine Brummell, of Cloyne, also assisted with information on mineral occurrences in the area. Mr. Lukas Boland, of Marble Lake, extended his hospitality and assisted on several occasions. The cooperation of all residents of the area, on whose land the mapping was carried out, is greatly appreciated.

Some details of the bedrock geology and structure were provided by Mr. J.F. Chappell, graduate student at Carleton University, Ottawa.

Petrographic studies for this report were carried out by the authors in the Department of Geology, Carleton University. Certain aspects of the petrology of the metavolcanics are based on chemical analyses by Dr. G.H. Holland, Durham University, England.

Physiography

The average elevation in the area is 1100 feet above sea level. The lowest elevations occur around Big Gull Lake (850 feet) with the highest found on the east side of Lower Mazinaw Lake (1220 feet). In general the southern and western parts of the map area are relatively flat with swampy areas and lakes separated by low, rocky ridges. The northern part of the area is slightly more rugged and consists of low, rolling hills. With the exception of Bon Echo (Lowjohn) Lake all rivers and lakes in Anglesea Township flow southward into the Skootamatta River. Bon Echo Lake and the rivers and lakes of Barrie Township form part of the drainage system of the Mississippi, which flows into the Ottawa River.

Bedrock exposure is excellent on the major plutonic bodies and the mafic volcanic rocks, typically exceeding fifty percent. More felsic volcanic rocks are mainly well exposed, as are some relatively resistant metasedimentary units, such as pelites and coarse clastic rocks of the Flinton Group, and relatively uniform dolomitic marbles. Other units are less consistently exposed, and some schists and impure carbonates offer only a few percent outcrop. The largest swamps are located over fragmental metavolcanics and volcaniclastic rocks, particularly north and west of Pringle Lake, west of Big Gull Lake, and east of Story Lake. Scattered outcrops are easily mapped on small farms which are scattered along the main routes, but relations in complex units (particularly in the metavolcanics) are difficult to establish in the forest which covers the major part of the area. Excellent exposures are afforded by lake shores and by roadcuts on Highway 41, which cuts a north-south cross section through the map area.

GENERAL GEOLOGY

The map area is underlain by almost equal amounts of granitic plutons, metavolcanics, and metasediments (see Figure 3, Chart A, back pocket). Lithologic units are listed in Table 1.

The oldest rocks are basalts[1] which can be traced into the Tudor metavolcanics of Lumbers' (1967) Hermon Group. These are overlain and intruded by a complex succession of flow and pyroclastic rocks, flow breccia, stocks, dikes, sills, and fine- to medium-grained mafic to silicic clastic metasediments of probable volcanic origin; the volcanic succession has a maximum apparent thickness of 7 km. To the north and northeast the metavolcanics are unconformably overlain by thick dolomite, calcite, and dolomite-calcite marble. Occurrences of copper, lead, zinc, gold, and associated metals are related to the metavolcanics and directly overlying carbonate rocks.

In the western and southern part of the area the metavolcanics are intruded by granodiorite plutons. These plutons are close in age to the volcanic rocks and could have been emplaced late in the volcanic cycle.

Unconformably overlying all of the above rock types are conglomerate, pelite, marble, and calcareous and graphitic schists of the Flinton Group (Moore 1967; Sethuraman 1970; Thompson 1972; Moore and Thompson 1972); which appear to postdate all major igneous activity in the area.

The structure is complex; all of the major lithologic units, including the plutons, were regionally metamorphosed and have undergone at least two phases of deformation. Metamorphism accompanied and outlasted most of the penetrative deformation.

Zircons from Tudor dacite in Tudor Township, 4 km southwest of the map area, yielded a lead isotopic age of 1310±15 m.y., whereas isotopic dates from granodiorite-trondhjemite plutons intruding the mafic metavolcanics give age of 1250±25 m.y. Regional metamorphism and intrusive activity continued until approximately 1050 m.y. ago (Silver and Lumbers 1966; Krogh and Hurley 1968).

No Paleozoic sedimentary rocks are exposed in the map area, but barite-fluorite veins are probably post-Ordovician. A variety of Pleistocene glacial and fluvioglacial deposits cover much of the area.

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[1] All rocks in the area have been metamorphosed and therefore, the rock names will not be prefixed by "meta".

TABLE 1 TABLE OF LITHOLOGIC UNITS FOR THE MARBLE LAKE AREA.

- PHANEROZOIC
  - CENOZOIC
    - QUATERNARY
      - PLEISTOCENE AND RECENT
        - Gravel, sand, clay, swamp, lake deposits.

Unconformity

- PRECAMBRIAN
  - LATE PRECAMBRIAN
    - LATE METASEDIMENTS
      - FLINTON GROUP
        - LESSARD FORMATION
          - Calcareous, feldspathic quartzite.
        - MYER CAVE FORMATION
          - Dolomitic marble, graphitic schist, biotite carbonate schist, graphitic marble, carbonate-pebble conglomerate, pelitic schist, calcitic marble.
        - BISHOP CORNERS FORMATION
          - Pelitic schist, quartzite, garnet-biotite schist, quartzite-pebble conglomerate, pebble quartzite, micaceous quartzite, polymictic conglomerate, impure calcitic marble, calcareous quartzite.

Unconformity

- FELSIC TO INTERMEDIATE INTRUSIVE ROCKS
  - SKOOTAMATTA STOCK
    - Monzonite, syenite, quartz syenite, porphyritic syenite
  - MAZINAW LAKE GRANITE AND SMALL POTASSIC INTRUSIONS
    - Granite, granite porphyry.
  - ELZEVIR AND NORTHBROOK BATHOLITHS AND SMALL SODIC INTRUSIONS
    - Granodiorite, trondhjemite, derived gneisses, intrusive breccia, quartz monzonite, feldspar and quartz-feldspar porphyry dikes, felsite.

Intrusive Contact

- INTERMEDIATE INTRUSIVE ROCKS
  - Diorite, quartz diorite, diorite intrusive breccia.
- MAFIC AND ULTRAMAFIC INTRUSIVE ROCKS
  - Gabbro, peridotite, hornblendite, hornblende schist, mafic and intermediate dikes.

Intrusive Contact

- EARLY METASEDIMENTS
  - CARBONATE METASEDIMENTS
    - Dolomitic marble, calcitic marble, siltstone, wacke, interlayered marble and mafic and intermediate sills.
  - CARBONATE AND CLASTIC METASEDIMENTS
    - Intercalated dolomitic marble, dolomitic siltstone, carbonate wacke, wacke, minor calcitic marble.
  - SULPHIDE-GRAPHITE METASEDIMENTS
    - Pyritic, pyrrhotitic graphitic schist, black chert.

CLASTIC INTERMEDIATE TO FELSIC METASEDIMENTS

Volcanic wacke, siltstone, tuffaceous wacke, minor volcanic conglomerate.

CLASTIC MAFIC METASEDIMENTS

Interflow metasediments in basaltic rocks.

METAVOLCANICS

RHYOLITIC METAVOLCANICS

Lapilli-tuff, tuff-breccia, ash-flow tuff, rhyolite, rhyolite porphyry and granite porphyry dikes and sills.

DACITIC METAVOLCANICS

Flows, flow breccia, lapilli-tuff, tuff-breccia, layered-tuff, carbonate volcanic breccia, dacite and andesite porphyry dikes and sills.

ANDESITIC METAVOLCANICS

Flows, flow breccia, autoclastic breccia, tuff-breccia, lapilli-tuff, agglomerate, mass-flow deposits, andesite and andesite porphyry dikes and sills.

BASALTIC METAVOLCANICS

Flows, pillowed flows, flow and pillow breccia, autoclastic breccia, amphibolite, hornblende schist, basaltic andesite flows, breccia, plagioclase-phyric basaltic andesite flows, diabase, and amphibolite dikes, sills and small gabbroic intrusions.

Late Precambrian

METAVOLCANICS

Basaltic Metavolcanics (Map Unit 1)[1]

Basaltic rocks are the oldest and most abundant rocks of the volcanic succession. They are widely distributed as pillow lava, massive and amygdaloidal flows, and autoclastic breccia. Outcrops east of the Elzevir Batholith indicate a maximum total exposed thickness of 5.5 km, in which individual flows vary from 1 to 15 m thick. The lower boundary of the unit is not exposed in the map area, however adjacent to the southwest of the map area, between the villages of Elzevir and Flinton, there is a gabbro-diorite pluton with ultramafic inclusions, which is cut by a mafic-intermediate dike system. This complex, which predates the Elzevir pluton, concordantly underlies the basalts and has been suggested by R.L. Brown *et al.* (1975) to be part of an oceanic crust on which they were extruded.

The basaltic flows are divided into two units: the lower (1a) is up to 4 km thick, and consists mainly of fine-grained amphibolites and hornblende schists,

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[1] Numerals after rock names refer to unit codes on the Geological Map in the back pocket.

originally aphyric or with small phenocrysts only. These have a relatively uniform composition of olivine tholeiite or tholeiite (Sethuraman and Moore 1973). Basalt and basaltic andesite higher in the succession (1b) are less mafic and typified by medium or coarse pseudomorphs of plagioclase phenocrysts. The two units are separated in the vicinity of Cloyne by rocks of sedimentary origin; southeast of Bishop Corners they are in contact. The transition from these rocks to overlying andesite (2) is abrupt; the latter flows and pyroclastic rocks are biotite-rich and have a distinctly lower colour index.

The basalts display a wide variety of primary textures and structures such as grain gradation within flows, chilled flow contacts, varioles, amygdules, relict plagioclase phenocrysts, flow top and bottom breccia, pillows and pillow breccia (Photos 1,2). These are variably deformed but clearly evident where the strain is mainly extensional, as in road exposures around Bishop Corners. Pillows provide the main criterion of facing in the flows. Pillowed flows compose approximately 10 percent of the basalt succession, occurring mainly near the midpoint and the top of (1a) and also in (1b).

The basalts vary from fine-grained, massive flows to fine- and medium-grained porphyritic types. They are dark green or grey and composed, in order of decreasing abundance, of plagioclase (oligoclase or andesine), amphibole, epidote, chlorite, and magnetite with accessory apatite, carbonate, biotite, quartz, pyrite, pyrrhotite, and chalcopyrite. Colour index is typically 40 to 50. Porphyroblasts of hornblende and garnet are locally abundant and minor talc and serpentine are found in the lower part of the succession.

The flows are cut by basaltic dikes and sills (1c) typically 0.3 to 1 m wide, fine grained, and uniform. Similar in composition to the flows, these intrusions are mainly too small to appear on the map. They are also in volcanic and sedimentary units higher in the succession.

Andesitic Metavolcanics (Map Unit 2)

In the northwestern part of the map area andesite flows, lapilli-tuff, tuff-breccia (2), and mineralogically similar clastic metasediments (6) overlie basalts (1a). These rocks are distinguished from the basalts on the basis of texture, mineralogy, and colour index. Near Bishop Corners, the upper boundary of the basalts is unexposed, but the succeeding exposures are of dolomite marble. Farther south, where the upper contact is complicated by complex deformation and partly obscured by Flinton Group rocks (see below), andesites overlie either plagioclase-rich basalts (1b) or fine-grained uniform flows (1a).

Lapilli-tuff and tuff-breccia are the most abundant of the andesitic rocks (Photos 3,4,5). Thick deposits are exposed north of Big Gull, south of Nervine, north of Star, and east of Pringle Lakes, respectively. The deposits consist of 20 to 70 percent angular to subround fragments, all of which have been flattened and elongated to varying degrees, and which are dominantly accessory in nature. Fragments vary from 2 mm to 1.5 m across; average size is 6 cm in tuff-breccia and 1 cm in lapilli-tuff. Fragments are composed of basalt, gabbro, andesite, diorite, quartz diorite, volcaniclastic rocks, and minor dacite. These are enclosed by a fine- to medium-grained matrix of sodic plagioclase,


OGS 10 622

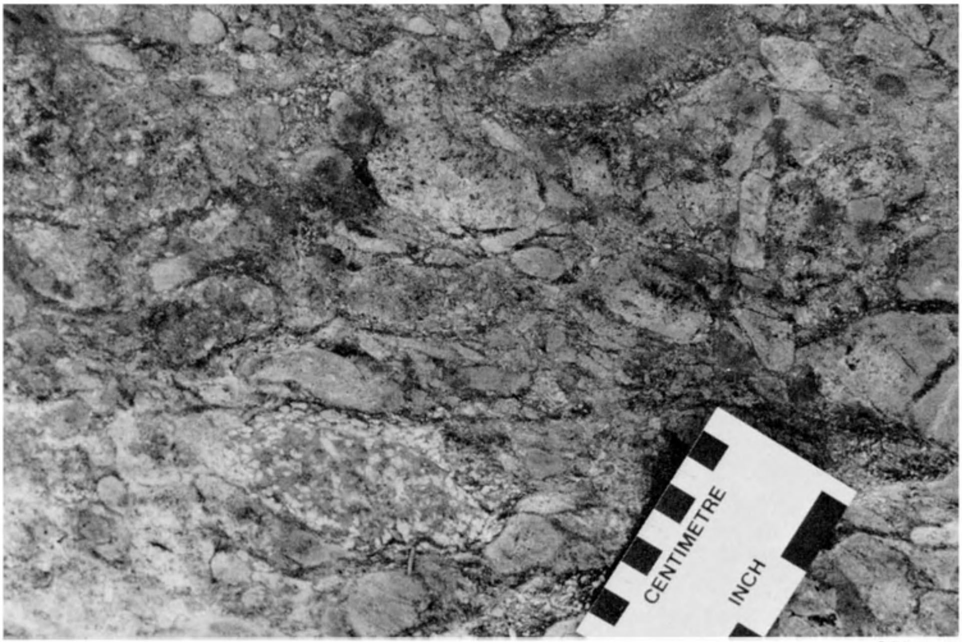
Photo 1–Pillows in basalt (1a) at Bishop Corners. Flow top toward top of photo.


OGS 10 623

Photo 2–Pillow breccia on Highway 41 at Cloyne, at top of tholeiitic basalt (la).

OGS 10 624

Photo 3–Calc-alkalic andesite breccia (2b) on Highway 506 at Marble Lake. Fragments contain carbonate amygdules, relict plagioclase, and hornblende phenocrysts.



OGS 10 625

Photo 4–Tholeiitic andesite-dacite tuff-breccia or mass-flow deposit (2b). Highway 41, 1.5 km north of Cloyne. Horizontal surface shown.

OGS 10 626

Photo 5–Same outcrop as in Photo 4. Vertical surface oriented north-south shows tectonic elongation of clasts.

biotite, quartz, and hornblende, with lesser amounts of chlorite, epidote, magnetite, pyrite, and calcite. Relict, angular crystals of plagioclase are found locally, and irregular to worm-like areas composed of epidote, chlorite, carbonate, magnetite, and quartz are interpreted to represent essential fragments.

Lapilli-tuff and tuff-breccia are estimated to compose 70 percent of the andesitic succession; individual units range from 2 m to 100 m in thickness.

Andesite flow rocks vary from amygdaloidal and massive to autoclastic and flow breccia. Pillow lava is rare; andesite dikes (2c), cutting the upper part of the basalt succession are common.

Andesite flows have a colour index that ranges from 20 to 35 percent and relict plagioclase and hornblende phenocrysts are well preserved. These fine- to medium-grained, grey to brownish grey rocks are composed, in order of decreasing abundance, of oligoclase, biotite, amphibole, quartz, muscovite, magnetite, pyrite, apatite, sphene, and chalcopyrite. Epidote is generally present only as an alteration product of plagioclase and knots of coarse, interleaved biotite aggregates appear to be pseudomorphs after hornblende.

In thin section the andesites differ from the basalts in the following:

1. greater abundance of plagioclase and biotite with biotite being the most abundant mafic mineral;
2. lower percentage of mafic minerals;
3. presence of muscovite;
4. abundant quartz and general lack of epidote in the matrix.

Dacitic Metavolcanics (Map Unit 3)

Dacite flow and pyroclastic rocks are abundant only in the Lower Mazinaw-Pringle and Nervine-Kashwakamak Lake areas. These rocks are distinguished from the andesites by their low colour index (less than 15 percent) and by the presence of relict quartz and plagioclase phenocrysts.

South of Kashwakamak Lake dacite lapilli-tuff and tuff-breccia (3b) are exposed over a strike-length of 3.5 km. These rocks overlie andesite lapilli-tuff, and are in turn overlain by massive marble. To the west they interfinger with andesite pyroclastic rocks and are themselves interlayered with dacite flow and volcaniclastic rocks.

These tuffaceous rocks vary from layered types with streaky and swirled matrices to massive successions containing a wide variety of andesite and dacite rock fragments. Fragment size increases towards the west where numerous dacite stocks and dikes are exposed.

The matrix of these pyroclastic rocks is composed of relict plagioclase and quartz crystals enclosed in a fine groundmass of plagioclase, quartz, and biotite with accessory muscovite, epidote, chlorite, calcite, pyrite, chalcopyrite, tourmaline, and hornblende. Potassic feldspar is a rare mineral and where present occurs entirely interstitial to quartz and plagioclase.

A distinctive dacite breccia with a calcite matrix (3c) forms a discontinuous horizon near the top of the volcanic succession south and west of Kashwakamak Lake. It is also exposed in a road-cut at the southwestern part of Marble Lake, where it has abundant pyrite in the matrix.

Dacite flow rocks (3a) are relatively rare, with outcrops east of Pringle and south of Big Gull Lakes, respectively. In general, flow rocks are weakly layered and fine grained, equigranular or porphyritic. Amygdaloidal types are rare and almost all flows are either autoclastic or flow breccia. Dacite flows are composed of plagioclase, quartz, and biotite with minor amounts of muscovite, epidote, chlorite, sphene, calcite, magnetite, rutile, amphibole, and microcline. Colour index ranges from 5 to 15.

Dacite stocks and dikes (3d) are common south of Nervine and Kashwakamak and east of Star Lakes, respectively. These rocks are invariably fine grained and porphyritic with a colour index of 5 to 15 percent. They are composed of relict plagioclase and quartz phenocrysts (up to 40 percent) set in a matrix of quartz, plagioclase, and biotite with accessory magnetite, muscovite, sphene, apatite, potassic feldspar, rutile, and epidote. In places the stocks contain disseminated pyrite and chalcopyrite, and both stocks and adjacent rocks are cut by quarz-biotite-potassic feldspar stringers which carry pyrite, chalcopyrite, and bornite.

Rhyolitic Metavolcanics (Map Unit 4)

Pyroclastic rocks of rhyolitic composition occur only around Lower Mazinaw Lake, although rhyolite dikes are common throughout the upper part of the volcanic succession. These are quartz-plagioclase-muscovite-rich rocks; pyroclastic rocks contain abundant rhyolite, dacite, and andesite fragments. The pyroclastic rocks are typically layered and have colour index less than 10 percent. Again, potassic feldspar is only a minor constituent of these rocks.

Related Subvolcanic Dike Rocks

Numerous diabase, amphibolite, and andesite to rhyolite dikes (1c, 2c, 3d) cut all of the previously described volcanic units. They are generally similar in mineralogy to their hosts. Basaltic dikes are uniform and slightly coarser than the host flows; andesitic types usually contain relict plagioclase phenocrysts in a fine matrix. Dacitic and rhyolite dikes are feldspar and quartz-feldspar porphyries, commonly metamorphosed to augen schist.

Volcanic Centres

Spatially and genetically related volcanic and intrusive rocks have been grouped by the authors into two volcanic complexes intrusive into, and built upon thick successions of basalt. The criteria for establishing the Pringle-Lower Mazinaw Lake and Nervine Lake-Harlowe areas as volcanic centres are:

1. presence of numerous and varied intrusive bodies, which are mineralogically similar to volcanic flow and pyroclastic units in the vicinity;
2. swarms of dacite to rhyolite dikes;
3. abundance of pyroclastic deposits that vary from lapilli-tuff to tuff-breccia and possible agglomerate, which flank intrusive centres;
4. decrease in fragment size away from centres;
5. evidence of hydrothermal activity in and adjacent to the intrusive complexes.

