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Summary of Field Work, 1979 by the Ontario Geological Survey

edited by
V. G Milne, O. L. White, R. B. Barlow and C. R. Kustra

1979

Ontario

Ministry of Natural Resources

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Minister

Dr. J. K. Reynolds
Deputy Minister

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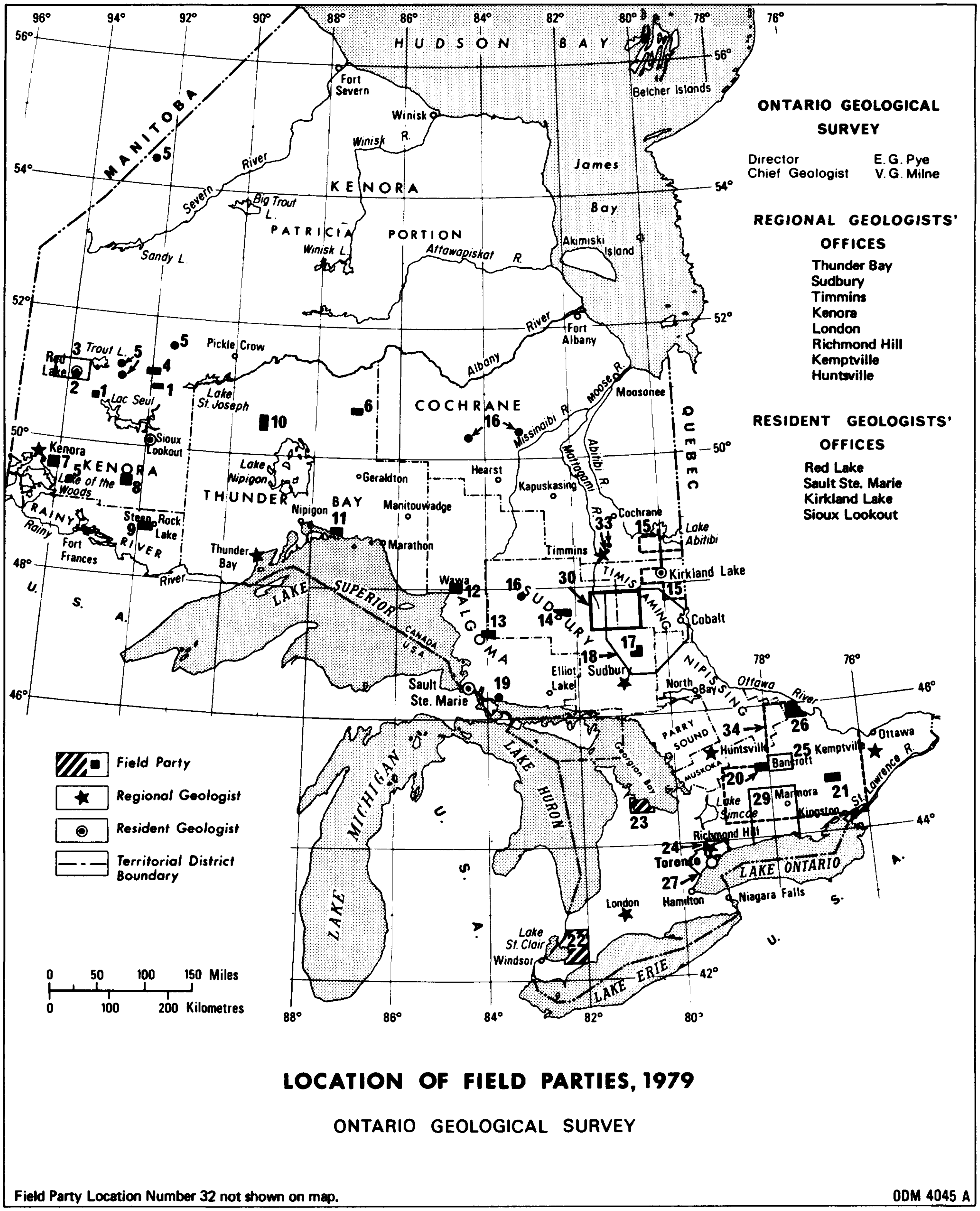
Preface

During 1979, the Geological Survey carried out a large number of independent geological, geophysical, geochemical, geochronological and mineral deposit studies. In addition studies were undertaken in cooperation with the ministry's regional geological staff, the Ontario Centre for Remote Sensing (Ministry of Natural Resources), the Geological Survey of Canada, the Royal Ontario Museum and with private contract companies. Funding for a number of regional stimulation projects was provided by the Ministry of Northern Affairs and Ministry of Treasury, Economics and Intergovernment Affairs. Project involvement is summarized in the section introductions which follow.

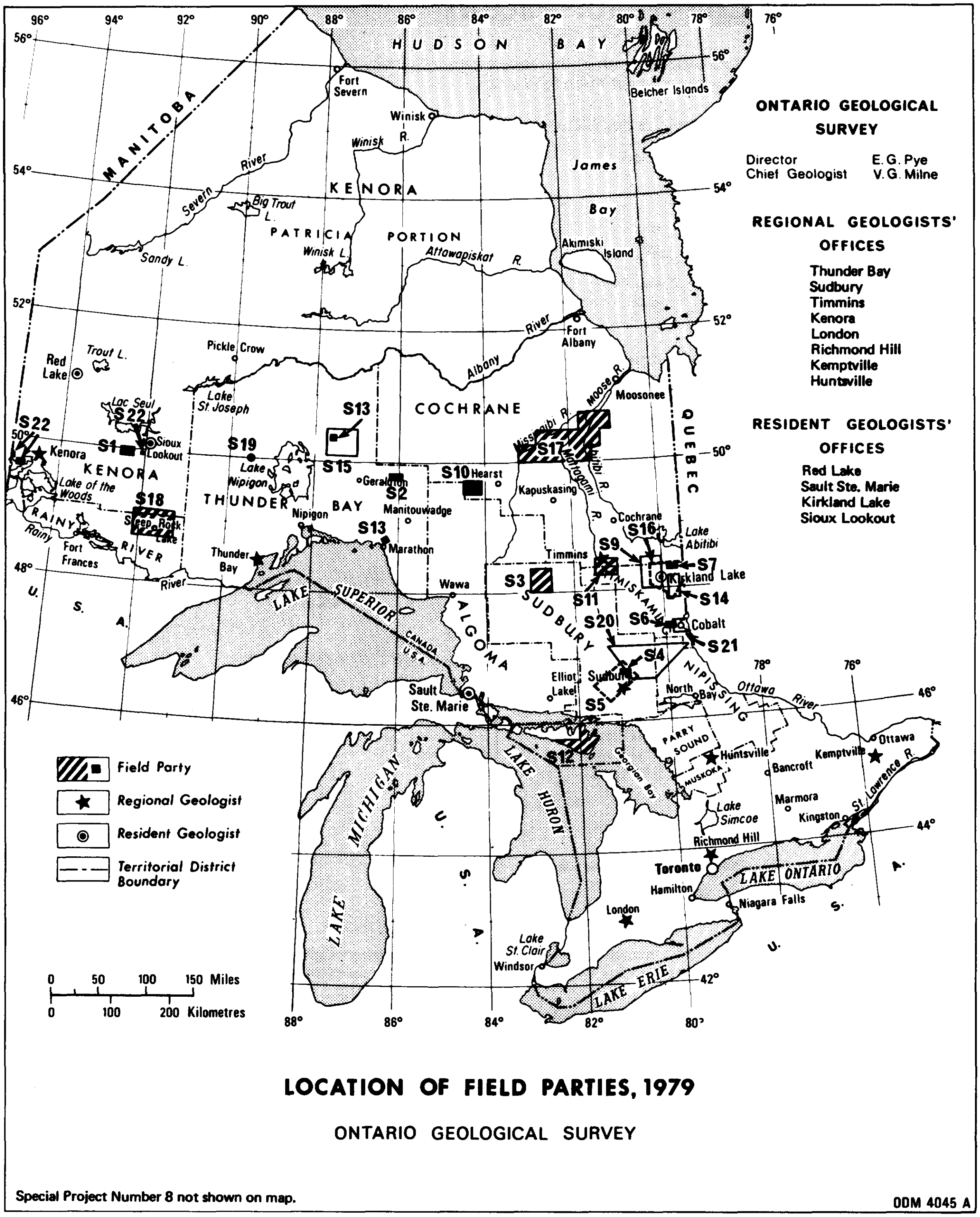
The locations of the areas investigated are shown on two maps of the Province at the beginning of this report. The preliminary results of the work are outlined in this summary, which contains reports prepared by leaders of each of the projects. In these reports, some emphasis has been placed on the economic aspects of the different investigations. It is the hope of the Ontario Geological Survey that the information thus provided will help in the mineral resource evaluation of these areas and so will be a valuable aid to mineral prospecting and resource planning in the Province. Also as a direct result of this summer's work, research was undertaken on a number of theses at the B.Sc. and graduate level.

Coloured maps and final detailed reports covering most of the field projects are being prepared for publication. In the interim, however, uncoloured preliminary geoscience maps with comprehensive marginal notes, will be released for distribution mostly during the winter of 1979-1980. Notices of the releases will be mailed to all persons or organizations on the Mineral Resources Group notification list, and will be published in the technical journals and other media.

Contents



Location of Field Parties of the Ontario Geological Survey, 1979.



Location of Special Projects of the Ontario Geological Survey, 1979.

Metric Conversion Factors

Many of the measurements given in this report were originally in Imperial units. The following factors were used to convert them to SI units.

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.

Precambrian Geology Section

Precambrian Geology Section 1979

V.G. Milne[1]

A total of 27 field survey projects were directed by the Section during the 1979 field season. This represents an increase of 3 projects over 1978 due to an increase in the number of contractual projects managed and directed by the Ministry of Natural Resources under agreements with the Ministry of Northern Affairs, Ontario and the Department of Regional Economic Expansion, Canada (D.R.E.E.).

Section staff directed 16 projects and 11 were operated by contract project leaders. In the Section's basic program approximately 2940 km^2 were mapped at a detailed scale (1:31 680 or 1:12 000) and 5 special projects (Nos. S1, S2, S4, 15, 17) were undertaken. An additional 1280 km^2 detailed scale mapping was completed and 3 special projects (Nos. S5, S7, S8) were commenced under the Ministry of Northern Affairs and D.R.E.E. supported programs.

Of the total projects undertaken, 19 comprise the Section's component of the ongoing program of the Ontario Geological Survey, Mines Group, Ministry of Natural Resources. The objectives of this base program are to provide geologic data, geologic interpretation and concepts which will stimulate mineral exploration and increase the effectiveness of mineral exploration and mineral resource potential evaluation and management throughout the 650 000 km^2 Precambrian bedrock area of Ontario. Due to the size of the area involved, survey projects are currently focussed upon high mineral potential sectors of six major geologic belts, rather than disseminated across the Province. This is so that an adequate data base, leading to sound interpretation and mineralization concepts, can be developed for these areas in a reasonable time, and as a basis, through analogy, for interpretation of other sectors. The principal sectors being studied are (1) the Uchi Belt west of Pickle Lake, (2) the western Wabigoon Belt from Savant Lake to Lake of the Woods, (3) the eastern Wabigoon Belt between Geraldton and Cariboo Lake, (4) the English River Belt margins, (5) the Abitibi–Wawa Belt adjacent to Lake Superior, (6) the Abitibi Belt from Kirkland Lake to Chapleau, (7) the Cobalt embayment of the Southern Province from Cobalt to Lake Wanapitei, and (8) the Grenville Province of southeastern Ontario.

In the western Uchi Belt, detailed geological survey coverage at 1 inch to 1000 feet is now complete for the entire Red Lake camp (No. 2). Concurrent with geological survey coverage of the Red Lake area complementary gravity survey (1976) and airborne electromagnetic and magnetic surveys (1978) were completed by the Geophysics/Geochemistry Section. Together this data constitutes an excellent basis for planning exploration and for regional concept and metallogenetic studies. Preliminary results of the Red Lake synoptic survey (No. 3) contain interesting implications for gold exploration methods in the Red Lake area.

Also in the Uchi Belt the Ferdinand Lake project (No. 4) completes detailed (1 inch to ½ mile) coverage of the large area between Bamaji–Fry Lakes, Birch Lake and Confederation Lake which will advance stratigraphic correlation between these mineralized areas, and the larger objective of regional correlation and identification of mineralized geological environments of the whole Uchi Belt west of Pickle Lake. The special study of felsic volcanic centres (No. 5) will ultimately examine and attempt to characterize petrographically and chemically, mineralized and non-mineralized volcanic centres of the Uchi Belt. The study so far indicates interesting analogies between the Shonia Lake and South Bay Mine felsic volcanic areas.

In 1978 field work on a special project covering the western Wabigoon from Crow Lake to Savant Lake was completed and preliminary results have been presented (Milne *et al.* 1978; Trowell *et al.* in preparation). This research provides an improved framework for the

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1 Chief Geologist, Ontario Geological Survey, Toronto.

study of mineral deposits, and mineral potential assessment and provides direction for further detailed surveys. As a continuation of this work in 1979, detailed surveys were undertaken in the Lake of the Woods (No. 7), Bending Lake (No. 8) and Atikokan (No. 9) regions. A detailed mapping program in the eastern Wabigoon continued in 1979 with surveys in the Caribou Lake (No. 10) and Melchett Lake (No. 6) areas. The iron deposits in the Melchett Lake area are well known but the base metal potential and parallels between this area and the mineralized Marshall Lake area are not well known. The present survey indicates that volcanic rocks in the area are more extensive than previously indicated and that base metal sulphides occur associated with proximal facies felsic volcanic rocks in the area. The Marshall Lake and Melchett Lake areas both contain interesting base metal occurrences that lie on the north flank of the Wabigoon Belt adjacent to and interstratified with English River Belt metasediments, and bear a resemblance to the Manitouwadge mining camp which is situated on the north flank of the Wawa Belt adjacent to the Quetico Belt metasediments.

In 1978 reconnaissance mapping of the English River Belt and adjacent margins was completed from Savant Lake west to Manitoba (Breaks *et al.* 1978). Stemming from this, a special project to examine the economic potential of felsic plutonic environments was initiated in 1979 concentrating initially on the English River and marginal belts and ultimately extending to the Quetico Belt. The objective of this project is to improve understanding of metamorphic and felsic magmatic mineral-concentrating processes to provide exploration guides principally for economically important lithophile elements.

Detailed mapping has been underway in 3 high potential metavolcanic belts adjacent to the Lake Superior basin for some time. Detailed mapping coverage of the Batchewana belt is nearing completion (No. 13), in the Heron Bay–Schreiber belt (No. 11) is well advanced, and in the Wawa–Renabie belt (No. 12) is at an early stage. All these belts have good mineral potential and are highly significant to the economic development of the Lake Superior area.

In the Abitibi Belt detailed mapping (No. 14) and synoptic surveys (No. 15) continued with the objective of providing basic data for unmapped areas of the Belt and to extend and improve stratigraphic and mineralization concepts developed in 1979 for the Timmins–Kirkland Lake section of the Abitibi Belt.

