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Report 240

Geology of the
Shining Tree Area
Districts of Sudbury and Timiskaming

1987

Ontario

Ministry of
Northern Development
and Mines

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by
M.W. Carter

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FOREWORD

SHINING TREE AREA

The Shining Tree Area metavolcanic-metasedimentary belt and adjacent granitic rocks, contain occurrences of gold, copper, lead, zinc, molybdenum, asbestos, nickel, iron, cobalt, and silver. A series of detailed mapping projects was initiated in 1971 to provide a more effective basis for determining the mineral potential of the region and for guiding exploration. This report presents a compilation of the detailed projects and a regional synthesis and interpretation of the entire area.

V.G. Milne
Director
Ontario Geological Survey

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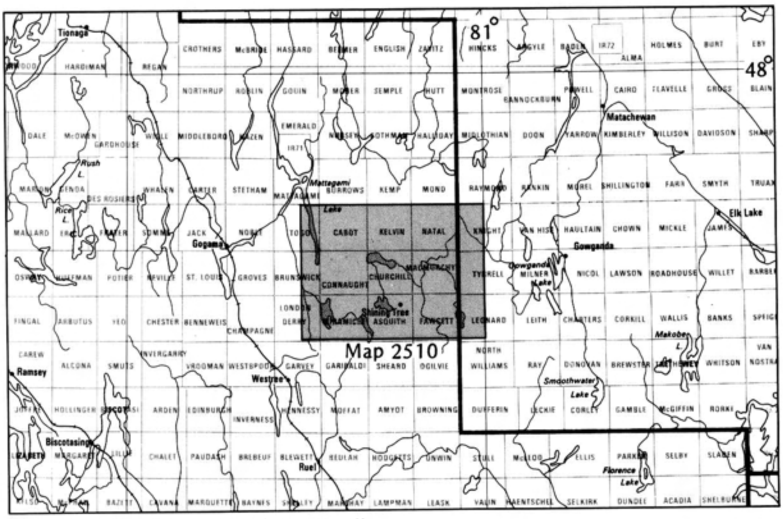
GEOLOGICAL MAP

(back pocket)



Scale: 1:1 584 000 or 1 inch to 25 miles

Figure 1–Key map showing location of Shining Tree Area.

ABSTRACT

This report describes the geology and mineralization in the Shining Tree Area in which the Village of Shining Tree is located. The map area covers an area of about 1000 km^2.

Consolidated rocks within the area are of Early, Middle, and Early to Late Precambrian age. These are covered by a mantle of Pleistocene and Recent deposits.

Early Precambrian rocks comprise a metavolcanic-metasedimentary sequence, mafic and felsic plutonic rocks, and diabase dikes. The metavolcanics, consist of komatiitic, tholeiitic, calc-alkalic, and alkalic rocks, with interlayered clastic and chemical metasediments and have a combined thickness of about 19 000 m. The sequence commences with felsic metavolcanics followed by a later cycle beginning with a mafic tholeiitic lower unit and closing with pyroclastic rocks and interlayered sediments and alkalic metavolcanics. Mafic intrusive plutons comprise quartz gabbro, olivine gabbro, and diorite. The felsic intrusive rocks comprise: syntectonic batholiths consisting of quartz monzonite, and porphyroblastic granodiorite and trondhjemite; and late tectonic stocks of massive and porphyritic quartz diorite, trondhjemite, syenodiorite, and diorite.

Middle Precambrian rocks comprise clastic and chemical sedimentary rocks of the Quirke Lake and Cobalt Groups and intrusive Nipissing-type diabase sills.

Early to Late Precambrian diabase dikes cut the previous formations. These dikes form a northwest and northeast trending set. One younger, alkalic dike follows an east-southeasterly trend and could be a member of the Sudbury dike swarm.

The major structural feature of the metavolcanics-metasediments is a doubly-plunging synclinorium, with secondary folds on the flanks. Numerous north-trending faults that cross the area are part of the Onaping Lineament.

Deposits of gold, silver, cobalt, copper, nickel, and iron occur in the area. There were 2 producing gold mines: the Ronda Mine and the Tyranite Mine.

Geology of the Shining Tree Area, Districts of Sudbury and Timiskaming, by M.W. Carter. Ontario Geological Report 240, 41p. Accompanied by Map 2510, scale 1:50 000. Published 1987. ISBN 0-7729-2232-2.

Résumé

Le présent rapport décrit la géologie et la minéralisation de la région de Shining Tree dans laquelle se trouve le village du même nom. La zone représentée sur la carte s'étend sur près de 1 000 km^2

Les roches consolidées de la région datent d'âge précambrien inférieur, milieu et inférieur à supérieur. Elles sont recouvertes d'un manteau de dépôts datant de l'âge pléistocène et holocène.

Les roches du début du précambrien inférieur sont composées d'une série de roches métavolcaniques et métasédimentaires, de roches plutoniques mafiques et felsiques et de filons diabasiques. Les roches métavolcaniques sont formées de roches komatiitiques, tholéiitiques, calco-alcalines et alcalines, entrecoupées de roches métasédimentaires clastiques et chimiques dont l'épaisseur avoisine 19 000 m. La série commence par des roches métavolcaniques felsiques suivies d'un cycle plus tardif débutant par une unité inférieure tholéiitique mafique pour se terminer par des roches pyroclastiques, des sédiments intercalés et des roches métavolcaniques alcalines. Les plutons intrusifs mafiques comprennent des gabbros quartzeux, des gabbros d'olivine et de la diorite. Les roches intrusives felsiques sont composées de batholithes syntectoniques formés de monzonite quartzifère et de granodiorite et trondjhémite porphyroblastique; ainsi que des stocks tectoniques supérieurs, de diorite quartzique massif et porphyritique de trondjhémite, de syénodiorite et de diorite.

Les roches précambriennes moyennes sont composées de roches sédimentaires clastiques et chimiques du lac Quirke et des groupes Cobalt ainsi que de filons-couches diabasiques intrusifs de type Nipissing.

Des filons diabasiques d'âge précambrien inférieur à supérieur recoupent les formations antérieures. Les filons sont orientés vers le nord-ouest et le nord-est. Un filon alcalin plus récent a une orientation east-sud-est et pourrait faire partie d'un groupe de filons de Sudbury.

La principale caractéristique structurelle des roches métavolcaniques et métasédimentaires consiste en un synclinorium à plongement double, présentant des plis secondaires sur les flancs. De nombreuses failles orientées vers le nord et traversant la région font partie du linéament d'Onaping.

On a découvert dans la région des gisements d'or, d'argent, de cobalt, de cuivre, de nickel et de fer. Il existait deux mines d'or : la mine Ronda et la mine Tyranite.

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

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

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

Shining Tree Area

Districts of Sudbury and Timiskaming

by

M.W. Carter[1]

INTRODUCTION

Location

The Shining Tree map area is bounded by Latitudes 47°30′ and 47°45′N, and Longitudes 81°00′ to 81°30′W and includes the Village of Shining Tree (*see* Figure 1). It covers an area of about 1000 km^2 and is a compilation of 3 complete, and portions of 12 contiguous townships mapped by the author during the period 1971-1976 inclusive. It coincides with the "Shining Tree" N.T.S. sheet 41 P/11 and conforms to the Ontario Division of Mines - Geological Survey of Canada Aeromagnetic Map series which covers 15 minute by 30 minute quadrangles (*see* ODM-GSC 1970). Two contiguous townships were mapped each summer. These were: Macmurchy and Tyrrell mapped in 1971, Leonard and Fawcett mapped in 1972, Connaught and Churchill mapped in 1973, Natal and Knight mapped in 1974, Cabot and Kelvin mapped in 1975, and Miramichi and Asquith (with adjoining parts of Togo, Brunswick, and Londonderry) mapped in 1976. Final reports were written for all the areas except Miramichi and Asquith, for which only preliminary maps with marginal notes have been published. Each of the townships was mapped at a scale of 1:15 840.

The purpose of the mapping was to determine the general stratigraphy and structure of the map area and to determine how the known mineral deposits of the area relate to these features.

[1] Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto. Manuscript approved for publication by the Chief Geologist, July 1981. This report is published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Accessibility

The area is readily accessible via Highway 560, an all-weather gravel road, which crosses it diagonally in a northeasterly direction. The Grassy River and Bay Lumber branch roads traverse the central part of the area in a northerly and southerly direction respectively. The highway and its branch roads and connecting trails intersect numerous rivers and lakes which afford access by canoe to most areas. However, southeastern Cabot Township, central Kelvin Township, central Natal Township and southeastern Asquith Township are best reached by fixed-wing, float-equipped small aircraft.

Physiography

The map area is one of generally moderate relief of about 61 m except for an area at the central part of the northern boundary, where a maximum relief of 122 m occurs at a fault scarp (*see* N.T.S. map 41 P/11). Locally, areas of low relief occur in regions underlain by glaciolacustrine sands in the northwestern and southwestern parts of the map area. Steep crescentic ridges of windblown sand form sand dunes in the northeastern part of Cabot Township. Straight, steep ridges of sand also occur in southwestern Miramichi Township. The relief in these areas is about 24 m. Eskers, which occur in the northwestern and northeastern parts of the map area, form sinuous, narrow ridges that locally have a relief of about 18 m.

The main drainage is northwesterly in the northwestern part of the map area, via Mattagami Lake (an enlargement of the Mattagami River) of the Hudson Bay river system; and northerly, easterly, and southeasterly in the central and eastern parts of the map area via the West Montreal River, which connects with the Ottawa River as part of the St. Lawrence river system.

Previous Geological Work

In 1875 geological investigations began in the area when Robert Bell (1877) described the rock at the southern end of Mattagami Lake. He crossed over the portage into Wanatangua Lake.

In 1896 E.M. Burwash (1897) examined the country along the Nipissing-Algoma line, part of which forms the common boundary between Fawcett and Leonard, Macmurchy and Tyrrell, and Natal and Knight Townships in the eastern part of the map area. A geological sketch map of the area along the line was published in the text of his report at a scale of 1 inch to 2 miles.

In 1900 A.P. Coleman (1901) traversed the upper reaches of Mattagami Lake via Nabakwasi Lake and followed the canoe route along the northern part of Churchill Township into Fawcett Township en route to Shining Tree Lake. He returned to Mattagami River via Macmurchy Township. The geology along the route, and the iron deposits and geology of the area around Shining Tree

Lake, previously studied by E.M. Burwash in 1896, were restudied in greater detail. No separate geological map was prepared, but the results were incorporated on a compilation geological map at a scale of 1 inch to 8 miles (Parks 1900).

Between 1908 and 1910, W.H. Collins carried out geological surveys in the Gowganda Mining Division which included Knight, Tyrrell, and Leonard Townships (Collins 1908, 1909, 1910, 1911). These surveys provided the material for a report on the whole area referred to as the "Gowganda Mining Division" (Collins 1913).

Between 1910 and 1912, W.H. Collins carried out a geological survey in the Onaping area. He mapped Miramichi, Asquith, Fawcett, and Leonard Townships and southern Connaught, Churchill, Macmurchy, and Tyrrell Townships, at a scale of 1 inch to 4 miles, and Churchill and Asquith Townships at a scale of 1 inch to 1 mile (Collins 1911, 1912, 1914). These surveys provided the material for a report on the whole area referred to as the "Onaping Map Area" (Collins 1917).

In 1911 R.B. Stewart (1912) visited the West Shining Tree area and examined the townships of Macmurchy, Churchill, Asquith, and Fawcett. In 1912 he returned to the region and made a geological sketch map of the south-central parts of the map area at a scale of 1 inch to 1 mile and examined the western half of Leonard Township (Stewart 1913a, 1913b).

In 1919 P.E. Hopkins (1920) made a preliminary examination of the West Shining Tree gold area and prepared a revised map of the area, which included the same area mapped by R.B. Stewart in 1912, at a scale of 1 inch to 40 chains (1 inch to ½ mile).

In 1925 F.L. Finley (1927) mapped southwestern Macmurchy Township and southeastern Churchill Township, which formed part of the Wasapika Section of the Shining Tree Gold Area, at a scale of 1 inch to ½ mile. He also (in Gledhill 1927) mapped Cabot, Kelvin, and Natal Townships at a scale of 1 inch to 1½ miles.

In 1926 G.B. Langford (1927a, 1927b) mapped the southwestern corner of Macmurchy Township at a scale of 1 inch to ⅛ mile, and the Shining Tree Silver Area which included all of Leonard Township and adjoining parts of Fawcett, Macmurchy and Tyrell Townships, at a scale of 1 inch to ¾ mile.

In 1931 A.R. Graham (1932) mapped the townships of Tyrrell and Knight and the adjoining eastern parts of Macmurchy and Natal Townships, at a scale of 1 inch to 3/4 mile.

In 1933 H.C. Laird (1935) mapped the west-central part of the map area at a scale of 1 inch to 1 mile.

Between 1971 and 1976, M.W. Carter (1977a, 1977b, 1979a, 1979b, 1980, 1981a, 1981b) mapped the townships of the Shining Tree map area, at a scale of 1 inch to ¼ mile. These are: Macmurchy, Tyrrell, Fawcett, Leonard, Churchill, Connaught,Natal, Knight, Cabot, Kelvin, Miramichi, and Asquith.