Metavolcanic Rock Chemistry

In 1967 two detailed stratigraphic sampling traverses were made in the vicinity of Bishop Corners. The sections were sampled at approximately 120 m intervals and 57 samples were analyzed by the Geological Survey of Canada. The results were reported by Sethuraman (1970), Baragar (1972), and Sethuraman and Moore (1973).

During this study the area of the traverses was remapped and the lithology of the sampled rocks reinterpreted. Averages of the chemical analyses are given in Table 2.

The analyses show that the basalts sampled on the western traverse (1a) are low-potassium tholeiites. Basalt in the lower part of the succession contains normative olivine. Some of these samples are nepheline normative, apparently as a result of secondary sodium enrichment rather than primary silica undersaturation. The lower basaltic succession, 4 to 4.5 km thick, extends from the Elzevir Baltholith to Story Lake. This series of rocks is characterized by high total FeO (greater than 10 percent), low SiO_2 (compared to other metavolcanics

TABLE 2 AVERAGE ANALYSES OF METAVOLCANICS (WEIGHT PERCENT). ANALYSES REGULATED VOLATILE-FREE.

	Tholeiitic Suite					Calc-Alkalic Suite			
	Tudor basalt[2]	Plag-phyric basalt[1]	Basaltic andesite[1]	Andesite[1]	Rhyolite[2]	Basalt[2]	Andesite[2] (flow)	Andesite[2] (frag)	Dacite[2]
SiO_2	49.9	50.9	56.3	62.2	73.0	56.7	57.8	60.5	62.9
Al_2O_3	15.2	17.0	16.3	13.5	13.0	16.9	17.4	17.8	17.9
FeO*	12.8	11.7	8.9	9.2	4.1	7.4	6.6	5.3	4.3
MgO	7.3	4.0	3.6	2.1	0.5	6.3	5.3	4.1	3.3
MnO	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
CaO	9.4	7.7	5.8	4.1	1.1	5.5	6.5	4.9	3.9
Na_2O	3.6	4.0	4.3	4.1	4.4	5.0	4.4	4.6	5.2
K_2O	0.2	1.9	2.3	2.5	3.2	0.4	0.9	1.3	1.3
TiO_2	1.2	2.0	1.7	1.3	0.4	1.0	0.6	0.6	0.5
P_2O_5	0.1	0.5	0.4	0.5	0.1	0.3	0.2	0.2	0.2
Total	99.90	99.90	99.80	99.70	99.90	99.60	99.80	99.40	99.60
N**	22	6	4	5	8	4	4	5	3

[1] Ayer (1979)
[2] Sethuraman (1970) and this study
* Total iron calculated as FeO
**Number of samples

in the area), and low K_2O (0.1 to 0.2 percent). MgO varies from 5 to 11 percent and TiO_2 is everywhere greater than 1 percent.

The metavolcanics of the eastern traverse, overlying 1a, include parts of 1b, 2, and 3. They are invariably calc-alkalic, with normative quartz and hypersthene. The upper basalts (1b) are 0.5 to 1 km thick, extending east and northeast from Morgan Lake. Mineralogically these basaltic rocks differ from those in the lower succession in containing more plagioclase and less hornblende. Chemically, compared to the lower basalt, these rocks have lower total iron, higher Al_2O_3 (greater than 16 percent), higher SiO_2, lower MgO and TiO_2, and slightly higher content of K_2O (0.4 percent).

A few layers approach ultramafic composition, and are probably small intrusions. Gabbro dikes are chemically similar to the basalt in the lower part of the succession. Basaltic metasediments, dominantly present in the lower succession, are higher in total iron, CaO, and CO_2 than the flows; they are lower in Al_2O_3 (12 percent) and SiO_2.

TABLE 3 CHEMICAL ANALYSES OF METAVOLCANICS AND ASSOCIATED ROCKS FROM MARBLE LAKE AREA. TOTAL IRON DETERMINED: Fe_2O_3 CALCULATED SO THAT RATIO FERRIC:TOTAL IRON (MOLAR) = 0.24. MAJOR ELEMENTS BY X-RAY FLUORESCENCE WITH TITRIMETRIC DETERMINATION OF FeO; TRACES BY EMISSION SPECTROGRAPHY.

MAP NO.	1	2	3	4	5	6	7	8	9	10
FIELD NO.^{5}	168M	175M	176M	126M	124M	130M	038A	053M	105M	103M
UTM-E: 3^1	2538	2503	2506	2350	2352	2372	2483	2541	2481	2465
UTM-N: 49	7087	7067	7067	6925	6995	6885	7018	7011	6960	6944
Rock Type^2	GRA	UMF	GAB	BAS	BAS	BAS	DAC	AND	RHY	GAB
Structure^3	INT	INT	INT	FLW	FLW	FLW	FLW	TUF	DIK	INT
MAJOR COMPONENTS (in wt. percent)										
SiO_2	68.26	47.93	44.05	51.59	50.65	50.33	62.97	54.25	74.47	48.92
Al_2O_3	14.59	6.70	20.97	15.35	16.34	12.63	15.02	17.84	13.05	13.83
Fe_2O_3	0.67	2.90	1.52	2.91	2.64	3.79	0.82	1.81	0.49	2.27
FeO	2.13	9.26	4.96	9.18	8.49	11.81	2.70	5.78	1.58	7.30
MgO	1.01	17.99	10.55	4.17	3.64	5.23	2.00	3.71	0.16	9.90
MnO	0.05	0.31	0.10	0.17	0.16	0.26	0.05	0.07	0.02	0.16
CaO	2.39	11.01	11.02	6.41	7.16	8.92	4.70	5.90	2.74	10.57
Na_2O	6.34	0.95	1.61	3.31	3.90	3.50	3.92	4.60	6.06	2.70
K_2O	1.32	0.31	1.56	2.71	1.78	0.31	2.57	2.57	0.93	0.64
TiO_2	0.51	0.45	0.09	2.29	2.03	2.57	0.49	1.67	0.24	0.86
P_2O_5	0.12	0.03	0.01	0.59	0.50	0.33	0.24	0.51	0.01	0.11
H_2O	1.55	2.15	3.00	1.31	0.01	0.01	1.64	0.45	0.24	1.74
CO_2	1.04	*	0.56	*	2.69	0.29	2.55	0.83	*	0.97
S	0.05	0.02	0.02	0.02	0.02	0.01	*	0.03	0.02	0.07
TOTAL	100.03	100.01	100.02	100.01	100.01	99.99	99.67	100.02	100.01	100.04
TRACE ELEMENTS (in ppm)										
Ba	242	89	89	357	280	159	713	283	216	132
Nb	15	3	<1	18	13	21	16	7	19	3
Zr	495	34	10	301	226	249	223	216	648	101
Y	60	20	4	64	52	65	14	33	105	29
Sr	171	22	674	219	280	131	295	517	94	327
Rb	42	20	32	73	67	4	72	84	20	12
Zn	24	119	47	81	95	160	34	62	14	126
Cu	3	10	5	1	6	51	47	3	23	33
Ni	15	370	216	52	53	31	16	68	11	87
Cr	3	1417	100	53	52	37	15	196	8	603
V	**	**	**	**	**	**	**	**	**	**

continued ....

* Not detected
**Not determined

TABLE 3 continued ...

MAP NO.	11^4	11^4	12	13	14	15	16	17	18	19	20
FIELD NO.^{5}	064M	064M	006M	021M	027M	079M	048M	041M	193M	205M	206M
UTM-E: 3^1	2498	2498	2780	2844	2900	2932	2562	2661	2702	2877	2887
UTM-N: 49	6875	6875	6848	6892	6993	7049	6673	6696	6767	6671	6649
Rock Type^2	GAB	GAB	ESD	RHY	GRA	RHY	ESD	GAB	ESD	DAC	DAC
Structure^3	INT	INT		TUF	INT	FLW?		DIK		TUF	TUF
MAJOR COMPONENTS (in wt. percent)											
SiO_2	48.05	48.00	52.88	72.17	80.11	74.19	62.60	48.78	53.71	61.41	57.83
Al_2O_3	17.65	17.45	2.29	13.31	0.11	13.21	11.03	13.16	15.86	15.41	13.26
Fe_2O_3	2.35	2.42	4.09	0.87	1.30	0.61	2.58	3.25	2.52	0.64	1.28
FeO	7.50	7.69	13.10	2.77	4.12	1.91	8.25	10.26	8.04	2.23	4.16
MgO	6.29	6.88	6.20	0.31	0.83	0.37	5.07	11.07	4.87	1.27	3.41
MnO	0.18	0.16	0.28	0.19	0.04	0.05	0.11	0.23	0.10	0.03	0.08
CaO	11.11	11.49	11.32	1.71	*	0.07	2.56	9.12	4.90	2.99	10.00
Na_2O	2.86	2.82	3.64	4.12	5.09	3.10	0.27	1.23	1.72	3.21	3.75
K_2O	0.69	0.73	0.51	3.06	6.65	6.09	4.56	0.35	3.58	2.95	2.21
TiO_2	1.03	1.01	2.61	0.28	0.43	0.31	0.75	1.09	1.96	0.40	0.55
P_2O_5	0.13	0.10	0.27	*	*	0.02	0.15	0.09	0.69	0.21	0.20
H_2O	1.15	1.23	0.07	0.19	0.64	0.06	1.49	0.61	1.38	0.13	0.43
CO_2	1.00	*	2.74	1.01	0.67	*	0.53	0.72	0.65	9.12	2.81
S	0.04	0.04	0.01	0.01	0.03	0.01	0.11	0.08	0.04	0.01	0.05
TOTAL	100.03	100.02	100.01	100.00	100.02	100.00	100.06	100.04	100.02	100.01	100.02
TRACE ELEMENTS (in ppm)											
Ba	155	141	161	671	974	782	221	48	305	478	375
Nb	2	1	8	20	18	19	17	1	16	11	9
Zr	58	70	143	826	717	737	491	68	280	186	147
Y	26	24	51	133	108	69	73	36	55	11	12
Sr	277	267	280	126	67	32	70	47	140	358	427
Rb	18	17	9	79	118	154	145	6	91	93	75
Zn	109	117	147	25	64	34	64	189	76	64	74
Cu	14	15	25	1	13	1	563	117	332	5	37
Ni	14	15	13	11	7	10	18	159	68	22	85
Cr	104	97	12	9	1	<1	<1	478	53	112	215
V	**	**	**	**	**	**	**	**	**	**	**

* Not detected

**Not determined

continued ....

TABLE 3 continued ...

MAP NO.	21	22	23	24	25	26	27	28	29	30
FIELD NO.[5]	157M	153M	209M	151M	181M	141M	143M	144M	160M	353M
UTM-E: 3[1]	2950	2887	2887	2917	2889	2936	2974	3004	3007	3034
UTM-N: 49	6648	6618	6619	6604	6579	6547	6575	6600	6628	6370
Rock Type[2]	BAS	DAC	PPB	PPB	PPB?	GAB	DAC	PPB	DAC	GAB
Structure[3]	FLW?	INT	FLW	FLW	FLW	INT	INT?	FLW	INT	INT
MAJOR COMPONENTS (in wt. percent)										
SiO_2	51.63	65.50	52.90	46.38	51.67	51.64	64.87	54.49	64.92	57.41
Al_2O_3	13.32	17.65	16.83	15.44	15.69	13.83	15.13	15.94	15.66	11.57
Fe_2O_3	1.86	0.59	2.07	2.30	2.03	2.94	0.77	2.30	0.95	3.20
FeO	5.95	1.89	6.66	7.46	6.58	9.43	2.53	7.26	3.04	10.00
MgO	9.05	1.49	3.43	7.36	6.46	5.78	1.68	4.21	2.08	5.98
MnO	0.14	0.03	0.10	0.16	0.09	0.18	0.05	0.14	0.05	0.25
CaO	9.45	3.39	6.69	14.61	8.22	9.04	2.25	8.78	3.45	7.87
Na_2O	3.13	3.33	4.02	2.21	3.00	2.96	7.03	4.00	5.45	2.08
K_2O	1.04	3.69	2.40	0.06	1.79	0.01	0.28	0.41	1.67	0.15
TiO_2	1.22	0.54	1.60	0.70	0.82	1.36	0.35	1.29	0.54	0.95
P_2O_5	0.95	0.17	0.43	0.10	0.24	0.18	0.24	0.41	0.32	0.16
H_2O	0.43	1.08	0.09	1.23	1.87	1.20	3.71	0.25	0.49	0.24
CO_2	1.83	0.65	2.75	1.98	1.52	1.39	1.12	0.51	1.36	0.10
S	0.01	0.01	0.05	0.03	0.05	0.14	0.01	0.01	0.04	0.05
TOTAL	100.01	100.01	100.02	100.02	100.03	100.08	100.02	100.00	100.02	100.01
TRACE ELEMENTS (in ppm)										
Ba	589	528	369	76	519	65	81	185	486	92
Nb	17	10	9	2	7	5	8	6	6	4
Zr	332	169	223	44	156	111	200	193	190	106
Y	32	10	35	21	17	44	14	34	14	35
Sr	600	287	485	398	285	171	288	693	252	97
Rb	25	97	68	2	46	1	12	10	47	3
Zn	95	47	93	75	111	113	52	107	72	158
Cu	26	14	38	145	3	222	3	55	7	20
Ni	106	42	49	112	149	46	25	27	53	72
Cr	357	164	106	270	310	51	37	40	96	95
V	**	**	**	**	**	**	**	**	**	**

* Not detected

**Not determined

continued ....

TABLE 3 continued ...

MAP NO.	31	32	33	34	35	36	37	38	39	40
FIELD NO.^{5}	7-28	7-58	7-29	7-57	7-56	7-30	7-55	7-31	7-54	7-53
UTM-E: 3^1	2415	2426	2440	2450	2463	2475	2482	2495	2502	2519
UTM-N: 49	6155	6172	6185	6193	6204	6202	6207	6208	6230	6243
Rock Type^2	BAS	BAS	BAS	BAS	BAS	BAS	CSD?	BAS	BAS	BAS
Structure^3	FLW	FLW	FLW	FLW	FLW	FLW		FLW	BRE	FLW
MAJOR COMPONENTS (in wt. percent)										
SiO^2	46.50	47.9	49.2	47.5	48.2	47.9	48.6	47.0	51.2	45.0
Al_2O_3	13.50	14.1	14.0	13.7	13.7	14.6	17.1	14.6	15.2	12.2
Fe_2O_3	1.4	1.8	1.9	2.7	1.9	1.7	1.8	1.2	1.5	1.5
FeO	10.00	9.3	12.7	12.6	11.5	9.5	13.8	10.7	10.2	7.3
MgO	9.20	9.7	7.8	7.5	8.0	8.6	7.0	7.9	10.8	9.9
MnO	0.18	0.16	0.24	0.23	0.23	0.20	0.24	0.20	0.22	0.14
CaO	11.40	9.6	10.2	10.5	10.0	10.9	11.2	8.8	8.0	10.3
Na_2O	3.2	3.3	2.8	3.1	3.8	3.5	1.9	3.8	3.7	3.3
K_2O	0.4	0.2	0.1	0.2	0.2	0.3	0.2	0.1	0.1	0.2
TiO_2	1.10	0.66	1.01	1.30	1.37	0.63	0.50	0.74	0.96	1.48
P_2O_5	0.10	0.03	0.12	0.08	0.07	0.04	0.15	0.06	0.05	0.02
H_2O	1.4	2.1	1.6	1.5	1.4	1.6	1.9	0.6	2.1	1.5
CO_2	0.4	1.6	0.1	0.7	0.6	0.6	4.4	0.4	0.1	<0.1
S	**	**	**	**	**	**	**	**	**	**
TOTAL	98.78	100.45	101.77	101.61	100.97	100.07	108.49	96.10	104.13	92.94
TRACE ELEMENTS (in ppm)										
Ba	43	33	15	27	15	85	16	16	17	21
Nb	**	**	**	**	**	**	**	**	**	**
Zr	110	57	89	140	100	40	35	60	76	170
Y	**	**	**	**	**	**	**	**	**	**
Sr	130	82	53	64	54	69	120	55	78	75
Rb	**	**	**	**	**	**	**	**	**	**
Zn	**	**	**	**	**	**	**	**	**	**
Cu	140	330	180	110	240	*	120	70	80	29
Ni	140	84	59	44	70	100	130	72	73	52
Cr	350	210	120	630	110	490	300	350	190	99
V	520	400	620	560	400	430	340	440	440	650

* Not detected
**Not determined

continued ....

TABLE 3 continued ...

MAP NO.	41	42	43	44	45	46	47	48	49	50
FIELD NO.[5]	7-52	7-51	7-32	7-50	7-49	7-33	7-47	7-46	7-48	7-45
UTM-E: 3[1]	2532	2540	2552	2555	2569	2584	2592	2600	2612	2625
UTM-N: 49	6245	6262	6202	6252	6263	6225	6286	6300	6297	6312
Rock Type[2]	GAB	BAS	BAS	CSD	BAS	BAS	BAS	GAB	UMF	ESD
Structure[3]	INT	FLW	FLW		FLW	FLW	FLW	INT	INT	
MAJOR COMPONENTS (in wt. percent)										
SiO_2	47.0	45.2	49.4	66.1	47.1	47.1	46.9	49.7	42.0	47.2
Al_2O_3	12.6	13.2	15.4	3.9	13.0	11.3	13.1	15.2	14.8	17.9
Fe_2O_3	1.8	1.9	1.2	7.1	1.2	0.9	2.0	1.4	1.8	1.3
FeO	12.0	10.4	9.5	16.7	11.5	10.4	11.1	10.3	13.2	6.2
MgO	8.4	7.4	9.7	2.7	8.1	9.2	9.4	8.1	9.4	11.2
MnO	0.22	0.18	0.18	0.53	0.23	0.21	0.19	0.20	0.22	0.12
CaO	9.4	11.7	9.0	1.7	9.6	8.0	9.9	9.9	12.9	11.4
Na_2O	2.9	3.2	3.6	0.1	3.4	4.0	2.6	3.5	1.8	2.6
K_2O	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3
TiO_2	1.17	0.80	0.61	0.29	0.69	0.74	0.85	0.74	0.89	0.20
P_2O_5	0.09	0.05	0.04	0.13	0.04	0.05	0.05	0.04	0.05	0.08
H_2O	1.7	1.6	2.0	1.2	1.4	2.5	1.8	1.4	1.8	2.5
CO_2	5.0	6.2	0.1	1.3	6.1	8.1	2.7	0.6	1.0	0.5
S	**	**	**	**	**	**	**	**	**	**
TOTAL	103.08	102.03	100.83	101.85	102.46	102.60	100.69	101.18	100.16	101.50
TRACE ELEMENTS (in ppm)										
Ba	26	37	26	12	19	15	16	18	24	59
Nb	**	**	**	**	**	**	**	**	**	**
Zr	120	64	51	180	61	48	72	45	88	*
Y	**	**	**	**	**	**	**	**	**	**
Sr	93	62	150	*	81	81	73	64	58	100
Rb	**	**	**	**	**	**	**	**	**	**
Zn	**	**	**	**	**	**	**	**	**	**
Cu	130	210	10	190	91	39	100	140	550	160
Ni	49	71	86	77	69	55	64	84	76	170
Cr	120	140	260	<20	96	180	110	170	270	600
V	530	370	410	89	430	420	460	430	580	210

* Not detected
**Not determined

continued ....

TABLE 3 continued ...