Work in the southern tectonic province was confined to the Cobalt Embayment with detailed mapping in the Chiniguchi Lake area (No.17) and commencement of a regional study of the stratigraphy, structure and sedimentology of the Embayment (No.18). Preliminary findings of the latter project indicate significant deformation of the lower Huronian prior to deposition of the upper Huronian, thus uranium exploration drilling may be mislead if upper Huronian structures are directly extrapolated in the search for uraniferous lower Huronian strata. This project also suggests interesting potential for disseminated base metal stratabound deposits in the middle and upper Gowganda Formation. Also the increased price of cobalt and silver has resulted in re-examination of several old silver deposits in the area.

Two detailed mapping projects were completed in the southern Grenville tectonic province. Mapping in the Centre Lake area (No.20) confirms uranium mineralization controls previously outlined in the Eels Lake area (Bright 1977) in that uranium deposits in the area are concentrated stratigraphically in alkalic metavolcanics and metasediments of the upper Hermon Group. In addition interesting magnetite deposits associated with ultramafic intrusives were located. In the Sharbot Lake area (No. 21) industrial minerals seem to hold the principal potential with garnet feldspar, carbonate, and, most interestingly a talc-tremolite-serpentine-calcite schist unit in Oso Township which may represent an economically interesting talc deposit.

The remaining 8 projects are funded jointly by the Ministry of Northern Affairs, Ontario and the Department of Regional Economic Expansion, Canada under two programs, the Kirkland Lake Incentives Program (K.L.I.P.), and the Northern Ontario Geoscience Surveys (N.O.G.S.). The objectives of these programs are to stimulate exploration and mineral development in selected northern regions.

Under the K.L.I.P. program the Section initiated this year a 3 year detailed stratigraphic mapping project (No. S8) which when complete will provide detailed maps and stratigraphic interpretation of the main Keewatin–Timiskaming belt from Matachewan to the Quebec boundary. Preliminary findings of this project indicate that the green carbonate unit associated with gold mineralization is an alteration feature discordant to lithologic boundaries. In addition a major synclinal structure is present south of the break in the Larder Lake area, and carbonate associated with the Kerr-Addison Mine gold is located in the hinge of this fold. Thus the area on the southwest projection of this hinge south of Larder Lake may have gold potential.

Under the N.O.G.S. program detailed mapping projects were undertaken in the Vermillion Lake area (No. S1), Long Lac area (No. S2), Chapleau area (No. S3), Cobalt area (No. S6), and Capreol area (No. S4) and special 3 year studies were initiated in the Sudbury irruptive area (No. S5) and in the Abitibi belt (No. S7).

The Vermilion Lake area project covers an area of high molybdenum and gold potential which is currently under active exploration. Work in the Chapleau area was aimed at assessing the chrome and aluminum potential of the Shawmere anorthosite body which is similar to chrome-bearing anorthosites in Greenland. The survey indicates that chromite does not appear to be present but large units of pure high alumina anorthosite are. Work in the Cobalt area is complimentary to the regional project of the ongoing program and provides essential stratigraphic information on a previously unmapped area. Likewise detailed mapping in Capreol area is integrated with the special study on the Sudbury area (No. S5) and studies being conducted by the Mineral Deposits Section (A.C. Colvine and D.G. Innes this volume). The Sudbury special study is directed principally at the Sudbury Irruptive sublayer and footwall rocks to determine the influence of these or mineralization. The Abitibi belt study will attempt to define alteration in volcanic rocks as guides to mineralization. Neither study is sufficiently far advanced beyond the preliminary stages to permit conclusions at this time.

The summaries contained in this volume represent a first appraisal of raw geological field data as do the preliminary maps which are in preparation for publication during the 1979-1980 winter period. These summaries and maps were designed as a means of rapidly disseminating highlights and general outlines of new information. More extended analysis of field data in conjunction with detailed office and laboratory research for final report and map publication can be expected to result in changes to the field terminology, interpretations, and concepts expressed.

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No. 1 Lithophile Mineralization in Northwestern Ontario, Rare Element Granitoid Pegmatites

F.W. Breaks[1]

Introduction

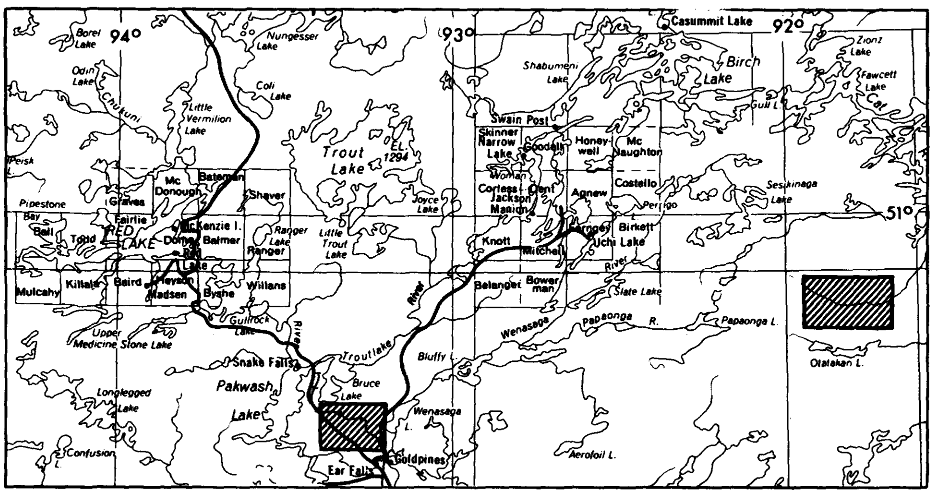
Rare-element granitoid pegmatites are strongly restricted to high grade gneissic belts; a well known metallogenic feature of the Superior Province of northwestern Ontario and adjacent Manitoba (Cerny and Trueman 1978). Such pegmatitic mineralization is generally lacking in metavolcanic-rich subprovinces such as the Uchi Subprovince, but if it is apparent it exhibits a spatial restriction to marginal parts of metavolcanic belts contacting the high grade gneissic subprovinces, as in the Southern Plutonic Domain, English River Subprovince (Breaks, Bond and Stone 1978) – Wabigoon Subprovince interface in the Dryden–Vermilion Bay area (Dryden Field of Mulligan 1965) and Uchi Subprovince – Northern Supracrustal Domain, English River Subprovince, (Breaks, Bond and Stone 1978) interface in Roadhouse River – Pashkokogan Lake region. This study was instigated to examine all important rare-element-bearing granitoid pegmatitic deposits relating to the English River Subprovince including the peripheral zones. Important pegmatitic mineralization in the Quetico Subprovince will also be investigated.

This project involves detailed mapping, assessment of regional metamorphic context, and geochemical/petrologic character of important individual pegmatitic units with the object of gaining a more comprehensive picture of their evolution so that the full potential of the known mineralized areas can be ascertained and than currently unknown mineralization can be predicted. Several previously undated major plutonic and gneissic complexes of the English River Subprovince were sampled to establish a geochronological framework within which the mineralization factors can be identified.

1 Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto, Ontario.

Lithogeochemistry Program

Lithogeochemistry constitutes an efficient means of exploring for new deposits or of re-evaluating presently known pematite districts. The purpose of the geochemical study will be to derive multi-element discriminatory diagrams based upon whole rock and mineral chemistry to aid the explorationist in screening barren, or uneconomic pegmatites. In addition to major and minor elements, the important trace elements Ta, Nb, Li, Cs, Rb, Sr, Ba, Be,



LOCATION MAP

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

Sn, W, U, Th, Zr, Mo, B, F, and REE will be analyzed. In particular, it is necessary to establish whether any enrichment of the important elements Ta and Sn has developed in any of the pegmatites. Virtually nothing is presently known regarding the distribution of Ta and Sn in felsic granitoid rocks of northwestern Ontario. Highly fractionated spodumene pegmatites are readily discriminated from all other granitoid rocks of the English River Subprovince by means of K/Rb and Ba/Rb discrimination diagrams (Breaks and Bond in preparation). Cerny and Turnock (1975) have demonstrated the importance of using chemistry of specific minerals as a means of evaluating pegmatite potential. Na, Li, and Cs contents of beryl of the Greer Lake area in Manitoba strongly reflect "geochemical and paragenetic characteristics of their parent pegmatites" (Cerny and Turnock 1975, p.58-59).

Together with some geochronological work (Rb/Sr and Nd/Sm), the geochemical study will yield constraints as to the type of plutonic body with which highly fractionated pegmatitic masses are associated.

Relationship to Regional Metamorphism

The project will also establish whether regional metamorphic zonation has controlled emplacement and diversification of pegmatitic mineralization. Thus exploration for such deposits possibly may be facilitated by consideration of metamorphic features.

1979 Field Studies

During the field season approximately 6 weeks were spent in examination of two areas containing known pegmatitic mineralization: 1) Roadhouse River area, and 2) Sandy Creek area, north of Ear Falls.

In addition, to the detailed sampling undertaken on these pegmatites, various granitoid plutonic complexes and anatectic leucosome material from migmatized metasediments of the Northern Supracrustal Domain (Breaks and Bond 1978) were sampled.

Roadhouse River Area

Mineral Exploration History

In the mid 1950s Capital Lithium Mines Limited discovered spodumene bearing pegmatitic dikes near the Roadhouse River, 6 km east of McCombe Lake. This group of patented claims known as the McCombe Property lies in the Root Lake Field of Mulligan (1965, p.64-65). Capital Lithium Mines Limited undertook detailed geological mapping (1:2,400 scale), magnetometer and resistivity check surveys and a programme of diamond drilling (six holes totalling 2,679 feet)[1]. An estimated 2.3 million tons averaging 1.3 percent LiO_2 has been outlined to the 500 foot level (Skinner 1969, p.8). Approximately 5,000 feet east of the main showing of Capital Lithium Mines Limited several spodumene-bearing dikes were investigated in 1956 by Consolidated Morrison Explorations Limited. Drilling totalling 6329 feet in 16 holes outlined a zone 4,000 feet in length and up to 47 feet in width. No tonnage figures[1] are known and the only available analyses indicate 2.63 percent Li over 13.0 feet and 1.86 percent Li over 17.5 feet[1].

Geology

The Capital Lithium Mines Limited property consists of two subconcordant dikes at the No. 1 showing, herein distinguished as Dike 1 and Dike 2. Dike 1, striking N90°E, is the more extensive, being exposed over a length of 176 m and maximum width of 15 m with both ends covered by glacial overburden. Dike 2, striking N80°E, is a lensoid mass 87 m in strike length and 19 m in maximum width with the eastern and western terminations defined. These dikes are emplaced in highly deformed, pillowed mafic metavolcanics and massive medium-grained mafic flows containing low grade regional metamorphic assemblages. A characteristic feature of these dikes is the presence of euhedral to subhedral white blocky alkali feldspar phenocrysts which achieve maximum dimensions of 15 cm x 15 cm.

Grain size and mineralogy of the matrix gives rise to two textural variants:

1) porphyritic texture with coarse-grained to pegmatitic matrix, abundant coarse-grained spodumene and rare lepidolite (designated as Pc), and

2) porphyritic texture with aplitic to medium-grained matrix, less spodumene, and often with fine-grained, accessory tourmaline (designated as PA).

In dike 1, the western 60 m is dominated by the Pc phase with about 10 percent PA pods (up to 20 m x 5 m) symmetrically disposed in the dike centre. Eastward along strike the PA phase increases and assumes predominance. Dike 2 is characterized by several small asymmetrically distributed Pc zones which have segregated near the center surrounded by the dominant PA phase (about 70 percent of dike). The southern contacts of both dikes are characterized by a zone of tourmaline enrichment. These zones (maximum width about 0.7 m) consist of fine-grained black tourmaline in an anastomosing vein system and medium to coarse-grained individual crystals which tend to show orientations normal to the contact.

Data of Stewart (1963) and Jahns and Burnham (1958) indicate that this deposit belongs to the low-temperature, high-pressure type, characterized by an absence of petalite. Preliminary geochemistry shows extremely low K/Rb ratios (mean of 11 in Breaks *et al.* 1978), low Ba/Rb,K/Cs and high trace levels of Sn, Be, Nb, and Cs (indicating a high degree of fractionation).

1 Resident Geologist's files, Ontario Ministry of Natural Resources, Red Lake.

Sandy Creek Beryl Occurrence

Location

This beryl occurrence is located 9.5 km north of Ear Falls via Highway 105 and a short distance by trail east of the highway (Breaks *et al.* 1976).

Mineral Exploration History

The property has been investigated by Madsen Red Lake Gold Mines Limited who in 1962 staked a group of 41 claims over the showing and undertook some shallow trenching[1].

Geology

Beryl mineralization is sparsely present in a narrow dike (maximum width 5.5 m) trending N90°E and which is exposed for 52 m in an area of poor outcrop. Near the western end the dike bifurcates forming a discordant southwest-trending arm. The dike is largely concordant to the foliation of the host metasediments which are mainly muscovite biotite pelites and minor metawackes of medium grade regional metamorphism.

The dike is asymmetrically zoned with virtual restriction of a 0.3 to 0.9 m wide pegmatite facies to the northern contact. Near the eastern end of the exposed dike this narrow zone deflects into the centre of the dike forming a core zone 15 m in length. The aplitic facies comprises approximately 80 percent of the dike and consists of subhedral to anhedral quartz phenocrysts embedded in a matrix of felty, white to pink cleavlandite, and accessory purpurite, beryl, muscovite and apatite. The pegmatite contains essentially the same megascopic mineralogy as aplite, however, modal percentage and coarseness of muscovite, purpurite, and apatite tend to be greater. The highest percentage and coarsest beryl occurs in the pegmatite where maximum crystal diameters of 7.5 cm were observed. Pod-like masses enriched in coarse grained tourmaline occur sporadically in the host metapelites along the northern contact between tourmaline-free sediments and the pegmatite.

1 Resident Geologist's files, Ontario Ministry Natural Resources, Red Lake.

Preliminary geochemical data indicates low levels of Li, Cs and Rb, and anomalous trace levels of Sn recorded in 7 of 11 samples (maximum of 75 ppm). The aplitic facies is characterized by extremely high Na_2O levels (9.09-9.71 percent), and higher, less fractionated K/Rb ratios (mean of 136) relative to the Roadhouse River spodumene pegmatites.

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No. 2 Heyson Township Area District of Kenora, Patricia Portion

J. Pirie[1]

Introduction

During the 1979 field season detailed mapping at a scale of 1 inch to 880 feet (1:10 560) was completed on Heyson Township in the southern part of the Red Lake metavolcanic-metasedimentary belt. The mapping of Heyson Township was part of a two-year project which included the mapping of Byshe, Willans and Ranger Townships in 1978. (Pirie 1978; Pirie and Kita 1979a,b,c).