Present Geological Work

Field work for this compilation was done from 1971 to 1976, when the various townships of the map area were mapped. For such mapping, vertical aerial photographs at a scale of 1:15 840, supplied by the Timber Branch, Ontario Ministry of Natural Resources, were used. Logging roads were also used in the search for outcrop areas. Pace-and-compass traverses were run at intervals of 400 m in areas where outcrop was extensive. Traverses were run irregularly where outcrop was sparse, so as to examine all exposures. Traverses across outcrop areas were run at right angles to the strike in most cases. Geological data were plotted directly onto acetate sheets which were attached to the aerial photographs carried on the traverses. The data were then transferred to 1:15 840 cronaflex basemaps which were compiled by the Cartography Section, Division of Lands, from map sheets of the Forest Resources Inventory of the Division of Forests, Ontario Ministry of Natural Resources.

In addition, field work was carried out during 1976 in the region between the western boundary of the Shining Tree map area and the western boundaries of Cabot, Connaught, and Miramichi Townships, in order to complete the field coverage of the area.

Acknowledgments

The author wishes to express his thanks to all assistants who participated in the field work when the various townships were being mapped and to Mr. C. Storey, senior assistant and Mr. W. Evans, junior assistant, when field work in 1976 was being done.

The author also wishes to thank Mr. Howard Lovell, Resident Geologist of the Ontario Ministry of Natural Resources at Kirkland Lake, for valuable discussions and help during the season, and Mr. and Mrs. G. Cruikshank of Shining Tree for their many courtesies and help.

GENERAL GEOLOGY

Geological Summary

The major lithological groups shown on the map face are listed in Table 1. The consolidated rocks range in age from Early to Late Precambrian, and the unconsolidated sediments date from the Cenozoic.

Early Precambrian rocks comprise an interlayered sequence of metavolcanics and metasediments intruded by mafic and felsic plutonic rocks and diabase dikes.

The metavolcanics and metasediments together comprise the most abundant rocks in the map area and are the oldest rocks exposed. The metavolcanics consist of subalkalic and alkalic rocks, and the less voluminous metasediments comprise clastic and chemical sediments. The estimated combined thickness of the rocks is about 19 000 m.

The sequence (Figure 2) is interpreted by the author to represent a foundered, distorted, composite volcanic edifice referred to as the Natal Volcanic

TABLE 1 — TABLE OF LITHOLOGIC UNITS FOR THE SHINING TREE AREA

PHANEROZOIC

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT

Gravel, sand, swamp and alluvial deposits

Unconformity

PRECAMBRIAN

EARLY TO LATE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS

ALKALIC DIABASE DIKES

Porphyritic diabase

SUBALKALIC (THOLEIITIC) DIABASE DIKES

Massive, medium-grained, granophyric, leucocratic diabase.

Intrusive Contact

MIDDLE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS (Nipissing-Type Diabase Sills)

Quartz, massive, porphyritic, granophyric and coarse-grained diabase; actinolitic gabbro

Intrusive Contact

HURONIAN SUPERGROUP

COBALT GROUP

LORRAIN FORMATION

Arenite

GOWGANDA FORMATION

Wacke, orthoconglomerate and paraconglomerate, arenite, siltstone, argillite, slate

QUIRKE LAKE GROUP

ESPANOLA FORMATION

Limestone with magnetite

Unconformity

EARLY PRECAMBRIAN

FELSIC INTRUSIVE ROCKS

Massive, porphyritic and gneissic granitoid; granodiorite and granodiorite-porphyry; biotite trondhjemite; quartz monzonite; syenite, syenodiorite-diorite, diorite and quartz diorite; aplite; migmatite

Intrusive Contact

METAMORPHOSED MAFIC INTRUSIVE ROCKS

Quartz, and olivine gabbro, diorite

Intrusive Contact

METAVOLCANICS AND METASEDIMENTS

METASEDIMENTS

CHEMICAL METASEDIMENTS

Chert, hematite and magnetite, ironstone, jasper, pyrite

CLASTIC METASEDIMENTS

Argillite, arenite, wacke, siltstone, conglomerate, slate, biotite-quartz-feldspar gneiss

METAVOLCANICS

ALKALIC METAVOLCANICS[1]

Intermediate Metavolcanics

Flows, lapilli-tuff, tuff-breccia

Mafic Metavolcanics

Flows, lapilli-tuff

SUBALKALIC METAVOLCANICS

Tholeiitic and Calc-Alkalic Metavolcanics

Felsic Metavolcanics

Flows, tuff, lapilli-tuff, tuff-breccia, breccia

Intermediate Metavolcanics

Flows, tuffs, tuff-breccia, lapilli-tuff, chlorite-quartz-feldspar schist

Mafic Metavolcanics

Flows, lapilli-tuff, tuff-breccia, amphibolite, chlorite schist

Komatiitic Metavolcanics

Ultramafic komatiite, green carbonate rock

1 Because of the possibility of alteration involving the redistribution of alkalies and silica, the rocks classified as alkalic may in some cases be altered volcanic rocks of subalkalic affinity. They do however define a consistent group of volcanic rocks on the basis of field appearance, petrography and available chemistry.

Complex. Figure 3 illustrates its development in 4 stages:

Stage 1 shows the development of the submarine edifice.

Stage 2 shows the development of subaerial volcanic deposits in the southwest, and alkalic and ultramafic volcanics on the northeast.

Stage 3 shows the foundering of the central part of the edifice with the contemporaneous formation of subaqueous tuff in the centre and the diapiric uprise of the Round Lake and Miramichi Batholiths on the flanks.

Stage 4 shows the distortion and the formation of the major synclinorial structure by lateral compression, and the development of foliation in the metavolcanics restricted to the batholithic aureoles.

The entire sequence of rocks is folded about a doubly-plunging synclinorial axis, which trends on average N40°W in the eastern part of the map area, N60°E in the north-central part of the area, and easterly in the western part of the area. This synclinorial axis is also considered by the author to represent the median axis of the volcanic edifice, as the lithological units are symmetrically related to it.

The oldest rocks in the map area are considered to be the rhyolitic pyroclastic rocks, exposed in the northwestern corner of the area, which form the Lower Volcanic Group (*see* Figure 2). These were followed by the extrusion of subaqueous, subalkalic, predominantly mafic flows, best exposed in the west and the southeast of the area, which formed the lower part of the Upper Volcanic Group.

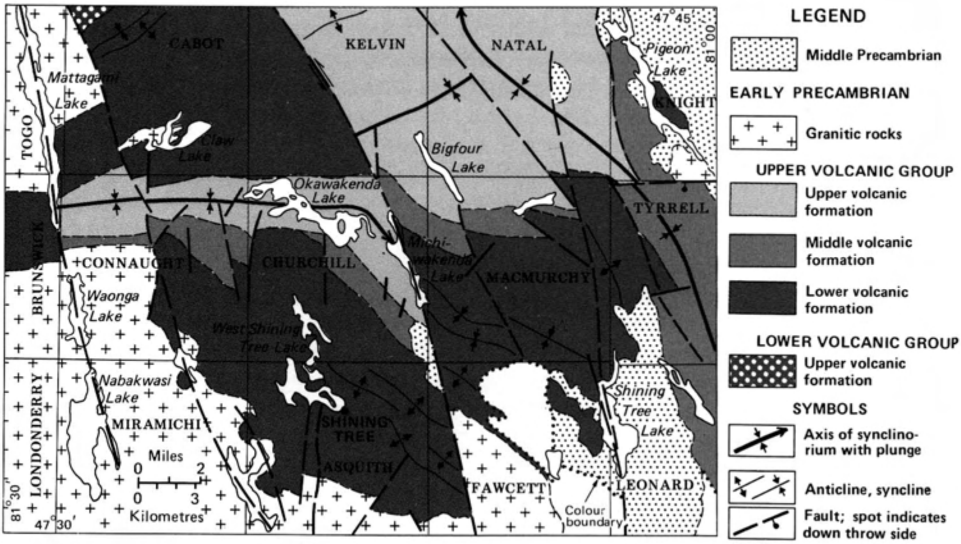


Figure 2–Stratigraphic interpretation of the volcanic sequence in the Shining Tree Area.

The mafic rocks form a symmetrical pattern on either limb of the median synclinorial axis. The rocks on the northeastern limb are only partly exposed. They are best seen in the northeastern corner of Knight Township (Carter 1981b) where they trend northwest and face southwest, and in eastern Tyrrell Township (Carter 1977a) where they face west and are partly covered by the overlying Huronian rocks. Evidence for the subaqueous character of the mafic metavolcanics lies in the ubiquitous occurrence of pillowed structures, and interflow sediments.

Although mafic rocks predominate in the lower part of the Upper Volcanic Group, felsic volcanism also occurred as indicated by thin, aphanitic and porphyritic felsic volcanic rocks.

The lower formation is followed conformably by the middle volcanic formation of the Upper Volcanic Group, and consists predominantly of felsic volcanic rocks interlayered with intermediate and minor mafic metavolcanics. This middle volcanic formation occurs on the southern limb of the synclinorial axis but is absent on the northern limb. In the northeast of the map area its place is taken by ultramafic flows. The absence of the felsic metavolcanic unit cannot be ascribed to faulting, as evidence for this is lacking. The author considers that felsic volcanism was restricted to the southern part of the volcanic complex. This felsic volcanism may have been subaerial in character because pillowed structures were not observed in the mafic volcanic flows which are interlayered with these rocks.

Because explosive activity was not violent, the felsic rocks are aphanitic to finely porphyritic and coarse pyroclastic units are rare. It appears that ultramafic flows were being extruded along the northeastern flank of the volcanic edifice while felsic volcanic rocks were being extruded, probably subaerially, to

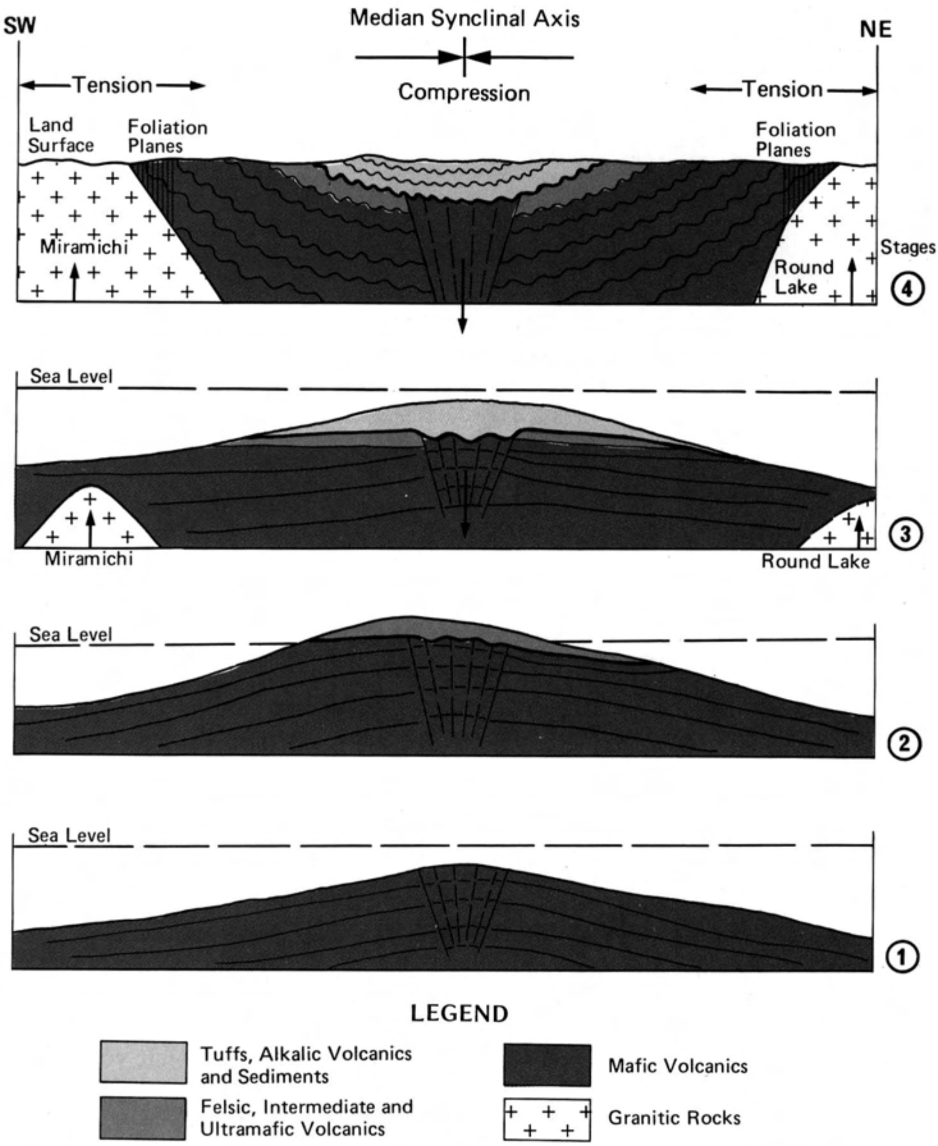


Figure 3–Stages in the development of the Shining Tree (Natal Township) Volcanic Complex.

the southwest (*see* Figure 3). The ultramafic rocks were extruded subaqueously and are interlayered with pillowed mafic metavolcanics.

After the extrusion of felsic and ultramafic rocks, the area was again submerged and calc-alkalic subaqueous tuff, metasediments, and alkalic rocks were deposited forming the upper volcanic formation with the first appearance of bedding in the volcanic rocks. Associated with these rocks were minor ultramafic flows best exposed in eastern Kelvin Township. The contact between the subaqueous tuffs and sediments and the underlying flows is conformable and is placed at the first appearance of bedded sedimentary features. The alkalic rocks do not appear to be related to a fracture zone, but the marked development of these rocks in this area suggests some specialized local conditions for their occurrence. The rocks resemble some of the alkalic rocks described from Kirkland Lake (Cooke and Moorehouse 1969) but leucitic varieties are absent in the Shining Tree area. This period of predominantly explosive volcanic activity and sedimentation ended the volcanic activity in the area.