MAP NO.	51	52	53	54	55	56	57	58	59	60
FIELD NO.[5]	7-44	7-43	7-42	7-41	7-40	7-39	7-38	7-37	7-36	7-35
UTM-E: 3[1]	2636	2648	2660	2670	2683	2697	2705	2718	2730	2744
UTM-N: 49	6315	6325	6340	6345	6349	6364	6375	6387	6401	6402
Rock Type[2]	BAS	BAS	BAS	GAB	BAS	BAS	ESD	BAS	BAS	GAB
Structure[3]	FLW	FLW	TUF	INT	FLW	FLW		FLW	FLW	INT
MAJOR COMPONENTS (in wt. percent)										
SiO_2	52.0	51.4	47.8	46.8	49.5	50.2	44.7	50.0	47.8	50.8
Al_2O_3	12.7	15.1	14.2	14.0	15.8	13.4	21.3	14.9	15.8	16.7
Fe_2O_3	1.8	1.8	1.8	1.9	2.4	2.6	<0.1	2.2	3.9	5.1
FeO	11 4	12.0	9.9	10.2	9.4	13.0	4.0	9.6	7.2	7.3
MgO	7.4	3.9	6.4	9.0	5.2	7.2	7.8	7.0	5.9	6.2
MnO	0.21	0.22	0.15	0.19	0.18	0.24	0.07	0.17	0.17	0.20
CaO	10.0	7.3	10.7	10.2	11.0	8.9	12.1	8.6	8.9	7.0
Na_2O	2.1	4.7	3.7	2.7	3.6	2.4	3.7	4.1	4.6	4.4
K_2O	0.1	0.1	0.4	0.2	0.2	0.4	0.6	0.1	0.2	0.2
TiO_2	1.06	1.38	2.02	1.07	1.46	2.09	0.19	0.99	0.74	0.88
P_2O_5	0.09	0.35	0.19	0.09	0.19	0.12	<0.02	0.14	0.18	0.23
H_2O	1.6	1.2	1.2	2.2	1.5	1.8	2.3	1.4	1.0	1.4
CO_2	0.7	2.2	2.5	2.8	1.3	1.1	2.0	0.7	1.4	0.5
S	**	**	**	**	**	**	**	**	**	**
TOTAL	101.16	101.65	100.96	101.35	101.73	103.45	98.88	99.90	97.79	100.91
TRACE ELEMENTS (in ppm)										
Ba	22	38	89	16	44	33	71	14	51	350
Nb	**	**	**	**	**	**	**	**	**	**
Zr	150	180	300	120	250	250	*	120	94	90
Y	**	**	**	**	**	**	**	**	**	**
Sr	100	210	160	130	250	110	240	220	390	62
Rb	**	**	**	**	**	**	**	**	**	**
Zn	**	**	**	**	**	**	**	**	**	**
Cu	110	56	190	130	36	62	51	19	160	110
Ni	59	*	62	77	27	35	51	53	43	27
Cr	100	*	140	27	30	48	180	160	110	<20
V	630	340	700	500	500	770	170	510	490	450

* Not detected

**Not determined

continued ....

TABLE 3 continued ...

MAP NO.	61	62	63	64	65	66	67	68	69	70
FIELD NO.[5]	7-34	342M	346M	BL7-27	7-26	7-25	7-24	7-23	7-22	7-21
UTM-E: 3[1]	2754	3187	3143	3160	3175	3190	3194	3205	3205	3215
UTM-N: 49	6283	6510	6365	6220	6224	6223	6237	6236	6256	6265
Rock Type[2]	BAS	AND	AND	BAS	DAC	BAS	BAS	BAS	PPB	PPB
Structure[3]	FLW	TUF	FLW	FLW	DIK	FLW	FLW?	FLW	FLW	FLW
MAJOR COMPONENTS (in wt. percent)										
SiO_2	50.3	57.03	57.83	52.9	62.8	47.7	45.4	48.8	55.6	55.0
Al_2O_3	15.4	16.61	15.84	15.0	17.1	13.5	17.1	14.4	16.3	17.1
Fe_2O_3	2.9	1.53	1.57	1.5	0.1	3.4	1.5	4.1	1.9	1.4
FeO	11.7	4.87	5.04	10.9	3.2	11.7	6.7	11.3	6.4	5.3
MgO	5.6	5.92	6.06	5.9	1.7	6.0	9.1	5.3	6.2	6.3
MnO	0.23	0.06	0.08	0.19	0.04	0.24	0.13	0.22	0.11	0.11
CaO	8.5	5.37	4.58	7.4	3.4	8.5	9.8	7.3	5.4	5.5
Na_2O	3.9	3.38	5.12	3.7	4.5	4.0	4.4	4.7	4.7	5.1
K_2O	0.2	2.46	0.36	0.1	2.9	0.1	0.2	0.9	0.8	<0.1
TiO_2	1.17	0.68	0.78	2.04	0.45	2.29	0.65	2.68	1.00	1.00
P_2O_5	0.12	0.19	0.27	0.34	0.16	0.33	0.08	0.23	0.24	0.29
H_2O	1.3	0.64	2.09	1.3	1.0	1.2	1.9	0.7	1.1	1.3
CO_2	0.4	1.25	0.02	0.4	1.3	1.8	2.6	0.9	0.1	0.2
S	**	0.03	0.73	**	**	**	**	**	**	**
TOTAL	101.72	100.02	100.37	101.67	98.65	100.76	99.56	101.53	99.85	98.70
TRACE ELEMENTS (in ppm)										
Ba	28	427	143	82	440	34	27	110	300	37
Nb	**	6	4	**	**	**	**	**	**	**
Zr	120	139	153	200	190	230	580	330	200	200
Y	**	12	21	**	**	**	**	**	**	**
Sr	160	243	535	160	160	240	180	120	270	350
Rb	**	64	9	**	**	**	**	**	**	**
Zn	**	137	61	**	**	**	**	**	**	**
Cu	58	8	29	17	*	46	63	89	43	96
Ni	<20	78	81	*	*	30	69	*	41	35
Cr	37	266	253	*	<20	47	170	<20	140	85
V	620	**	**	600	51	590	310	670	230	220

* Not detected
**Not determined

continued ....

TABLE 3 continued ...

MAP NO.	71	72	73	74	75	76	77	78	79	80
FIELD NO.[5]	7-20	7-19	7-18	7-17	7-16	7-15	7-14	7-13	7-12	7-11
UTM-E: 3[1]	3225	3240	3245	3252	3259	3266	3277	3282	3290	3303
UTM-N: 49	6272	6282	6289	6296	6311	6315	6323	6331	6346	6348
Rock Type[2]	DAC	PPB	HAB	HAB	PPB	DAC	DAC	DAC	PPB	DAC
Structure[3]	BRE	FLW	BRE	BRE	FLW	INT?	BRE	BRE	FLW	INT?
MAJOR COMPONENTS (in wt. percent)										
SiO_2	62.0	55.2	56.7	54.6	57.8	64.6	62.1	62.4	54.1	62.6
Al_2O_3	17.1	17.7	16.9	17.5	16.9	15.8	17.5	16.6	16.5	16.5
Fe_2O_3	1.5	1.7	1.9	0.8	1.1	0.4	0.8	1.3	1.7	0.6
FeO	2.8	5.1	4.5	5.9	5.9	2.9	3.6	3.6	5.0	3.6
MgO	3.5	5.0	4.3	5.8	5.8	1.2	2.0	2.8	4.8	3.8
MnO	0.06	0.09	0.09	0.11	0.10	0.04	0.06	0.08	0.11	0.04
CaO	4.2	6.1	6.8	6.5	7.5	4.0	4.3	4.8	7.1	2.3
Na_2O	5.4	4.2	4.5	4.1	4.0	3.4	3.9	4.0	4.8	4.8
K_2O	0.8	1.2	0.7	1.2	0.5	3.0	2.5	1.9	1.2	1.6
TiO_2	0.50	0.70	0.62	0.71	0.63	0.43	0.47	0.57	0.76	0.47
P_2O_5	0.14	0.23	0.37	0.26	0.14	0.13	0.22	0.22	0.38	0.13
H_2O	0.7	1.1	0.8	1.1	1.0	1.0	1.1	0.9	0.9	1.0
CO_2	0.1	0.7	0.4	0.1	0.4	1.4	1.3	0.5	0.9	0.2
S	**	**	**	**	**	**	**	**	**	**
TOTAL	98.80	99.02	98.58	98.68	101.77	98.30	99.85	99.67	98.25	97.64
TRACE ELEMENTS (in ppm)										
Ba	210	330	230	290	72	410	410	460	530	250
Nb	**	**	**	**	**	**	**	**	**	**
Zr	120	130	190	150	100	190	190	190	290	130
Y	**	**	**	**	**	**	**	**	**	**
Sr	370	480	800	380	430	180	320	460	450	250
Rb	**	**	**	**	**	**	**	**	**	**
Zn	**	**	**	**	**	**	**	**	**	**
Cu	50	30	37	48	93	32	24	46	34	*
Ni	30	22	46	69	81	*	*	23	45	<20
Cr	<20	34	84	15	16	*	*	40	85	<20
V	110	190	120	170	210	46	57	120	200	77

* Not detected
**Not determined

continued ....

TABLE 3 continued ...

MAP NO.	81	82	83	84	85	86	87	88	89	90
FIELD NO.[5]	7-10	7-9	7-8	7-7	7-6	7-5	7-4	7-3	7-2	7-1
UTM-E: 3[1]	3310	3315	3312	3312	3315	3330	3340	3353	3346	3346
UTM-N: 49	6360	6375	6383	6392	6406	6420	6433	6442	6450	6459
Rock Type[2]	DAC	HAB	HAB	DAC	AND	AND	AND	AND	AND	AND
Structure[3]	INT?	BRE	FLW	BRE	FLW	BRE	BRE	FLW	BRE	BRE
MAJOR COMPONENTS (in wt. percent)										
SiO_2	64.2	53.5	53.5	61.3	59.8	59.8	60.5	59.4	58.9	58.2
Al_2O_3	16.8	18.6	17.3	18.0	15.8	17.0	16.4	16.6	18.4	17.7
Fe_2O_3	0.4	2.1	1.9	0.8	1.0	1.5	1.7	1.4	1.9	2.3
FeO	3.3	4.2	5.9	4.0	4.4	3.8	4.0	3.6	3.8	2.9
MgO	3.1	4.8	7.5	3.7	5.0	3.7	4.8	3.1	4.8	3.7
MnO	0.05	0.08	0.11	0.05	0.08	0.06	0.06	0.06	0.06	0.06
CaO	2.4	7.0	8.5	3.1	4.7	4.2	5.8	4.7	5.2	5.1
Na_2O	4.7	4.7	3.6	5.8	5.0	4.8	4.0	4.5	4.1	4.7
K_2O	1.8	1.6	0.5	0.9	0.4	1.0	0.5	1.4	0.9	1.3
TiO_2	0.45	0.72	0.74	0.63	0.63	0.60	0.60	0.59	0.63	0.68
P_2O_5	0.13	0.33	0.20	0.20	0.18	0.20	0.19	0.21	0.19	0.22
H_2O	1.0	1.7	1.5	1.0	1.1	1.1	1.0	1.0	1.4	1.1
CO_2	0.5	1.5	0.1	0.4	0.1	0.5	0.1	1.4	0.1	0.7
S	**	**	**	**	**	**	**	**	**	**
TOTAL	98.83	100.83	101.35	99.88	98.19	98.26	99.65	97.96	100.38	98.66
TRACE ELEMENTS (in ppm)										
Ba	300	330	130	170	84	180	210	230	160	210
Nb	**	**	**	**	**	**	**	**	**	**
Zr	130	180	140	94	180	130	170	210	130	140
Y	**	**	**	**	**	**	**	**	**	**
Sr	210	340	350	330	400	240	420	310	380	220
Rb	**	**	**	**	**	**	**	**	**	**
Zn	**	**	**	**	**	**	**	**	**	**
Cu	38	36	20	34	51	10	28	*	22	36
Ni	<20	36	75	<20	47	32	40	<20	38	45
Cr	<20	49	210	<20	100	61	110	31	84	84
V	67	160	280	85	150	120	160	110	160	140

* Not detected
**Not determined

continued ....

TABLE 3 continued ...

MAP NO.	91	92	93	94	95	96	97	98	99	100
FIELD NO.[5]	247M	338M	366M	268M	269M	271M	272M	273M	274M	332M
UTM-E: 3[1]	3277	3372	3440	3515	3490	3482	3477	3467	3460	3535
UTM-N: 49	6202	6345	6245	6254	6307	6343	6380	6382	6402	6375
Rock Type[2]	BAS	DAC	BAS	BAS	AND	CSD	DAC	AND	DAC	AND
Structure[3]	FLW	INT	FLW	FLW	FLW		INT	DIK	DIK	TUF
MAJOR COMPONENTS (in wt. percent)										
SiO_2	45.86	62.66	47.46	48.53	60.53	64.97	67.73	56.21	63.34	50.77
Al_2O_3	15.44	14.29	17.02	14.16	15.68	10.28	14.32	20.27	15.52	14.57
Fe_2O_3	2.39	0.86	1.89	1.93	1.22	2.49	1.00	1.15	1.18	1.42
FeO	7.66	2.86	6.03	6.34	3.91	7.80	3.17	3.66	3.78	6.52
MgO	9.87	1.50	9.92	7.14	4.15	2.42	1.43	2.36	2.37	5.70
MnO	0.14	0.09	0.13	0.19	0.10	0.10	0.09	0.04	0.10	0.12
CaO	13.11	6.32	13.84	14.31	6.70	6.54	3.59	5.54	4.03	8.11
Na_2O	1.58	3.18	1.33	2.44	2.36	1.41	4.84	5.82	3.46	2.60
K_2O	0.21	3.01	0.32	0.12	2.56	1.68	1.88	2.36	2.80	3.80
TiO_2	0.85	0.61	0.45	0.66	0.56	1.79	0.37	0.68	0.82	0.89
P_2O_5	0.06	0.24	0.07	0.12	0.16	0.27	0.20	0.31	0.44	0.50
H_2O	1.72	1.52	1.10	1.59	0.50	0.01	0.33	0.42	1.03	1.35
CO_2	0.92	2.79	0.43	2.44	1.56	0.00	1.04	1.16	1.01	3.65
S	0.39	0.12	0.02	0.07	0.03	0.49	0.05	0.03	0.21	0.03
TOTAL	100.20	100.05	100.01	100.04	100.02	100.25	100.04	100.01	100.09	100.03
TRACE ELEMENTS (in ppm)										
Ba	48	547	60	66	338	220	538	357	595	607
Nb	2	10	1	3	6	12	10	5	14	7
Zr	61	182	35	44	127	224	222	256	267	213
Y	28	14	15	20	16	55	16	15	17	15
Sr	154	371	283	346	315	105	311	453	450	276
Rb	5	64	8	2	50	58	63	54	71	99
Zn	95	81	53	73	189	44	90	67	92	64
Cu	187	23	76	5	8	1510	34	9	23	9
Ni	106	25	161	83	59	18	13	30	21	94
Cr	358	59	526	293	140	16	13	51	32	170
V	**	**	**	**	**	**	**	**	**	**

* Not detected

**Not determined

continued ....

TABLE 3 continued ...

MAP NO.	101	102	103	104	105	106	107	108	109
FIELD NO.[5]	330M	325M	322M	310M	313M	306M	283M	282M	278M
UTM-E: 3[1]	3548	3606	3632	3725	3729	3801	3850	3878	3943
UTM-N: 49	6415	6547	6615	6749	6694	6690	6840	6820	6855
Rock Type[2]	AND	AND	AND	DAC	DAC	AND	GAB	DAC	AND
Structure[3]	FLW	TUF	TUF	DIK	TUF	TUF	INT	FLW	TUF
MAJOR COMPONENTS (in wt. percent)									
SiO_2	61.49	57.24	49.71	65.66	66.82	48.89	40.54	64.59	58.15
Al_2O_3	16.05	17.11	14.65	15.59	15.63	12.15	13.36	14.82	15.13
Fe_2O_3	1.40	1.69	1.99	0.77	0.85	1.94	1.90	0.82	1.70
FeO	4.42	5.35	6.59	2.46	2.59	6.52	7.34	2.68	5.38
MgO	3.27	5.37	5.77	1.47	1.93	5.14	6.18	1.67	6.62
MnO	0.07	0.21	0.12	0.06	0.05	0.17	0.11	0.07	0.08
CaO	4.44	4.17	8.33	3.72	3.58	13.54	10.09	5.21	6.17
Na_2O	1.83	3.33	2.42	5.18	4.71	2.72	1.86	4.11	2.69
K_2O	4.39	2.94	3.85	2.09	2.58	1.12	0.15	1.62	2.04
TiO_2	1.00	1.03	0.90	0.55	0.61	0.78	0.74	0.54	1.02
P_2O_5	0.54	0.67	0.51	0.22	0.22	0.34	0.25	0.27	0.37
H_2O	1.09	0.83	2.37	0.01	0.01	1.09	1.84	1.27	0.17
CO_2	*	*	2.76	2.20	0.42	5.43	15.63	2.31	0.47
S	0.02	0.09	0.05	0.03	0.02	0.38	0.02	0.02	0.03
TOTAL	100.01	100.03	100.02	100.01	100.02	100.21	100.01	100.00	100.02
TRACE ELEMENTS (in ppm)									
Ba	505	355	569	434	1626	218	84	433	464
Nb	13	7	8	9	9	3	5	12	5
Zr	330	172	216	189	185	120	119	203	178
Y	20	17	13	8	13	18	21	13	42
Sr	248	439	261	296	329	508	969	387	439
Rb	87	62	101	49	54	23	3	36	44
Zn	66	94	65	16	47	44	104	36	136
Cu	38	89	7	7	104	3	15	7	12
Ni	40	34	101	29	30	91	134	18	120
Cr	28	28	306	49	52	258	266	32	1085
V	**	**	**	**	**	**	**	**	**

* Not detected

**Not determined

Footnotes:

[1] Universal Transverse Mercator Grid reference, Zone 18.
Eastings preceded by 3; Northings by 49.
Grid Reference appears on following map.

Canada Department of Energy, Mines and Resources
1978: Mazinaw Lake; Dept. Energy, Mines and Resources, Surveys and Mapping Branch, Map 31C14, 4th edition, scale 1:50 000. Information current as of 1976.

[2] Rock type code, based on megascopic and chemical data (NB all rocks metamorphosed):
BAS: basalt
HAB: high-alumina basalt
PPB: plagioclase-phyric basalt
AND: andesite
DAC: dacite
RHY: rhyolite
UMF: ultramafic
GAB: gabbro, diorite
GRA: granodiorite, granite
ESD: epiclastic sedimentary
CSD: chemical sedimentary

[3] Structure code, based on field and textural data:
FLW: flow
TUF: tuff, lapilla-tuff
BRE: breccia, tuff-breccia
DIK: dike, sill
INT: small intrusion

[4] Duplicate analysis of same sample

[5] Samples suffixed by 'M' or 'A' collected in 1976, and analyzed by Dr. J. G. Holland, Durham University, mainly by X-Ray fluorescence methods. Samples prefixed '7' (full designation is BL7-XXX) collected by J. M. Moore, Jr., K. Sethuraman, and W.R.A. Baragar, 1967, and analyzed by the Geological Survey of Canada.

* Not detected
**Not determined

Andesite flow and pyroclastic rocks are chemically similar in that they both exhibit high Al_2O_3 (greater than 15 percent), and lower total iron (less than 7 percent), MgO (less than 6 percent), CaO (less than 7 percent), and TiO_2 than rocks of the upper basalt succession. Flows and pyroclastic rocks differ in abundance of SiO_2, with pyroclastic rocks exhibiting higher values. Andesites contain from 0.4 to 1 percent K_2O, higher than found in either the lower or upper basalt succession.

Dacites are silica-rich rocks (greater than 61 percent) with relatively low MgO, CaO, and FeO contents. Na_2O is always greater than 4 percent and K_2O varies from 1 to 3 percent.

During the present mapping, a new suite of metavolcanics and associated rocks was sampled, in order to make the analyses more representative, geographically and stratigraphically. These analyses are reproduced in Table 3, and their averages included in Table 2. They are mainly from the upper, calc-alkalic metavolcanics and their trends are in accord with those previously reported. Whereas no rocks more siliceous than dacite are indicated in the central and eastern parts of the map area, samples from the vicinity of Lower Mazinaw Lake are true rhyolite, with over 70 percent SiO_2. A more detailed chemical study by J.A. Ayer (1979) has shown that the succession around the south end of Lower Mazinaw Lake is a tholeiitic basalt-andesite-rhyolite complex, chemically distinct from the calc-alkalic basalt-andesite-dacite succession to the southeast. Average analyses from Ayer's study, which include data from the area adjacent to the north of the map area, are included in Table 2.