Access

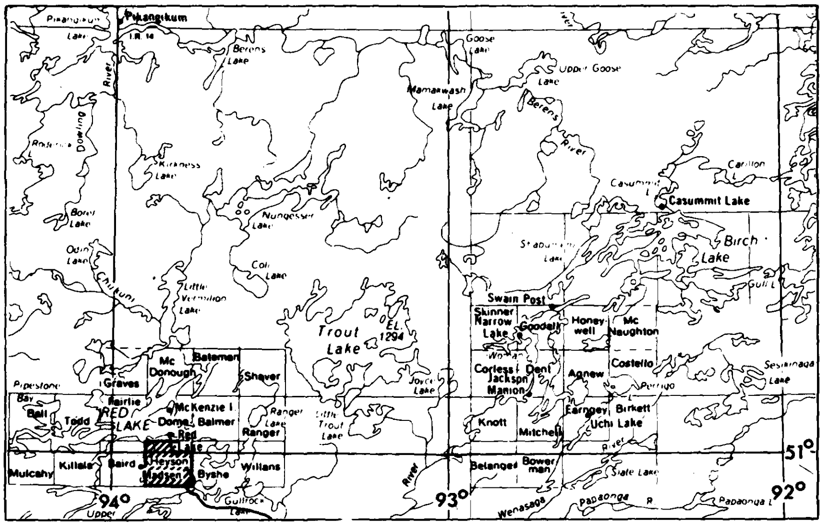
The northern two thirds of Heyson Township is accessible from Highways 105 and 618, the nearby power-lines, and some of the larger lakes such as Faulkenham and Sully Lakes. The southern portion of Heyson Township is accessible by float plane or helicopter using the small lakes scattered throughout.

1 Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.

Mineral Exploration and Production

Ferguson (1968) indicates that the Howey mine, owned by Teck Corporation Limited, produced 421 324 ounces of gold and 144 253 ounces of silver between 1930 and 1941 when the mine closed. The adjoining Hasaga Gold Mines Limited produced 219 320 ounces of gold and 92 823 ounces of silver between 1938 and 1952. A shaft was sunk to a depth of 200 feet on the Buffalo Red Lake Mines Limited property in 1947. Some underground exploration and development work was carried out but no gold was produced. The underground workings of Madsen Red Lake Gold Mines Limited in Baird Township extends northeast into Heyson Township just south of the three-mile post below the twenty-first (3350 foot) level (Ferguson 1968). No separate record of production from the Heyson Township part of the mine is available.

Exploration for gold continued well into the 1960s in the northern part of Heyson Township and the work carried out in this area is described by Ferguson (1968). Since that time additional work has been carried out on some of the properties but no substantial discoveries have been made. The southern part of the township was also prospected for gold in the past with no success. More re-



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

cently several areas have been investigated by companies for base-metal potential but apart from the uncovering of minor concentrations of pyrite and pyrrhotite no encouraging mineralization has been found. Detailed information on exploration done to date in the township is available in the Resident Geologist's files, Ontario Ministry of Natural Resources, Red Lake.

General Geology

Regional geological mapping was carried out by Horwood (1940) on both townships. The northern part of Heyson Township was also mapped at a scale of 1 inch to 1000 feet by Ferguson (1968).

Most of Heyson Township is underlain by a sequence of Archean mafic to felsic metavolcanics largely of calc-alkaline affinity and similar in nature to those mapped in Byshe Township to the east (Pirie and Kita 1979b). As in Byshe Township there is a general increase in metamorphic grade towards the southern end of the township where the rocks are intruded by a variety of granitoid batholithic phases.

The major lithologic units trend northeast from Baird Township to the west and swing in a more easterly direction across the township, exemplified by the thick unit of felsic metavolcanics which outcrops just north of Faulkenham Lake and trends northeastwards along Highway 618, across the north end of Killoran Lake then eastwards towards Byshe Township just south of Highway 125. This unit which is up to 1200 m wide, comprises highly siliceous aphanitic flow layered, commonly spherulitic flows with local flow breccia and mixed pyroclastic material in places. Towards the south the unit contains massive to foliated crowded quartz plagioclase porphyritic tuffs and lapilli tuffs as well as thin bedded fine-grained tuffs. South of this unit are a large number of interdigitating units of intermediate to mafic flows commonly pillowed and amygdular with variable proportions and sizes of porphyritic plagioclase throughout as well as pyroclastic lapilli-stone units of similar material incorporating minor amounts of heterolithic fragments. Plagioclase ± quartz porphyritic felsic tuffs are present as narrow units throughout this more mafic part of the volcanic pile. Granitoid batholithic phases form a narrow belt of intrusions across the township from Faulkenham Lake to Sully Lake. Here the volcanic rocks take on a more schistose appearance with primary features not commonly visible. From Sully Lake to the southern boundary of the township a similar mixture of felsic and intermediate to mafic metavolcanics occurs with lesser amounts of bedded clastic metasediments derived from felsic volcanic rocks. These rocks retain primary features such as pillow structures polygonal jointing and graded bedding, although they are intruded by granitoid dikes and sheets and are at a moderately high metamorphic grade.

In the northwest corner of the township is a sequence of pillowed amygdular flows with associated flow-top breccias varying from mafic to ultramafic (actinolite-rich) in colour index (tholeiitic to basaltic komatiitic). In many localities these are altered by pervasive silicification, giving a pale intermediate aspect to many of the rocks. Towards the southeast, these mafic metavolcanics are interbedded with felsic flow and tuff units and then overlain by the thick felsic metavolcanic unit described above.

In the northeast corner of the township the thick unit of monolithic to heterolithic lapilli-stone in Byshe Township to the east (Pirie 1978), thins along Highway 125 and appears to pinch out to the west of Highway 105.

A few minor interflow metasedimentary units occur in the metavolcanics. At the northeast end of Snib Lake thin layered to laminated chert and ironstone layers alternate with both magnetite and pyrite-rich layers present in the ironstone. At the base of the thick felsic unit southeast of Snib Lake and Highway 618 there is a narrow zone of siliceous pyrite-bearing rock which may be a chemical metasediment.

Dikes and sheets of medium grained gabbro and diabase containing leucogabbro to quartz diorite differentiates commonly intrude the calc-alkaline metavolcanic sequence. These are typically massive, actinolite-bearing and usually magnetite-bearing. In the tholeiitic to komatiitic sequence of mafic metavolcanics in the northwest corner of the township, narrow dikes and sheets of mafic and actinolite-rich material are hard to distinguish from the metavolcanics. Dikes and thicker sheets of ultramafic serpentinized peridotite are restricted to this sequence of metavolcanics and are highly magnetic, medium grained and commonly have talc-rich fracture fillings and veins.

The Dome stock, largely in Dome Township to the north, occurs in the northern part of Heyson Township between St. Pauls Bay and Highway 618 within the town of Red Lake. The stock is medium to coarse grained massive homogeneous biotite hornblende granodiorite with colour index about 10, but is well foliated to highly sheared towards the contact where chlorite is the main mafic mineral.

The "Howey Diorite", an intermediate intrusive complex, occurs east of Highway 618 around the south end of the town of Red Lake and across Highways 105 and 125 to the northeast corner of the township. The major phases present are hornblende quartz diorite to diorite with colour index 15–20 and trondhjemite with colour index generally less than 10. Magnetite is a common accessory in most phases. These rocks are commonly highly sheared and locally brecciated and mylonitized giving a deceiving impression of deformed pyroclastic textures in places. Classification of these rocks especially around the town of Red Lake is also complicated by the occurrence of some deformed felsic to intermediate porphyritic lapilli tuffs and tuff material which is locally heterolithic. No contact between the "Howey Diorite" and Dome Stock is exposed but the rocks near the assumed contact are highly sheared and chloritized but can be differentiated by the generally coarser grain size and quartz-rich nature of Dome Stock.

As well as these large intrusive bodies, narrow dikes of fine grained and porphyritic trondhjemite to quartz diorite are common throughout the metavolcanic sequence.

In the southern half of the township a number of medium- to coarse-grained granitoid plutons cut the metavolcanics. Much of Faulkenham Lake is underlain by coarse-grained foliated to massive biotite granodiorite to quartz monzonite. To the east, a number of small intrusions as well as narrow dikes and stringers of similar material cut the metavolcanics. East of Sully Lake a larger xenolith-rich intrusion of biotite hornblende trondhjemite to quartz diorite outcrops and extends eastwards into Byshe Township.

Similar smaller intrusive bodies of medium- to coarse-grained leucocratic quartz monzonite cut the schistose metavolcanics along the southern boundary of the township. Throughout the southern part of the township are dikes and small stocks of a characteristic medium-grained porphyritic hornblende diorite with lesser biotite and colour index about 30, and these may be a phase of the batholithic rocks. Late pink K-feldspar-rich pegmatites and aplites commonly cut these plutonic rocks and the nearby enclosing country-rocks.

Structural Geology

Well preserved primary structures such as pillows in intermediate and mafic flows and graded bedding in felsic tuffs and clastic metasediments indicate that the metavolcanic sequence faces southwards from the margins of the Dome Stock and "Howey Diorite" as for as a line across the township through Faulkenham and Sully Lakes which appears to be the trace of a synclinal axis. South of this line facing observations are sporadic but the sequence in general faces northwards east and north of Sparks Lake suggesting an east-trending synclinal axis through Sully Lake. A few tentative observations south of this lake suggest the rocks there again face southwards requiring an anticlinal axis through the south end of Sparks Lake and trending towards the southeast corner of the township.

North of Faulkenham Lake the metavolcanics dip steeply to the south and strike east-northeast swinging eastwards southeast of the town of Red Lake. In the southern part of the township, the units trend eastwards with steep to vertical dips and locally show indications of outcrop scale folding. Most of the metavolcanics are foliated and this planar feature is steep to vertical in dip and trends generally eastwards more or less parallel to the lithologic units.

The strong shearing in the northern part of the township is parallel to the foliation in the mafic metavolcanics around Cain Lake and is restricted to a zone around the contact of the Dome Stock as it swings northeast through the town of Red Lake. The "Howey Diorite" is strongly sheared and deformed up to 1 km east of the Dome Stock. In this area the shearing direction generally trends northeast with a steep to vertical dip and it is in this highly deformed zone that the Howey and Hasaga gold mines previously operated. To the east in the "Howey Diorite" the rocks are also strongly sheared but on wider spaced planes, which generally trend eastwards.

Economic Geology

The Howey and Hasaga mines in the town of Red Lake exploited one main fracture zone, containing gold-bearing quartz stringers, lenses and veins, which trends northeast parallel to the intensely deformed structures permeating trondhjemite and quartz diorite phases of the "Howey Diorite". A shaft was sunk by Buffalo Red Lake Mines Limited near the southern sheared contact of the Dome Stock to exploit minor amounts of gold mineralization related to quartz tourmaline veins in the stock (Ferguson 1968). Much of the material on the waste dump at the shaft is sheared granodiorite of the Dome Stock and it appears likely that this was the host rock for the gold-bearing veins and not supracrustal quartz latite as interpreted by Ferguson (1968). All these gold-bearing environments appear to be epigenetic vein type with the gold perhaps being moved and concentrated during the major period of intense deformation along the borders of the Dome Stock and the western portion of the "Howey Diorite".

The main gold-bearing zones in the Madsen mine in Baird Township were intimately associated with a metavolcanic unit known as the Austin Tuff (Ferguson 1965). The extension of this unit northeast into Heyson Township has been tested in detail by surface diamond drilling but no substantial gold mineralization has been discovered. The stratigraphic unit in which the Madsen mine is located is close to the boundary between the overlying calc-alkaline felsic to mafic metavolcanic sequence to the southeast and the underlying tholeiitic to komatiitic mafic sequence in the northwest corner of the township. These mafic metavolcanics commonly are altered by silicification similar to the altered mafic metavolcanics in the vicinity of the mines at Balmertown (Pirie and Grant 1978) and Cochenour (Pirie 1979) and may merit closer attention for potential gold mineralization.

The unaltered calc-alkaline sequence which underlies most of Heyson Township and Byshe Township to the east contains only sporadic minor gold mineralization and this may be significant in any attempt to understand the metallogenetic relationships of gold mineralization in the Red Lake area. This sequence however which contains thick rhyolitic units in places may have base metal potential but exploration for massive sulphide targets has been carried out in a number of areas with no success and a recently published airborne magnetic and electromagnetic survey of the Red Lake area (Ontario Geological Survey 1978) indicates no conductors of significance in this area except for one at the southeast corner of the township which has been tested.

In the Dome Stock east of St. Pauls Bay, minor chalcopyrite and molybdenite occur in thin quartz filled fractures in a few places. Although no significant amount of this type of mineralization has been uncovered to date, its presence suggests that "porphyry type" Cu-Mo mineralization may be a potential target in felsic to intermediate intrusive bodies such as the Dome Stock.

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No. 3 Red Lake Synoptic Project, District of Kenora

James Pirie[1]

Introduction

As part of a project to produce a 1:50 000 geological map and synoptic report on the Archean Red Lake metavolcanic-metasedimentary belt, detailed mapping was completed on Dome Township located in the centre of the belt. Some preliminary chemical data on rocks from Dickenson gold mine and the general area are also discussed.

General Geology

Dome Township was included in the regional mapping of Horwood (1940) and was subsequently mapped by Chisholm (1951) and Ferguson (1966). Parts of the township were re–examined during 1978 field season (Pirie 1978) and in 1979 the remainder of the township was mapped for publication in preliminary form at a scale of 1:12 000.

The sequence of mafic and variolitic metavolcanics (tholeiitic to basaltic komatiitic) mapped in McDonough Township (Pirie and Sawitzky 1977) and Bateman Township (Pirie and Grant 1978a) trend into the northeast quadrant of Dome Township where the upper part interdigitates with a sequence of felsic pyroclastics and metasediments around the north end of McKenzie Island. The lower part continues south through Cochenour village and may swing eastwards towards Balmertown, although there are a number of reversals in facing directions based upon pillow shapes southeast and east of Cochenour. All the mafic volcanics from East Bay southwest through the old McMarmac Mine area to Cochenour and east and southeast as far as McNeely Bay and Balmer Township show varying degrees of pervasive silicification with or without accompanying carbonatization and late quartz-carbonate veins, lenses and stringers. Many of the flows are variolitic with varioles forming up to 95 percent of the pillow volumes. This makes it difficult to estimate the amount of alteration which has taken place since the original composition of these particular variolite portions is

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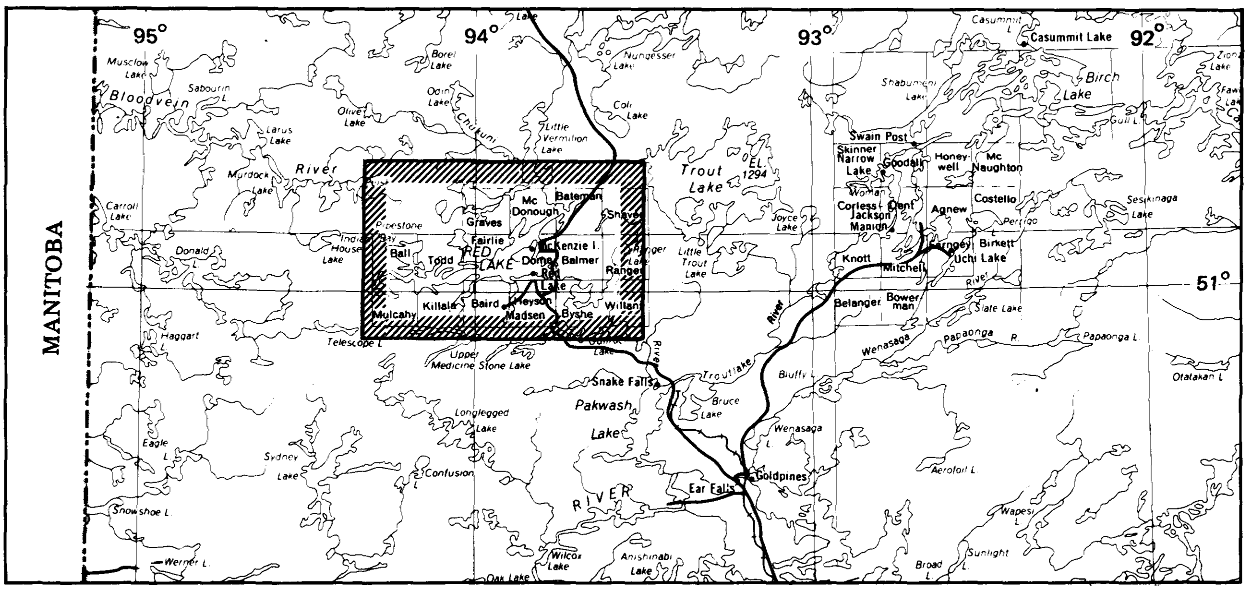

LOCATION MAP

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

not known. Where fresh variolitic pillowed flows have been examined in McDonough Township (Pirie and Sawitzky 1977) the coalesced varioles have a composition of leucobasalt. Interbedded with the mafic metavolcanics south of the Red Lake airport on the Wilmar property are featureless units of fine grained felsic volcanic material which are very similar to the "siliceous rock" found in the Campbell Mine at Balmertown (Pirie and Grant 1978b). South of this by Rahill Beach heterolithic felsic breccia and lapilli–stone containing large fragments of flow-layered rhyolite occur and are mixed in with monolithic felsic flow breccia units. Southwards the material is still felsic but tends to be more bedded, heterolithic and with sufficient rounding of fragments to be classified as clastic metasediments. This unit may extend northwest and north from Rahill Bay and interfinger with a chert-ironstone unit along the east shore of Bruce Channel and out into the Lake. On the shore northwest of Cochenour Mine the very fine grained massive felsic material, locally termed "Point rock", (Ferguson 1966) is reminiscent of the material on the Wilmar property and may well be a felsic flow or dome. The unit has been hydrothermally altered and in places contains small vague circular structures which may be spherulites. Elsewhere andalusite has been identified in 'Point rock' (Ferguson 1966) and this is consistent with a rock of rhyolitic composition which has had all its alkali content flushed out during hydrothermal alteration.