Mafic rocks occur as elongated lenses intrusive into the metavolcanic-metasedimentary sequence, and are most abundant in the northwestern area. They are undifferentiated bodies comprising quartz gabbro, olivine gabbro, or diorite. They occur both in the lower and upper parts of the volcanic-sedimentary sequence.

The felsic intrusive rocks occur as parts of large batholithic complexes and as elliptical and circular stocks intrusive into the metavolcanics-metasediments. The batholithic masses are mainly massive and porphyroblastic but are gneissic along their borders and are believed by the author to be syntectonic. They comprise quartz monzonite, massive and porphyroblastic granodiorite, and trondhjemite and are: the Togo Batholith located in the northwest of the area; and the Miramichi Batholith underlying the southern part of the area. They are separated by a band of metavolcanics-metasediments. The eastern boundary of the Togo Batholith is in faulted contact with the metavolcanics and metasediments but shows intrusive relationships with these rocks on the southern boundary and it is therefore younger than these rocks.

The Miramichi Batholith shows intrusive relationships on its northern, northeastern, and eastern contacts with the enclosing metavolcanics-metasediments; these contacts are parallel to the regional structure and this batholith is therefore also syntectonic and probably mesozonal. The elliptical and circular stocks are entirely enclosed by the metavolcanics and metasediments. Only the 2 largest of these bodies have been given names: the Claw Lake Stock, located in the northwest of the map area; and the Milly Creek Stock, located in the northeast. The rocks are massive, aphyric, and porphyritic. They are considered by the author to be late tectonic and comprise quartz diorite and trondhjemite, both of which have porphyritic facies, and syenodiorite or diorite.

Middle Precambrian rocks within the map area are represented by rocks of the Huronian Supergroup and Nipissing-type intrusive diabase sills and possible dikes. The Huronian is represented by the Quirke Lake and Cobalt Groups which lie unconformably on, or in faulted contact with the Early Precambrian rocks. These sedimentary rocks are best exposed in the northeastern and southeastern parts of the map area. The Nipissing-type diabase occurs as 2 sills, best exposed in the southeastern corner of the map area. The lower sill was emplaced at the Early-Middle Precambrian unconformity and is associated with cobalt-silver mineralization. Outliers of this sill occur in other parts of the map area.

Early to Late Precambrian rocks comprise diabase dikes which form a predominantly north-northwesterly trending set. Locally some of the dikes trend northerly or north-northeasterly. A few dikes trend east-southeasterly, and these occur in the northwest of the map area. All of these dikes have been grouped as Early to Late Precambrian because some dikes having a north-northwesterly trend cut Huronian rocks (e.g. in northwestern Leonard Township) and are thus Late Precambrian. As they have the same trend as dikes which cut only Early Precambrian rocks, trend direction alone is not a safe guide to the age of the dikes.

In the northwest of the region, silver-cobalt mineralization, which in the map area is restricted to Middle Precambrian diabase, was found associated with a northwesterly trending dike cutting only Early Precambrian rocks. This dike may be of Middle Precambrian age. These northwesterly trending dikes are tholeiitic.

The east-southeasterly trending dike cuts the northwesterly set and is therefore younger. It is an alkalic diabase and may be a member of the Sudbury dike set.

Cenozoic rocks are represented by Pleistocene and Recent deposits. They are best developed in the southwestern corner of the map area where they form extensive sand plains, mainly of lacustrine deposits that were deposited in glacial Lake Barlow-Ojibway (Douglas 1970) which once covered parts of the area. North-trending eskers also occur.

Petrography and Chemistry

EARLY PRECAMBRIAN

Metavolcanics and Metasediments

METAVOLCANICS

Metavolcanics within the map area have been classified into subalkalic and alkalic rocks on the basis of the alkalies-silica plot, Figure 4, using the MacDonald (1968) dividing line. This dividing line gave a more consistent classification of similar looking rocks than the Irvine and Baragar (1971) dividing line. The subalkalic rocks, apart from the komatiitic rocks, have been plotted on the AFM diagram of igneous petrology, Figure 5, and are seen to be tholeiitic and calc-alkalic.

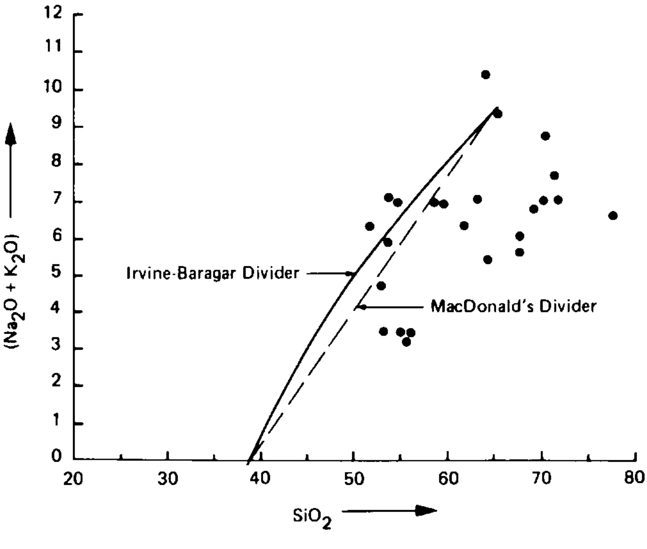


Figure 4–Alkalies-silica plot of tholeiitic, calc-alkalic and alkalic metavolcanics of the Shining Tree Area. Plot in weight percent anhydrous basis.

SUBALKALIC METAVOLCANICS

Komatiitic Metavolcanics

Ultramafic komatiitic rocks, recognized as such on the basis of field characteristics and associations, have been classified according to the system of Jensen (1976) (*see* Carter 1981b). All these rocks have been altered through regional metamorphism, local metamorphism, and hydrothermal processes to varying degrees, and cannot in all cases be accurately classified on their major element chemistry. However, the lithological and petrographic characteristics of the least altered rocks were used to group the more altered rocks into the various categories. Pyroclastic rocks have been classified according to the system of Fisher (1966).

Komatiitic flows are greenish grey, dun-coloured, or reddish brown on the weathered surface and bluish black, dark green, light green, and grey on the fresh surface. In most exposures polysuturing, spinifex, or variolitic textures were observed. The rocks range in specific gravity from 2.66 to 3.01. Rocks showing low specific gravities are assumed to be altered. Natural exposures were not sufficiently continuous to provide data on the structure of the flows but komatiitic units vary in thickness from 30 to 457 m.

Cumulate, microspinifex, poikilitic, variolitic, and devitrified textures were observed in thin section. The rocks consisting of olivine show various degrees of alteration to antigorite and chlorite and also replacement by secondary quartz or carbonate with accessory chromite and magnetite (Carter 1981b). In variolitic and aphanitic types, altered microcrystalline material is believed by the author to represent devitrified ultramafic glass. Green carbonate rocks occur where these rocks have been subjected to carbon dioxide metasomatism (Turner and Verhoogen 1960, p.578-581). These rocks consist of dolomite associated with minor amounts of chlorite and quartz. In some of these rocks relict olivine grains can be seen (Carter 1981b).

The major oxide and chromium and nickel trace element content of these rocks show that they belong to the ultramafic and basaltic members of the komatiites (Carter 1981b).

A clastic rock known locally as "deckerite" is regarded by the author as a komatiitic lapilli tuff (Carter 1981b). It is mottled blue black, consisting of angular to subrounded, grey, yellowish green and greenish grey fragments 8 to 15 mm across, set in a dark greyish black, fine-grained matrix. This rock has associated nickel mineralization.

Tholeiitic and Calc-Alkalic Metavolcanics

MAFIC METAVOLCANICS

The mafic metavolcanics are light greyish green on the weathered surface and are black or dark green on the fresh surface. Where these rocks have been sheared they are pale green on the fresh surface. Where carbonatized, they are greyish white on the fresh surface and dark brown on the weathered surface.

Pillowed, brecciated, variolitic, amygdaloidal, vesicular, and porphyritic lithostructures were commonly observed and indicate the volcanic origin of the rocks. Pillow structures are a notable feature of these rocks and are best developed in Asquith and Churchill Townships along the shores of West Shining Tree Lake. Within the map area, pillows range in shape from irregular, to bun-, loaf-, and mattress-shaped, and range from 0.3 to 1.2 m in length and from 0.15 to 0.46 m in width. Many have well developed chilled margins measuring 1 to 5 cm. The interstices between the pillows are often filled with quartz or fine-grained, grey-green chloritic and epidotic material, or grey-green hyaloclastite.

The thickness of individual flows could not be determined except in a few cases, where they varied between 18 m and 90 m. Within areas underlain by the mafic metavolcanics, coarse-grained facies occur often showing ophitic texture. In the absence of clear evidence of intrusive relationships, such mafic rocks are mapped as coarse-grained interiors of flows.

Petrographically these rocks, when least altered, show relict ophitic, intergranular and porphyritic textures. The plagioclase is usually saussuritized or sericitized and ranges from An_8 to An_{20}. Ferromagnesian minerals comprise actinolite, chlorite, clinopyroxene, clinozoisite, and epidote. Opaque minerals comprise pyrite, ilmenite, and leucoxene. Calcite is present in most cases.

Chemically these rocks are tholeiitic and calc-alkalic in the system of Irvine and Baragar (1971) as shown in Figure 5 and as seen also in the basalt in Figure 6 (Irvine and Baragar 1971).

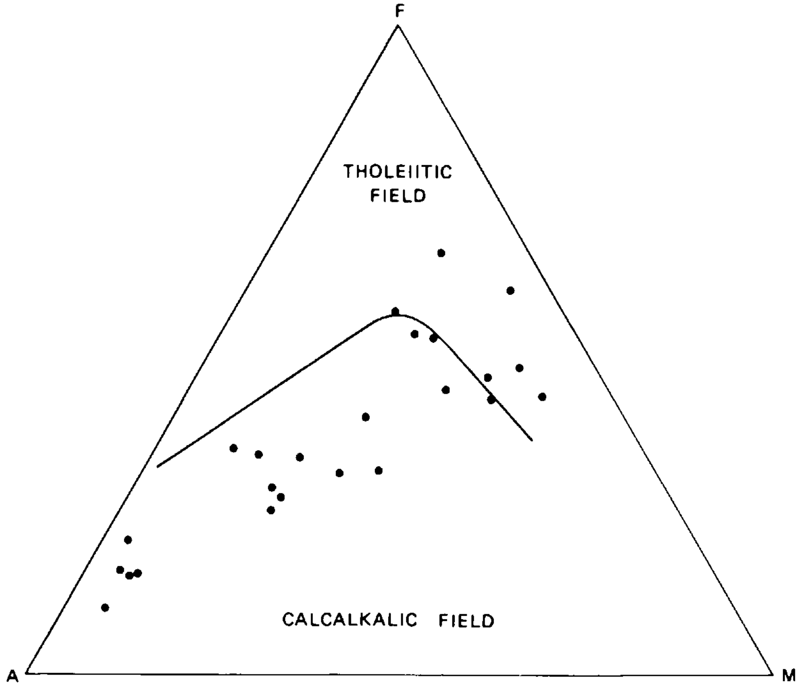


Figure 5–AFM diagram showing plot of tholeiitic and calc-alkalic metavolcanics of the Shining Tree Area. The solid line is taken from Irvine and Baragar (1971).

INTERMEDIATE METAVOLCANICS

The intermediate metavolcanic flows are dark grey-green to pale green, or grey on the fresh surface. They are megascopically aphanitic, porphyritic or glomeroporphyritic, amygdaloidal, spherulitic, variolitic, or brecciated. Chemically analyzed samples range in specific gravity from 2.69 to 2.75 and in colour index from 9 to 23. The porphyritic or glomeroporphyritic rocks show feldspar phenocrysts measuring 1 to 5 mm in length and up to 2 mm in width. Amygdaloidal rocks have amygdules 2 to 4 mm long by 1 mm wide. These amygdules are filled with white calcite and pale green chlorite, or in some cases quartz alone. Spherulites are 3 mm across and contain pale, yellow-green radiating feldspar crystals.

Medium-grained facies are considered by the author to represent the interior parts of flows, with grain sizes of 0.5 to 1.0 mm. The uncommon brecciated varieties are regarded as flow-top breccias and consist of angular fragments ranging from 8 to 75 mm across, set in a matrix of similar composition. Pillowed structures are also uncommon in these rocks. The pillows range up to 46 cm long by 15 to 23 cm wide with a well developed chilled margin. One example

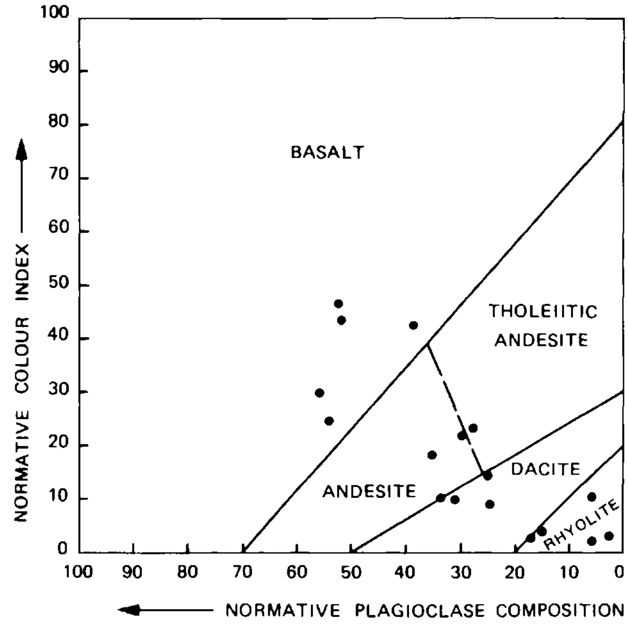


Figure 6–Plot of normative colour index versus normative plagioclase composition of tholeiitic and calc-alkalic metavolcanics from the Shining Tree Area. Plots in percent cation equivalents.

of a rare pillow breccia showed angular disoriented blocks of pillows up to 10 cm in length. These occurrences of pillow breccia were local and did not form separate lithologic units.