EARLY METASEDIMENTS

Clastic Mafic Metasediments (Map Unit 5)

Interlayered with the basalts mainly near the middle of the succession, are bedded to massive basaltic metasediments. The fine- to medium-grained, dark grey rocks are composed of amphibole, calcite, chlorite, epidote, and plagioclase with lesser amounts of talc, magnetite, hematite, pyrite, pyrrhotite, arsenopyrite, biotite, and quartz. Basalt clasts are common, colour layering occurs locally, and garnet porphyroblasts are abundant but not ubiquitous. Individual beds range from 5 cm to 4 m in thickness; the thickest uninterrupted section reaches 0.2 km. Associated with these metasediments are numerous small gold prospects.

Clastic Intermediate to Felsic Metasediments (Map Unit 6)

Clastic metasediments, similar in mineralogy to andesite and dacite, form a relatively thick succession south of Lower Mazinaw Lake, and are interlayered with flow and pyroclastic rocks south of Nervine and east of Pringle Lakes, respectively.

OGS 10 627

Photo 6–Slump breccia of dolomite marble clasts in wacke matrix (6) near Highway 506, 1.5 km east of Highway 41.

Beds in these metasediments are up to several metres thick, although centimetre-scale layering is locally present. They are fine to medium grained, and are gradational into mineralogically similar rocks which contain abundant andesite and basalt clasts (tuffaceous wacke), and in at least one locality dolomite clasts (Photo 6). Locally these rocks exhibit graded bedding and soft-sediment deformational features, sufficiently well preserved for top determination.

Sulphide-Graphite Metasediments (Map Unit 7)

Black, fine-grained sulphide-bearing metasediments occur as interflow layers (too thin to appear on the map) in the basalt (1a) notably south of the Harlowe road, and also several mappable lenses at the top of the volcanic rocks east of Bishop Corners. Here, they are thinly laminated, intensely folded, locally weathered to gossan and poorly exposed. Quartz, sodic plagioclase, biotite, and muscovite are the principal silicates; pyrite and pyrrhotite constitute up to 10 percent. Some layers are sufficiently high in silica to be chert.


OGS 10 628

Photo 7–Thin-layered dolomite marble and wacke (8) 2 km north of Cloyne. D_1 minor folds plunge steeply southwest; axial surfaces dip steeply southeast.

Carbonate and Clastic Metasediments (Map Unit 8)

Interlayered with the volcaniclastic metasediments east of Cloyne are lenses and beds of dolomite and calcite marbles, sandy dolostone, dolomitic siltstone and wacke (Photo 7); the whole assemblage constitutes unit 8. Dolomite and calcite marble beds vary from 5 cm to 15 m thick and are typically gradational into siltstone and wacke.

Sandy dolostone, dolomitic siltstone, and wacke constitute a marker horizon that can be traced south from Lower Mazinaw Lake for a distance of 7 km. This unit is important, for in areas of poor exposure it outlines approximately the shape of the folds.

Primary sedimentary features can be recognized in these rocks, including size and colour grading, flames, rip-ups, and other soft-sediment deformational features. In general the rocks are composed of calcite and dolomite with lesser amounts of hornblende, quartz, muscovite, chlorite, garnet, and staurolite. In places large, irregular grains of quartz and plagioclase (2 mm to 1 cm across) are set in a finer carbonate-quartz-plagioclase-biotite matrix. These grains are elongate parallel to the primary layering and plagioclase exhibits relict twins which abut against broken grain boundaries.

Carbonate Metasediments (Map Unit 9)

Carbonate metasediments are intercalated with, and unconformably overlie, the metavolcanic succession. They are the most abundant rock type in Barrie Township, whereas only minor amounts are exposed in Anglesea and the northern parts of Kaladar and Kennebec Townships. These metasediments consist of massive or layered white, grey, bluish grey, greyish buff, and buff, fine- to coarse-grained marble. Varieties dominated by dolomite (9a) and calcite (9b) can be distinguished. Units 9c and 9d are calcite-dolomite marbles with, respectively, an abundance of small mafic to intermediate intrusions, and numerous wacke beds.

A relatively thick, massive uniform, fine-grained dolomitic marble (9a) lies between basalts (1a and 1b) east and northeast of Bishop Corners. To the north, it gives way laterally to interlayered metasediments, dolomitic siltstone, and wacke (6, 8); southward it tapers out. It is fine grained, locally colour-layered and consists almost entirely of dolomite with accessory calcite, quartz, muscovite, epidote, and scapolite. There are a few layers of carbonate breccia comprising dolomite clasts 2 mm to 50 mm across, angular to subrounded, set in a calcite matrix and constituting 15 to 80 percent of the rock.

It was earlier suggested, despite lack of conclusive evidence, that the volcanic succession is unbroken by sedimentation and that this dolostone and its lateral equivalents were faulted into position (Sethuraman and Moore 1973). In the present survey it has been confirmed that all reliable top criteria to either side indicate north- to east-facing, and that the volcanic rocks above and below are different. It is thus concluded that the carbonate is autochthonous, and a deeper-water facies equivalent of the clastic metasediments to the north.

Carbonate rocks south and east of Harlowe also alternate with metavolcanic units. It is possible that all this marble lies above the metavolcanics, and that folding and faulting account for their repetition. The structure in this area is not sufficiently well established to exclude primary intercalation, however.

Most of the marble lies with minor unconformity on top of the metavolcanics. It includes both massive dolostone and layered, calcite and calcite-dolomite rocks. All units contain quartz, which varies from trace amounts to approximately 25 percent of the rock. In addition to quartz, small amounts of phlogopite and graphite are present in most samples. In a few places, such as north of Marble Lake, actinolite and tremolite are locally abundant. The tremolite occurs as small, single crystals and as sheaves of crystals with a maximum length of 8 cm; it can compose up to 25 percent of the marble. Dark green, radiating sheaves of actinolite crystals, as much as 6 cm in length compose up to 10 pecent of a single marble layer. Fine-grained disseminations and massive streaks of pyrite (4 mm to cm wide) are locally abundant in beds north of Marble Lake and south of Kashwakamak Lake.

Original bedding is locally evident, particularly on the shores of Kashwakamak and Mississagagon Lakes. Bedding is defined by colour layering, concentrations of tremolite, actinolite, or phlogopite in layers 5 mm to 10 cm thick, and by interbeds of calcareous siltstone containing up to 40 percent biotite, chlorite, muscovite, and quartz. Conical stromatolites are found in fine-grained dolostone on the east side of Marble Lake (Photo 8).

OGS 10 629

Photo 8–Conical stromatolites in dolomite marble (9a) near hinge zone of minor fold, east shore of Marble Lake. Pen (13 cm long) is oriented with cap pointed northeastward, parallel to axial plane of folds and in direction of stratigraphic top. Outcrop surface is horizontal; beds are overturned, dipping steeply toward the southwest.

Minor quantities of gold, lead, zinc, copper, antimony, arsenic, and tungsten are associated with marble units in various parts of the map area (see section on "Economic Geology"). This mineralization varies from disseminations to crosscutting veins and stringers, and in most places is situated within a few hundred metres of the marble-metavolcanic contact.

Like the lower basalts, the younger volcanic succession of basalts, andesites, and dacites probably correlates with Lumbers' (1967) Hermon Group, and could be at least partly equivalent to his Oak Lake Formation. The intercalated metasediments would thus also fall in the Hermon Group, but the overlying thicker carbonates, lacking in volcanic material are more typical of Lumbers' Mayo Group.

MAFIC AND ULTRAMAFIC INTRUSIVE ROCKS (MAP UNIT 10)

Dikes, sills, and small plutons of gabbro, hornblendite, and peridotite (10a) cut the basalts; these rocks also occur as xenoliths in flows low in the metavolanic succession. They are of similar mineralogy to the basaltic rocks, except that peridotite contains talc and serpentine. Textures vary from medium granoblastic to coarse, clotty augen schist modified from coarse gabbroic textures, in which hornblende porphyroclasts are enveloped in a fine matrix mainly of plagioclase. The occurrence of these rocks suggests that they are subvolcanic gabbro and cumulates from basaltic magma.

Numerous dikes and sills of basaltic and andesitic composition (1c, 2c) cut all of the aforementioned rock units, including the thick carbonate rocks (9).

INTERMEDIATE INTRUSIVE ROCKS (MAP UNIT 11)

Intermediate stocks and dikes are found throughout the area, but are most common south of Pringle Lake, east of Lower Mazinaw Lake, and south of Kashwakamak Lake. The small size of the stocks, their mineralogy, and texture, and the fact that they contain basalt and andesite fragments but are cut by andesite and dacite dikes, indicate that they are high-level intrusions, probably related to andesitic volcanism.

These intrusive bodies vary from circular and elliptical to lenticular and from 5 m to 900 m in maximum dimension. They are fine- to medium-grained, equigranular or porphyritic rocks with colour index ranging from 20 to 40. Generally mottled black and grey, they are composed of plagioclase, hornblende, biotite, quartz, chlorite, and epidote with accessory muscovite, sphene, apatite, magnetite, pyrite, chalcopyrite, and bornite. Potassic feldspar is an uncommon mineral in these rocks except locally where they are mineralized, as around Pringle Lake and west of McCausland Lake. At these localities, minor quantities of pyrite and chalcopyrite are present and the diorite, along with adjacent felsic metavolcanics, has been altered to rocks rich in microcline, quartz, biotite, epidote, and pyrite with or without magnetite, bornite, and chalcopyrite.

FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

Elzevir and Northbrook[1] Batholiths and Small Sodic Intrusions (Map Unit 12)

The volcanic succession has been intruded by two large plutonic masses comprising mainly granodiorite, trondhjemite, and derived gneisses (12a). In the map area, these constitute the Elzevir and Northbrook Batholiths.

The Northbrook "gneiss" (also known as Cross Lake gneiss) (Smith 1958) has been the subject of recent, detailed studies (Chapman 1968; Ehrlich *et al.* 1972; Byerly and Vogel 1973; Kamilli 1974) and thus, for the purposes of this report, will only be dealt with in a general way.

This body is a metamorphosed granodiorite batholith (400 km^2 outcrop area) comprising three distinct northeast-trending bodies, two of which extend

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[1] The Northbrook Batholith is also known as the Cross Lake Batholith.

from Big Gull Lake in the map area, eastward to Donaldson in Palmerston Township. The southernmost body continues southwestward beyond the map area almost to Actinolite in Elzevir Township.

The belts of granodiorite are separated by thin septa of metavolcanics which join westward, and appear to be stratigraphically distinct; the Northbrook Batholith may thus be a series of lenses (Smith 1958).

Typically grey, locally pinkish grey, the granodiorite possesses a lenticular foliation defined by biotite and quartz aggregates, and deformed aplitic veins and mafic inclusions. A lineation is also defined by biotite and quartz spindles which are typically 1 cm to 2 cm long. These structures are concordant with those in the enclosing metavolcanics. Layering or other persistent inhomogeneities are notable by their absence.

The granodiorite is uniformly medium to coarse grained, essentially granoblastic but showing relict igneous textures in thin section. The mode is relatively uniform, being typically oligoclase (50 percent), quartz (25 percent), microcline (10 percent), biotite (5 percent), hornblende (3 percent), and epidote (1 percent), with accessory sphene, allanite, zircon, and magnetite. This composition is similar to that of the granodiorite of the Elzevir Batholith. There is a general increase in hornblende and a concomitant decrease in biotite, muscovite, and epidote from east to west along the strike of the intrusion; samples vary from quartz monzonite to trondhjemite (leucotonalite) (Kamilli 1974).

The pluton becomes finer grained within 10 m to 20 m of the contact with unit 1a, where it typically contains abundant lenticular inclusions of amphibolite up to 1 m by 10 m or more. In the metavolcanics, sills and/or transposed dikes of granodiorite are concordant with foliation but locally cut the layering, and are up to a metre wide. Generally, the contact between outcrops where one or other rock clearly predominates can be defined within 10 m or less. Away from the contacts, xenoliths constitute much less than 1 percent of the outcrop.

The granodiorite is intruded by numerous aplite, granite, and pegmatite dikes (mainly too small to map) and in places by diorite and diabase (10b). Irregular sets of quartz veins are locally developed.

The Elzevir Batholith underlies some 300 km^2 in Elzevir, Anglesea, Grimsthorpe, and Kaladar Townships. Only that part of the batholith included in Anglesea Township was examined during the present survey.

Here, the batholith varies from minor diorite and quartz diorite to trondhjemite and granodiorite. Diorite and quartz diorite (11) form two northeast-trending bodies on the east side of the batholith, which vary from 0.2 km to 2.5 km in width. Smaller, more irregular masses and dikes of diorite not shown on the map occur northwest of Slave Lake and just south of Skootamatta Lake, in the map area.

The dioritic rocks are generally medium or coarse grained and massive to well foliated, with the foliation paralleling that of the adjacent metavolcanics. Coarse plagioclase phenocrysts 2 cm to 3 cm long are present locally. Both diorite and quartz diorite are mottled grey and black with a colour index which varies from 20 to 40 percent. They are composed of plagioclase (oligoclase or andesine), hornblende, biotite, and quartz with accessory sphene, apatite, chlorite, epidote, magnetite, and carbonate. Quartz varies from trace to 5 percent in the diorite, to as much as 20 percent in the quartz diorite.

Regionally, trondhjemite and granodiorite are the most abundant rock types within the Elzevir Batholith. Inasmuch as numerous dikes of these rocks cut the dioritic rocks and fragments of diorite are in them it is concluded that the trondhjemite and granodiorite represent a younger intrusion.

The granodiorite is grey to pinkish grey with a colour index that ranges from 10 to 25; trondhjemite is similar except that the colour index is less than 10. They are generally medium grained, massive to well foliated and typically granoblastic. However, igneous textures are visible locally in outcrop as well as in thin section.

In thin section these rocks are composed of oligoclase, microcline, biotite, and quartz with accessory muscovite, epidote, hornblende, sphene, zircon, allanite, and magnetite. The only petrographic distinction from rocks of the Northbrook Batholith is that the metamorphic fabric is not prominent in the Elzevir mass. The contact between Elzevir granodiorite and basalt is well exposed on the power line at the Skootamatta River. It is less deformed than the contact of unit 1 with the Northbrook Batholith, and planar dikes of fine-grained granodiorite 1 m to 2 m wide can be traced at least 30 m in the flows. Angular, 0.2 m to 0.5 m inclusions of amphibolite in the pluton show various degrees of assimilation.

A third large trondhjemite-granodiorite body, the Weslemkoon Batholith, lies north and west of Lower Mazinaw Lake, out of the map area. Together with the Elzevir and Northbrook bodies, it forms a "frame" of major trondhjemitic batholiths around the volcanic-sedimentary succession, and intrusive into at least its lower part. Although granitic rocks exist between the Weslemkoon Batholith and the map area (Ayer 1979), much of the intervening ground, not yet mapped in detail, comprises metavolcanics and associated shallow intrusive rocks.

Small granodiorite bodies (12a,b), in part porphyritic and locally intrusive breccia with numerous fragments of the enclosing volcanic rocks and hypabyssal equivalents, are located around McCausland Lake. These appear to be cogenetic with the enclosing volcanic complex. Pink quartz monzonite (12c) is a border variant of the Northbrook Batholith near the south-central boundary of the map area. Myriad small intrusions of dacitic and rhyolitic composition (12d), mainly tabular and subconcordant, cut all the older rock units and are prominent in the marble. Those in the carbonates, which may have fed younger volcanic units now removed by erosion, are distinctive in commonly bearing potassic feldspar.

Mazinaw Lake Granite and Small Potassic Intrusions
(Map Unit 13)

In the extreme northern part of the map area, the Mazinaw Lake Granite, which is exposed south of Bon Echo Part (north of the map area) on both the east and west sides of Lower Mazinaw Lake, underlies the northern parts of Anglesea and Barrie Townships. It is a fine- to medium-grained, equigranular to porphyritic intrusion that appears to be gradational into a thick succession of dacite and rhyolite flows and tuff that are exposed north of Tiny Shabomeka Lake north of the map area. The body contains several types of intrusive breccia; its overall size and shape have yet to be completely determined.

In thin section, both the granite and associated felsic metavolcanics are of similar composition, consisting of microcline, albite, quartz, magnetite, and biotite with or without hornblende, sphene, apatite, muscovite, and pyrite. The colour index is everywhere below 5; in much of the rock magnetite and pyrite are the only iron-bearing minerals.

Small, pink granitic intrusions cut the eastern part of the Skootamatta Syenite (see below) and the marble southeast of Myers Cave.

Skootamatta Stock (Map Unit 14)

The Skootamatta Syenite underlies some 80 km^2 in the centre of Anglesea Township. Only that part of the syenite exposed north and south of Big Island was examined during the present project.

Roughly elliptical in plan view, the syenite is intrusive into basalt, and diorite and quartz diorite of the Elzevir Batholith. Dikes of syenite cut the adjacent plutonic rocks, though none were observed in the basalt. Contacts are sharp and small fragments of basalt were observed in the syenite along the shore of Skootamatta Lake.

The syenite is a light grey to pale pink, massive, equigranular rock which exhibits only weak foliation. Adjacent to its contacts megacrysts of potassic feldspar (3 mm to 1 cm long) are abundant; these have either grown across groundmass material or are wrapped by a foliated matrix. The syenite varies from medium to coarse grained, grain size generally decreasing towards the contacts.

In thin section the syenite is composed of microcline, albite, and biotite with accessory apatite, sphene, and magnetite. Colour index is typically 5 or less. Quartz is visible only in thin section, and varies from trace amounts to approximately 5 percent.

None of these igneous bodies, major or minor, shows any evidence of having intruded the Flinton Group (see below). To the contrary, clasts of the more salic types (excepting syenite) are locally abundant in the Flinton conglomerates.

LATE METASEDIMENTS

Flinton Group

The Flinton Group (Thompson 1972; Moore and Thompson 1972, 1980) is a succession of mainly clastic rocks which overlies, with profound angular unconformity, all of the major units so far described, and which has itself been metamorphosed and deformed. In the present map area, it occupies a syncline passing through Myers Cave (Fernleigh Syncline of Moore and Thompson 1980) and a synclinorium extending across the south side of the map area (Flinton Synclinorium), as well as smaller infolds. Evidence of angular unconformity includes:

1. truncation of contacts between a variety of older rock units, includ-

ing plutons, by the base of the Flinton Group;

2. total absence of igneous intrusions or extrusions in the Flinton Group;
3. opposed facing of pre-Flinton and Flinton rocks;
4. sedimentary facies and facies changes strongly contrasting with those of pre-Flinton rocks;
5. clasts of pre-Flinton rocks locally in the Flinton Group.

Two Formations are well represented in the map area. The basal Bishop Corners Formation (15) is predominantly of quartzite and quartzite-clast conglomerate, grading to pelitic schist toward the north and east. The overlying Myer Cave Formation (16) is predominantly of marble and carbonate-clast conglomerate, with fine-grained graphitic schists. Calcareous feldspathic quartzite of the Lessard Formation (17), the lateral equivalent of the Myer Cave, is in outcrop at only one locality in the southwestern part of the map area, at the northern closure of the Bishop Corners Syncline (Moore and Thompson 1980), and will not be described in detail here.

BISHOP CORNERS FORMATION (MAP UNIT 15)

The coarser clastic facies of the Bishop Corners Formation is best exposed at the Ore Chimney Mine southeast of Bishop Corners (see Figure 5), where it lies on Tudor basalt. The flows face north, as evidenced by pillows at the mine and nearby. The metasediments face south, on the basis of numerous well-preserved crossbeds, and constitute the north limb of the Flinton Synclinorium.