Structural Geology

The northwest-facing felsic pyroclastic unit which occurs on the western side of McKenzie Island is capped by limestone and mudstone units which strike southwest into Fairlie Township. The lower part of this pyroclastic unit on southeast McKenzie Island is intruded by the Dome Stock and McKenzie Island Stock. This unit may be continuous with a south-facing unit of similar lithology which occurs south of McNeely Bay and trends eastwards into Balmer Township where it was mapped as intermediate pyroclastics by Pirie and Grant (1978b). If this correlation is correct then the trace of an anticlinal axis trends northeast between Rahill Bay and East Bay. Any detailed assessment of folding however is hampered by the presence of a strong east- to east-southeast-trending steeply dipping foliation which cuts across the strike of lithologic units around and to the north of Cochenour and McKenzie Island and has flattened primary structures such as pillows and fragments in this direction making top determinations rather tentative in the area around Cochenour and east towards Balmer Township. Pillow tops around the old Marcus shaft and to the northeast face south whereas pillows around the Red Lake airport and along Highway 125 to the east face north, suggesting an east–trending synclinal axis not far north of the airport runway. Because of large areas with no outcrop however any assessment of the structure is at best tentative in the northeast quadrant of Dome Township.

Economic Geology

The degree of hydrothermal alteration of the metavolcanic units around Cochenour, Rahill Bay, and east to Balmer Lake and Balmertown is striking when these rocks are compared with the less altered metavolcanics seen in McDonough and Bateman Townships to the north. In the altered zone however the mafic metavolcanics retain pillowed and amygdular structures and textures but are much lighter in colour and have a lower colour index. Felsic metavolcanics show little visible change in characteristics. Comparison of major element chemical data from fresh and altered rocks show: 1) a striking decrease in sodium to trace levels from a more typical 2 to 4 percent, 2) an increase in silica which is less easily quantifiable but is in the order of 4 to 10 percent, and 3) locally an increase in carbon dioxide from less than 1 percent up to about 8 percent. The trace element data show: 1) an increase in arsenic from values typically less than 5 ppm in fresh rocks to greater than 50 ppm in altered rocks especially in the vicinity of the mines. 2) Antimony commonly shows a complementary tenfold increase from about 0.5 ppm to greater than 5 ppm but is more eratic in the fresh rocks and therefore this variation may not be as significant.

Analyses of mafic metavolcanic wallrock and the adjacent gold-bearing quartz vein from 13th level Dickenson Mine 'F' zone in drift 13–2852 are shown in Table 1. Values for some elements in the vein are shown under sample 1632A. Sample 1632B comprises the first 4 cm of wall-rock outward from the vein and 1632C from 4 cm to 8 cm from the vein. The two show typical decrease in content of elements such as Au, As, Hg, Sb away from the vein which contains pyrrhotite, arsenopyrite, pyrite and native gold. The data demonstrate the large variations in content of some elements over a very small scale sampling interval.

At several locations in the Dickenson Mine a highly altered rock type, termed "chickenfeed" by mine personnel, occurs in masses of varying size. Where an ore zone abuts against "chickenfeed" it invariably terminates. In some places in the mine this brown to buff coloured siliceous to carbonatized altered rock seems to grade into material termed "talcy chickenfeed" and eventually into a serpentinized peridotite and it is suspected that much of the "chickenfeed" in the mine is highly altered peridotite likely of intrusive origin. Chemical data from diamond drill hole 29–7 on the 29th level drilled through a zone of "chickenfeed" into serpentinized peridotite is shown in Table 1. Sample 473 is from a depth of 401 feet and is fine–grained pale siliceous "chickenfeed"; sample 474 is from 406 feet and is similar to sample 473; sample 476 is from 422 feet, is logged as "talcy chickenfeed", and is darker in colour fine grained schistose and slightly magnetic; sample 477 is from 446 feet and is dark green serpentinized peridotite and strongly magnetic. The more altered material is higher in Fe_2O_3, CaO, Co_2, Au, As, Sb and lower in MgO than the least altered peridotite. It is also worth noting that the Cr and Ni values for the most al-

TABLE 1 | Major and trace element analyses of samples from Dickenson Mine, Balmer Township. For sample description see text.

Major element analyses in weight percent

	1632A	1632B	1632C	473	474	476	477
SiO_2	nd	64.8	59.5	31.1	43.8	35.4	41.0
Al_2O_3	nd	13.0	11.6	3.68	2.74	2.94	3.47
Fe_2O_3	nd	9.73	12.6	19.2	19.8	10.6	10.5
MgO	nd	2.69	4.44	20.3	14.0	30.7	30.6
CaO	nd	2.08	4.25	8.11	8.68	1.57	1.38
Na_2O	nd	0.32	0.06	0.00	0.00	0.00	0.00
K_2O	nd	2.08	1.21	0.00	0.27	0.00	0.00
TiO_2	nd	0.82	0.73	0.19	0.17	0.15	0.21
P_2O_5	nd	0.07	0.07	0.04	0.03	0.03	0.04
MnO	nd	0.17	0.35	0.38	0.38	0.17	0.11
CO_2	9.05	0.54	3.16	16.4	11.50	16.3	6.05
S	0.65	1.40	0.38	0.26	0.20	0.01	0.01
TOTAL	nd	97.7	98.4	99.7	101.6	97.9	93.4
LOI	nd	3.70	4.90	16.7	11.0	19.0	12.2

TRACE ELEMENTS IN PPM, EXCEPT FOR Au, Hg IN PPB

	1632A	1632B	1632C	473	474	476	477
Ag	51	<3	<3	<3	<3	<3	<3
Au	872 ppm	900 ppb	150 ppb	20 ppb	10 ppb	<10 ppb	<10 ppb
As	3700	5400	340	1360	256	1	45
Ba	nd	110	80	30	110	20	20
Co	nd	55	40	135	87	97	107
Cr	210	201	186	1620	1100	1740	1350
Cu	32	109	95	15	12	36	56
Hg	2900 ppb	160 ppb	20 ppb	nd	nd	nd	nd
Li	nd	16	25	25	50	8	4
Ni	170	199	89	1960	1360	1730	2020
Pb	10	69	11	<10	<10	<10	<10
Rb	nd	50	50	10	<10	<10	<10
Sb	21	5.5	1.7	36.2	13.9	1.8	4.3
Sr	nd	70	60	50	50	20	<10
Y	nd	10	20	<10	10	10	10
Zn	176	94	90	66	61	49	42
Zr	nd	40	20	<10	<10	<10	10

nd - not determined

tered rocks are at levels typical of ultramafic rocks suggesting that these elements were less mobile than other elements. These chemical data from detailed and drill hole scale sampling show a somewhat similar correlation between intensely altered wallrock and anomalously high levels of As and Sb as is seen in a general sense from the surface sampling of the obviously altered rocks in the vicinity of the mines at Balmertown and Cochenour when these are compared with the fresher rocks in the northeast portion of the Red Lake metavolcanic-metasedimentary belt. There is a strong possibility that anomalous Au values would accompany the anomalous As values even at the regional alteration scale and these data are at present being collected using a method with detection limit level of 1 ppb Au.

If this correlation between Au and As holds true, then lithogeochemical sampling on a property grid basis followed by analysis for As may help focus exploration attention on zones with anomalous As which in turn may host vein type gold-bearing ore deposits.

In terms of the genesis of mafic metavolcanic hosted gold deposits around Cochenour and Balmertown the limited chemical data suggest that the several cubic kilometres of hydrothermally altered rocks in the vicinity of the mines have in fact had As, Sb and possibly Au added rather than this large volume of rock being the source from which Au, As and Sb have been mobilized and concentrated into the gold-bearing vein deposits present at the various mines. This means that the large areas of hydrothermal alteration seen on surface and in the mines are sites of gold deposition from the ore-bearing fluids and the source of the Au remains enigmatically at depth with little information available as to its nature and the process by which Au is mobilized.

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No. 4 Ferdinand Lake Area, District of Kenora, Patricia Portion

Henry Wallace[1]

Location and Access

The project area, bounded by Latitudes 51°7.5′ and 51°15′N and Longitudes 91°45′ and 92°15′W, is about 130 km east of Red Lake. Access to this region is by float– or ski–equipped aircraft from Red Lake, Sioux Lookout or Pickle Lake, all roughly equidistant from Ferdinand Lake. Transportation within the area is difficult since few of the lakes and river systems are navigable for more than a few kilometres.

History of Mineral Exploration

The area has received very little exploration attention to date. Gold has been sought in the region between the Red Lake and Pickle Lake camps since the 1920s but no discoveries were ever reported from the Ferdinand Lake area.

In 1969 Madsen Red Lake Gold Mines Limited did considerable work on two molybdenite showings located about 3 km north of the central part of Ferdinand Lake. Altogether 14 trenches were cut across the the molybdenite-bearing zones and four diamond drill holes totalling 114 m were put down (Assessment Files Research Office, Ontario Geological Survey, Toronto).

In 1974 Union Miniere Explorations and Mining Corporation Limited did exploratory diamond drilling in this region following up combined airborne electromagnetometer and magnetometer surveys flown in 1972. Three diamond drill holes totalling 196 m were drilled to intersect conductors between Ferdinand and Senior Lakes, but nothing of economic significance was reported (Assessment Files Research Office, Ontario Geological Survey, Toronto).

General Geology

This area is entirely underlain by Early Precambrian (Archean) rocks, roughly 80 percent of which belong to felsic to intermediate plutonic masses. A supracrustal belt between 1 and 4 km wide transects the project area from

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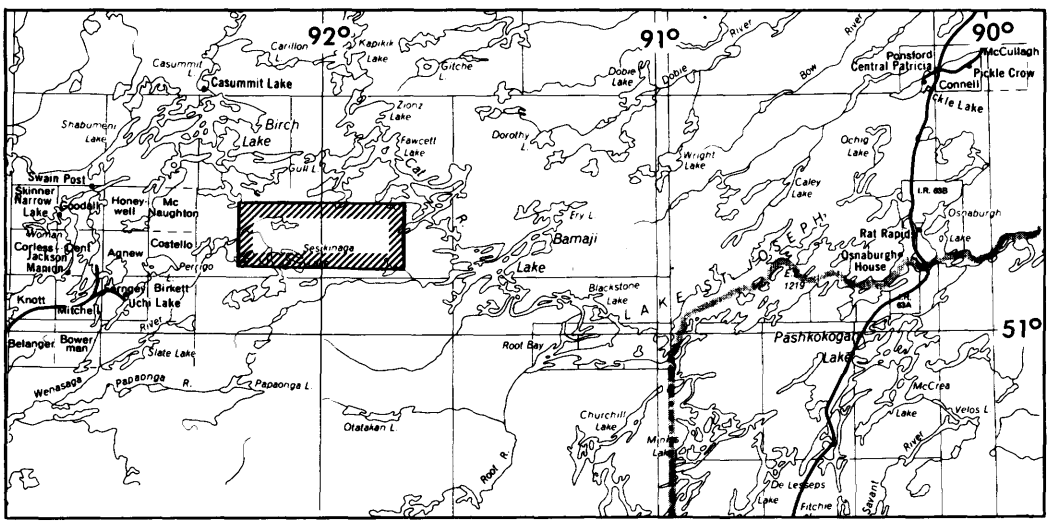

LOCATION MAP

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

east to west, but is truncated by trondhjemitic rocks south of Senior Lake. This belt consists predominantly of fine grained fissile amphibolite units in which pillows can commonly be discerned but rarely used as reliable top indicators. Near contacts with the plutonic masses to the north and south of the supracrustal belt the amphibolite units are migmatized and cut by innumerable sill-like injections of various porphyritic and aphyric phases generally trondhjemitic to granodioritic in composition.

Felsic to intermediate metavolcanics were found in appreciable volumes in only a few places, notably north of Hailstone Creek and north and west of Deaddog Lake. These units appeared to be mostly monolithic dacitic lithic tuffs and lapilli-tuffs. Pyroclastic units containing tephra coarser than lapilli are rare.

Clastic metasediments were found mostly on the southern side of the supracrustal belt, but minor interflow units of wacke and mudstone occur scattered throughout the belt. The sediments are thickest in the areas west of Marsh Lake where highly deformed polymictic paraconglomerates and coarse wacke units form a high proportion of the stratigraphic sequence, and south of Hailstone Creek where the sediments are biotite schists derived from "dirty" sandstones.

Chemical sedimentary units which give rise to appreciable positive magnetic anomalies occur just west of Deaddog Lake and between Senior and Fawthrop Lake. The occurrence west of Deaddog Lake consists of interlaminated magnetite-quartz ironstone and chert in close association with a thin sequence of dacitic pyroclastic rocks. The sequence west of Senior Lake is also predominantly magnetite- quartz ironstone and chert, but units of graphitic schist, pyrrhotite ironstone and calc-silicate (amphibole and carbonate) also occur interlayered with them. These chemical sediments are associated with fine clastic sediments and intermediate tuff units.

Coarse amphibolite, believed to be metamorphosed gabbro forms several relatively small, irregular bodies between Senior Lake and a large unnamed lake north of Ferdinand Lake. Minor zones of serpentinized peridotite and other ultramafic differentiates occur in several places in that area.