Petrographically the commonest texture of the flows was pilotaxitic. This texture formed the whole of aphanitic rocks or the matrix of porphyritic rocks. Microcrystalline, cryptocrystalline, and devitrified hyalopilitic textures also occur. Plagioclase feldspar, often saussuritized and sericitized, ranges from An_2 to An_{55}. Ferromagnesian minerals comprise chlorite, chloritized biotite, brownish hornblende and greenish clinopyroxene.

Chemically these rocks are andesites and dacites, (*see* Figure 6) (Irvine and Baragar 1971).

Pyroclastic rocks are grey to brownish grey on the weathered surface, and grey to dark grey, or light to dark green on the fresh surface. They may be bedded or unbedded. Where bedded they show well developed sedimentary structures such as graded bedding, load casting, flame structures, and slump structures. These rocks show crystal grains from 0.5 to 4 mm across and form graded-bedded units up to 22.5 mm thick. They sometimes show interbanded units of coarse and fine tuff, the bands being 3 mm thick. Bedded units comprising coarse ash grading into fine ash and into chert at the top, form tuff-chert units varying from 15 to 46 cm thick.

In thin section the tuffs show vitroclastic and microgranular texture. The crystal grains consist of angular and subangular, euhedral to anhedral grains of quartz and sericitized plagioclase (An_{0-10}); euhedral and subhedral brownish green pleochroic hornblende; colourless subhedral grains of serpentinized and chloritized common clinopyroxene; and chlorite and epidote set in matrices containing calcite, chalcedony, pyrite, magnetite, ilmenite, leucoxene and apatite.

Clasts within the lapilli tuffs consist of fragments of quartz and feldspar grains, quartz porphyry, quartz-feldspar porphyry and aphanitic intermediate volcanic rocks. The lithic fragments range in size from 6 to 60 mm, but more commonly from 3 to 25 mm and are angular to subrounded. These lapilli tuffs show no bedding and are very poorly sorted. The clasts are set in a very fine-grained matrix which consists of crystals of feldspar 2 mm across.

Tuff-breccias consist of blocks of aphyric and porphyritic intermediate volcanic rocks ranging from 60 to 170 mm across, set in a matrix of fine, lithic material of intermediate composition. These rocks are unsorted and unbedded, and the clasts range from angular to rounded.

FELSIC METAVOLCANICS

Felsic metavolcanic flows are megascopically aphanitic and porphyritic rocks which vary in colour from greyish white to dark grey, cream, yellow, pink, orange, and red on the fresh surface. Their hardness exceeds 6 on Mohs scale, and chemically analyzed samples range in specific gravity from 2.62 to 2.70. Their normative colour index ranges from 2 to 11. Porphyritic varieties consist of phenocrysts of quartz and/or feldspar varying from 1 to 3 mm wide by 6 to 7 mm long. Mafic minerals are 1 mm by 2 mm.

Flow banding was rarely present. Brecciated rocks were observed in a few areas and consisted of angular fragments of felsic volcanic rock set in finer material of similar composition. Such breccia was interpreted as the top portion of the flows and not as a pyroclastic unit. Megascopic foliation is developed in the aureoles of the Miramichi and Togo Batholiths.

Petrographically these rocks show porphyritic-microcrystalline or porphyritic-microgranular texture. Where they have been more highly metamorphosed they show blastoporphyritic texture in which the phenocrysts show indented margins in a recrystallized matrix. The phenocrysts consist of quartz and/or feldspar, hornblende and biotite set in a matrix of albite, orthoclase or perthite. The plagioclase composition varies from An_6 to An_{10}.

Chemically these rocks are rhyolites (*see* Figure 6).

Pyroclastic rocks are light to dark grey, cream or greyish green on the fresh surface with a greyish white weathered surface. The hardness of these rocks exceeds 6 on Mohs' scale and grains and clasts range from 0.5 mm in the tuffs to 30 cm in agglomerates. Vitroclastic and cryptocrystalline textures are observed in thin section and the fragments consist of grains of quartz, feldspar, clasts of quartz porphyry and quartz-feldspar porphyry. The pyroclastic rocks can be subdivided into tuff, tuff-breccia and agglomerate.

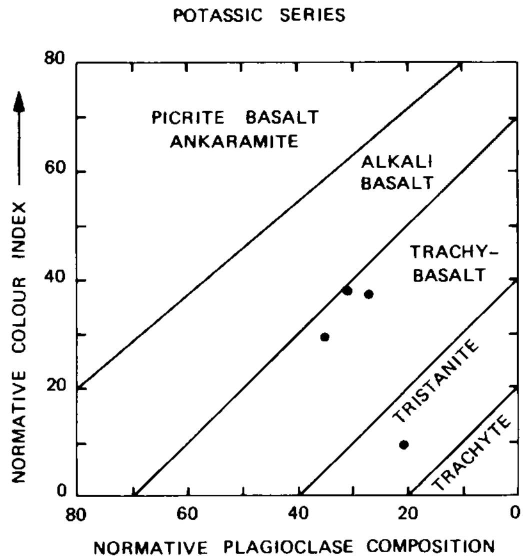


Figure 7–Plot of normative colour index versus normative plagioclase composition of potassic alkalic metavolcanics from the Shining Tree Area. Plots in percent cation equivalents.

Alkalic Metavolcanics

These rocks are best developed in the northeastern part of the map area and comprise flows and pyroclastic rocks. A plot of a representative set of these rocks is shown in Figures 4 and 7.

MAFIC METAVOLCANICS

Mafic metavolcanic flows are fine- to medium-grained aphanitic and porphyritic rocks ranging in colour from dark purple to dark mauve. The porphyritic rocks contain phenocrysts of acicular, euhedral hornblende 10 mm long by 2 mm wide and pale greenish pyroxene in a dark-red, purple or mauve feldspathic matrix.

Petrographically the rocks show phenocrysts of euhedral and subhedral hornblende, colourless clinopyroxene (some of which are altered to chlorite and epidote) and somewhat ovoid and irregularly shaped grains of granular epidote, in a pilotaxitic matrix of albitic plagioclase showing wavy extinction due to strain. In some altered examples the mafic phenocrysts are chloritized and carbonatized and appear to be relict olivine. Accessory minerals consist of irregularly shaped grains of dusky brown epidote, opaque grains of pyrite and leucoxene, and sphene after ilmenite.

Mafic lapilli tuffs are similar in appearance to the flows but have subrounded fragments ranging in size from 6 to 30 mm. The clasts comprise both aphanitic and porphyritic alkalic metavolcanics. Where the clasts are porphyritic the phenocrysts consist of feldspar, hornblende, and augite.

INTERMEDIATE METAVOLCANICS

Intermediate alkalic metavolcanic flows are light mauve, brick red, pale pink, and pale brown and are aphanitic and porphyritic. Porphyritic varieties are the commonest. These consist of phenocrysts of pyroxene, and equant feldspar, ranging in size from 1 mm by 2 mm to 2 mm by 6 mm, and set in a mauve to brick-red matrix.

Petrographically the phenocrysts comprise hornblende, actinolite, clinopyroxene, sericitized and saussuritized feldspar (unaltered clear portions range from An_4 to An_{36}), set in a quartzofeldspathic granular, pilotaxitic or trachytic matrix consisting of oligoclase microlites (An_{20}) enclosed in potassic feldspar. Accessory minerals occurring in the matrix consist of calcite, quartz, chlorite, epidote, chloritized biotite, apatite, and opaque minerals comprising pyrite, ilmenite-magnetite, and leucoxene.

Tuffs are fine-grained purplish rocks which show small crystals of feldspar 0.5 to 1 mm across. These crystals are best seen on the weathered surface, though they are also apparent on the fresh surface. Euhedral and subhedral fresh albite (An_4) crystals are set in a slightly altered microgranular matrix of quartz and alkali feldspar. The matrix also contains irregular patchy areas of calcite, chlorite, apatite, and leucoxene.

Tuff-breccias contain clasts up to 152 mm long of aphanitic, reddish green intermediate alkalic rocks set in an aphanitic greenish matrix. These rocks form units 60.9 m wide.

Agglomerate consists of rounded bombs ranging in size from 25 to 152 mm in length and 13 to 38 mm across. The bombs are of pink or dark red porphyritic alkalic rocks in a dark green to dark purple fine-grained matrix. The phenocrysts in the bombs consist of hornblende crystals 3 mm by 2 mm. The agglomerate forms units 305 m wide.

METASEDIMENTS

Metasediments comprise clastic and chemical sediments, the clastic sediments being the more abundant.

Clastic Metasediments

The clastic metasediments are best exposed in the centre of the area at Okawakenda Lake, in eastern Kelvin Township and in the northeast of Fawcett Township.

Conglomerate consists of rounded clasts of felsic and intermediate metavolcanics and granitic rocks 50 to 200 mm across, and pebbles of quartz and felsic metavolcanics 20 to 40 mm across. These are set in a dark wacke, arenite, or an argillaceous matrix.

Arenites are buff or brown, medium-grained rocks which weather white, and are best exposed in northwestern Fawcett Township. They are massive or foliated, and are composed predominantly of quartz grains with less than 25 percent feldspar.

Wacke is a massive rock, black on the fresh surface, and greyish white on the weathered surface. It shows scattered grains of white-weathering feldspar 0.5 mm by 0.5 mm set in a dark aphanitic argillaceous matrix. In some cases the wacke shows regular banding, the bands being 3 to 5 mm thick. This latter rock type consists of very fine grained layers of wacke alternating with coarser grained layers consisting of feldspar grains 0.5 mm across in an aphanitic matrix. Wacke sometimes forms composite beds with chert. Such wacke-chert units comprise wacke similar to that described above and chert occurring at the uppermost part of the bed. The chert is aphanitic and grey in colour. A regular gradation from wacke to chert can be observed. These composite units vary from 15 to 25 mm thick.

Siltstones are pale brown on the weathered surface and grey on the fresh surface. They are composed of angular, subangular, and in a few cases subrounded grains of quartz, and completely sericitized and carbonatized grains of feldspar. They have a cloudy argillaceous matrix containing chlorite, secondary silica and opaque grains of leucoxene and pyrite.

Argillites comprise massive aphanitic unbedded units which are brownish grey on the weathered surface and black on the fresh surface. Sometimes a crude colour banding can be seen on the weathered and fresh surfaces, the bands varying from 2 to 4 mm thick. In thin section, some rocks show laminated structure, the rock comprising elongated chips of quartz, feldspar and pale yellowish micaceous grains, set in an almost isotropic matrix containing irregular elongated spongy streaks of leucoxene, and grains of pyrite.

Chemical Metasediments

Chert units, which occur independently and not as parts of composite units, are black, grey-green, or grey on the fresh surface and are interlayered with the volcanic rocks. The beds vary from 11 to 16 cm in thickness. Colour banding, minute grain-size gradations, and intricate contorted layering are visible in some cases on the weathered surfaces.

A thin section shows the rock to consist of fine particles of quartz and untwinned feldspar, and sparse grains of greenish hornblende and yellow-green epidote, in a light-coloured matrix which is dark grey when viewed under crossed polars. The slightly coarser-grained part of the chert is seen to contain irregular coarse-grained clots which consist of subhedral and euhedral grains of altered twinned and untwinned feldspar, euhedral fresh hornblende, and irregular patches of calcite and grains of epidote, set in a fine-grained matrix which polarizes to a very dark grey. It is believed by the author that these bands mapped as chert are, in some cases, silicified tuffs.

Ironstone consists of interbanded layers of grey or greyish black chert, red jasper, red and brown hematite and brown and black magnetite. Pyrite may or may not be present and can occur in amounts of up to 30 percent as disseminated blebs or grains 1 to 4 mm across in the jasper bands. Massive layers of pyrite were not observed. These composite units form beds varying from 2 to 150 m wide and occur discontinuously along strike lengths of up to 720 m. The character of the units varies in different parts of the map area. Thus, in Okawakenda and Michiwakenda Lakes, in the central part of the map area in northern Churchill Township, the formation consists of interbanded layers varying in thickness from 2 to 64 mm of argillite, hematite, magnetite, and black chert, with no pyrite, and forming composite units 50 m wide. In the southeast of the same township, argillite is absent and the formation comprises hematite, jasper, and white chert, with 30 percent pyrite as blebs 3 mm across and as fine disseminated grains. In the northeast of the same township only hematite is present. In the southeast of the map area in eastern Leonard Township, in the neighbourhood of Fournier Lake, the ironstone consists of jasper, magnetite, and hematite. This horizon represents the most promising ironstone unit, the total magnetite content not exceeding 15 percent (Collins 1917, p.124-125).

Metamorphosed Mafic Intrusive Rocks

The mafic plutonic rocks are medium- to coarse-grained rocks, brownish on the weathered surface and black, medium green, and grey-green on the fresh surface. They can be deceptively fine-grained in appearance when metamorphosed. The weathered surface shows them to be massive equigranular rocks. In some cases 3 by 1 mm dark green to black pyroxene grains can be seen. These rocks form units varying from 30 by 122 m to 366 m by 2.7 km. They are ellipsoidal bodies elongated in the direction of the regional strike and are most common in the lower part of the sequence.