At the base is 6 m of dark biotite schist (15a) which grades down to chlorite-hornblende schist and up to quartz-muscovite schist. It contains abundant magnetite porphyroblasts, with minor garnet and staurolite, in a matrix of quartz, oligoclase, biotite, chlorite, muscovite, and hematite, with accessory tourmaline, apatite, and pyrite. Overlying the schist is 15 m of light grey or pure white, fine-grained quartzite (15b) with accessory muscovite, kyanite, hematite, and tourmaline. It exhibits crossbedding throughout, marked by hematitic laminae; foresets are 10 cm to 100 cm thick. Deformation has obscured the current direction, but tops are distinct (Photo 9). Abruptly overlying the quartzite is a clast-supported oligomictic conglomerate (15c) comprising a framework of well-rounded and sorted pebbles and cobbles of quartzite, in a micaceous quartzite matrix. Clasts are typically 10 cm to 20 cm long; matrix is 20 percent or less of the rock. Most of the clasts are of light grey, fine-grained quartzite with hematite laminae, as in the underlying unit. Subordinate clast types include white massive "vein" quartz and black chert, and a few black schist pebbles. (Amphibolite clasts are rare except at one outcrop on the unconformity, which may be of pre-Flinton volcaniclastic sediment.) The conglomerate is at least 60 m thick; its top is not exposed. To the south, it is interlayered with coarse micaceous quartzite or small-pebble conglomerate (Photo 10). Also southward, the conglomerate matrix becomes feldspathic and slightly calcareous, and increases to constitute over half of the rock in places (15d). A few buff granodioritic pebbles occur locally. East of the Ore Chimney Mine, toward the core of the synclinorium, fully half the clasts are in places pebbles of pinkish buff dacite, porphyritic in part, and granodiorite. On the south flank of the

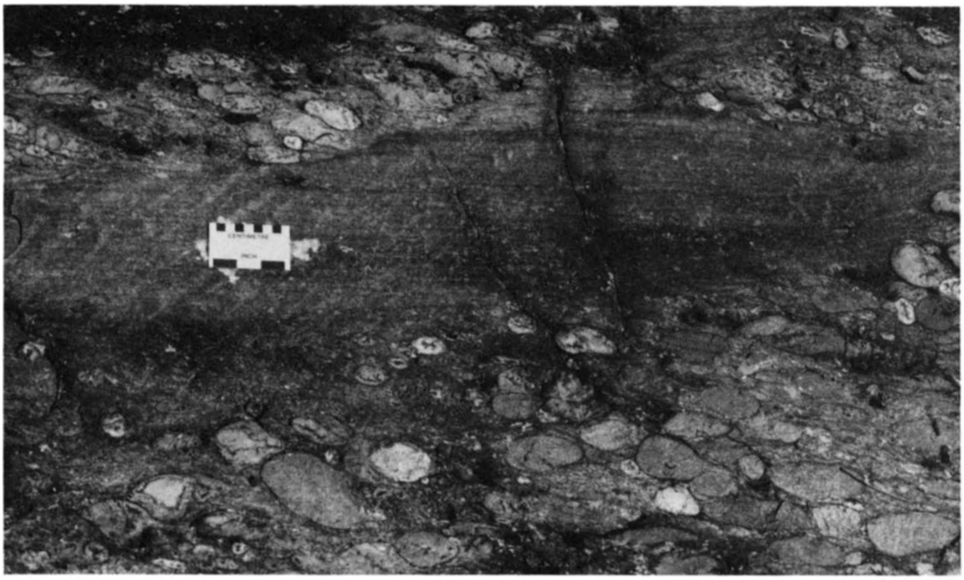
OGS 10 630

Photo 9–Folded crossbedding in quartzite of Bishop Corners Formation (15b), Ore Chimney Mine. Vertical section; beds are upright in core of small fold.

synclinorium, where the Bishop Corners Formation lies on the Northbrook Batholith, no schist is exposed. Crossbedded quartzite faces north; it is feldspathic and micaceous, in places with calcite (15e). The overlying conglomerate matrix is similar, but there are few granitic clasts. On the southern and eastern margins of the Flinton Synclinorium, where the base is exposed, there is a thin impure calcareous horizon (15e); typically a schistose biotite-calcite marble. This unit, locally at least 10 m thick, is difficult to distinguish from some pre-Flinton carbonate rocks except by its distribution.

rocks except by its distribution.

Minor synclinal infolds into the metavolcanics between Ore Chimney Mine and Bishop Corners grade from quartz-rich, coarse clastics in the south to dominantly pelitic schist in the north, with minor conglomerate and



OGS 10 631

Photo 10–Quartzite layer in quartzite-pebble conglomerate (15c), Bishop Corners Formation, Ore Chimney Mine. Note scour at top, and tectonically flattened clasts. Top toward top of photo; beds face south.

quartzite interlayered near the base. The muscovite schist, typically 50 m thick, is exceedingly uniform on the north limb of the Fernleigh Syncline, and continuously exposed from near Marble Lake northeast for at least 50 km to the vicinity of Flower Station, in Lavant Township (east of the map area) (Smith 1958). Southwest of Marble Lake, exposure of the Flinton Group is interrupted by sand plain and swamp, but the schist and overlying units almost certainly are continuous to the closure just west of Highway 41. On the south limb, the schist is less continuous and appears to be dislocated and locally repeated by tectonism.

The pelitic schist which has been described in detail by Hounslow and Moore (1967) is, in the map area, a fine-grained, grey muscovite-quartz schist containing porphyroblasts of, from place to place, biotite, sodic plagioclase (albite or oligoclase), garnet, staurolite, chloritoid, kyanite, and magnetite. Generally the porphyroblasts do not exceed 1 cm across, and many are only 1 mm to 2 mm across, and thus are difficult to recognize in hand specimen. There are two facies of pelite: oxidized and reduced, corresponding respectively to red and dark shales. The predominant, oxidized facies is steely grey, with up to 10 percent of very fine hematite plates in the matrix, along with magnesian chlorite. Ferromagnesian silicates constitute less than 5 percent. The reduced facies, concentrated near the top of the pelite, is a darker muscovite-poor schist with little oxide and abundant biotite, garnet, and staurolite. The base of the pelite, which is transitional over a few metres from the underlying metavolcanics, marble, or wacke, is typically a dark grey, quartz-rich schist with abundant plagioclase, biotite, and epidote.

MYER CAVE FORMATION (MAP UNIT 16)

In the Fernleigh Syncline, the Bishop Corners Formation is abruptly succeeded by a relatively pure pale grey, fine-grained dolomite marble, 20 m thick and containing minor quartz (16a). The overlying metasediments (16b) comprise fine-grained black pelite, calcareous pelite, and dark grey marble in layers typically 3 m to 10 m and aggregating 30 m to 300 m. These rocks mainly comprise varying proportions of quartz, pale biotite, muscovite, sodic plagioclase, calcite, and graphite. Garnet and staurolite porphyroblasts are prominent in some of the less calcic layers; pyrite composes up to 5 percent of some of the pelite; trace amounts of chalcopyrite may also be present. The uppermost unit of the formation (16c) is also heterogeneous, and characterized by coarse carbonate-clast conglomerate and breccia beds 2 m to 5 m thick interlayered with rocks similar to unit 16b. True aggregate thickness cannot be estimated, but is at least 200 m. Dolomite breccia, with a black biotite-calcite schist matrix, is well exposed by the new bridge at Myers Cave. Clasts are angular to subrounded and very poorly sorted, ranging from 1 mm to 1 m in length. In the core of the syncline, south of Myers Cave, the conglomerate comprises mainly layered calcite marble cobbles, somewhat better rounded and sorted. As this unit is followed eastward, the amount of interlayered marble increases and the rocks become lighter in colour (16d). In poor, wooded exposures it is difficult to ascertain whether or not a particular carbonate outcrop is conglomeratic. The breccia around Myers Cave was supposed to be of tectonic origin according to Meen (1944); B.L. Smith 1958) mapped the northeast extension of the same horizon and offered alternative arguments favouring either sedimentary or autoclastic origin. However, the presence of variety of textures and compositions in the clasts, the alternation of relatively thin, planar breccia layers with uniform marble and pelite, and the absence of any transitions between breccia and layered carbonates of appropriate lithology identifies the coarse carbonate clastics as of primary sedimentary origin.

LESSARD FORMATION (MAP UNIT 17)

The sole outcrop of Lessard Formation in the map area comprises uniform medium-coarse calcareous, feldspathic quartzite. Bedding on the scale of a few centimetres is weakly expressed by variations in the proportion of quartz to microcline, sodic plagioclase, muscovite, and calcite.

LATE VEINS

Syn- and post-metamorphic veins can be distinguished in most of the rock units.

Syn-metamorphic veins and lenses are typically concordant, pinch-and-swell structures several mm to 20 cm wide. Where discordant, they are usually folded. The main minerals are quartz in siliceous rocks, and dolomite and/or calcite in carbonate rocks. Accessories are coarser grained equivalents of minerals in the host. For example, quartz lenses in pelite (15a) at Ore Chimney Mine and Marble Lake contain coarse blue-grey kyanite. Aluminous minerals such as staurolite and plagioclase are typically enriched along the borders of these quartz veins, which are concluded to be locally derived segregations.

Post-metamorphic calcite and quartz veins seal shear zones and fractures throughout the map area. The veins strike northwest and northeast, both parallel and perpendicular to the strike of the host rocks. They cut all other rock types in the area, including those of the Flinton Group.

The veins consist either of calcite with or without minor amounts of quartz, pyrite, barite, and traces of fluorite, galena, and sphalerite; or of quartz with minor amounts of calcite, tourmaline, pyrite, and traces of chalcopyrite and sphalerite. The vein minrals are generally coarse grained and veins pinch and swell both along strike and down dip. They vary from 2 mm to 15 cm in width and can be traced for distances up to 25 m.

The age of these veins is not determined, but those bearing barite and fluorite are similar to veins which cut limestone of the Ordovician Black River and Trenton Groups in the vicinity of Madoc.

Phanerozoic

CENOZOIC

Quaternary

PLEISTOCENE AND RECENT

The glacial deposits in the map area are similar to those found in nearby Limerick and Tudor Townships (Lumbers 1969, p.6 and 7). Glacial till of ground moraine deposits is commonly gravelly to sandy, containing numerous pebbles and boulders derived from Precambrian rocks. Throughout most of the map area the ground moraine is not more than a few metres thick, though thicker accumulations occur in valleys or between prominent rock ridges.

Numerous small deposits of sand and gravel overlie, and in places are interstratified with, ground moraine material. These deposits are locally bedded, and are found at the edges of swampy areas or along stream valleys. They have been used extensively for local road construction.

The thickest and most extensive Pleistocene sand and gravel deposits occur in a belt extending south from Lower Mazinaw Lake across the area in the vicinity of Highway 41, spreading eastward from Story Lake. These deposits appear to represent an ancient river channel and outwash system, possibly constituting the main drainage of Lower Mazinaw Lake in immediate postglacial times.

STRUCTURAL GEOLOGY

Folding

The gross geometry of rock units in the map area is complicated by the unconformable relation between pre-Flinton and Flinton Group rocks, and by the disposition of the large plutons, which probably have exerted a tectonic control throughout the deformation history. Metavolcanics and overlying carbonate and wacke metasediments face east, away from the Elzevir Batholith and north from the contact of the Northbrook Batholith. South of Lower Mazinaw Lake there is limited evidence of southward facing in dacitic tuffs. The pre-Flinton succession thus lies in a broad, northeast-trending syncline, closing westward and ringed by plutons. The carbonate-rich rocks which occupy the core underlie topographic basins containing Mississagagon and Kashwakamak Lakes. That at least some deformation of this succession has taken place before deposition of the Flinton Group is shown by the discordance at the base of the Bishop Corners Formation. There need not have been a large angle of unconformity at that time; post-Flinton strain undoubtedly accounts for the present near-perpendicular contacts southwest of Marble Lake. Pre-Flinton metamorphic fabric is indicated in Tudor amphibolites west of Highway 41, where two schistosities are locally present, and the later accords with that in the Flinton Group. In wacke of unit 6 east of Cloyne, there is a weak cleavage subparallel to bedding, which is at a high angle to the northeast-striking cleavage in the nearby Flinton Group. Southwest of the map area, xenoliths of Tudor amphibolite in little-deformed Elzevir granodiorite have a strong, coarse hornblende schistosity and lineation. These fabrics are variably oriented from one inclusion to the next, confirming pre- or syn-intrusive (and hence pre-Flinton) metamorphism. It is possible that all the pre-Flinton fabric and deformation accompanied emplacement (diapiric?) of the plutons.

The northeast-trending synclines containing the Flinton Group are isoclinal, with sharp hinges where the closures are exposed. These have the major schistosity and foliation parallel to their axial traces, and represent the first post-Flinton deformation D_1. The approximate parallelism of the limbs and the schistosity in much of the map area suggests that the hinge lines of the major folds are mainly subhorizontal except near the fold closures. In the vicinity of Bishop Corners, however, plunges are ncecssarily steep and opposing in adjacent synclines. The Flinton Synclinorium is upright; the Fernleigh Syncline is steeply overturned southeastward.

Fragments, pillows, varioles, and amygdules in the volcanic rocks, and clasts in the Flinton Group provide strain markers. These show flattening in pre-Flinton rocks at the east boundary of the map, and along the plutonic contacts, with extension becoming dominant around Highway 41 between Cloyne and Bishop Corners. Flattening is everywhere predominant in the Flinton Group; this is manifest in the more ductile clasts such as dacite and metasediments, whereas quartz, quartzite, and plutonic rocks remain relatively undeformed. Linear strain features plunge gently northeast to southwest in the east, steepening westward through southwest attitudes to subvertical from Highway 41 to the Elzevir Batholith. Axes of D_1 minor folds are more variable than extension features; the two are subparallel in areas of large extension, as in the vicinity of Cloyne, probably because the fold hinges have been rotated toward parallelism with the axis of principal strain. At Ore Chimney Mine, cleavage-bedding relations in the Hermon metavolcanics show that minor and major folds plunge 60° to 70° northeast, whereas conglomerate clasts of the Flinton Group show the principal strain to be oriented steeply southwest.

A second post-Flinton deformation, D_2, has folded D_1 surfaces (schistosity and flattened clasts) throughout the area, but particularly near major D_1 fold closures and around the blunt, plunging terminations of lobes of the Northbrook Batholith. Small folds plunge variably (Thompson 1972); a weak axial plane schistosity may be associated. No major folds of this generation have been documented in the Marble Lake map area, but they are prominent in rocks of higher metamorphic grade in the surrounding areas. Foliation attitudes in the Northbrook Batholith show the granodiorite lobes to be D_2 antiforms (for example see Sethuraman and Moore 1973), but the prolongation of these folds cannot be documented in the eveloping rocks suggesting that they die out upwards.

Gently plunging crenulations, and kink bands with shallow axial surfaces and axes, are ubiquitous. Kink planes are in many places filled with muscovite-quartz or carbonate-quartz veins; in pelites pervasive tourmalinization of the walls may be associated. These shallow features are possibly associated with a third post-Flinton deformation phase D_3, which may also be represented by regional bending of the metasedimentary/metavolcanic fold belts around the major plutonic masses, late in the deformation history.

Faulting

Faults have been inferred only where the disposition of rock units requires that they exist. A number of lineaments have been noted; these may have little displacement associated. Prominent schistosity and abundant, lenticular quartz veining, typically seen in Flinton pelite (15a), were used by Meen (1944) as the basis for inferring a fault along the north limb of the Fernleigh Syncline ("Fernleigh-Clyde Fault" of Hewitt 1956, 1964). There is no evidence, however to support the existence of a discontinuity other than the unconformity described above. Furthermore, the fault drawn by Meen (1944) and by Hewitt (1964), southward from Lower Mazinaw Lake through the Ore Chimney Mine area, could not be substantiated in the present mapping. The major escarpment on the east shore of Lower Mazinaw Lake ("Mazinaw Rock", long a favourite of climbers) must have a tectonic origin, but there is no persuasive evidence of either horizontal or vertical displacement along it. South of the lake, in the map area, the volcanic and volcanogenic-sedimentary succession changes rapidly across the projection of the lineament, and an early fault has been inferred. It is possible however, that rapid lateral facies change is responsible. South of Star Lake, there is no evidence whatever of faulting along the same trend; the south limb of the Fernleigh Syncline is continuous. The offset of the north limb of the Flinton Synclinorium at Ore Chimney Mine (see Figure 5, Chart A, back pocket) is clearly the result of D_1 folding, as is probably the offset of the volcanic-carbonate contact shown by Meen (1944) south of Kashwakamak Lake.

In places, small faults, probably synchronous with D_1 have been noted. These are prominent on outcrop scale in the quartzites at Ore Chimney Mine. Undoubtedly many, some perhaps of significant magnitude, have gone unnoticed because they strike subparallel to layering, and have been metamorphosed and deformed. The observed patterns can be adequately interpreted, in the main, by invoking unconformable relations and multiple deformation.

West-northwest-trending lineaments in the northern half of the map area contain calcite-barite-fluorite veins at Mississagagon Lake, and thus may have been active in Lower Paleozoic or later time.

Late (Cretaceous-Tertiary) normal faults, associated with the Ottawa-Bonnechère Graben, have been identified in the region beyond the map area. For example the Plevna Fault (Smith 1958, p.24) strikes northwest, and has a topographic relief of about 100 feet, with the northeast side elevated. The break along Lower Mazinaw Lake may have moved concurrently, perhaps along a line determined by Precambrian structure.

METAMORPHISM

Considerable information bearing on metamorphic grade and history in the area has already been published (Lumbers 1964; Hounslow and Moore 1967; Moore and Thompson 1972; Sethuraman and Moore 1973; Hutcheon and Moore 1973; Thompson 1973). One major metamorphism is detectable; any textural relicts are either of igneous or sedimentary origin, or "upgrade pseudomorphs" related to the establishment of the present metamorphic isograds. Accordingly, any mineralogical evidence of pre-Flinton metamorphism has been overprinted during D_1 or later.

Grade of metamorphism generally increases toward the east. In pelitic schists (15a) the assemblage diagnostic of lowest grade, chloritoid-chlorite, occurs just west of Bishop Corners. Typical of greenschist facies, this combination gives way eastward to chloritoid-staurolite-biotite (garnet) at Bishop Corners. To the west, there is no pelite. Chloritoid disappears southwest of Myers Cave, leaving characteristic pseudomorphs in rocks containing garnet, staurolite, and biotite. Farther east, there are no other pelitic isograds evident in the map area. The stability of chlorite is clearly dependent upon oxidation state of iron in the pelites (Hounslow and Moore 1967). It persists to just northeast of the map area in hematite-rich rocks.

Isograds in amphibolite roughly parallel those in pelite. A boundary based on the upgrade limit of magnesian chlorite approximately coincides with the "chloritoid-out" isograd (Sethuraman and Moore 1973), but can be mapped over a greater length because mafic metavolcanics are more widely distibuted. Diopsidic clinopyroxene first appears in calcite-bearing amphibolite just east of the map area; the typical assemblage of basalt is thus hornblende-plagioclase.

In siliceous dolostone, an isograd based on the alternative assemblages dolomite-quartz (low) and tremolite-calcite (high) has been mapped in detail around Marble Lake (Hutcheon and Moore 1973) and can be approximately traced southeastward. It is not parallel to the other boundaries, but has not been shown to intersect them. Field identification of tremolite is uncertain in some appropriate rocks, as both clinozoisite and scapolite may have very similar appearance.

Textural changes support the metamorphic gradient inferred from mineral assemblages. Both porphyroblasts and matrix in pelite tend to coarser grain eastward, and relict textures in metavolcanics are progressively obliterated (Sethuraman and Moore 1973). To the northeast the marble generally changes from fine-grained, colour laminated types with numerous, irregular quartz veins to coarse-grained, more massive varieties. As well, bedding becomes more distorted and less well defined, and calcite veins exhibit ptygmatic folding.

Not only are isograds evidently unaffected by the plutons, but there is also subtle evidence of a parallel change in the assemblages of the Northbrook Batholith itself. Hornblende decreases and, concomitantly, biotite, muscovite, and epidote increase in amount toward the east. Feldspar structural state and composition are consistent with an eastward increase in grade (Kamilli 1974).

Metamorphic fabrics were established during D_1, and deformed during D_2, but minerals so affected are unstrained and little retrograded, indicating that the peak of metamorphism outlasted D_2. This conclusion is substantiated by the highly discordant isograds, and by the evidence that they were never closely folded.