Plutonic rocks ranging in composition from trondhjemite to granite form a number of discrete intrusions in the Ferdinand Lake area. Biotite trondhjemite phases intruded only by late quartz monzonitic pegmatite dikes are volumetrically predominant between Fawthrop and Deaddog Lakes and between Ferdinand and Snelgrove Lakes. In the northeastern corner of the map-area around Kezik Lake the intrusive history is complex with younger quartz monzonitic and granodioritic phases being most abundant. An extensive zone of pegmatoid biotite quartz monzonite exists between the southeastern corner of the project area and Hailstone Lake. A discrete pluton consisting mostly of massive pegmatoid trondhjemite and granodiorite occupies the area around Tarpley Lake. Just west of the northern part of Snelgrove Lake there is a small sub-circular body of gneissic biotite trondhjemite which is clearly outlined on air photographs by strong curvilinear topographic features. However what appears to be a similar structure around Sesikinaga Lake consists of non-gneissic, only moderately foliated, trondhjemitic rocks.

Metamorphic rank in the supracrustal rocks appears to be medium grade (Winkler 1976) but no diagnostic index minerals were identified in the field.

Structural Geology

This area lies within the Uchi tectono-lithologic subprovince. The local supracrustal sequence is connected with the Bamaji-Fry Lake Belt in the east, and with the Birch-Uchi Lake Belt in the west. On the basis of bedding and foliation patterns the Ferdinand Lake metavolcanics appear to be in a synformal structure with a relatively shallow plunge to the west. Facing determinations were made in only a few places but these suggest that the fold is a syncline.

As far west as Ferdinand Lake trondhjemitic rocks show moderately well developed cataclastic textures resulting from the continuation of the same series of east-west-trending faults and shear zones which profoundly affect the North Bamaji Lake intrusion just to the east of the project area (Wallace 1978). Numerous lineaments and probably faults, mostly northeast and northwest-trending occur within the area but few can be shown to be responsible for major stratigraphic dislocations.

Economic Geology

The only notable mineral occurrences are molybdenum-bearing zones in and around quartz veins, shear zones and pegmatite dikes cutting granitoid rocks which are mostly trondhjemitic in composition. Showings at the southwestern end of Senior Lake have recently been described by Sutherland (1978). Two showings located north of a small lake about 4 km southeast of Fawthrop Lake have been referred to as the Ferdinand Lake Option of Madsen Red Lake Gold Mines Limited by Sage and Breaks (1976). Both showings occur along contacts between trondhjemitic rocks and mafic amphibolites at the northern edge of the main supracrustal belt. In one of these showings coarse grained clots of molybdenite are sparsely disseminated with minor pyrite within foliated biotite trondhjemite and concordant quartz and quartz-potassium feldspar veins over a strike length of at least 60 m. The highest concentrations of molybdenite, over 20 percent in places, were found in a narrow (1-2 cm) biotite-rich zone within the trondhjemite and in a quartz vein adjacent to that zone which both strike at approximately 075°. In the same area just south of the metavolcanic-trondhjemite contact, molybdenite was also found as disseminated patches up to 2 cm across in irregular quartz monzonite pegmatite dikes up to 5 m wide, striking subparallel to the surrounding gneissic amphibolite. Highest assay value from this showing was 0.33 percent MoS_2 from a 0.6 m channel sample taken from the No.1 trench.

The other showing, about 1 km to the west of the first, is in foliated trondhjemite about 100 m north of the metavolcanic contact. The trondhjemite contains fine, sparsely disseminated molybdenite flakes with pyrite, pyrrhotite and minor chalcopyrite over a wide area, but the mineralization is concentrated in and near irregular south-dipping quartz and quartz-potassium feldspar veins. As in the first showing, molybdenite is particularly concentrated in narrow biotite-rich zones along the contacts between quartz veins and host trondhjemite. Innes (1969) also reported the association of molybdenite with a flat to shallow dipping quartz vein in the same area. Best results of diamond drilling were on the second showing where one hole intersected 0.63 m of 0.96 percent MoS_2 (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Recommendations for Future Mineral Exploration

Obvious targets for future mineral exploration are scarce in this area. Reconnaissance prospecting will possibly uncover additional molybdenum occurrences which are numerous in this region, particularly to the east of the project area (Sutherland 1978). Several small occurrences were found by the field party in the Gull–Christina Lakes area and south of Ferdinand Lake. New occurrences should be checked for gold, silver, copper, bismuth and antimony contents.

Potential for gold mineralization is largely unknown. A few sulphide-bearing quartz veins were encountered in mapping and assayed grab samples of such material contained only traces of gold. Most of such veins occur within 0.5 km of the contact between metavolcanics and the surrounding plutonic rocks, and may also be expected in the screen of large metavolcanic inclusions north of Sesikinaga Lake.

Base metal sulphide occurrences are not known in the project area but iron sulphide-rich units have been intersected in diamond drill core obtained between Senior and Fawthrop Lakes. Prospecting in this area, where Sage and Breaks (1976) have also reported sulphide concentrations, may find surface mineralization. The most favourable targets for base metal sulphide exploration in terms of stratigraphy are in the areas north of Hailstone Creek and north and west of Deaddog Lake where intermediate pyroclastic rocks are concentrated and chemical sediments are known to occur.

Investigation of the mafic and ultramafic intrusive rocks around the unnamed lake to the northeast of Ferdinand Lake should be done to evaluate their copper and nickel content.

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No. 5 Felsic Centres of Volcanism, Uchi and Gods Lake Subprovinces, Northwestern Ontario

P.C. Thurston[1]

Introduction

This project is designed to assess the economic potential of felsic volcanic centres in the Uchi and Gods Lake Subprovinces. Mapping and chemical sampling of selected centres has been carried out during the 1979 field season to ascertain the style of volcanism, stratigraphy of the resulting accumulation of felsic volcanic rocks, and associated rock types. The five areas examined are described below.

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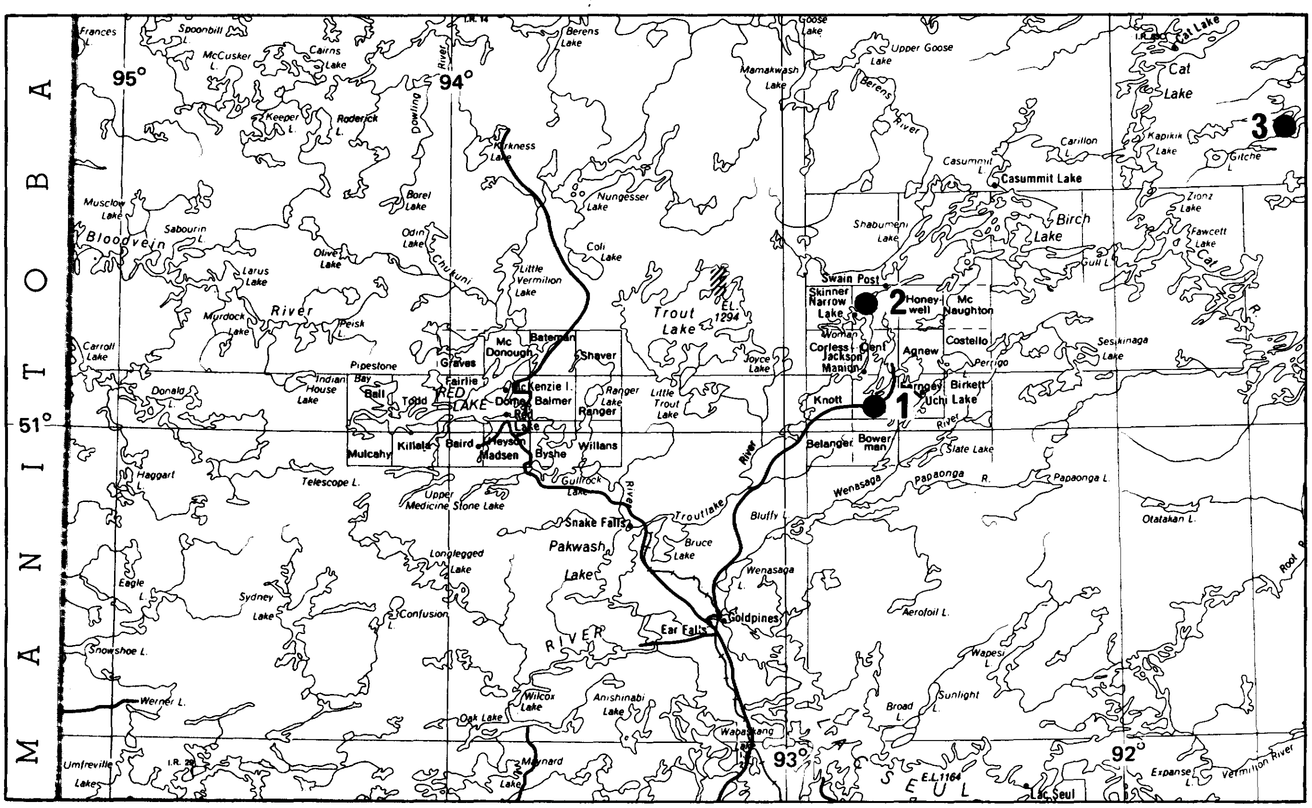
1. Fly Lake Area

The area lies 78 km east of Red Lake. Access is via the 80 km road proceeding northeast from Ear Falls to a route involving 2 portages to Fly Lake or by aircraft from Red Lake or Ear Falls.

All bedrock in the area is Early Precambrian in age and part of the Birch–Uchi Lakes metavolcanic-metasedimentary belt within the Uchi Subprovince (Ayres *et al.* 1971). Previous mapping has been conducted by Pryslak (1969), Goodwin (1967), and Thurston and Jackson (1978).

This area lies in the uppermost of three basalt to rhyolite volcanic cycles in the Uchi–Confederation Lake area (Thurston and Jackson 1978). This uppermost cycle



LOCATION MAP

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

includes the South Bay Mine, a volcanogenic Cu-Zn-Ag massive sulphide (Pollock *et al.* 1972). The cycle proceeds from a basaltic base through intermediate flows and pyroclastic rocks to felsic flows and pyroclastics. Part of the felsic metavolcanics lie in a fault bounded structure (Figure 1) termed a sector graben (Williams 1941). The field work was designed to provide a more precise structural and lithologic framework for the South Bay deposit, with work concentrated in the Fly Lake area and south of the narrows of Confederation Lake. Within the sector graben a sequence of rhyolite flows and associated hyaloclastites and brecciated flows (terminology of Dimroth and Rocheleau 1979) about 5,000 feet thick is succeeded upward by a 1500 feet thick unit of tuff, lapilli tuff and tuff breccia which is characterized by lack of bedding, reverse-size grading of beds with pumice-rich tops and lithic-rich base, consistent with an origin as ash flows with minor intercalated air fall material. This in turn is succeeded by about 500-700 feet of unbedded heterolithic pyroclastic rocks, which represent debris flows, capped by 150-200 feet of pillowed mafic flow. Above this lies a complex composed mainly of felsic flows and local accumulations of pyroclastic rocks representing collapse of the endogenous dome at the South Bay Mine (Pollock *et al.* 1972).

A secondary purpose of the work at Fly Lake was to elucidate the structure which has been the subject of varying interpretations.

1) Pryslak (1970) indicates that the units south of South Bay strike south and conformably overlie the basaltic base of the third cycle.

2) Asbury (1975) suggests that folds in the mine area plunge to the northeast at about 45 degrees, whereas mapping outside the mine area (Thurston *et al.* 1975; Pryslak 1970) indicates a steep northerly plunge.

3) Thurston *et al.* (1978) amplified Asbury's (1975) suggestion that the felsic volcanics forming the upper part of cycle III occur in a fault bounded block with a structure differing from the regional structure by postulating that the fault bounded block is a sector graben (Williams 1941). This work confirms the sector graben interpretation in that the strike of units within the graben is approximately NE (Location map). Rhyolite flows south of the South Bay Mine strike at approximately N30°E, again at variance with the regional strike beyond the faulted boundary of the graben. Units within the sector graben are folded about a shallow northeast plunging anticlinal axis, based upon top determinations using pillow shape and packing, grain gradations in airfall tuffs, and reverse-size grading in ash-flow units.

TABLE 1 DETAILED STRATIGRAPHY OF THE WOMAN LAKE TUFF (AFTER THURSTON 1979)

TOP

12 m	unwelded felsic airfall tuff, lapilli-tuff, minor tuff breccia a) uppermost 1.5-3 m felsic tuff-breccia with 20-30% pumice, 10-15% lithic fragments, unbedded in ash matrix. b) lower 9-10.5 m airfall tuff 6 to 8, 4 to 60 cm thick normally graded tuffs with 3-5 mm feldspar and quartz grains and lithic clasts (25%) in an ash matrix.
4.5 m	unwelded felsic lapilli-tuff (20% pumice avg. 2 cm x 1 cm)
2 m	unwelded felsic lapilli-tuff a) uppermost 25-30 cm bedded parallel laminated ash b) 1.8 m felsic lapilli-tuff with 20-30% 2 cm x 2 cm pumice fragments.
100-120 m	welded felsic lapilli-tuff (unit 2) a) uppermost 0.2 m parallel bedded felsic tuff b) unwelded felsic lapilli-tuff 2 m thick with 20-30% 1 cm x 2 cm pumice c) 47.8 m partly welded to welded felsic lapilli-tuff (a distinctive 1 m thick unit with 10% mafic lapilli occurs toward the top of this section).
50 m	welded felsic lapilli-tuff (unit 1) a) uppermost 3 m - up to 45 cm x 4 cm pumice clasts (50%) in an ash matrix b) remainder of unit - 5 cm x 5 m pumice clasts in an ash matrix with rare lithic clasts c) a 30 cm thickness about 1 m above the base is locally vitrophyric
1 m	unwelded felsic crystal lithic airfall tuff thin-bedded (2-8 cm) normally graded with sparse lapilli

BOTTOM

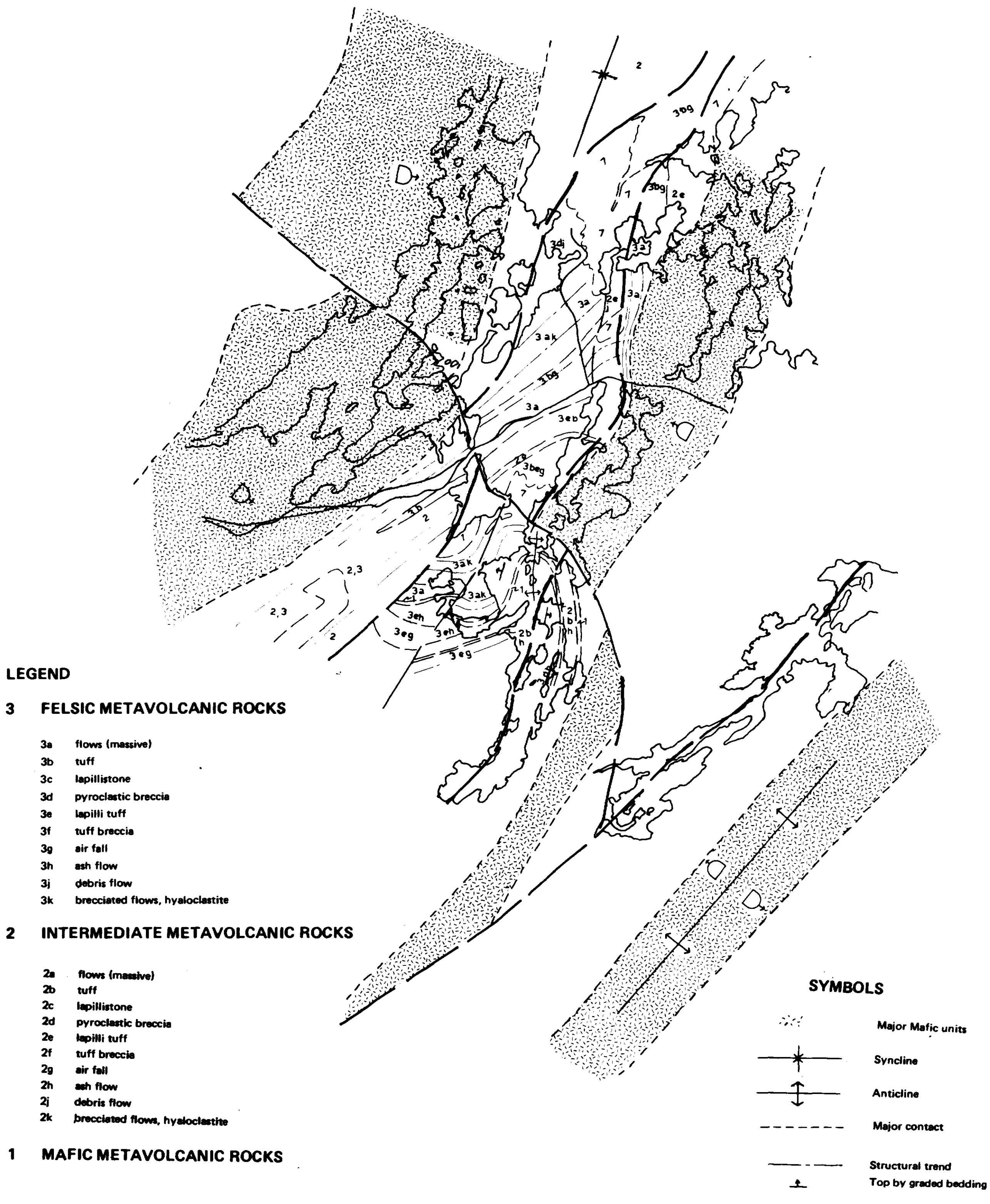


Figure 1—Sketch Map of the Fly Lake Area.