Petrographically these rocks show hypidiomorphic granular texture and consist mainly of altered plagioclase (An_{34}) and common clinopyroxene. The plagioclase is brownish to almost opaque through alteration and is commonly saussuritized with the development of larger grains of epidote in places. The clinopyroxene may be fresh or altered to actinolite and chlorite, the actinolite showing ragged terminations.

In the silica oversaturated varieties, quartz and interstitial micropegmatite are present. In silica undersaturated varieties, olivine occurs as serpentinized euhedral and anhedral grains. Accessory minerals consist of epidote, chlorite, calcite, quartz, and leucoxene after ilmenite. The mode of one of these quartz gabbros was quartz 4 percent, altered feldspar 76 percent, common clinopyroxene 15 percent, chlorite 3 percent, epidote 1 percent, and 1 percent leucoxene after ilmenite. Four of these rocks, including the one above, were analyzed and they have been classified as calc-alkalic and tholeiitic in the chemical system of Irvine and Baragar (1971) (see Carter 1980, 1981a).

Felsic Intrusive Rocks

The granitic rocks in the map area occur as parts of large batholithic complexes or circumscribed stocks intrusive into the metavolcanics-metasediments. The batholithic masses are believed to be syntectonic, as they show foliation and gneissosity in places. The circumscribed stocks are regarded as post-tectonic being entirely unfoliated. These rocks have been classified according to the system of Ayres (1972) and Bateman *et al.* (1963) and plots of modal analyses are shown on Figure 8.

BATHOLITHIC COMPLEXES

There are 2 batholithic complexes within the map area. They represent the eastern and northern parts of large batholithic masses which extend to and beyond the west and south of the map area respectively. One of these batholiths, exposed in the northwest of the map area, is here called the Togo Batholith. The other, occurring in the south of the map area, is known as the Miramichi Batholith.

Togo Batholith

The Togo Batholith is exposed in the northwestern corner of the map area, over an irregular area approximately 10 km by 5 km. Its eastern boundary is in faulted contact with the volcanic rocks, but its southern contact shows intrusive relationships with these rocks. The batholith is therefore later than the metavolcanics. The southern part of the batholith is predominantly a pink, massive, medium-grained porphyroblastic microcline phase, which is locally non-porphyroblastic and gneissic.

The porphyroblastic phase consists of buff microcline porphyroblasts of perfect euhedral shape averaging 4 cm long by 3 cm wide and forming about 5 percent of the rock, and equant vitreous subhedral quartz grains 7 mm long by 5 mm wide in a granular matrix. Cursory examination in the field gives the impression that this is a porphyritic rock, but closer examination of the 'phenocrysts' show them to enclose all the matrix minerals, and thin section examination shows that the microcline 'phenocrystic' material extends out from the 'phenocrysts' into the interstices of the matrix. The author believes that this potassic material has been metasomatically introduced. In some areas the quartz is hematite-stained and looks deceptively like garnet.

Three thin sections were studied and the modes calculated (Carter 1981a). The matrix is hypidiomorphic granular to allotriomorphic granular consisting of: anhedral quartz showing wavy extinction; euhedral and subhedral fresh oligoclase (An_{12}); anhedral interstitial microcline; euhedral and subhedral green to dark green hornblende; lath-shaped green biotite; and accessory sphene, epidote, leucoxene, and pyrite. In some sections the plagioclase is cloudy and shows patchy alteration to epidote.

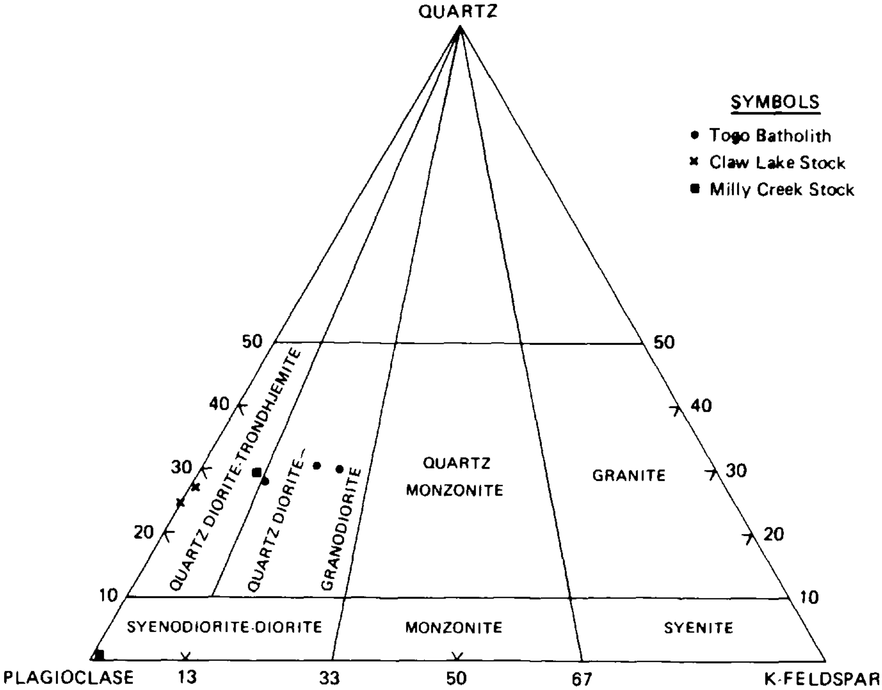


Figure 8–Volume percent of quartz, potassic feldspar, and plagioclase in felsic intrusive rocks of the Shining Tree Area. Percentages were determined by modal analyses and recalculated to 100 percent. Classification after Bateman *et al.* (1963) and Ayres (1972).

The composition of the matrix is granodiorite in the clasification of Ayres (1972). This agrees with the overall composition of the rock, although the amount of porphyroblastic microcline was not measured on the outcrop, but was estimated at about 5 percent.

Miramichi Batholith

The Miramichi Batholith occurs in the southwest of the map area and extends outside the area to the southwest and southeast. The batholith shows intrusive relationships on the northern, northeastern, and eastern contacts which parallel the trend of the enclosing metavolcanics. The batholith consists of a dominantly massive medium-grained phase, a lesser porphyritic phase, and a late dike phase comprising porphyries and aplite.

The massive medium-grained to coarse-grained facies is white, grey, pink, or pale greenish grey. Mafic minerals present are biotite and hornblende. The average grain size is 3 mm and the colour index ranges from 2 to 20. A well developed foliation shown by the parallel alignment of mafic minerals trends N65°W and forms the marginal facies of the rocks in Fawcett Township. Modal analysis of rocks from this facies showed them to be quartz monzonite, biotite granodiorite, and biotite trondhjemite in the classification of Ayres (1972).

The porphyritic phase is similar in field appearance to that observed in the Togo Batholith. It consists of phenocrysts or porphyroblasts of feldspar 1.9 cm long and anhedral quartz up to 1.3 cm across. The rock is pink and some of the feldspar phenocrysts are brick red.

Late porphyry dikes comprising feldspar, hornblende, and hornblende-feldspar porphyries cut the massive rocks and the surrounding metavolcanics-metasediments. They are brownish rocks consisting of phenocrysts of white or pink feldspar varying from 2 to 7 mm across and acicular hornblende 3 mm by 1 mm in size set in a fine- to medium-grained, reddish brown matrix. In thin section these rocks contain quartz phenocrysts (1 to 3 percent), feldspar phenocrysts (14 to 35 percent), hornblende phenocrysts (4 to 20 percent) and biotite (up to 2 percent). These are set in a microgranular matrix amounting to 42 to 69 percent and containing 2 to 3 percent accessory apatite, sphene, epidote, and leucoxene. It can contain up to 8 percent epidote.

STOCKS

Within the map area, elongated or roughly circular granitic stocks of various sizes and entirely enclosed by the metavolcanics-metasediments occur on the flanks of the regional synclinal axis. The 2 largest of these bodies are the Claw Lake Stock located in the northwestern part of the map area, and the Milly Creek Stock, located in the northeast. Only these 2 stocks will be described. Both are mineralized with molybdenum, copper, and gold.

Claw Lake Stock

The Claw Lake Stock is an irregular lens-shaped body, elongated in the direction of the regional trend of the volcanic rocks which it intrudes. The stock is 3.6 km long by 1.2 km wide at its widest (central) part. It consists of a massive and a porphyritic facies.

The predominant massive facies comprises quartz diorite and trondhjemite as defined by Ayres (1972). The quartz diorite is a medium-grained, greenish grey rock consisting of quartz, altered plagioclase and interstitial micropegmatite with accessory pyrite and ilmenite (Carter 1981a). The trondhjemite forms a minor facies of the stock and is pink and medium grained with a colour index of 5. It consists of quartz, plagioclase, potassic feldspar, and quartz-orthoclase micropegmatite, with muscovite, biotite, and accessory calcite, apatite, and pyrite (Carter 1981a).

The porphyritic facies forms a phase of the stock and also occurs as dikes. This facies consists of either a dark green quartz diorite or a pale buff trondhjemite (Carter 1981a).

Milly Creek Stock

The Milly Creek Stock is lensoid in shape, 2.4 km long by 2 km wide, and elongated parallel to the strike of the country rocks. The true length must be greater, as it is truncated at its southern end by a fault, and covered by Middle Precambrian rocks to the north. Porphyritic facies were not present within this stock.

The rock is a massive grey (most common) or pink granitoid. These are both medium- to coarse-grained hornblende-plagioclase rocks containing accessory apatite, magnetite, ilmenite, leucoxene, zircon, and hematite. Owing to the altered nature of the plagioclase, the rocks could not be named modally but will be syenodiorite, diorite, trondhjemite, or quartz diorite in the classification of Ayres (1972) (*see* Carter 1981b).

MIDDLE PRECAMBRIAN

Huronian Supergroup

QUIRKE LAKE GROUP

Espanola Formation

The Espanola Formation, here the only representative of the Quirke Lake Group, comprises limestone occurring as white and grey recrystallized calcite associated with magnetite. These rocks are exposed in the southwest of the map area in the valley of Elephant Head Creek, 0.8 km above its entry into Elephant Head Lake at the southern boundary of Connaught Township. They occur over an area 244 m long by 152 m wide, strike N20°W and dip 15°NE. Minor upright folds of wavelength of about 0.6 m and an amplitude 31 cm occur within the formation. The limestone unconformably overlies Early Precambrian rhyolite.

COBALT GROUP

The Cobalt Group is represented by the Gowganda Formation and the Lorrain Formation. These occur predominantly in the eastern but also in the west-central parts of the map area.

Gowganda Formation

The Gowganda Formation comprises polymictic orthoconglomerate, paraconglomerate, wacke, arenite, siltstone, argillite, and slate.

Polymictic orthoconglomerate occurs at and near the base of the formation and is characteristically pink and brownish. It consists of subrounded and rounded cobbles and boulders of granite (the most abundant rock type), granite-gneiss, felsic metavolcanics, schist, ironstone, quartzite and quartz. These are set in a medium to coarse, sand-sized, arkosic or fine-grained wacke, siltstone, or argillite matrix. The clasts generally are clast supported. They comprise from 5 to 50 percent of the volume of the rock and vary in size from 5 to 30 cm.

Paraconglomerate is uncommon within the Gowganda Formation. It is exposed along Highway 560 in northeastern Macmurchy Township and in northwestern Leonard Township and usually occurs in association with orthoconglomerate. It consists of sparse pebbles of massive pink granitic rock ranging in size from 6 mm to 51 mm lying in a massive, dark green argillaceous matrix. The clasts are entirely matrix supported.

Wackes are medium-grained, dark, greenish grey rocks on the fresh surface. They contain grains of quartz and feldspar averaging 0.5 mm across and rare chips of subangular and subrounded reddish brown jasper 0.5 mm by 1.5 mm. Lithic fragments are rare. Graded bedding, ripple marks, and flame structures were observed. The wacke commonly occurs interlayered with the conglomerate, rather than as an independent member.

Arenites are pink, grey, greyish white, yellow, and pale reddish brown and are fine-grained. They consist predominantly of quartz and feldspar and are best developed in the northeastern corner of the map area. The grain size of these rocks is uniform, the grains being usually less than 0.5 mm in maximum dimension. Coarser grained varieties are much less common. Bedding is well developed, the rocks occurring as bedded units 25 to 41 cm in thickness. In the fine-grained rocks, lithic components are rare. In the coarser varieties, called pebbly arenites, lithic fragments are common and form the pebbles. These pebbles are angular to subangular, range from 2 mm by 2 mm to 1 cm by 1 cm and consist mainly of pink granitic rocks. A few of the larger fragments are of quartz or feldspar.

The siltstones are dark-greyish rocks and occur in massive beds varying from 2 cm to 0.8 m thick. They are characterized by numerous irregular pink patches which consist of irregular arenaceous material and detached parts of fine sandstone units. It is believed by the author that such structures are due to simultaneous deposition of argillaceous and arenaceous material.

On the southwestern shore of Mullen Lake at a dark grey siltstone outcrop about 0.4 km from the extreme southern end of the lake, curious worm-like impressions are found as well as irregular annular structures. They vary from 2 to 15 mm across and consist of red silty material. The central parts of the annular structures are usually weathered out, the cavities are cylindrical and cross-cut the bedding. This increases the resemblance of these structures to worm borings.

The argillites are massive, blocky, black rocks which in many outcrops look deceptively like basalt. They contain rare ovoid granule-sized fragments of granite. These rocks are best exposed in the northeastern corner of the map area in Knight Township and less commonly in southwestern Tyrrell Township. Some of the argillites are very finely laminated and show grain gradation in the silty parts. Contorted bedding structures are well displayed especially in the exposures in southwestern Tyrrell Township.