Lumbers' (1964) regional "Low-Medium" grade boundary is left open toward the east in the vicinity of Highway 41. Evidently it should be closed somewhere between Bishop Corners and Marble Lake, depending upon the criteria used (see Figure 2, Chart A, back pocket).

The pesence of regional kyanite and staurolite, and the absence of andalusite and cordierite, in the map area assigns the metamorphic rocks to an intermediate-pressure facies series. The cordierite cited by Meen (1944, p.14) in pelite at Myers Cave was sought, but not found. Porphyroblasts in these rocks have very similar appearance to cordierite, but were confirmed to be sodic plagioclase by X-ray diffraction.

SUMMARY OF GEOLOGICAL HISTORY

The earliest recorded geological event in the map area was the extrusion of a thick succession of submarine tholeiites. The foundation of these rocks is not exposed. This basaltic activity was succeeded, from place to place, by eruption of more silicic tholeiites, carbonate sedimentation, and/or calc-alkalic volcanism. Tuffs and volcanogenic clastic sediments were contributed to the carbonate basins. The volcanic association is consistent with development of a mature island arc on a more primitive arc tholeiite foundation (Condie and Moore 1977) or directly on ocean floor. When volcanism ceased, the edifice subsided and was covered by carbonate rocks.

Metal deposition accompanied periodic cessation of volcanic activity, as well as the emplacement and cooling of small intrusions in the volcanic centres. Volcanicity continued sporadically, concurrently with carbonate deposition. Local fumarolic centres contributed metals to the carbonate-depositing sea.

Perhaps concurrently with the latter stages of volcanism, large masses of diorite and granodiorite magma invaded the lower parts of the succession. Volcanic rocks were domed and metamorphosed, with grade decreasing outward from narrow aureoles to a low prevailing regional metamorphic grade.

A period of slow uplift and erosion ensued under a tropical or subtropical climate. Plutons were unroofed, and all the rocks were deeply weathered to an oxidized regolith. Rejuvenation of this terrain in Flinton time resulted in erosion and clastic sedimentation, yielding red shale, sandstone and conglomerate to local basins. Disposition of these rocks was determined in part by topography resulting from differential erosion of older rocks. As source uplift proceeded, detritus became less mature, and included fresh feldspar and lithic clasts derived from the batholiths. A facies transition from fluvial sedimentation in the south to shallow marine in the north demonstrates a northward paleoslope. As source areas rose in the south, water deepened in the north and restricted circulation resulted in preservation of black, sulphidic shale and limestone. Metals eroded from the volcanic basement were precipitated in some carbonate and clastic facies; subaqueous slides carried in coarse carbonate debris from shallow water. Although some evidence of volcanism at this time has been cited by Smith (1958), there is no evidence in the map area of a resumption of igneous activity.

After deposition of an unknown thickness of the Flinton Group, the entire terrain was subjected to pervasive deformation about northeast-trending, variably plunging axes, and to progressive regional metamorphism. Peak temperatures, which increased from west to east, were imposed after the first folding, but outlasted a second deformation, which produced domes on the sites of large plutons and myriad minor structures on various scales. Development of the metamorphic zoning required burial to a depth of *ca.* 20 km and temperatures of at least 500C.

These events have been fitted into a plate tectonic model by Brown *et al.* (1975). Early subduction on the margin of an ocean of unknown extent yielded volcanic rocks and plutons; as plate movement slowed, carbonates were deposited and then the succession was uplifted and eroded. Continental collision followed, with regional deformation and metamorphism resulting in at least the southern Grenville Province.

These events span the time interval between *ca.* 1300 m.y. ago, when the volcanism began, to *ca.* 1050 m.y., when pegmatites were emplaced in zones of high-grade regional metamorphism (Silver and Lumbers 1966; Krogh and Hurley 1968).

No further tectonism occurred until probably Mesozoic time when, after the present erosion surface had been largely established, the region was broken into blocks to form the Ottawa Valley graben system. Circulating solutions deposited vein minerals in some of the normal faults.

Pleistocene glaciation modified drainage and topography, and left a mantle of unconsolidated deposits over the region.

ECONOMIC GEOLOGY

Introduction

Occurrences of gold, copper, lead, zinc, arsenic, and tungsten in the map area have been the subject of investigation during at least a century. The only documented metal production, however, is of $1,941.00 in gold from 976 tons of ore at the Star Mine in 1904-05 (Meen 1944, p.46). Gold prospecting was extensive from the turn of the century to World War II; base metals have received relatively little attention. A great variety of marble types can be be found in Barrie Township; these have been sporadically exploited by a few small quarries. Presently there is a small production for terrazzo, decorative aggregate, and roofing granules.

Classification of Occurrences

Metallic mineral occurrences in the area fall into two main associations:

1. copper and associated sulphide mineralization in metavolcanics and associated shallow intrusive rocks, as well as in some volcanogenic metasediments;
2. lead-zinc-arsenic-gold mineralization in volcanogenic metasediments, and in carbonate metasediments directly overlying the metavolcanics; also in, and at the base of, the Flinton Group.

Nonmetallic mineral associations comprise:

1. rock units of industrial importance (marble, quartzite);
2. Mesozoic (?) vein deposits with barite and fluorite;
3. unconsolidated Pleistocene deposits of sand and gravel.

COPPER MINERALIZATION IN METAVOLCANICS AND RELATED ROCKS

Within the metavolcanics and associated intrusive rocks, sulphide assemblages can be divided into three distinct types based on mineralogy and rock associations:

1. pyrite + pyrrhotite with traces of chalcopyrite; in basalt flows, peridotite and gabbro, andesite flows and tuff, and rhyolite flows and tuff.
2. pyrite + magnetite with or without chalcopyrite and arsenopyrite; in rhyolite flows and tuff, and associated granitic intrusions.

3. pyrite + chalcopyrite with or without bornite and chalcocite in quartz diorite, diorite, and dacite porphyry stocks and adjacent andesite-dacite metavolanics.

The first type is the most abundant and widespread. Sulphide minerals are found as disseminations, amygdaloidal fillings, narrow stringers, and rims around mafic fragments. Arsenopyrite and magnetite occur in trace amounts whereas pyrite and pyrrhotite, with chalcopyrite, vary from less than 0.1 percent to 7 percent by volume. Associated minerals are calcite, dolomite, quartz, zoisite, and chlorite with or without biotite, hematite, and epidote. Sulphide-rich zones range from a single vein to areas 15 m wide and 10 m to 30 m in length. This type is found throughout the units in question, for example south of Pringle Lake. They appear to be related either to circulating meteoric waters immediately after deposition or during metamorphism, or to small, fumarolic vents which were far removed from the centres of volcanism.

The second type of mineralization is composed of magnetite porphyroblasts and stringers associated with single crystals or anhedra of pyrite, with traces of chalcopyrite and arsenopyrite. Quartz, potassic feldspar, and muscovite are associated with the sulphide minerals, which are found in rhyolite flows and tuff, and related fine-grained granitic rocks east and west of Lower Mazinaw Lake.

The third type, though the least common, may be the most important because the nature and distribution of the sulphide minerals and associated alteration minerals is suggestive of the "porphyry copper" type of deposit. In these occurrences sulphide minerals are associated with diorite, quartz diorite, and dacite porphyry stocks; both stocks and adjacent metavolcanics are extensively altered and mineralized.

The sulphide minerals are found as disseminations, single veins, or stockwork stringers which vary from 3 to 10 per square decimetre. Pyrite is the most abundant sulphide mineral (0.1 to 8 percent) followed by chalcopyrite (0.1 to 2 percent), then bornite and chalcocite. Associated minerals are magnetite, potassic feldspar, epidote, biotite, quartz, chlorite, hornblende, and calcite. The Buffadison Occurrence (4)[1], east of Lower Mazinaw Lake, is the only example of this deposit type on which any exploration work has been performed.

Copper-bearing sulphide occurrences are also found in metasediments colsely associated with basaltic flows. Pyrite, pyrrhotite, and traces of chalcopyrite are disseminated in black, thin-bedded pelites. These are found as thin interflow layers, for example low in the tholeiite succession along the power line near the Skootamatta River. Also, black metasediments at the top of the basalts and andesites east of Bishop Corners contain the same assemblage. An aeromagnetic anomaly in this area appears to derive from pyrrhotite in these rocks. Accompanying minerals are typically quartz, sodic plagioclase, biotite, graphite, and ilmenite. Garnet may also be present.

The deposits associated with the metasediments could represent exhalative sulphide deposition associated with periods of quiescence between or after submarine eruption of basaltic flows.

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[1] Numbers in parentheses refer to property number on the Geological Map (back pocket).

LEAD-ZINC-GOLD MINERALIZATION IN METASEDIMENTS

In the pre-Flinton succession, base metal and gold mineralization shows close association with carbonate-bearing rocks either within or directly overlying the metavolcanics. These occurrences can be subdivided into:

1. pyrite + sphalerite + arsenopyrite, with or without pyrrhotite, galena, and gold, in basaltic interflow metasediments;
2. galena + sphalerite + chalcopyrite + pyrite, with or without arsenopyrite and gold, in dolomitic or calcitic marble overlying metavolcanics.

In the first type, pyrite, pyrrhotite, arsenopyrite, and sphalerite, with or without galena, are associated with calcite, magnetite, hematite, quartz, zoisite, amphibole, and chlorite in bedded rocks interpreted to represent sediments derived from basaltic flows and tuff. Small amounts of gold are associated with these occurrences, though most gold values are extremely low. The gold appears to be primarily associated with pyrite and arsenopyrite which occur in quartz veins and stringers within the metasediments. Examples of this type are found in the continuous horizon of basaltic metasediments west of Highway 41.

Deposits of the second type are quartz-carbonate vein systems commonly with tourmaline, within a few hundred metres of the top of the main volcanic succession. There may be associated interbeds of andesite-dacite tuff or tuffaceous wacke, as at the Star Mine, or a total absence of interstratified volcanic material, as in occurrences west and south of Kashwakamak Lake.

In the Flinton Group, the principal locus of sulphide mineralization is the thin, persistent dolomite marble horizon (16a) in the Myer Cave Formation. In the map area and to the northeast along strike for at least 14 km, it contains numerous occurrences of pale sphalerite, galena, pyrite, and chalcopyrite with sulphosalts such as boulangerite and jamesonite and traces of gold. These are lenses and disseminations within subconcordant quartz-carbonate stockworks. There is no evidence of associated igneous activity. Overlying black pelite contains pyrite with traces of chalcopyrite locally. The two units are separated by a thin (1 m to 2 m) bleached pyritic muscovite schist. It is probable that the metals were eroded from the pre-Flinton volcanic rocks and concentrated in a favourable sedimentary environment.

The presence of a number of gold occurrences at or near the base of the Flinton Group could be taken as evidence of detrital concentrations, subsequently remobilized by metamorphism. All of these occurrences contain sulphide mineralzation as well, however, and without exception lie in metavolcanics or associated carbonates, beneath the unconformity. Although the lowermost part of the basal pelitic schist (15a) typicaly is pyritic, no other sulphide minerals have been observed in the Flinton Group and most of the unit is highly oxidized. One small pit was located in this member southwest of Harlow, but although gold was rumoured to have been discovered there is no evidence. In the vicinity of the mineral occurrences, the pre-Flinton surface is not far from the top of the volcanic succession, and it may have been localized by erosion along this horizon. Accordingly, it is suggested that the control of the mineralization does not relate directly to deposition of the Flinton Group. Two alternative controls of mineralization should not be ignored, however:

1. secondary enrichment under the pre-Flinton surface;
2. metamorphic remobilization, particularly of gold, by solutions generated in the Flinton pelites during regional metamorphism.

Bishop Corners muscovite schist (15a) is high in metamorphic tourmaline, probably grown from boron-rich clays rather than heavy detritus. Tourmaline is also a member of most gold-bearing assemblages. Northeast of the map area, in Clarendon Township, the Boerth and Webber properties (Smith 1958) have gold values in tourmalinized pre-Flinton metawacke, close to the unconformity.

Although no uranium occurrences have been reported, the Flinton Group poses an interesting potential control of uranium deposition. The strongly oxidizing environment accompanying early Flinton erosion and sedimentation would have resulted in the solution of uranium from granitoid basement, and the subsequent deposition of more reduced facies has resulted in potential traps higher in the succession.

NONMETALLIC DEPOSITS

Pink and grey fine-grained dolomitic marble is being quarried south of the Ministry of Natural Resources forestry tower, 2 km east of Myers Cave, and presently supplied to the Stoklosar processing plant at Madoc. W.R. Barnes, Limited operates a crushing and beneficiation plant on Highway 41, 2 km south of Bishop Corners. Formerly this plant produced marble chips, but it now accommodates a variety of custom industrial processing contracts.

The variety and abundance of marble in the area is so great that virtually unlimited potential exists for future production.

Pure quartzite of the Bishop Corners Formation, especially where thickened by folding as at Ore Chimney Mine, constitutes suitable sources of high-silica material.

Only one calcite-barite-fluorite vein was observed, on Green Bay at the south end of Mississagagon Lake, 2 km northeast of Myers Cave. The vein, with an exposed width of only 0.5 m, lies in a strong west-northwest lineament. It is probable that prospecting of the lineament and other subparallel features would yield more occurrences.

The thick Pleistocene sand and gravel deposits extending southwad from the foot of Lower Mazinaw Lake have seen limited exploitation because of restricted demand in the area.

Metallogenesis

In summary, it is possible to tentatively divide the prospects, showings, and occurrences of metallic minerals into six genetic classes based on rock associations mineralogy, and texture. The six types are:

1. porphyry copper types associated with intrusive centres;
2. exhalative types associated with chemical precipitates and mafic metasediments;

3. deposits from meteoric or metamorphic solutions, associated with most metavolcanic units;
4. isolated vent types associated with the deposition of carbonates;
5. distal lead-zinc deposits in carbonates, perhaps associated in time with volcanism;
6. lead-zinc deposits associated with weathering and solution of older metal concentrations.

To what extent metamorphism has played a part in the present localization of mineralization is difficult to assess. Certainly the present textures are of metamorphic origin, as is the disposition of mineralization in subconcordant lenticles. Although metamorphic solution and redeposition may have been important concentrators, most of the observed mineralization is in stratigraphic settings which accord well with those of metal deposits in nonmetamorphic rocks.

Description of Properties

INTRODUCTION

Data on all documented mineral occurrences in the area are presented in Table 4. Most of these are numbered on the geological map. Where an occurrence was located during this study, its position is marked with a solid triangle. Old properties which were not found during the present work are located only approximately on the map.

Meen (1944) summarized the exploration history to 1940. A.L. Sangster (1970) revisited many of the localities and contributed new data on mineralogy and host rock association. Those deposits on which significant new information was accumulate during the present study are described below, in alphabetical order. Field and petrographic data are combined with previous reports, both published and in the Assessment Files Research Office, Ontario Geological Survey, Toronto.

BUFFADISON OCCURRENCE (4)[1]

This copper prospect is situated 2.4 km east of Lower Mazinaw Lake on the north boundary of the map area. The property was optioned by Buffadison Gold Mines in 1956 and between then and 1959 the company carried out a program of geological mapping, trenching, and the diamond drilling of 11 holes.

Copper sulphide minerals are associated with a diorite to quartz diorite stock that has intruded andesite and dacite flows, tuff, and their sedimentary equivalents. Both the metavolcanics and the intrusion are overlain by rhyolite tuffs.

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[1] Nmber in parentheses refers to property number on the Geological Map (back pocket).

TABLE 4 MINERAL DEPOSITS IN THE MARBLE LAKE AREA

Property No.	Deposit Name	Township	Lot	Con.	Host Rock[1]	Economic Minerals[2]	References[3]
1	Barrie Syndicate	Barrie	8,16	IX	Dol. M.	*sp,gn,td,bl,jm,py*,cp,asp	Meen (10), Sangster
2	Big Dipper Occurrence	Barrie	16	X	Cal. M.	py,sp	Meen (16)
3	Buckhorn Occurrence	Barrie	24	IX	Dol. M.	py	Meen (7)
4	Buffadison Occurrence	Barrie	25,26	XI	Vol.	*cp,py,bn*,cc,cv,Cu	N.R.
5	Camgar (Kashwakamak) Occurrence	Barrie	13,14	VI	Dol. M.	*td,sp,gn*,cp,py,po	Meen (6), Sangster
6	Camgar (Mill Claims) Occurrence	Barrie	34,36	II	Dol. M.	py,cp,td,asp	Meen (5)
7	Cobalt-Frontenac	Barrie	11,13	I	Vol.	*py,po,sp*,Au	Meen (11), Sangster
8	Cook, H. Occurrence	Barrie	25	VI	Dol. M.	*sp,gn,py*,td,cp,hem,ci	N.R.
9	Dome Occurrence	Kennebec	32	II	Dol. M.	py,cp,cc,gn,Au	Harding, Sangster
10	Gold Base Occurrence	Kennebec	30	V	Dol. M.	*py,cp*,Au	Harding, Sangster
11	Helena Occurrence	Barrie	20	VI	Dol. M.	cp,Au	Meen (17)
12	Mazinaw Base Metals	Barrie	12	VIII	Dol. M.	*sp,gn,td,bl,jm*,py,cp,asp	Meen (9), Sangster
13	O'Donnell I	Anglesea	8	II	Vol. Sed.	mene,sp,gn,py,asp,Au	Meen (3), Sangster
14	O'Donnell II	Anglesea	7	III	Vol. Sed.	py,cp	Meen (2), Sangster
15	O'Donnell III	Anglesea	6	III	Vol. Sed.	asp,sp,gn,cp,mene,Au	Meen (1), Sangster
16	Ore Chimney Mine	Barrie	34,36	I	Vol.	*py,cp,sp,gn*	Meen (13), Sangster
17	Ore Mountain Occurrence	Barrie	32	I	Vol.	—	Meen (18)
18	Pay Rock Gold	Barrie	16	I	Dol. M.	py,Au	Meen (12)
19	Star Gold Mine	Barrie	24	X	Dol. M.	*py,cp,sp*,Bi,bm,shee	Meen (15), Sangster
20	Stead Occurrence	Barrie	15	VI	Dol. M.	*sp,gn,td*,cp	Meen, Sangster
—	Kennefic (?)	Anglesea	7	V	Vol. Sed.	asp,vlt,Au	Meen (4), Sangster
—	—	Anglesea	6	IV	Vol. Sed.	asp	Meen
—	—	Kaladar	32	XI	Dol. M.	py,cp,bn	Harding

Footnotes:

[1] Cal. M. — Calcitic Marble
Dol. M. — Dolomitic Marble
Vol. — Volcanic
Vol. Sed. — Volcanogenic Sedimentary

[2] asp — arsenopyrite
Au — gold
Bi — Bismuth
bl — boulangerite
bm — bismuthinite
bn — bornite
cc — chalcocite
ci — cinnabar
cp — chalcopyrite
Cu — copper
cv — covellite
gn — galena
hem — hematite
jm — jamesonite
mene — meneghinite
po — pyrrhotite
py — pyrite
shee — sheelite
sp — sphalerite
td — tetrahedrite
vlt — valleriite

[3] Meen (1944) Numbers in brackets following Meen are locations on Map 51d.
Harding (1944)
Sangster (1970)
N.R. This Survey Only

The stock, which lies outside the map area, is elongate in a northeast direction, varies from 300 m to 1000 m in width, and is composed of plagioclase, hornblende, biotite, and quartz with accessory apatite, zircon, sphene, and magnetite. Chalcopyrite, bornite, chalcocite, and pyrite are sparsely disseminated through the intrusive body, and may represent original accessory minerals.

Both the stock and adjacent metavolcanics are moderately to intensely fractured, schistose, and altered. Fractures are sealed by chalcopyrite, pyrite, bornite, chalcocite, and covellite, with traces of native copper accompanied by magnetite, potassic feldspar, epidote, quartz, and biotite. The mineralized fractures vary from 0.1 mm to 5 mm in width and from less than 1 to 10 per square decimetre. Both alteration and sulphide minerals occur as disseminations in metavolcanics though their extent and volume are not known. No assays are available from the Buffadison drill core.