2) Woman Lake Area

The area lies about 70 km east-northeast of Red Lake in the Birch-Uchi metavolcanic-metasedimentary belt, a portion of the Uchi Subprovince (Ayres *et al.* 1971). Previous mapping includes the work of Pryslak (1971), Goodwin (1967), Greig (1927), Bruce (1928), and Thurston and Jackson (1978). The upper portion of Pryslak's (1971) second cycle (cycle II) was examined with a view to documenting the detailed stratigraphy of the felsic volcanic rocks. Table 2 below gives an abbreviated account of the stratigraphy in the area of the portage from Woman Lake to Narrow Lake.

Above the sequence in Table 2 lies about 150 m thickness of intensely welded tuff and lapilli-tuff ash flows. This unit, described in Table 1, is intensely welded to the point where subaerial deposition is the most probable origin. The unit is more thoroughly described in Thurston (1979).

3) Lang Lake Area

The area lies 168 km east-northeast of Red Lake and 100 km east of Pickle Lake. Access is via float or ski-equipped aircraft available in either locality. The area has been previously mapped by Laird (1930), Emslie (1960), and Fenwick (1969). Fenwick's mapping disclosed that east-striking Early Precambrian (Archean) felsic metavolcanics forming the upper part of a mafic to felsic volcanic sequence are folded about an east-trending synclinal axis. The main occurrences of felsic metavolcanics are: 1) a unit about 150 m thick and 1.5 km long along the northern rim of the syncline at Boyes Lake; 2) the correlative of unit 1 on the south limb of the syncline, which is about 400 m thick and extends 5 km east from the east end of McVicar Lake; and 3) a third major unit of felsic metavolcanics, herein termed the Shonia Lake occurrence, which is 10.5 km long extending from south of Long Lake to east of Andy Lake. Units 1 and 2 consist of felsic lapilli-tuffs and lapilli-stones with abundant pumiceous clasts, overlain by intermediate, finely laminated air-fall tuff, and felsic lapilli-tuffs of ash flow origin in turn overlain by felsic tuff breccia and graphitic metasediments with chert clasts. The Shonia Lake unit consists of felsic tuff, lapilli-tuff and tuff-breccia units which strike N45°W to N, approximately at right angles to other supracrustal rocks in the area. The north-striking unit consists of from base to top:

1) subaqueous tuff-breccia and lapilli-stone, non-bedded, with subangular to rounded clasts consisting dominantly of pumice and occasional lithic clasts, little or no matrix, and occasionally at 30-60 m intervals a 2-10 cm thickness of finely banded tuff. Total thickness of this rock type is about 1170 m.

2) Lapilli-tuff to tuff-breccia consisting of several 30-50 cm thick non-bedded units with a lithic-fragment-rich base, pumice-rich upper portion. The uppermost 2-3 m is commonly bedded with beds 1-10 cm thick. Pumice fragments vary over the thickness of the unit from relatively undeformed (flattening ratio 3-4:1 to a ratio approaching 10:1; measured after the method of Peterson 1961). These units are interpreted in the basis of the above characteristics as welded ash flows, possibly representing subaerial volcanism (Parsons 1969).

3) A single large outcrop area consisting of 60 m of 0.6-1 m thick bedded units containing subangular lithic fragments with less than 10 percent pumiceous clasts as 2-10 cm thick beds succeeded upward by 2-8 cm thick finely-bedded tuff units. The units are considered to be small scale ignimbrites. The 60 m thickness, represents several hundred individual eruptive events. The upper part of the exposure consists of a 10 m thick ash flow succeeded by thin bedded tuffs for 2 m.

4) A single outcrop of tuff-breccia to pyroclastic breccia with 0.3-0.6 m lithic fragments in a tuffaceous matrix occurs about 400 m south of Lang Lake, due south of the outlet of Boyes Creek. The fragments vary from angular to somewhat rounded, are all felsic lithic clasts in a felsic ash matrix and many fragments have complex amoeboid shapes and re-entrant angles. The lack of a brecciated source rock and the above characteristics suggests that the outcrop rock type is a deposit at some minor distance from a subvolcanic dome produced by hydromagmatic

TABLE 2: STRATIGRAPHY OF THE LOWER PORTION OF CYCLE II PYROCLASTIC ROCKS, WOMAN LAKE AREA

Lithology	Origin	Comments
TOP		
Intermediate tuff-breccia	debris flow	
Felsic lapilli-tuff, tuff	ash flows	reverse grading common
Mafic flow		massive
Felsic tuff, lapilli-tuff, intermediate tuff	airfall	possibly subaerial
Mafic flow		massive

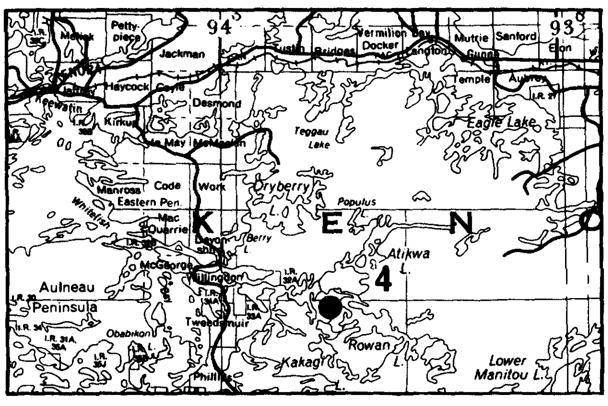
explosion (Dimroth 1977).

Structure

The main portion of the belt is folded about an east-trending synclinal axis. The Shonia Lake unit trends nearly at right angles to this, and based upon several top determinations using grain-gradations in the ignimbritic rocks is folded about a northwest-trending synclinal axis. Therefore the Shonia Lake felsic metavolcanics post-date the other two units of felsic metavolcanics. The Shonia Lake unit is truncated by an east-trending 300 m thickness of intermediate subaqueous debris flows, wackes, and cherts found along the south shore of Lang Lake. Thus the Lang Lake area contains two ages of felsic metavolcanics, the main east trending mafic to felsic sequence (felsic units (1) and (2)) and a later, perhaps rift controlled, NW trending sequence of subaqueous to subaerial intermediate to felsic metavolcanic (Shonia Lake) sequence, which was followed by deposition of subaqueous metavolcanics and metasediments forming the central part of the main Lang Lake syncline, centered on Lang Lake.

4) Atikwa Lake

The Maybrun mine of Maybrun Mines Limited about 35 km southeast of Kenora was examined with the purpose of developing a trace element method of detecting syngenetic Cu mineralization in mafic flows. Field work on the property shows that mineralization consisting of chalcopyrite, pyrite, pyrrhotite, and carbonate occurs in the inter-pillow spaces of pillowed mafic flows. Four separate flows marked by a base without pillows or having a few large pillows, grades upward into smaller pillows (0.3 to 0.6 m). As the pillows decrease in size, inter-pillow space, the thickness of dark selvage, and the amount of mineralization increases in amount. Flows are capped by thin (2 to 4 cm) collapsed pillow horizons 10 to 20 cm thick occasionally with thin beds of carbonate and felsic tuff. The flow top material may have acted as an impermeable seal, permitting extensive hydrothermal activity within the flow and deposition of mineralization. Work is in progress on the mineralogical and chemical characteristics of this type of mineralization.



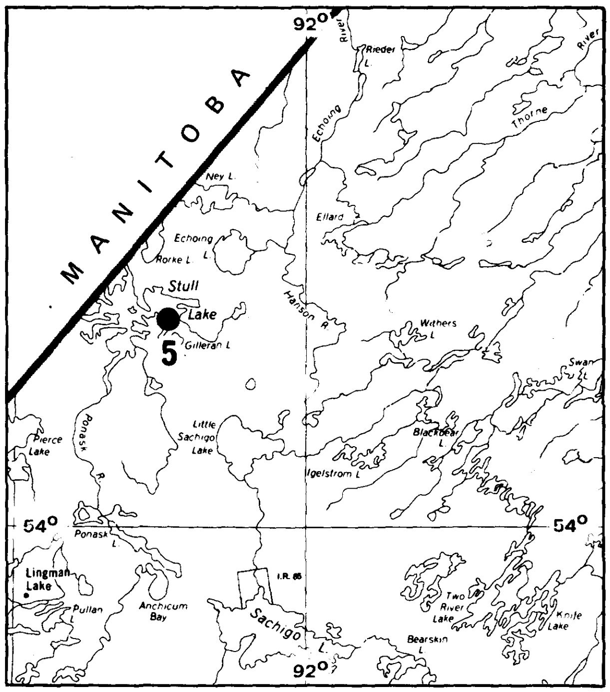
LOCATION MAP

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

5) Stull Lake

The area lies 375 km north-northeast of Red Lake and is accessible by float or ski-equipped aircraft from Red Lake or via Island Lake 150 km southwest, in Manitoba. The area lies in the Gods Lake Subprovince of the Canadian Shield (Ayres *et al.* 1971). Previous work in the area includes Satterly (1937) and Bennett and Siley (1969).

The rocks of the area are all Early Precambrian in age. Felsic metavolcanics and metasediments described by Satterly were examined briefly at the close of the field season. The felsic metavolcanics comprise several flow units along the east shore of the main part of the lake, ash flow units along the west shore of the lake, and units considered by Satterly (1936) to be conglomerates on the east shore of the lake. The latter are worthy of detailed examination as they may be large proximal ash flows or debris flows. Time did not permit a more detailed examination. Poor weather prevented reconnaissance of Rapson Bay of Stull Lake.



LOCATION MAP

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

Further Work

The metavolcanic occurrences described have been sampled for chemical analysis. Major element analyses will be carried out on the samples. Trace element and rare earth element analyses will also be carried out in order to determine whether trace and rare earth element contents of mineralized felsic metavolcanic occurrences differ from unmineralized localities.

Suggestions for Exploration

Volcanogenic massive sulphide orebodies associated with felsic volcanic rocks appear to occur in close association with subaqueous endogenous domes and associated dome collapse breccias, products of hydro-magmatic explosions, and flows (Dimroth 1977; Matsukuma and Horikoshi 1970). In that the felsic metavolcanics at Lang Lake and Woman Lake are more predominantly of distal tuffaceous character these areas do not have the same high potential as the Fly Lake – Confederation Lake area of cycle III volcanism in the Uchi–Confederation Lakes area. However massive sulphide occurrences are associated with subaerial ash-flow volcanism in the Hackett River area of the Northwest Territories (Frith *et al.* 1977) and elsewhere (Swanson *et al.* 1978).

Therefore the tuff-breccia occurring south of Lang Lake as well as the structurally highest rocks in the north-trending syncline of the Shonia Lake occurrence may warrant detailed investigation using geological and geophysical techniques with appropriately oriented traverse lines.

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No. 6 Melchett Lake Area, District of Thunder Bay

W.D. Bond[1]

Introduction

In 1979 the author began a two-year, detailed (scale 1:15 340), mapping project in the Melchett Lake area. The area is of interest in that:

i) There are known base-metal showings associated with felsic to intermediate metavolcanics (Thurston and Carter 1969).

ii) The Melchett Lake area is potentially correlative with and is situated in a similar geological environment to the Marshall Lake area, the site of considerable base metal mineralization (Amukun 1978).

Beginning in mid-July, approximately six weeks were spent in the map-area.

Melchett Lake is situated within the Thunder Bay mining division and is located 64 km north-northwest of Nakina. Nakina is situated on the Canadian National Railway about 263 km northeast of Thunder Bay.

The area is accessible by fixed-wing, float-equipped aircraft from Nakina. A road (Highway 643) extends north from Nakina past O'Sullivan Lake to Melchett Lake. This road is open to the public north to Terrier Lake. Thereafter the road is owned by Dominion Foundries and Steel Limited (Dofasco) and access is restricted.