Slates are uncommon in the map area and are formed from the argillites in narrow zones of fracturing.

Lorrain Formation

The Lorrain Formation occurs in the southeastern corner of the map area, southeast of Shining Tree Lake. It is overlain and underlain by a Nipissing Diabase sill. At one point along the eastern shore of the lake a dip of 5° south was recorded and from the disposition of outcrops and contact relationships with the diabase, the strata appear to be dipping inwards in all directions, forming a shallow basin-type structure.

The rocks consist of well sorted pink, cream, and white arkose and quartz arenite, varying from coarse to medium grained. In some cases the coarser varieties have magenta coloured clasts 2 to 4 mm across.

Mafic Intrusive Rocks (Nipissing-Type Diabase Sills)

Most of the mafic intrusive rocks occur as 2 diabase sills, an upper and a lower, best exposed in the southeastern corner of the map area. Away from this area and scattered throughout most of the region are irregular-shaped areas underlain by diabase. These are believed by the author to be outliers of the lower sill. They rest directly on the metavolcanics. The lower sill was intruded along the unconformity between the Huronian sediments and the Early Precambrian rocks. The upper sill was intruded into the Lorrain Formation.

Diabase is typically a medium-grained, greenish black or mottled white and black massive rock on the fresh surface, and reddish brown on the weathered surface. The weathered surface commonly shows a coarse, crude, ophitic texture.

In thin section the fresh rock shows coarse ophitic to subophitic texture consisting of fresh and altered brown saussuritized plagioclase (labradorite, An_{59}) and fresh, uralitized and chloritized common clinopyroxene. The plagioclase and clinopyroxene form a framework which encloses interstitial irregular grains of quartz, micropegmatite, and graphic quartz-feldspar intergrowths. Opaque grains are of magnetite or ilmenite. This rock type comprises most of the mafic rocks forming the sills.

Where altered the pyroxene is partially changed to hornblende, epidote, and chlorite, the feldspar is saussuritized, and the rock is then dark green in colour. Leucocratic facies occur locally and for these the colour index is about 20. A leucocratic facies occurs as an east-trending diabase dike on the eastern and western shores of Big Four Lake, Macmurchy Township, about 1.2 km south of the northern boundary of the township.

Flow structure may be developed in the diabase, as expressed by the alignment of feldspar laths in subparallel arrangement. This can be seen on the southern shore of Ashburn Lake in Macmurchy Township.

Actinolite gabbro is a medium-grained facies best developed in southwestern Churchill Township. The amphibole occurs as grains 3 mm across. In thin section the rock consists of pale green pleochroic actinolite with ragged terminations, some grains of which show wavy extinction. The actinolite is altered in places to chlorite, and completely or partly encloses altered, lath-shaped, euhedral plagioclase which consist of albite (An_8) pseudomorphs of sericitized and epidotized plagioclase containing irregular patches of calcite. Interstitial anhedral grains of epidote and magnetite are scattered through the rock.

Quartz diabase is not common in the area. Examples occur in north-central Connaught Township as part of the sill-like masses. The rock is similar to the unaltered non-porphyritic diabase except that the quartz diabase is much coarser grained. The quartz forms grey, subhedral grains about 1 to 2 mm across.

The 1 occurrence of porphyritic diabase was on the mid-western shore of Oddur Lake in southwestern Churchill Township. The rock is unaltered, black and medium grained, with glomeroporphyritic yellow feldspar phenocrysts 6.4 mm across.

Coarser-grained pegmatitic facies also occur within the sills. These consist of radiating acicular crystals of hornblende and amphibolitized augite, up to 20 mm long and 3 mm wide, associated with pink and yellowish green epidotized plagioclase feldspar 2 to 10 mm across. This pegmatitic facies is commonly associated with a fine-grained feldspathic facies virtually devoid of ferromagnesian minerals. In thin section the pegmatite shows augite in all stages of conversion to hornblende or actinolite and biotite and altered andesine (An_{34}) surrounded by interstitial quartzofeldspathic granophyric intergrowths. Much of the plagioclase is altered to sericitic mica and calcite, and the biotite is altered in places to pale green chlorite. Accessory minerals consist of magnetite, ilmenite, and quartz. During the mapping, areas of chalcopyrite or silver mineralization were found to be spatially associated with diabase-pegmatite occurrences.

Granophyric diabase shows phenocrysts of pyroxene and hornblende in a dark red to mauve, fine-grained groundmass. This granophyric material may comprise 30 to 70 percent of the rock, and in the latter case the rocks resemble syenite. A thin section shows it to consist of lath-shaped plagioclase (acid andesine, An_{33}) embedded in an iron-stained, patchy quartzofeldspathic granophyric matrix. The augite is altered to hornblende and chlorite.

EARLY TO LATE PRECAMBRIAN

Mafic Intrusive Rocks

Diabase dikes in the map area belong to a generally north-northwesterly trending set. A few dikes follow a less important east-southeasterly trend. The latter is younger than the former.

SUBALKALIC (THOLEIITIC) DIABASE

The subalkalic diabase forms northwesterly dikes which vary in width from 0.3 to 60 m. Chilled margins are common. The dikes can be followed intermittently for distances of up to 10 km. The longest is exposed in the northeast of the map area.

The rocks are fine to medium grained, are black on the fresh surface and rusty brown on the weathered surface. Ophitic texture can commonly be observed on the weathered surface. They may be porphyritic or glomeroporphyritic, with pale yellow feldspar phenocrysts 7 to 25 mm in largest dimension. Leucocratic facies have a colour index of about 20 and granophyric phases show irregular interstitial patches of dark red micropegmatite.

Eight thin sections were examined. The textures observed were intergranular, subophitic, and porphyritic-intergranular; in all of these, disoriented laths of plagioclase enclosed grains of common clinopyroxene. A reverse intergranular texture was observed in one case in which laths of clinopyroxene enclosed granular plagioclase. Mineralogically the rocks comprise anhedral quartz (3 to 4 percent); plagioclase (34 to 67 percent) $An_{50\ to\ 56}$ variably saussuritized to sericite, calcite, and epidote; common clinopyroxene (23 to 37 percent) variably altered to hornblende, chlorite, and epidote; micropegmatite (up to 6 percent); and opaque minerals (2 to 4 percent) comprising pyrite, magnetite and ilmenite.

Two of these rocks were chemically analyzed and are tholeiitic in the classification of Irvine and Baragar (1971). They are thus tholeiitic diabases (Carter 1981a). The rocks are always magnetic, often markedly so.

ALKALIC DIABASE

The alkalic diabase forms dikes with an east-southeasterly trend and were observed in northwestern Cabot Township 0.8 km west of the southern end of Ketchiwaboose Lake. Other dikes of this trend are believed by the author to be of the same type.

This type of dike is a porphyritic, black, medium-grained magnetic rock. It contains yellowish green euhedral, lath-shaped and rectangular phenocrysts of feldspar measuring from 5 mm by 2 mm to 20 mm by 5 mm. These phenocrysts are glomeroporphyritic in places.

Petrographically the rock shows intergranular texture. This consists mostly of fresh, lath-shaped disoriented plagioclase (andesine: An_{35}) enclosing intergranular areas of clinopyroxene, hornblende, and biotite. Opaque crystals of ilmenite-magnetite showing alteration to leucoxene occur as square, rectangular, triangular, and irregular grains. Some of the plagioclase is altered to sericite and the clinopyroxene to hornblende, biotite, chlorite, and magnetite. The magnetite occurs both as square, rectangular, and irregular grains in the altered and fresh minerals, and as a border around the clinopyroxene. Al though most of the hornblende and biotite is secondary, some is primary as shown by the euhedral forms and lack of associated alteration.

Chemically the rock is alkalic and is classified with the sodic alkali basalt series of Irvine and Baragar (1971) and (Carter 1981a). The rock is not highly altered as shown by thin section examination and is thus confidently classed as an alkali-diabase.

On the basis of its alkalic composition, the east-southeasterly trend, and the fact that it is younger than the north-northwesterly trending dikes, this dike probably belongs to the Sudbury dike swarm and could then be Late Precambrian (Fahrig *et al.* 1965, p.287-289, p.295-296).

CENOZOIC

Quaternary

PLEISTOCENE AND RECENT

Gravelly and sandy till forming ground and end moraine deposits (Boissonneau 1965) occur in patches on high ground throughout the map area. They are best exposed along Highway 560, the Bay Lumber road in Macmurchy Township and along the Hydro-Electric Power Commission transmission lines and roads in the east and west of the area. Boulders, pebbles, and coarse and fine sand also occur in eskers located in the west and northeast of the map area. The boulders consist predominantly of granitic and volcanic rocks.

Fine white and yellow sand form outwash deposits in western Connaught Township and northeastern Cabot Township (Boissonneau 1965). In northeastern Cabot Township the sands form crescent-shaped dunes with steep ridges that are convex to the east-southeast. Similar narrow, steep, north-trending linear ridges occur in southeastern Connaught Township.

Fine sand also forms level plains of glacial lacustrine deposits (Boissonneau 1965) in southeastern Miramichi Township. These represent deposits of the glacial Lake Barlow-Ojibway (Douglas 1970, p.733-734).

Muskeg occurs in areas of variable size, mainly in Kelvin, Fawcett, and Leonard Townships.

STRUCTURAL GEOLOGY

Folding

The basement structure of the area mapped is interpreted by the author to represent a foundered, distorted, composite volcanic edifice: the Natal Volcanic Complex. Figure 3 (*see* Geological Summary section) shows the suggested development of the complex. This first order structure was intruded by granitic batholiths and subsequently unconformably overlain by Middle Precambrian sedimentary rocks containing intercalated mafic sills.

The volcanic rocks are folded about a major, sinuous, synclinorial axis which trends N40°W in the east and northeast of the map area; N60°E in the north-central part of the area; and westerly in the western half of the area. This axis is doubly-plunging: in the northeastern corner of the map area the plunge was calculated to be 20° to the northwest; and in the west the plunge was measured to be on average 35° to the southeast. The effect of the plunge of the axis is to cause the rocks to trend northeasterly in the northwestern part of the area, northwesterly in the northeastern part of the area, and southeasterly in the south.

The lower rocks of the sequence occur on both limbs of the major synclinorial axis and dip steeply between 45° and the vertical. Locally these rocks are overturned. Beyond the northeastern limit of the map area these lower mafic rocks occur in the northeastern corner of Knight Township (Carter 1981b) trending northwesterly and facing southwesterly. They continue with this same trend and facing, into eastern Tyrrell Township (Carter 1977a) where they are partly hidden by overlying Huronian rocks. Thus the lower mafic rocks form a symmetrical envelope consistent with the major synclinorial axial trend and support the view that the major edifice is that of a distorted volcanic complex.

Above the mafic rocks the sequence consists predominantly of intermediate and felsic pyroclastic rocks. These are overlain by interlayered clastic volcanic rocks, sedimentary rocks, and alkalic metavolcanics representing the uppermost part of the volcanic sequence.

Superimposed on the major structure are a set of concordant minor folds with a wavelength of about 0.9 km. These occur both in the lower and upper parts of the sequence. In the lower part they are best developed in northeastern Asquith Township. As the granite contact is approached, however, the folding is in most cases no longer evident. In the upper part of the sequence this second-order folding is well developed and displayed in northeastern Churchill Township in Okawakenda and Michiwakenda lakes. In these 2 areas even smaller scale folding is apparent, especially in the sedimentary rocks. The wavelength of this third-order folding is of the order of 10 to 30 m, readily visible on large outcrop areas, for example on islands in the extreme north of Michiwakenda Lake. The axes of these folds have not been shown on the map.

Although some of this very small-scale folding can be attributed to tectonic effects associated with the Michiwakenda Lake Fault, the folding can be observed at distances of 5 km west of the fault. It is believed by the author that the minor folds were formed last; they are not confined to the region of the granite contact where they could be interpreted as due to localized compression resulting from granite intrusion. Also, the symmetrical distribution pattern of the lower mafic metavolcanics forming an envelope to the major structure, and the concordance of the 2 folding patterns, imply that a major synclinal structure was formed first and that the tight minor folds were formed last, as a final adjustment of the rocks to continued compression.

The distortion of an original circular form of volcanic edifice is due to the intrusion of the granitic batholiths. This is suggested by the fold axes in the southwest of the area being subparallel to the contact with the granitic rocks. The major structure is described as synclinorial because the lower mafic rocks form an envelope around the younger rocks while, at the same time, a minor folding is impressed on all the rocks. Only in this way can the symmetrical arrangement of the rocks and the set of second-order fold axes be accommodated. The overall first-order structure is envisaged as a subsiding shallow basin.

It is not apparent, from evidence within the map area, why the major synclinorial axis is curved. It could be that the actual trend followed by the axis is determined by the relative position of the intrusive granitic batholiths. Reference to the Timmins-Kirkland Lake sheet, Map 2205 (Pyke *et al.* 1973), shows that the Shining Tree area lies between the Togo and Miramichi Batholiths to the west and the Round Lake Batholith to the east. The northeastern trend of the axis in the east of the area follows a median direction between these masses. In the west of the area the axis is east-trending reflecting the primary influences of the Togo and Miramichi Batholiths.

Faulting

The area is crossed by numerous faults comprising a north-northwesterly set, a minor northeasterly set and a minor east-trending set.

NORTH-NORTHWESTERLY FAULTS

The north-northwesterly faults are from west to east: the Mattagami Lake Fault, the Elephant Head Lake Fault, the Michiwakenda Lake Fault, the Jess Lake Fault, the Soot Lake Fault, and the Pigeon Lake Fault. Many less extensive faults and lineaments occur parallel and subparallel to these, but they are not named.