Copper sulphide minerals and alteration assemblages similar to those found at the Buffadison Option are associated with quartz diorite, diorite, and dacite porphyry stocks north of Harlowe, south of Pringle Lake, and southwest of Lower Mazinaw Lake. No exploration appears to have been carried out on these occurrences.

CAMGAR (KASHWAKAMAK) OCCURRENCE (5)

Several small lead-zinc prospects are located along the south shore of Kashwakamak Lake. All of the showings are in dolomite marble a few hundred metres north of the contact with metavolcanics. Numerous dacite porphyry dikes are intrusive into the marble close to each of the showings.

All of the showings are exposed in small pits, and the sulphide minerals are associated with quartz veins. The quartz veins vary from 1 cm to 20 cm in width and are generally parallel to the strike of the marble. Dolomitic marble adjacent to the veins contains disseminated pyrite and pyrrhotite with minor quantities of tourmaline, sphalerite, and galena. The quartz veins contain abundant pyrite with lesser amounts of tourmaline, chlorite, chalcopyrite, sphalerite, and galena. Traces of tetrahedrite, gold, and malachite have also been reported.

H. COOK OCCURRENCE (8)

Henry F. Cook owns the mineral rights to two claims on the south half of lot 25, concession VI, Barrie Township. The property is located some 400 m from the western edge of Kashwakamak Lake and the H.E.P.C. power line runs through the centre of the claim group.

The property was first staked in 1960 by Emrex Mines Limited. They carried out a limited trenching program as well as diamond drilling of three holes, totalling 409 feet. The claims then lapsed and were restaked by P.W. Kingston in 1967. Mr. Kingston contracted a geological survey of the property and undertook some rock sampling. Mr. Cook re-staked the property around 1970, and undertook a program of trenching, sampling, and pack-sack drilling which led to the option of the prospect for a time by Selco Mining Limited. The ground is presently held by Mr. Cook.

The property is situated in dolomite marble, with subordinate calcitic layers, 475 m north of their contact with metavolcanic flow and pyroclastic rocks. The marble is fine grained, massive or, locally, well bedded; calcitic marble is coarse grained and massive. Autoclastic or collapse marble breccias, similar to those described under General Geology, occur on the property. Layers of quartzose and biotite schists (pyroclastic rocks?) are interlayered with the marble. Fine muscovite schist layers have developed coarse scapolite porphyroblasts. Both the marbles and adjacent metavolcanics are cut by diabase and dacite dikes which contain minor amounts of disseminated pyrite, pyrrhotite, and chalcopyrite.

Sulphide minerals are found in both massive and brecciated marble, and in the fine-grained biotite schists as disseminations in veins associated with quartz, and as replacement of dolomite fragments in the marble breccias. Minerals present include sphalerite, galena, pyrite, tetrahedrite, chalcopyrite, hematite, and cinnabar.

The following is an excerpt from a geological report on the property (Kingston and Scott 1968). Their sketch map is reproduced in Figure 4 (see Chart A, back pocket).

> Assays by previous operators indicate an average grade of 0.01 oz. Au, 2.4 oz. Ag, 0.38 percent Cu over 10 feet by drilling, and 0.05 oz. Au, 6 percent Zn, 5 percent Pb, 0.6 percent Cu, 7 oz. Ag per ton across an average width of 4 feet in trenches 'f' and 'g'. Spectrographic analysis done for the present owner on grab samples of mixed sulphides gives:
>
> Pb 0.6 percent
> Zn 4.0 percent
> Hg 0.1 to 1.0 percent
> Cu 32 percent
> Cd 1 to 10 percent
> Ag 1 to 10 percent

ORE CHIMNEY MINE (16)

The Ore Chimney Mine is situated 1.6 km east of Highway 41, near Bishop Corners.

Gold was discovered on lot 35, concession I, Barrie Township in 1902 and in 1909 the Ore Chimney Mining Company was formed to carry out development of the property. They sunk a 400-foot shaft and established several northeasterly drifts which had a total known length of 2500 feet. At a point 270 feet east of the shaft a winze was sunk from the 400-foot level to the 500-foot level and 160 feet of drifting was completed at this level.

In 1915 a 20 stamp mill was built and operated for a short time. The concentrates produced from the mill were never treated or shipped.

In 1928 Bey Mines Limited purchased the property. Between 1928 and 1932 they carried out a program of geological mapping, trenching, ground magnetometer and E.M. surveys, and accomplished 3800 feet of diamond drilling. In 1932 they dewatered the shaft and drifts and carried out a program of detailed sampling. In 1935 they rebuilt the headframe and extended the underground workings.

No further work was done on the property until 1944 when it was purchased by East Webb Mines Limited. They carried out metallurgical tests of the ore and concentrate.

Again the property lay dormant until it was purchased in 1956 by the Cavalier Mining Corporation Limited. They carried out additional geological mapping and surface diamond drilling.

Since 1958 little work has been done on the prospect; the old mine buildings have been destroyed or removed, the original shaft and drifts are filled with water, and parts of the concentrate and waste dump are covered by a beaver pond. The property was leased in 1970 by Mr. G. Gayle.

In 1982, the property was acquired by Mr. A. Banner. From January to August 1983, the mine was dewatered and re-timbered to the 150-foot level and resampled with the assistance of provincial grants. Earlier assay results were confirmed (A. Banner, Cloyne, personal communication, 1983). The mine is presently flooded.

The old mine workings are situated close to the contact between Tudor metavolcanics and pelite, quartzite, and conglomerates of the Flinton Group (see Figure 5, Chart A, back pocket).

The metavolcanics are derived from massive to pillowed basalt, basaltic sediments and dacite lapilli-tuff or tuff-wacke. H.J. Logan (1932), in his report to Bey Mines described layers of iron formation which occur at depth.

Metasediments of the Flinton Group, described under General Geology, overlie the metavolcanics. Mapping of the contact, Flinton stratigraphy, and minor structures reveals a number of isoclinal to open folds, describing a large "S" shaped fold pair, plunging steeply northeastward. Although the short limb of the major fold appears to be faulted, probably during D_1 deformation, the cross fault shown on earlier maps is absent. The lateral offset of the Tudor-Flinton contact is entirely the result of folding.

The prospect was earlier reported to consist of gold-bearing quartz veins which contain minor amounts of silver, copper, lead, and zinc. No veins were observed on the surface in the vicinity of the shaft, thus the width and length of the mineralized zone is not known. However, an assay plan of the 400-foot level shows the drift to be 530 feet long, extending mainly to the northeast of the shaft. A pit at this distance contains quartz veins with chalcopyrite, sphalerite, and galena.

The following is an excerpt taken from the prospectus of the Cavalier Mining Corporation Limited, dated 1957 (Assessment Files Research Office, Ontario Geological Survey, Toronto):

The following is a summary of the ore shoot indicated by the underground samplings:

Level	Length (feet)	Av. Width (feet)	Gold (oz)	Silver (oz.)	Lead (%)	Zinc (%)
150 foot	50	1.5	0.108	14.0	-	-
250 foot	55	3.0	0.199	11.6	-	2.26
400 foot	75	4.0	0.230	7.3	1.6	1.90
500 foot	100	3.5	0.390	1.7	-	-
Winze	-	3.75	0.357	4.0	-	-
D.D. Hole No.3	605	3.25	0.158	7.8	3.2	1.9

The only ore exposed on three sides is that between the 400 ft. and 500 ft. levels but the sections containing ore values on the various levels indicate this to be a continuous shoot from 50 feet above the 150 level to the 500 level. Assays obtained in D.D. Hole No. 3 suggest it to continue to below 600 feet in depth.

Assuming a 4 ft. mining width there is a probable 11,000 tons between 50 feet above the 150 level to 50 feet below the 500 level. A further possible 5,000 tons may be estimated in the section from 50 feet below the 500 level to 50 feet below the intersection in D.D. Hole No. 3, and in the possible extension of the vein east of the 150 and 250 levels and above the 150 level.

On the basis of samples taken the weighted average of the 11,000 tons of probable ore tonnage is 0.20 oz. gold and 5.64 oz. silver. Insufficient assays were run to enable making an estimate of the probable average lead and zinc content. The results of assays run on samples from the 250 and 400 levels indicate an average of about one percent lead and two percent zinc.

Examination in 1983 shows that the mineralized zone, to the 150-foot level, comprises a layer of mafic biotite and biotite-hornblende schist, locally with muscovite, up to 10 m thick. An irregular system of lenticular white quartz veins with subordinate calcite, a few mm to 1 m thick, occupies up to 30 percent of a 2 m thick zone within the schist, which is enclosed by amphibolite (metabasalt), about 15 m stratigraphically below the Flinton Group. Pyrite, chalcopyrite, sphalerite, and galena constitute up to 20 percent of vein and associated wall rock. Gold values occur in both quartz-rich and sulphide-rich material; silver is associated with sulphide minerals and subordinate sulphosalts. One occurrence of visible gold is known from otherwise unmineralized, schistose wall rock.

STAR GOLD MINE (19)

The Star Mine, originally known as the Star of the East, was owned and operated by Star of the East Gold Mining and Milling Company, Limited until 1935. Historical details can be found in Meen (1944); in 1977 the property, which is owned by Mrs. Nancy Cannon of Cloyne, was being prospected by Albert Banner of Cloyne.

The property is situated 0.4 km north of Marble Lake. The mineralization is in dolomitic marble, with dacitic pyroclastic rocks interlayered, about 60 m south of a large thickness of andesite flows and pyroclastic rocks. Limited data suggest the beds face south, thus the carbonates rest on the metavolcanics. To the south are relatively pure dolomite, tremolite-dolomite, and calcite marbles.

The dolomite varies from grey and buff to pink or green, massive or layered, and contains subordinate quartz, calcite, actinolite, or tremolite.

Dacitic pyroclastic layers vary from 3 cm to 2 m thick. They are composed of biotite, quartz, and plagioclase with lesser amounts of hornblende, dolomite, and tremolite. Small (1 mmm to 4 cm) fragments of andesite and dacite are locally abundant.

For the most part work on the property consists of trenches which are centred on northeast-trending quartz vein systems, concordant with the layering and foliation in the marble. The quartz veins are narrow and lens-like, in places pinching out completely or disrupted by folding, and typically rimmed by coarse actinolite. Pyrite, chalcopyrite, scheelite, tourmaline, actinolite, and bismuthinite are associated with the quartz veins. In addition, pyrite, chalcopyrite, and sphalerite occur as disseminations in tuff and adjacent marble. Scheelite is also associated with pyrite in a fine-grained, green tremolite-talc-dolomite schist. North of the main trenches andesite flow and pyroclastic rocks are pyrite-rich and in places have been replaced by tourmaline, epidote, chlorite, biotite, and quartz.

The gold which origianlly attracted prospectors appears to be closely associated with pyrite in the quartz veins. Meen (1944) sampled some of the pyrite concentrate saved from the early milling operations and now located in a pile below the old mill site. Collectively these samples assayed 0.35 oz. gold per ton (Meen 1944, p.47).

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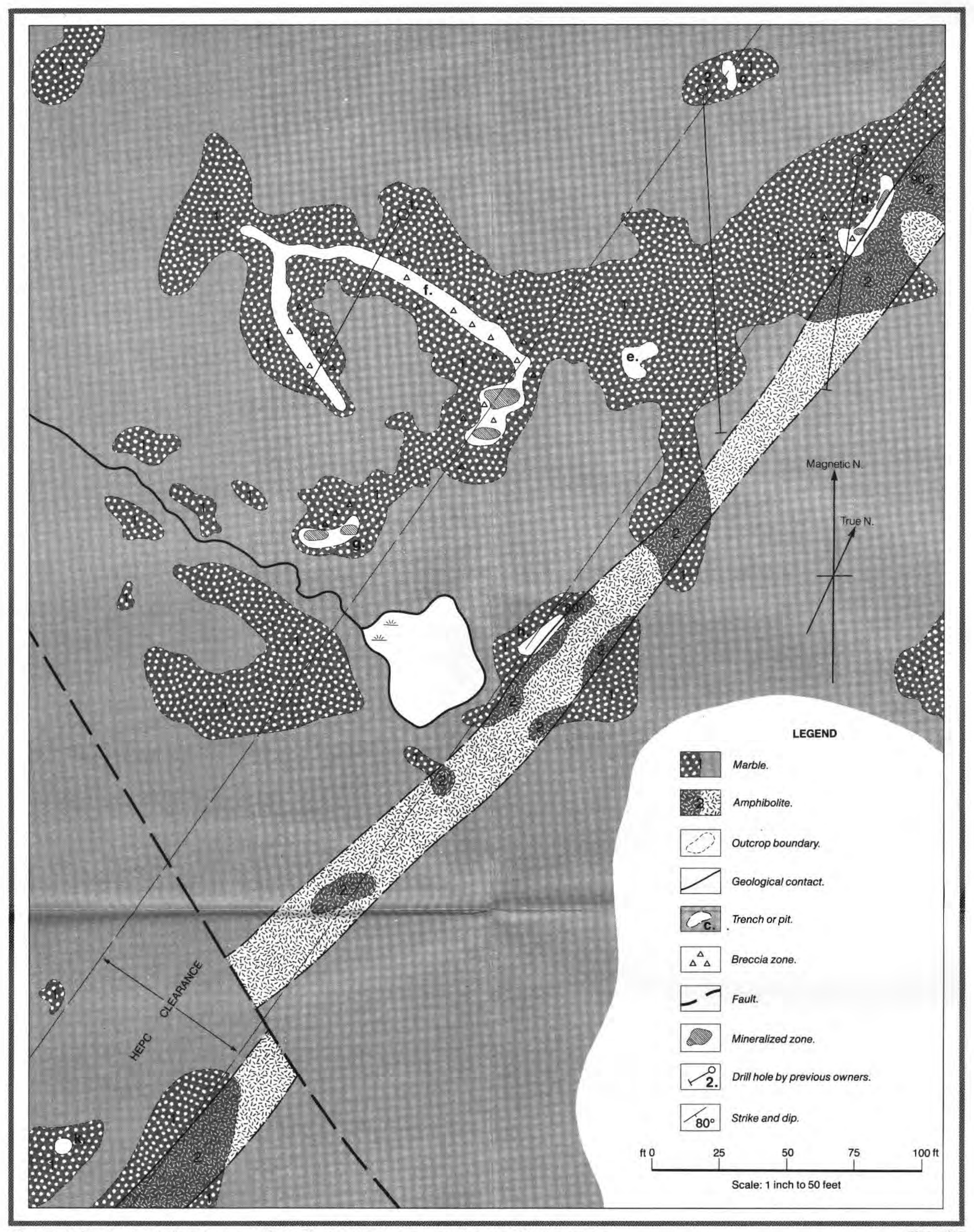


Figure 4: Geological sketch map of the H. Cook Occurrence from P. W. Kingston (Assessment Files Research Office, Ontario Geological Survey Toronto).

SMC 15357

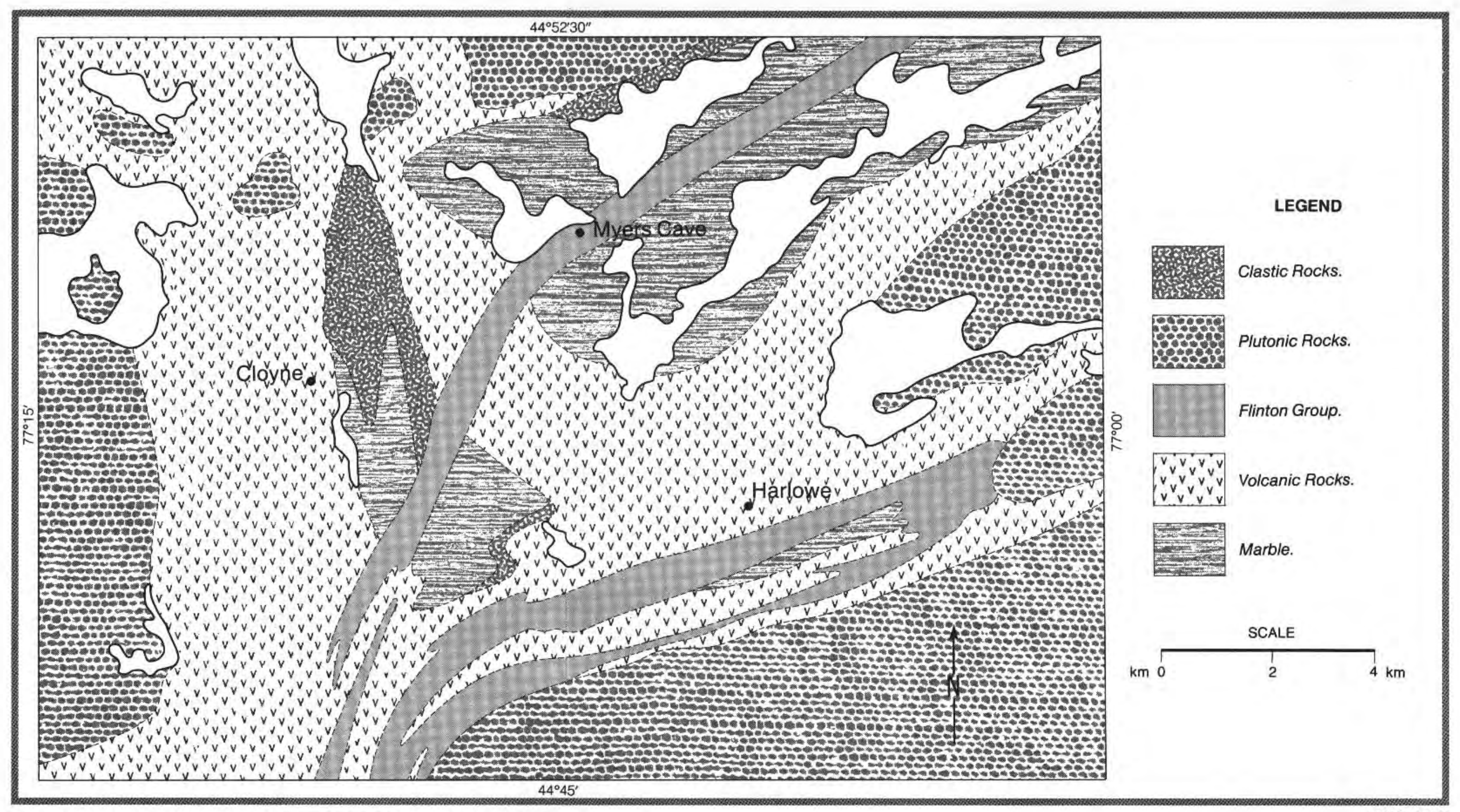
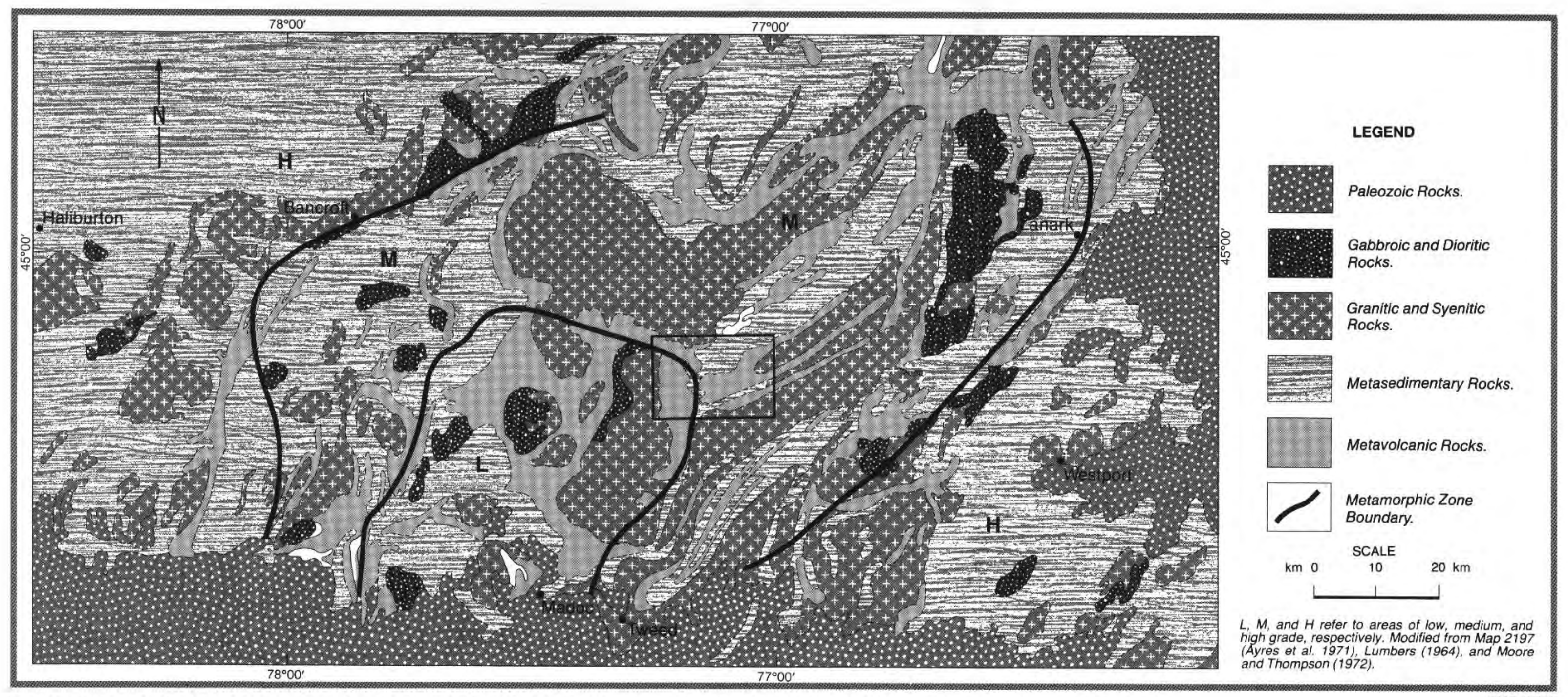


Figure 3: Generalized geology of the Marble Lake area.