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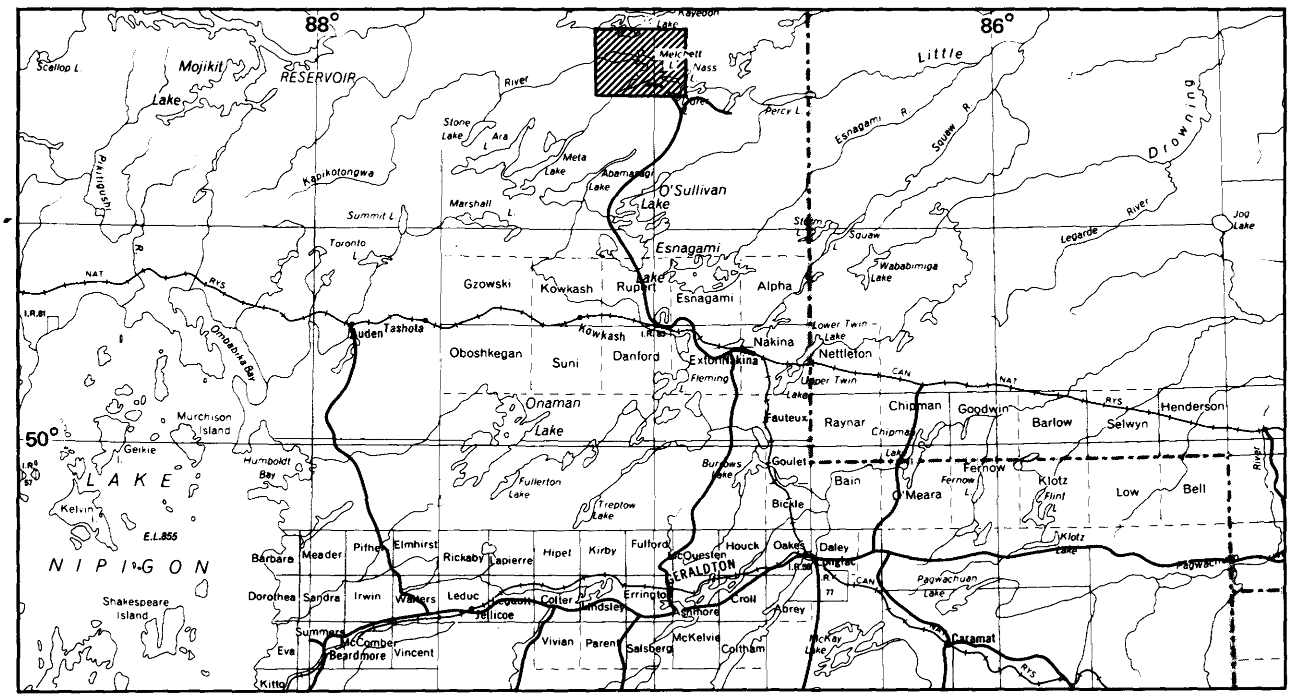
Mineral Exploration

Previous mineral exploration efforts have been concentrated on two parts of the area. Base-metal exploration has centered on the area north of and east of Kapikotongwa Lake while the area south and east-southeast of Melchett Lake has been extensively examined for its potential iron reserves.



LOCATION MAP

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

There is little evidence of any mining activity prior to 1954 when preliminary investigation of the Skibi Lake Iron Prospect (Shklanka 1968, p.445) was made. Sulphide mineralization was first discovered south of Relf Lake (frequently referred to as the east showings) in 1959 on the Lun-Echo Gold Mines Limited and Kerr-Addison Gold Mines Limited property. This property was optioned in 1960 to Little Long Lac Gold Mines Limited who did trenching, geophysical (self potential) and geochemical surveys and diamond drilled six holes (453.7 m) encountering sphalerite, minor galena and traces of gold and silver. The claims were allowed to lapse and in 1964 Shawmin Exploration Limited (now Shawmin Consulting Limited) restaked the ground and diamond drilled a further 4 holes (350.5 m). In 1968 the property was optioned to Chimo Gold Mines Limited who conducted a ground geophysical (EM and magnetic) survey (Assessment Files Research Office, Ontario Geological Survey, Toronto, File 63.2322).

In 1967 additional base-metal mineralization was discovered further west near the northeast end of Kapikotongwa Lake and in 1968 Nakina Mines Limited carried out a ground geophysical (EM and Magnetic) survey (Assessment Files Research Office, Ontario Geological Survey, Toronto, File 63.2352) on this discovery and diamond drilled 10 holes (1137 m). Assays (Assessement Files Research Office, Ontario Geological Survey, Toronto) indicated zinc and lead mineralization similar to the eastern zone with up to 0.21 ounces gold per ton and up to 1.59 ounces silver per ton.

In 1975 Falconbridge Nickel Mines Limited flew an aerodat airborne combined EM-Magnetic survey over several areas including both the east and west mineralized showings (Assessment Files Research Office, Ontario Geological Survey, Toronto, File 2.1906).

In 1978 Cominco Limited staked the property and conducted a geological survey (scale 1:5000) including the intervening ground between the two base metal showings (Assessment Files Research Office, Ontario Geological Survey, Toronto, File 2.2907). During the 1979 field season Cominco Limited completed an I.P. survey on this property.

At about the same time as the discovery of the western zone of base metal mineralization, Chimo Gold Mines Limited and United States Smelting Refining and Mining Company (hereafter U.S.S.R.M.) were concentrating their exploration efforts in the area north of Kapikokongwa Lake. Ground geophysical surveys (EM and Magnetometer) were conducted by Chimo Gold Mines Limited (Assessment Files Research Office, Ontario Geological Survey, Toronto, File 63.2390). In a joint venture Chimo Gold Mines Limited and U.S.S.R.M. conducted both geophysical (EM and Magnetometer) and geological (1:4800) surveys on part of this ground (Assessment Files Research Office, Ontario Geological Survey, Toronto, Files 63.2359, 63A-538). Five diamond drill holes (455.5 m) were put down to test individual anomalies and intersected minor amounts of chalcopyrite and traces of gold and silver. In 1970 U.S.S.R.M. completed ground geophysical (EM and Magnetometer) surveys (Assessment Files Research Office, Ontario Geological Survey, Toronto, Files 2.215, 63.2750) on the area to the west of the ground explored in 1968.

Cominco Limited conducted a geological survey (1:4800) over a small part of the above area in 1978 (Assessment Files Research Office, Ontario Geological Survey, Toronto, File 2.2868).

The ground between Nass and Colpitts Lake has been investigated by Aldor Exploration and Development Company Limited (Assessment Files Research Office, Ontario Geological Survey, Toronto, File 63A-374) in 1960, by Rio Tinto Canadian Exploration Limited (Assessment Files Research Office, Ontario Geological Survey, Toronto, File 2.372) in 1971 and by Cominco Limited in 1978 (Assessment Files Research Office, Ontario Geological Survey, Toronto, File 2.2886).

The Skibi Lake Iron Prospect is situated between Melchett Lake and Percy Lake. The history of exploration is given by Swenson (1960) and reviewed by Thurston and Carter (1970, p.51-52) and Shklanka (1968, p.445). Much of the exploration was done by Anaconda Iron Ore (Ontario) Limited who in 1975 sold the property to Dominion Foundries and Steel Limited.

General Geology

Reconnaissance geological mapping was previously carried out by Hopkins (1916, scale 1:500 000; 1917), Kindle (1931, scale 1:126 720) and Thurston and Carter (1969, 1970, scale 1;126 720). Pye *et al.* (1965) completed a compilation of the area at a scale of 1 inch to 4 miles. Except for isolated portions geologically mapped by various mining concerns the area has never been mapped in detail. During the 1979 field season the ground between Melchett, Kapikotongwa and Kayedon Lakes east to within 0.8 km of Relf Lake was mapped.

The metavolcanic belt is wider than indicated by Thurston and Carter (1969) and extends westward to at least Tennant Lake. The southern boundary is situated along the south shore of Kapikotongwa Lake; the northern limit coincides closely to the contact separating granitoid and sedimentary rocks indicated by Thurston and Carter (1969) just south of Kayedon Lake. North from Melchett Lake the volcanic sequence is 5250 m wide gradually thinning eastward to about 4000 m (between Tennant and Kapikotongwa Lakes). The volcanic belt is essentially surrounded by metasediments and is situated in the central part of the English River Subprovince.

The volcanic sequence is volumetrically estimated to be comprised of 80 percent intermediate, 10-15 percent mafic and 8 percent felsic assemblages and is dominantly pyroclastic in origin. Proceeding north to south the sequence north of the northeast end of Melchett Lake comprises the following major units (Table 1).

Layered pyroclastic rocks are prominent in units B, E and G and are medium to very thickly bedded (0.2 to greater than 3 m), dominantly matrix supported, and com-

TABLE 1 | VOLCANIC SEQUENCE NORTH OF MELCHETT LAKE

	Description	Thickness (Metres)
A)	mafic tuff breccia;	30-50
B)	intermediate tuff-breccia characterized by crystal (feldspar) tuff matrix, subordinate lapilli-tuff, porphyritic (feldspar) intermediate flows all interlayered with medium to thick-bedded mafic tuff-breccia (% of mafic breccia component decreases volumetrically to the south);	450-600
C)	intermediate tuff, lapilli-tuff, tuff-breccia, minor crystal tuff (layering is not as prominent);	300
D)	felsic tuff-breccia, felsic tuff and lapilli-tuff, with rare felsic flow (this unit is extensively mineralized - mainly pyrite with some sphalerite);	700 (west) thinning to 300 (east)
E)	well layered, thickly-bedded sequence of intermediate tuff-breccia, lapilli-tuff, rare crystal tuff interlayered with subordinate mafic tuff, tuff-breccia (mafic component is depleted towards the south). The southern 500 m is non-layered intermediate tuff. This unit characteristically contains mafic clots of both primary and secondary origin.	1500
F)	massive and pillowed, locally porphyritic mafic flows	500
G)	well layered, interbedded intermediate tuff/lapilli-tuff, mafic tuff-breccia, minor felsic tuff	500

prised of a heterolithic fragment population. The coarse fragments tend to be uniform in both size range and distribution. Grading of fragment lithologies is locally evident in unit E. Non-layered pyroclastic rocks such as in units C, D, and the southern part of E are characterized by a more monolithic fragment population. Mafic fragmental volcanic rocks are invariably coarse and garnetiferous. The garnets which are also developed throughout unit E are typically helecitic (Spry 1969) and locally exhibit sinuous rotational forms. The coarsest fragmental rocks are associated with units B, C, and D in the vicinity of the northeast part of Kapikotongwa Lake. Unit E characteristically contains mafic clots, lenticles and bands comprised of amphibole + plagioclase ± quartz. This mafic component is regarded to have originated by a combination of secondary reworking including metamorphic recrystallization, metamorphic differentiation, and hydrothermal activity. At least some of the mafic component is thought to be primary in origin (magma-magma mixing) and is similar to the mixed volcanic unit in the Savant Lake area (Bond 1978). Local evidence of grading of the pyroclastic rocks coupled with their proximity to pillowed mafic lavas in the south suggests they originated as subaqueous pyroclastic ash flows. The stratigraphic sequence outlined suggests the presence of at least two volcanic cycles with units A to D comprising one cycle.

Metasediments are dominantly comprised of sandstone + subordinate pelite beds. Except for bedding planes and local metamorphic grain size gradation the sediments do not exhibit any environmentally diagnostic structures. Metamorphic assemblages include biotite + muscovite ± sillimanite; biotite + rare almandine; biotite + rare chlorite (after cordierite). Almandine is found in single beds and is most abundant near the iron formation south of Melchett Lake. The assemblages are indicative of the quartz-muscovite-sillimanite zone of medium-grade metamorphism (Winkler 1974). At Melchett Lake many of the pelite members contain concordant and discordant layers, boudins and rootless intrafolial folds of quartz veins considered to be thermal mobilizate (Mehnert 1971, p.356). A similar mobilizate occurs at the same metamorphic grade in metasediments in the Lake St. Joseph area (Breaks, Bond, and Stone 1978, p.42). The metasediments are atypical of the metasediments observed in the western part of the English River Subprovince (Breaks, Bond, and Stone 1978) in that:

i) They are thinly bedded (average 1.2 to 10 cm) versus mainly thick bedded in the west, part of the English River Subprovince.
ii) Except for rare occurrences northwest of Kapikotongwa Lake, the metasediments have not attained high grade metamorphic conditions and consequently exhibit no evidence of partial melting.

A large body of homogeneous diatexite (end product of complete anatexis; Breaks, Bond, and Stone 1978) is situated between Kapikotongwa and Melchett Lakes and continues southwest out of the map-area. Thin dikes of diatexite are common throughout the metasediments. Almost all of the diatexite was observed to be intrusive into its present setting. South of Melchett Lake a muscovite-bearing pegmatite that is probably diatexite was dated at 2640 m.y. (Goldich *et al.* 1961, p.52) whereas a quartz biotite schist (metasediment) was dated at 2720 m.y. (Goldich *et al.* 1961) using the K-Ar method. Both of these dates agree closely with the date of sedimentation and pervasive migmatization in the Lac Seul area (Krogh *et al.* 1976).

Several intrusive events have occurred in the area. Rare thin mafic gabbroic sills and dikes intrude all supracrustal rocks; their intrusion is commonly controlled by cleavage planes related to the regional fold pattern. Following the mafic intrusive event and prior to the end of the regional deformation folding event, quartz feldspar porphyry (subvolcanic) dikes were intruded and are mainly associated with volcanic units A, B, C, and D. Also prior to the close of regional deformation, a sill varying in composition from trondhjemite to quartz diorite was intruded between volcanic units E and F. The sill is characterized by complementary mafic/felsic porphyroblastic, diffuse clots that originated either through metamorphic differentiation or as a stictolithic (partial melt) texture (Mehnert 1971, p.37). A relatively unmetamorphosed, weakly lineated, polyphase intrusive underlies Kayedon Lake. With decreasing relative ages the phases become progressively less mafic and range from ultramafic to gabbro, quartz diorite, and trondhjemite. The ultramafic-gabbroic phases locally exhibit cumulate textures. Diabase dikes mark the last major intrusive event in the area. The dikes mostly trend northwest, northeast, and north. A north-trending dike south of Melchett Lake was dated at 1480 ± 145 m.y. using the K-Ar method (Wanless *et al.* 1968, p.94).

Structural Geology

The volcanic supracrustal sequence strikes easterly. At Kapikotongwa Lake, north to north-northeast-trending linear structures plunging 50 to 70 degrees are developed in all lithologies. Farther east at Melchett Lake the lineations trend northeast because of a southeast flexure in the trend of the volcanic sequence.

Tops from pillow lavas and vague grading of fragment lithologies suggest the volcanic sequence faces south. Rare grain size gradations in the metasediments immediately south of the volcanic sequence support this south-facing trend. Numerous reversals in the metasediments in the vicinity of the iron formation occur. The structure of the iron formation is described in Thurston and Carter (1970, p.52).

Economic Geology

The volcanic belt is more extensive than formerly thought. The presence of a substantial volume of thick-bedded coarse pyroclastics suggest a volcanic center is close to the area. Volcanogenic base metal-mineralization is associated with several of the volcanic units. Volcanic unit D is invariably mineralized (2 to 20 percent) with disseminated pyrite and contains local concentrations of mainly sphalerite associated with minor galena, rare chalcopyrite, minor gold and silver. The mineralization occurs as thin discontinuous veins along fractures and as disseminations. Drilling to date has tended to be concentrated around the known mineral showings. Unit D itself has been traced laterally from just north of the northeast end of Kapikotongwa Lake east to Relf Lake for a distance of at least 5500 m. Thin felsic and intermediate volcanic lenses that are locally mineralized with pyrite-sphalerite are also associated with volcanic unit E. Locally the mineralization there appears to be remobilized and associated with the mafic clots and bands.

Uranophane staining was observed on one outcrop in the homogeneous diatexite south of Tennant Lake. The association of uranium mineralization to the diatexitic stage of migmatization has been previously reviewed (Breaks, Bond, and Stone 1978, p.46).

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No. 7 Gibi Lake Area, District of Kenora

N.F. Trowell[1]

Location

The map-area, bounded by Latitudes 49°32'W and 49°43'W and Longitudes 93°58'N and 94°14'N, comprises the four contiguous townships of Code, Work, McMeekin, and LeMay. The town of Sioux Narrows is approximately 25 km to the south, and Kenora is situated approximately 30 km to the northwest. Highway 71 passes through the central part of the map-area. Subsidiary gravel logging and camp access roads, from the main highway provide access to all but the southwest and southeast corners of the map-area. These remote areas are accessible by float-equipped aircraft.