The author believes these to be gravity faults, based on stratigraphic, geomorphological, structural evidence and also with strike-slip movement on the Michiwakenda Lake Fault. In the west of the map area the downthrow is to the east of the faults. This is deduced from the successively narrower remnants of metavolcanics west of the Elephant Head Lake and Mattagami Lake Faults. This interpretation is strengthened by the narrowed remnants being more highly metamorphosed, implying that deeper levels have been upthrown, the metavolcanics forming 'keels' suspended in granitic rocks. In the east of the map area, west of the Jess Lake Fault, geomorphological evidence indicates that the downthrow was to the west. On the Michiwakenda Lake Fault, in the centre of the area, the downthrow is to the east (based on stratigraphic evidence), as more of the upper part of the sequence is preserved between this fault and the Jess Lake Fault. Thus, the Shining Tree area occurs in a region affected by block faulting.

These faults occur in an area which coincides with the Onaping Lineament (Wilson 1949, p.239). Wilson suggested that this lineament formed the western margin of the Cobalt Graben which was bordered on the east by the Timiskaming Lineament. The Cobalt Graben is to the east of the map area, and the Cobalt Group rocks of the Huronian Supergroup, exposed in the eastern margin of the area, would represent the western edge of the Cobalt Graben cover rocks. This agrees with the interpretation here.

Strike-slip movement is seen on the Michiwakenda Lake Fault. The displacement as shown by the offsetting of granitic rocks along its southern part, is left-lateral and 5.7 km in extent.

NORTHEASTERLY FAULTS

Northeasterly faults occur in southeastern Asquith Township, central and northeastern Macmurchy Township and southeastern Natal Township. They may all belong to one fault, portions of which have been displaced by the north-northwesterly faults. They may thus be older than the north-northwesterly faults.

EAST-TRENDING FAULTS

East-trending faults occur in Tyrrell Township. The most important is the Milly Lake Fault. It is probably a gravity fault with downthrow on the south side, as the Milly Creek Stock is abruptly cut off and does not reappear south of the fault.

ECONOMIC GEOLOGY

Within the map area deposits of asbestos, cobalt, copper, gold, iron, lead, molybdenum, nickel, silver, and zinc occur in characteristic associations and in most cases show a definite relationship to rock type. The deposits are therefore described with respect to associations and types according to the classification of Stanton (1972).

Only gold was produced in the area and came from 2 mines: Ronda Mine in southwestern Macmurchy Township which produced in the year 1939 only, and Tyranite Mine in northeastern Tyrrell Township which produced from 1939 to 1942.

Considerable exploration activity was carried out for economic deposits of molybdenum in the Claw Lake felsic intrusive stock in Cabot Township, and for silver in the Nipissing-type diabase sill in southwestern Leonard Township. Much diamond drilling for nickel deposits was carried out in the southwestern Knight Township.

Syngenetic Deposits

DEPOSITS ASSOCIATED WITH ULTRAMAFIC ROCKS

Asbestos-Nickel

Ultramafic rocks occur in eastern Kelvin Township, in southwestern Knight Township and in southeastern Fawcett Township. These rocks are believed to be flows by the author.

Asbestos occurs mainly in southwestern Knight Township (Carter 1981b), as well as in northern Macmurchy Township (Carter 1977a) and in central Kelvin Township (Carter 1981a).

Nickel deposits occur mainly in Knight Township at Arthur Lake (Carter 1981b) and also in southeastern Fawcett Township (Carter 1977b).

STRATIFORM SULPHIDES OF MARINE-VOLCANIC ASSOCIATION

Copper-Lead-Zinc

Stratiform copper-lead-zinc deposits are believed by the author to be represented by the Mataris Prospect of Coniston Explorations and Holding Limited (Carter 1980), in northeastern Connaught Township, and to occur on the HBOG Mining Limited property in eastern Kelvin Township (Carter 1981a). Silver and gold are associated with these deposits (*see* Northern Miner Press 1970, 1971).

BANDED IRON FORMATION

Iron

Iron deposits, as oxide facies iron occurrences of the banded iron formation type of Stanton (Stanton 1972, p.429 et seq.), form sedimentary beds interlayered with the metavolcanics-metasediments at various horizons within the sequence (Carter 1977a, 1977b; 1980, property number 6). A promising deposit, on which the most exploration was done, was the McVittie-Bennett deposit at Fournier Lake in central Leonard Township (Carter 1977b).

DEPOSITS OF MAFIC-ULTRAMAFIC IRON-NICKEL-COPPER SULPHIDE—PLATINOID ASSOCIATION

Copper-Nickel

Within the map area various lensoid, elongated bodies of quartz gabbro and olivine gabbro occur, parallel to the regional trend. They are best developed in Cabot and northeastern Kelvin Townships (*see* Naldrett and Cabri (1976) for a description of the mafic-ultramafic metal association). Rocks described as diorite in company reports may be altered gabbros. Copper-nickel deposits of mafic-ultramafic rock association occur in Cabot Township (Carter 1981a).

DEPOSITS OF QUARTZ MONZONITE-GRANODIORITE COPPER-MOLYBDENUM SULPHIDE ASSOCIATION

Copper-Molybdenum-Gold

Deposits of copper, molybdenum, and gold showing resemblances to the quartz monzonite-granodiorite type of mineralization occur associated with the Claw Lake Stock in southern Cabot Township (Carter 1981a). The stock comprises both massive and porphyritic facies consisting of quartz diorite and trondhjemite. Considerable prospecting was carried out for gold and molybdenum intermittently between 1919 and 1972.

DEPOSITS OF NATIVE SILVER, COBALT-NICKEL ARSENIDE "COBALT TYPE"

Cobalt-Silver

Within the map area cobalt and silver occur together in the cobalt-nickel arsenide "Cobalt-type" association. In this setting cobalt occurs in quartz-calcite fissure veins in diabase sills and dikes as smaltite and cobalt bloom; and native silver as small flakes and scales in cracks in calcite, associated with chalcopyrite, native bismuth, niccolite, and galena. These deposits are particularly numerous in southwestern Leonard Township (Carter 1977b). They also occur in north-central Cabot Township (Carter 1981a).

DEPOSITS OF CONTACT-METAMORPHIC ASSOCIATION

Copper-Iron

A contact-metamorphic type of deposit is exemplified by the Saville Occurrence (Carter 1980) located near the southern boundary of Connaught Township near Elephant Head Lake. It is a vein-type and stratabound massive deposit associated with the Espanola Formation of the Quirke Lake Group. It consists of massive chalcopyrite, bornite, pyrrhotite, pyrite and magnetite, enclosed in calcite, and is similar to those described by Card and Innes (1973, 1974) in the Sudbury area.

Epigenetic Deposits

VOLCANIC PRECIOUS METAL TELLURIDE ASSOCIATION

Gold - Silver

In the volcanic precious metal telluride association gold can be native or combined with silver. It occurs in silicified and carbonatized shears and quartz fissure-veins in mafic subalkalic metavolcanics, alkalic metavolcanics, and associated metasediments. The veins are both concordant and discordant with the regional structural trend. One prominent vein set is north-trending and it is in such veins that the two former producing mines were located. The Ronda Mine (Carter 1977a, property number 21) and Tyranite Mine (Carter 1977a, property number 47) are good examples of this type of gold mineralization (*see* Northern Miner Press 1939). These produced 34 079 ounces gold and 9690 ounces silver in the period 1939 to 1942. Another set of veins trends northwesterly, parallel to the local regional structure. Two less important directions are northeasterly and easterly.

Ore minerals associated with the gold are chalcopyrite, molybdenite, pyrrhotite, barite, galena, tourmaline, pyrite, specular hematite, arsenopyrite, sphalerite, and tellurides. Gangue minerals are quartz, carbonates, talc, sericite, chlorite, feldspar, tourmaline, albite, and mariposite.

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Index

PROPERTIES

ASQUITH TOWNSHIP

1. Annett, Roy
2. Annett, Roy, MacBride, William, and Saville, Stewart
3. Armstrong, E.A.M. and others
4. Barbour, Margaret
5. Charnota, Alice, and Chyka, Arthur
6. Charnota, Alice, Chyka, Arthur, and Moore, J.J.
7. Coulson, J.P., Estate
8. Cousineau, Thomas, Estate
9. Featherstone, C.J., and Mitchell, A.C.
10. Hologden Mines Limited [1922]*
11. Johnston, H.O. [1968]
12. Jutras, Jacques
13. Kayak Explorations Limited
14. Leahy, M.J.D.
15. William MacBride Occurrence
16. McGuire, Frank, and McGuire, J.I.
17. Moore, A.R., and Moore, E.P.
18. Moore, J.J., Estate
19. Reipas, Alma, and St. Charles, W.P.
20. Russell, R.J.R., Estate
21. Saville, Albert
22. Sullivan, W.J.
23. Vale, P.A., Estate
24. Vintage Mines Limited

CABOT TOWNSHIP

1. Canadian Johns-Manville Prospect
2. Continental Diamond Drilling and Exploration Company Prospect
3. Doyon, P.
4. Falconbridge Nickel Mines Limited
5. Galata, E. [1970]*
6. Irving, M.A.
7. Jonsmith Mines Prospect
8. Larche, J.P.

CHURCHILL TOWNSHIP

1. Hames, C.M. (Cochrane Occurrence)
2. Jonsmith Mines Occurrence [1971]*
3. Jorgenson, W.D. (Gold Corona Occurrence)
4. McBride, W. (Gosselin Occurrence, McBride Occurrence)
5. McDiarmid, O.
6. Royal Mining Corporation [1971]
7. Triton Explorations Limited (Knox Prospect, Churchill Mining and Milling Company Limited Prospect)
8. Wiermeir, A.

CONNAUGHT TOWNSHIP

1. Active Mines Limited
2. Bagamac Mines Occurrences
3. Collins, R., Collins, Y., Marino, L., McKinnon, D., and Todd, B. [prior to 1972]*
4. Coniston Explorations and Holdings Limited (Mataris Prospect)
5. Duvay Gold Mines Limited [1950]
6. Foster Lloyd Occurrence
7. Goldhurst Resources Incorporated
8. Mid-North Engineering Services Limited
9. Murky Fault Metal Mines Limited [1967]
10. Royal Agassiz Mines (Saville) Occurrence

FAWCETT TOWNSHIP

1. Amax Potash Limited
2. Barbour, M.
3. Burkett, L.H.
4. Clarkson, I.B.
5. Jonsmith Mines Limited
6. Midrim Mining Company Limited [1966]*
7. Ramsay, R.G.

LEONARD TOWNSHIP

1. Archibald, E.B.
2. Associated Porcupine Mines Limited
3. Caswell-Eplett Prospect
4. Coulee Lead and Zinc Mines Prospect
5. Decker, A.
6. Explorations Projects [1959]*
7. Greave, E.L. [1912]
8. Leonard Silver Mines Limited [1912]
9. McVittie, J.P., and Bennett, W.S.
10. Neelands Prospect
11. Newnorth Gold Mines Limited [1957]
12. Saville Prospecting and Exploration Company Limited, The [1909]
13. Shining Tree Lake Occurrence
14. Silver Dollar Mines Limited [1947]
15. Silver Pack Mines Occurrences
16. Sullivan, M.J.

KELVIN TOWNSHIP

1. HBOG Mining Limited [1975]*
2. Talisman Mines Limited [1967]

KNIGHT TOWNSHIP

1. Amax Potash Limited [1971]*
2. Arthur Lake Mines Limited
3. Courageous Gold Mines Limited [1959]
4. Dalhousie Oil Company Limited
5. Decker, A.
6. Hurst, C.F. Occurrence
7. Metikemedo Mines Limited
8. Timiskaming Nickel Limited
9. Tyranite Mines Limited
10. Wahbic Explorations Limited
11. Zenella, A.

MACMURCHY TOWNSHIP

1. Amax Potash Limited
2. Amoco Canada Petroleum Company Limited
3. Annett, R. [1963]*
4. Big Four Lake Occurrence
5. Bilmac Gold Mines Limited
6. Brunet, C.W.
7. Cook, C.
8. Cooper, J.M., Manwell, A.E., and Moore, A.R.
9. Cryderman, B.M., Manwell, A.E., and Moore, A.E.
10. Edwards, A.A.
11. Featherstone, C.J.
12. Grantland Gold Limited [1954]
13. Houston Lake Jasper Deposit
14. Jefferson Deposit
15. Johnson, D.A., and Johnson, R.M.
16. Mayflower Metals Limited
17. Moore, J.J.
18. Sams Lake Deposit
19. Shining Tree Creek Deposit
20. Sutherland, W.D., and associates
21. Triton Explorations Limited
22. Wasapika Lake Deposit

MIRAMICHI TOWNSHIP

1. Courier Explorations Occurrence

NATAL TOWNSHIP

1. Arthur Lake Mines Limited
2. Ecstall Mining Limited
3. Fuller, A. [1945]*
4. McIntyre-Porcupine Mines Occurrence (a and b)
5. Nabigon, P. (a and b)
6. Natal Lake Copper Occurrence
7. Sommerville Copper Occurrence
8. Sutherland, W.D., and associates [1966]
9. Talisman Mines Limited [1967]
10. Timiskaming Nickel Limited [1967]
11. Whyte, A.