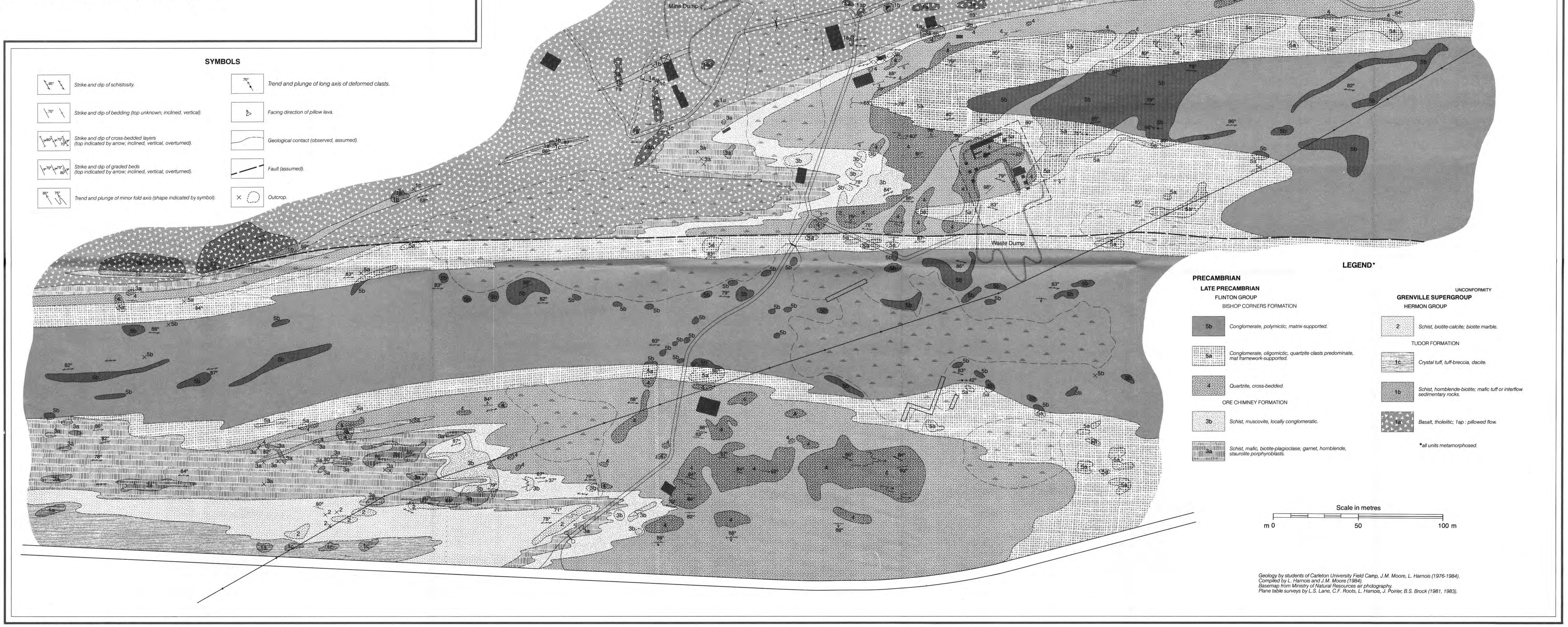
SMC 15356



L, M, and H refer to areas of low, medium, and high grade, respectively. Modified from Map 2197 (Ayres et al. 1971), Lumbers (1964), and Moore and Thompson (1972).

Figure 2: Generalized geology of region including the Marble Lake area showing the regional distribution of metamorphic grade.

SMC 15355



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Compiled by L. Harnois and J.M. Moore (1984).
Basemap from Ministry of Natural Resources air photography.
Plane table surveys by L.S. Lane, C.F. Roots, L. Harnois, J. Poirier, B.S. Brock (1981, 1983).

Figure 5: Detailed geological map of the Ore Chimney Mine area.

SMC 15358

Ministry of Natural Resources
Ontario

LEGEND

PHANEROZOIC

CENOZOIC[a]

QUATERNARY

PLEISTOCENE AND RECENT

Till, gravel, sand; organic deposits, alluvium.

UNCONFORMITY

PRECAMBRIAN[b]

LATE PRECAMBRIAN[c]

LATE METASEDIMENTS

FLINTON GROUP

LESSARD FORMATION[d]

17 *Calcareous, feldspathic quartzite.*

MYER CAVE FORMATION[d e]

- 16a *Dolomitic marble.*
- 16b *Graphitic schist, biotite-carbonate schist, minor graphitic marble.*
- 16c *Carbonate-pebble conglomerate, graphitic schist, pelite, marble.*
- 16d *Interlayered dolomitic and calcitic marble.*

BISHOP CORNERS FORMATION

- 15a *Muscovite schist, garnet-biotite schist, quartzite.*
- 15b *Quartzite.*
- 15c *Quartzite-pebble conglomerate; intercalated quartzite, pebbly quartzite, micaceous quartzite.*
- 15d *Polymictic conglomerate.*
- 15e *Impure calcitic marble, calcareous quartzite.*

UNCONFORMITY

FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

SKOOTAMATTA STOCK[f]

14 *Monzonite, syenite, quartz syenite, porphyritic syenite.*

MAZINAW LAKE GRANITE AND SMALL POTASSIC INTRUSIONS

13 *Granite, granite porphyry.*

ELZEVIR AND NORTHBROOK BATHOLITHS AND SMALL SODIC INTRUSIONS

- 12a *Granodiorite, trondhjemite.*
- 12b *Granodiorite intrusive breccia.*
- 12c *Quartz monzonite.*
- 12d *Feldspar and quartz-feldspar porphyry dikes, felsite dikes.*

INTRUSIVE CONTACT

INTERMEDIATE INTRUSIVE ROCKS[g]

11 *Diorite, quartz diorite, diorite intrusive breccia.*

MAFIC AND ULTRAMAFIC INTRUSIVE ROCKS[g]

- 10a *Gabbro, peridotite, hornblendite, hornblende schist.*
- 10b *Mafic and intermediate dikes.*

INTRUSIVE CONTACT

EARLY METASEDIMENTS[h]

CARBONATE METASEDIMENTS

- 9a *Dolomitic marble, typically massive.*
- 9b *Calcitic and subordinate, intercalated dolomitic marble, thin-layered; minor siltstone, wacke.*
- 9c *Layered marble with numerous mafic and intermediate sills and dikes.*
- 9d *Interlayered marble and wacke.*

CARBONATE AND CLASTIC METASEDIMENTS

8 *Intercalated dolomitic marble, dolomitic siltstone, carbonate wacke, wacke; minor calcitic marble.*

SULPHIDE-GRAPHITE METASEDIMENTS

7 *Pyrite, and/or pyrrhotite-bearing, graphitic schist; black chert.*

CLASTIC INTERMEDIATE TO FELSIC METASEDIMENTS

6 *Volcanic wacke, siltstone, tuffaceous wacke, minor volcanic conglomerate.*

CLASTIC MAFIC METASEDIMENTS

5 *Interflow metasediments in basaltic rocks.*

METAVOLCANICS[h i]

RHYOLITIC METAVOLCANICS

4 *Rhyolite lapilli-tuff, tuff-breccia, ash-flow tuff; rhyolite, rhyolite porphyry and granite porphyry dikes and sills.*

DACITIC METAVOLCANICS

- 3a *Dacite flows, flow breccia*
- 3b *Dacite lapilli-tuff, tuff-breccia, layered tuff.*
- 3c *Carbonate volcanic breccia.*
- 3d *Dacite, dacite porphyry dikes, sills, small intrusions.*

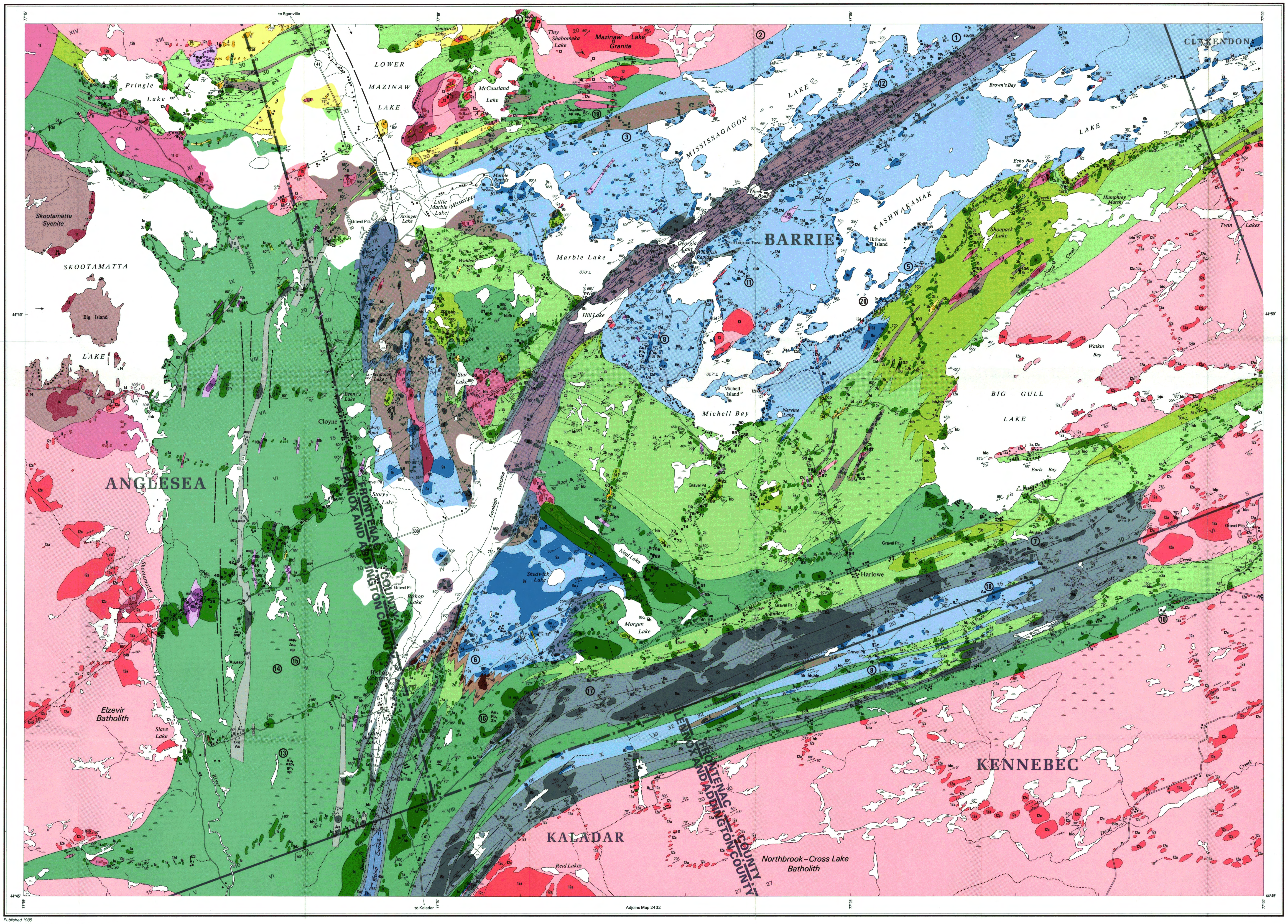
ANDESITIC METAVOLCANICS

- 2a *Andesite flows, flow breccia, autoclastic breccia.*
- 2b *Andesite tuff-breccia, lapilli-tuff; mass-flow deposits.*
- 2c *Andesite, andesite porphyry dikes, sills.*
- 2d *Andesite agglomerate, tuff-breccia.*

BASALTIC METAVOLCANICS

- 1a *Basalt flows, pillow lavas, flow and pillow breccia, autoclastic breccia; amphibolite, hornblende schist.*
- 1b *Basalt, basaltic andesite flows, breccia, pillowed in part, typically plagioclase-phyric; amphibolite.*
- 1c *Diabase, amphibolite dikes and sills, small gabbroic intrusions.*

△ △ △ △ *Breccia*



Published 1985

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

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

[c] *All rock units, with possible exception of Skootamatta Syenite, have undergone low-to middle-grade metamorphism and concomitant deformation, with substantially complete recrystallization. Primary lithologic names are used where identification is reasonably certain, and where metamorphic nomenclature is cumbersome.*

[d] *Lessard and Myer Cave Formations are considered to be laterally equivalent.*

[e] *Listing of members within formations implies stratigraphic succession only in part.*

[f] *Age relative to Flinton Group and Mazinaw Lake Granite not directly established.*

[g] *Relative ages of dioritic and more mafic intrusions are not established; probably include subvolcanic intrusions.*

[h] *Order of metasediments and metavolcanics only in part stratigraphic; lithologic subdivisions include two major metasedimentary, and three metavolcanic assemblages.*

[i] *Includes related intrusive rocks.*

As	*Arsenic.*
asp	*Arsenopyrite.*
Au	*Gold.*
ba	*Barite.*
bio	*Biotite.*
bn	*Bornite.*
cc	*Chalcocite.*
cp	*Chalcopyrite.*
Cu	*Copper.*
fl	*Fluorite.*
gn	*Galena.*
hb	*Hornblende.*
ky	*Kyanite.*
mb	*Marble.*
mi	*Mica.*
Pb	*Lead.*
py	*Pyrite.*
q	*Quartz.*
shee	*Scheelite.*
sp	*Sphalerite.*
Zn	*Zinc.*

Ontario Geological Survey

Map 2499

MARBLE LAKE

SOUTHERN ONTARIO

Scale 1:31,680 or 1 Inch to ½ Mile

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

Scale 1 inch to 50 miles
N.T.S. Reference 31C/14

SYMBOLS

Glacial striae. Glacial fluting or drumlin.

Esker.

Bedrock; (small outcrop, area of outcrop).

Bedding, horizontal.

Bedding, top unknown; (inclined, vertical).

Bedding, top indicated by arrow; (inclined, vertical, overturned).

Bedding, top (arrow) from grain gradation; (inclined, vertical, overturned).

Bedding, top (arrow) from cross bedding; (inclined, vertical, overturned).

Bedding, top (arrow) from relationship of cleavage and bedding; (inclined, overturned).

Lava flow; top (arrow) from pillows shape and packing. Lava flow; top in direction of arrow.

Direction of paleocurrent.

Schistosity; (horizontal, inclined, vertical).

Gneissosity; (horizontal, inclined, vertical).

Foliation; (horizontal, inclined, vertical).

Banding; (horizontal, inclined, vertical).

Lineation with plunge.

Geological boundary; (observed, position interpreted, deduced from geophysics).

1000γ MA *Magnetic contour; value in gammas. Magnetic attraction.*

Fault; (observed, assumed). Spot indicates down throw side, arrows indicate horizontal movement.

Lineament.

Jointing; (horizontal, inclined, vertical).

Drag folds with plunge.

Anticline, syncline, with plunge.

DH OV 120' *Drill hole; (vertical, inclined, projected vertically, projected up dip). Overburden shown.*

●3 *Location of sample.*

4" *Vein, vein network. Width in inches, feet or metres.*

RA *Radioactivity.*

Swamp.

540 *Motor road. Provincial highway number encircled where applicable.*

Other road. Trail, portage, winter road.

International or Provincial boundary.

VI *County, District, Regional or District Municipal Boundary, with mile post.*

VI *Municipal Boundary, (City, Town, Improvement District, Incorporated Township), with milepost.*

VI *Township, Indian Reserve, Meridian, Base Line, Provincial Park, with milepost, (surveyed, unsurveyed).*

2 ① *Mining property, surveyed. Mineral deposit or mining property, unsurveyed.*

Surveyed line. Unsurveyed line.

All boundary and survey lines are approximate position only.

Some symbols may not occur on this map.

PROPERTIES, MINERAL DEPOSITS

1. *Barrie Syndicate.*
2. *Big Dipper occurrence.*
3. *Buckhorn occurrence.*
4. *Buffadison occurrence.*
5. *Camgar (Kashwakamak) occurrence.*
6. *Camgar (Mills Claims) occurrence.*
7. *Cobalt-Frontenac occurrence.*
8. *Cook occurrence.*
9. *Dome occurrence.*
10. *Gold Base occurrence.*
11. *Helena occurrence.*
12. *Mazinaw Base Metals.*
13. *O'Donnell I.*
14. *O'Donnell II.*
15. *O'Donnell III.*
16. *Ore Chimney Mine.*
17. *Ore Mountain occurrence.*
18. *Pay Rock Gold.*
19. *Star Gold Mine.*
20. *Stead occurrence.*

Information current to 31 December, 1976.

Former properties on ground now open for staking are only shown where exploration information is available. For further information see report.

SOURCES OF INFORMATION

Geology by J.M. Moore Jr., R.L. Morton and assistants, Ontario Geological Survey, 1976.

Geology is not tied to surveyed lines.

Further information from field work of J.M. Moore Jr. (1961, 1962, 1964, 1966), K. Sethuraman (1966-68), I.E. Hutcheon (1969), P.H. Thompson (1969-71), and J.F. Chappell (1974). Inferred contacts along northern boundary west of Lower Mazinaw Lake, and western boundary north of Skootamatta Lake, in part from J.A. Ayer (1979) and R. Snyder, Graduate Student, State University of New York at Albany, personal communication, 1978. Elzevir Batholith contact at southwest corner based on J.M. Wolff (1978). Regional Geologist's Files, Ministry of Natural Resources, Kemptville.

Aeromagnetic map 97G, Geological Survey of Canada. Preliminary maps (OGS): P1563 Kaladar Area (1978), P2278 Clarendon Lake Area (1980), Scale 1 inch to ¼ mile.

Cartography by J.D. Holweg and assistants, Surveys and Mapping Branch, 1984.

Basemap derived from Ontario Forest Resources Inventory maps, Surveys and Mapping Branch, Ministry of Natural Resources.

Magnetic declination in the area was approximately 10°30'W. in 1976.

Parts of this publication may be quoted if credit is given. It is recommended that reference to this map be made in the following form:

Moore, J.M. Jr., and Morton, R.L.
1985: Marble Lake; Ontario Geological Survey Map 2499, Precambrian Geology Series, scale 1 inch to ½ mile, geology 1976.