TYRRELL TOWNSHIP

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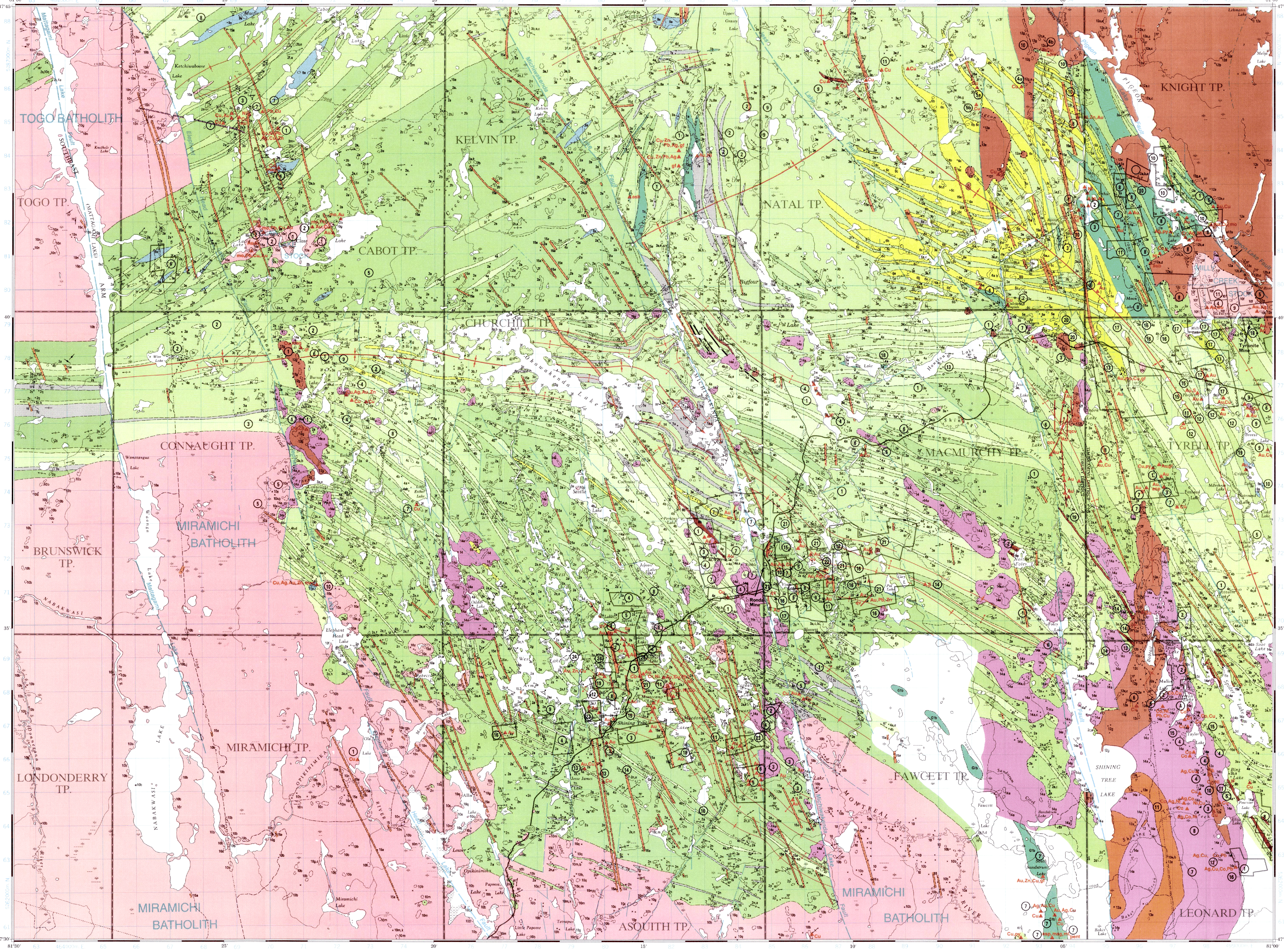
2. Associated Porcupine Mines Limited
3. Byberg, A.
4. Cleroux, D.F.
5. Cryderman, J., and McVittie, J. [1931]*
6. Dalhousie Oil Company Limited
7. Duggan, H., Gardiner, H.D., and Harkin, T.L.
8. Holmes Deposit
9. Lorenzo, F.A., and Shahen, A.
10. Mid-Tyrrell Matachewan Gold Occurrences
11. Mining Corporation of Canada Deposit
12. Ranworth Exploration Company Occurrence
13. Reford Mines Limited
14. Shining Tree Creek Deposit
15. Sunbeam Exploration Deposit
16. Sutherland, W.D., and associates
17. Timiskaming Nickel Limited
18. Tyranite Mines Limited

* Date in square brackets indicates the last year of exploration activity on land open for staking at the time of writing (1976).



Scale 1:50 000

Metres 1000 0 1 2 3 4 Kilometres

Chains 80 40 0 1 Miles

LEGEND

PHANEROZOIC
CENOZOIC
QUATERNARY
PLEISTOCENE AND RECENT
Gravel, sand, alluvial, and swamp deposits
UNCONFORMITY

PRECAMBRIAN
EARLY TO LATE PRECAMBRIAN
MAFIC INTRUSIVE ROCKS
ALKALIC DIABASE DIKES

16 — 16a Porphyritic

SUBALKALIC DIABASE DIKES

15 — 15 Unsubdivided; 15a Massive, medium grained; 15b Granophyric; 15c Leucocratic; 15d Coarse grained

INTRUSIVE CONTACT

MIDDLE PRECAMBRIAN
MAFIC INTRUSIVE ROCKS (NIPISSING-TYPE DIABASE SILLS)

14 — 14 Unsubdivided; 14a Diabase, massive; 14b Quartz diabase; 14c Diabase, porphyritic; 14d Diabase, granophyric; 14e Diabase, coarse grained; 14f Gabbro, actinolitic

INTRUSIVE CONTACT

HURONIAN SUPERGROUP
COBALT GROUP
LORRAIN FORMATION

13 — 13 Unsubdivided; 13a Arenite, feldspar rich; 13b Arenite, quartz rich

GOWGANDA FORMATION

12 — 12 Unsubdivided; 12a Argillite; 12b Siltstone; 12c Arenite; 12d Slate; 12e Paraconglomerate; 12f Wacke; 12g Orthoconglomerate

QUIRKE LAKE GROUP
ESPANOLA FORMATION

11 — 11 Unsubdivided; 11a Limestone, with magnetite

UNCONFORMITY

EARLY PRECAMBRIAN
FELSIC INTRUSIVE ROCKS

10 — 10 Unsubdivided; 10a Granodiorite, massive; 10b Hornblende-biotite quartz monzonite, massive; 10c Granite, massive; 10d Syenite, locally with hornblende; 10e Diorite; 10f Hornblende±biotite granite, massive; 10g Granite, porphyritic; 10h Biotite trondhjemite; 10j Granite, brecciated; 10k Aplite; 10m Granite, gneissic; 10n Biotite granite±hornblende and feldspar porphyroblasts; 10p Hornblende granite±biotite and feldspar porphyroblasts; 10q Biotite-hornblende granite, gneissic; 10r Gneiss-amphibolite migmatite; 10s Hornblende-biotite, gneissic

INTRUSIVE CONTACT

METAMORPHOSED MAFIC INTRUSIVE ROCKS

9 — 9 Unsubdivided; 9a Gabbro, diorite

INTRUSIVE CONTACT

METAVOLCANICS AND METASEDIMENTS
METASEDIMENTS
CHEMICAL METASEDIMENTS

8, 8b — 8a Chert; 8b Hematite and magnetite ironstone, with chert, jasper, and pyrite

CLASTIC METASEDIMENTS

7 — 7 Unsubdivided; 7a Argillite; 7b Arenite, quartz rich; 7c Wacke; 7d Siltstone; 7e Conglomerate; 7f Slate; 7g Arenite, feldspar rich; 7h Biotite-quartz-feldspar gneiss

METAVOLCANICS
ALKALIC METAVOLCANICS[a]
Intermediate Metavolcanics

6 — 6 Unsubdivided; 6a Flows, aphanitic; 6b Flows, porphyritic; 6c Lapilli-tuff; 6d Tuff-breccia

Mafic Metavolcanics

5 — 5 Unsubdivided; 5a Flows, aphanitic; 5b Flows, porphyritic; 5c Lapilli-tuff

THOLEIITIC AND CALC ALKALIC METAVOLCANICS
Felsic Metavolcanics

4 — 4 Unsubdivided; 4a Flows, aphanitic; 4b Flows, porphyritic; 4c Tuff; 4d Lapilli-tuff; 4e Tuff-breccia, breccia

Intermediate Metavolcanics

3 — 3 Unsubdivided; 3a Flows, aphanitic; 3b Flows, porphyritic; 3c Flows, pillowed; 3d Flows, amygdaloidal, vesicular; 3e Tuff; 3f Lapilli-tuff; 3g Tuff-breccia; 3h Brecciated; 3j Spherulitic; 3k Chlorite-quartz-feldspar schist; 3m Actinolite-quartz-feldspar schist

Mafic Metavolcanics

2 — 2 Unsubdivided; 2a Flows, aphanitic; 2b Flows, porphyritic, glomeroporphyritic; 2c Flows, amygdaloidal; 2d Flows, variolitic, vesicular; 2e Flows, pillowed; 2f Flows, coarse grained; 2g Flows, carbonatized; 2h Flows, brecciated; 2j Tuff; 2k Lapilli-tuff; 2m Tuff-breccia; 2n Amphibolite; 2p Chlorite-epidote-calcite schist; 2q Chlorite schist; 2r Sheared; 2s Foliated; 2t Silicified; 2u Mafic metavolcanic

KOMATIITIC METAVOLCANICS

1 — 1 Unsubdivided; 1a Peridotitic, serpentinized; 1b Green carbonate rock

NOTES

a. Because of the possibility of alteration involving the redistribution of alkalies and silica, the rocks classified as alkalic may in some cases be altered volcanic rocks of subalkalic affinity. They do, however, define a consistent group of volcanic rocks on the basis of field appearance, petrography, and available chemistry.

Ontario
Ministry of Northern Development and Mines
Mines and Minerals Division
Ontario Geological Survey

STOCK NO. 10 706

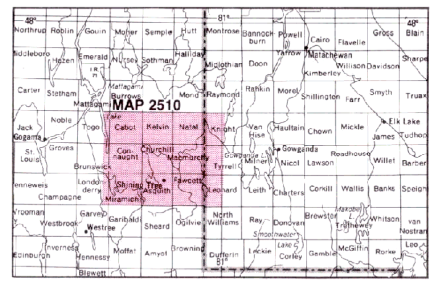
MAP 2510

PRECAMBRIAN GEOLOGY

SHINING TREE AREA

DISTRICTS OF SUDBURY AND TIMISKAMING

NTS Reference: 41 P/11
ODM-GSC Aeromagnetic Map: 285G
ODM Geological Compilation Map: 2205
Scale 1:50 000



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SYMBOLS

- Esker
- Small bedrock outcrop
- Area of bedrock outcrop
- Bedding, top unknown; (inclined, vertical)
- Bedding, top (arrow) from grain gradation; (inclined, vertical, overturned)
- Lava flow; top (arrow) from pillow shape and packing; (inclined, overturned)
- Schistosity; (horizontal, inclined, vertical)
- Gneissosity; (horizontal, inclined, vertical)
- Foliation; (horizontal, inclined, vertical)
- Banding; (horizontal, inclined, vertical)
- Lineation with plunge
- Geological boundary, position interpreted
- Geological boundary, geophysically interpreted
- Boundary between lower and upper part of metavolcanic-metasedimentary sequence
- Unconformable boundary
- Fault; (above—minor, below—major), arrows indicate horizontal movement; spot indicates downthrown side
- Lineament
- Synclinorium, with plunge
- Anticline, syncline, with plunge
- Cr — Shaft, mineralization
- Past producing mine
- Mining property, surveyed (see "List of Properties")
- 10 — Mining property or deposit, unsurveyed (see "List of Properties")
- Ag — Mineral occurrence
- Jointing; (horizontal, inclined, vertical)
- Vein, vein network
- Township boundary
- Wetlands
- Flooded lands

ABBREVIATIONS

Ag	Silver	mag	Magnetite
asb	Asbestos	ml	Millerite
asp	Arsenopyrite	mo	Molybdenite
Au	Gold	Ni	Nickel
Bi	Bismuth	Pb	Lead
Co	Cobalt	pent	Pentlandite
Cr	Chromium	py	Pyrite
Cu	Copper	qcv	Quartz Carbonate Vein
gf	Graphite	qv	Quartz Vein
hem	Hematite	S	Sulphide
IF	Iron Formation	Zn	Zinc

SOURCES OF INFORMATION

Base map derived from Map 41 P/11 of the National Topographic System.

Geological and geophysical maps and reports of mining companies.

Geology is not tied to surveyed lines.

Magnetic declination approximately 9°W, 1976.

Metric conversion factor: 1 foot = 0.3048 m.

CREDITS

Compilation of previously published maps supplemented by partial mapping of the area by M.W. Carter and assistants, 1976.

Cartography by C.L. Hazen and Jason Reid, Publication and Cartographic Services, Ontario Geological Survey, 1988, 1989

Every possible effort has been made to ensure the accuracy of the information presented on this map; however, the Ontario Ministry of Northern Development and Mines does not assume any liability for errors that may occur. Users may wish to verify critical information; sources include both the references listed here, and information on file at the Resident Geologist's Office and the Mining Recorder's Office nearest the map area.

Issued 1989

Information from this publication may be quoted if credit is given. Is is recommended that reference to this map be made in the following form:

Carter, M.W.

1989: Shining Tree Area, Districts of Sudbury and Timiskaming; Ontario Geological Survey, Map 2510, Precambrian Geology Series, scale 1:50 000. Geology 1976.

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