A seven-week reconnaissance survey was conducted along Highway 71, subsidiary side roads and several road-accessible lakes in the spring and summer of 1979. In 1980, the entire area will be completed in detail.

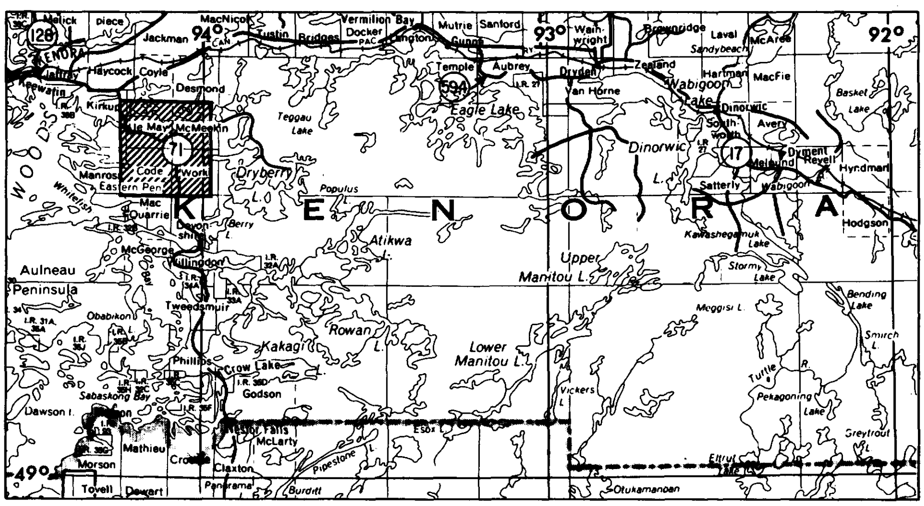
Mineral Exploration

Exploration, concentrating on gold, was initiated within the map-area during the late 1890s and continued into the early 1900s. Underground development and considerable trenching was undertaken, during this period, at the Triggs and Stella prospects situated in the northwest corner of Code Township (Beard and Garratt 1976). Sporadic activity continued at, and in the vicinity of, the Stella Prospect with additional trenching occurring during the periods 1935-1937 and 1946-1948 (Beard and Garratt 1976) and with diamond drilling by E.J. Stone in 1960[2]. A bulk sample was taken from the Triggs prospect in 1950 (Beard and Garratt 1976). In 1953 Rexora Mining Corporation Limited carried out geological mapping and diamond drilling in the vicinity[3]. In the same year they also conducted diamond drilling north of Hook Lake[3]. Further drilling near the Triggs prospect was conducted by Macassa Mines Limited in 1960[3]. In 1967, M. Hupchuk carried out diamond drilling east of Bug Lake[2]. D. Schack and A. Jensen (Olympia Gold Mines Limited) carried out diamond drilling west of Hook Lake in 1970[3]. Dome Exploration (Canada) Limited carried out airborne and ground, magnetic and electromagnetic surveys, and follow-up diamond drilling over several claim groups north, west, and south of Gibi Lake in the period 1972-1976.

1 Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.

2 Information from Regional Geologist's files, Ontario Ministry of Natural Resources, Kenora.

3 Information from Assessment Files Research Office, Ontario Geological Survey, Toronto.



LOCATION MAP

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

General Geology

The map-area has never been entirely mapped. In 1885, Lawson published his report covering the Lake of the Woods region to the west. Suffel (1931) and Fraser (1943) respectively mapped the northeast and southwest parts of the area. A geological compilation map by Davies and Pryslak (1967) covers the entire area.

All consolidated rocks except for Late Precambrian (Mackenzie dike swarm; Fahrig and Wanless 1963) diabase dikes are of Early Precambrian (Archean) age. They consist of a metavolcanic-metasedimentary assemblage, intruded by mafic to ultramafic intrusions and granitoid plutons and bounded and intruded to the north and south by the Dryberry Batholith.

Two major sequences of mafic metavolcanics are exposed in Gibi Lake and Black Lake areas. The Gibi Lake sequence consists of massive, amphibolitized flows to the north, to pillowed, locally plagioclase-phyric and amygdaloidal flows and autoclastic breccia zones to the south. Thin wacke-siltstone units locally occupy an interflow position.

The Black Lake sequence (as observed on and west of Highway 71) consists of amphibolitized massive and locally pillowed plagioclase-phyric flows that to the east occur as septa within granitoid phases of the Dryberry Batholith.

A fold-repeated sequence of mafic flows and fragmentals of possible ultramafic affinity occur along Highway 71 east of Gibi Lake. The flows are both plagioclase and pyroxene (now hornblende or biotite) phyric and are layered grading from an ultramafic cumulate base to a pillowed, plagioclase-phyric, and amygdaloidal top. Spinifex-like structures were locally observed. Locally intense deformation, accompanied by potassium metasomatism, transforms these flows to biotitic schists. The strike extent of this sequence was not determined, however they were traced northeastward into central McMeekin Township.

Intermediate and felsic fragmentals occupy the west-central part of Code Township. They vary from tuff to pyroclastic breccia in size and appear to be of both pyroclastic and autoclastic origin. Redeposition occurred by grain and debris flows. Quartz and quartz-feldspar porphyry phases suggest a hyabyssal component to the sequence. The fragmentals are intercalated with and apparently grade into clastic metasediments suggestive of contemporaneous degradation accompanying build-up of the original volcanic pile.

Three metasedimentary sequences are present within the map-area. Feldspathic arenites exposed on Andy Lake become more pelitic eastwards into McMeekin Township. They appear to be intercalated with and perhaps derived from the intermediate to felsic fragmental sequence. A second sequence of feldspathic wackes and siltstones, with minor mudstones, extends from Hump Lake southwest through Bug and Bunion Lakes. A zone of intercalated garnet-amphibole-magnetite ironstone and chert can be similarly traced near the southern margin of this metasedimentary sequence. The third sequence was only mapped along Highway 71, and its extent is not known. It consists of thickly bedded wackes and mudstones that have been metamorphosed to the andalusite-sillimanite (± garnet ± diopside) grade and that have been deformed apparently by a plastic soft-sediment style of deformation. This sequence may be a thrust slice, tectonically emplaced in its present relative position.

West of the south end of Dogtooth Lake, massive pods of pyroxenite and a layered ultramafic to mafic intrusion intrude the exposed base of the Gibi Lake mafic metavolcanic sequence. Similar pyroxenite pods intrude the metasediments exposed along Highway 71.

Synvolcanic plagioclase-phyric and massive diorite and gabbro intrusions are present within the mafic metavolcanic sequences.

Internal granitoid intrusions at Viola Lake and west of Bunion Lake (Fraser 1943) were not examined. The part of the Dryberry Batholith mapped during the present survey can be subdivided into three broad zones. West of Dogtooth Lake biotite-hornblende (pyroxene cores) monzodiorites intrude mafic metavolcanics and pyroxenites. They may have been derived by partial melting, at depth, of a lithology similar to that which they intrude at the level now exposed. To the north a rather uniform biotite granodiorite phase cut by sills of biotite trondhjemite and minor pegmatite covers the mapped part of LeMay Township. The biotite granodiorite phase intrudes the monzodiorite phase at Dogtooth Lake.

The part of the Dryberry Batholith exposed along Highway 71, in Work Township, consists of a 'gneiss dome' comprised of several complexly interlayed plutonic phases that were subsequently intruded by later phases ranging from predominantly trondhjemite to syenite and diorite in composition. More than 17 compositional and textural intrusive phases were recognized though time relationships have not yet been determined. Several stages of pegmatite emplacement were recognized, apparently ending with diatexitic pegmatites intrusive into the bordering metasediments.

Gower (1978) pointed out salient features that suggested the Dryberry Dome may be a part of the English River Subprovince. He noted that the Dryberry Dome has a similar magnetic signature as the Winnipeg River Plutonic Complex situated within the English River Subprovince. He also noted that sediments that are common in the Wabigoon Subprovince near the border with the English River Subprovince also occur along the southern margin of the Dryberry Dome. The 'gneiss dome', possible diatexitic pegmatites, and the andalusite-sillimanite grade metasediments within the present map-area all have features similar to those described for the English River Subprovince and its interface with the Wabigoon Subprovince (Breaks *et al.* 1978; Gower 1978). The author concurs therefore with Gower (1978) that in the genetic sense the Dryberry Dome can be considered to be part of the English River Subprovince.

Structural Geology

Structural deformation within the map-area varies from plastic soft-sediment folding, through folding of the metavolcanic-metasedimentary assemblage along predominantly east-west trending axial planes and deformation of the earlier fold pattern by emplacement of the Dryberry Batholith, to late brittle fracture evidenced by pseudotachylite developed in the metasediments. Brown (1976) has completed a structural study of the west half of the present map-area and an adjacent area to the west.

Economic Geology

Gold prospects (Triggs; Stella) occur in quartz veins along shear zones within the lower part of the Gibi Lake mafic metavolcanic sequence. Subsequent diamond drilling (Rexora Mining Corporation Limited, 1953[1]; E.J. Stone, 1960[1]; Macassa Mines Limited, 1961[2]; D. Schack and A. Jensen (Olympia Gold Mines Limited), 1970[2]; and Dome Exploration (Canada) Limited, 1973-1974[2]) in the lower section of the Gibi Lake mafic metavolcanic sequence indicated trace amounts of gold, silver, copper, nickel, and zinc in several conductive zones comprising siliceous shear zones and cherty, locally graphitic, pyrite- and pyrrhotite-bearing tuffaceous and sedimentary interflow units. The distribution of the mineralization, would suggest that it may have been originally stratigraphically controlled with subsequent mobilization and emplacement along late fractures.

Extensive tourmalization is present within the northern part of the metavolcanic-metasedimentary assemblage. The tourmaline occurs as massive pods and as joint and fracture fillings in the pyroxenites and mafic metavolcanics. Quartz-tourmaline veins containing minor sulphide minerals occur in both the mafic metavolcanics and metasediments. With the exception of minor tourmaline in late pegmatites cutting the Dryberry Batholith, tourmaline was not observed in the bounding granitic rocks. The tourmaline may owe its original source to detrital tourmaline in the metasediments that was driven off in solution, and subsequently redeposited during metamorphism. The tourmalization, the intense deformation, and the indication of extensive solution movement through the mafic metavolcanics and pyroxenites, locally transforming them into biotitic schists, suggests that this area should be prospected for areas of potential gold mineralization.

Drilling of conductors by Dome Exploration (Canada) Limited[2], in 1973 and 1974, within the intermediate to felsic fragmental sequence, picked up traces of copper, zinc, and lead in intercalated intermediate to felsic tuffs and pelitic graphite-bearing sediments. Traces of copper and zinc are also present in the intercalated ironstone and chert east of Bug Lake (M. Hupchak 1967)[1] and in sulphidic ironstone units within mafic metavolcanics north of Black Lake (Hudson Bay Exploration and Development Company Limited, 1975)[2]. The distribution of the mineralization and its association with intercalated metavolcanic-metasedimentary lithologies suggest that the mineralization could be due to deposition of distal exhalative solutions from an original volcanic centre. Exploration programmes for this area should take into consideration that the original centre of volcanism may possibly be situated in the west-central part of the map-area.

Several pegmatites similar to those described by Breaks *et al.* (1978) and postulated to be of diatexitic origin were observed within metasediments at the boundary with the Dryberry Batholith, south of Gibi Lake. In addition to potassium feldspar, plagioclase, and quartz these pegmatites contain yellow-green muscovite, magnetite, garnet, apatite, and tourmaline. Yellow and green beryl were also tentatively identified . Spodumene was tentatively identified in one hand specimen. A shallow-dipping 5 to 10 cm thick pegmatite located on Highway 71, east of Black Lake (south of the map-area) contains from 3 to 5 percent, 1 to 3 cm, pale yellow crystals identified as beryl (Geoscience Laboratories, Ontario Ministry of Natural Resources, Toronto). Samples of these minerals have been submitted for X-ray analysis to confirm their field identification. These pegmatites locally fluoresce a pale yellow-green colour. Exploration should be directed towards this zone containing these pegmatites, in the search for lithium and beryllium, and associated elements including caesium and tantalum, and possibly tin.

Titano-magnetite and apatite cumulate segregations were observed in the layered ultramafic to mafic intrusion west of Dogtooth Lake. The possibility of cumulate mineralogies indicate that this body should be checked for potential nickel, copper, and platinum content, and possibly also gold due to it being intensely deformed and altered.

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No. 8 Kawashegamuk Lake Area, District of Kenora

C.E. Blackburn[1]

Location

Kawashegamuk Lake lies about 30 km southeast of Dryden, in the District of Kenora. The map-area is bounded by Latitudes 49°22′30″ and 49°33′N, and Longitudes 92°15′ and 92°30′W, and covers approximately 200 km^2. Approximately 65 km^2 in the north-central part of the area were mapped by the author and one assistant during the month of July 1979. The remainder of the area will be mapped in 1980.

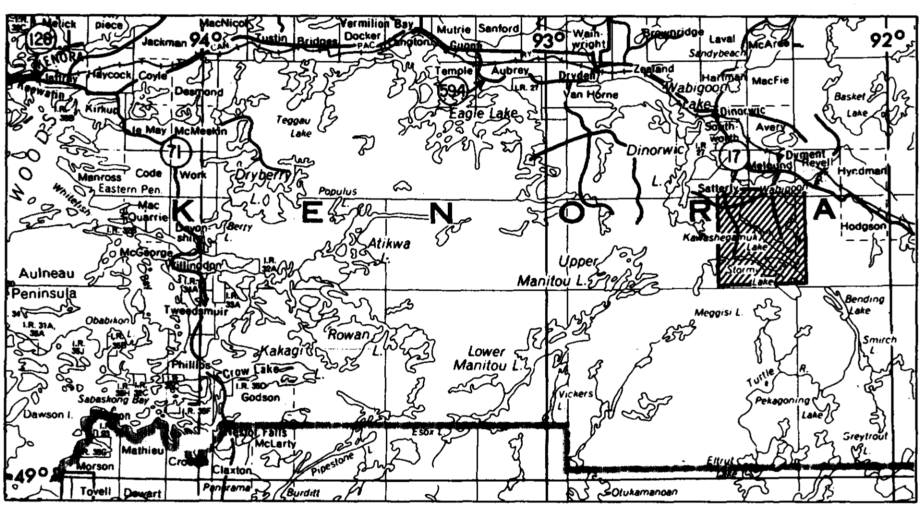
Access to the map-area is facilitated by two gravel roads. A lumber road, currently in use by Reed Paper Company of Dryden, commences from Highway 17, the Trans Canada Highway, at Jackfish Lake, approximately 10 km east of Dinorwic. This road gives access to the western part of the map-area and to Stormy Lake. A township road that commences at Borup's Corner on Highway 17, gives access to the eastern part of the map-area, and to Kawashegamuk Lake.

1 Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.

Mineral Exploration

The Manitou–Stormy Lake area, of which Kawashegamuk Lake is a part, was the scene of considerable gold prospecting and mining activity during the period 1895 to 1912, and again in the 1930s (Thomson 1933). Most of the activity centred around the Manitou Lakes in the west, and north of Kawashegamuk Lake in the east. The only deposit to attain significant production in the eastern area was the Sakoose Mine, from which during the period 1899 to 1947, 3,669 ounces gold and 145 ounces silver are recorded to have been produced (Beard and Garratt 1976). The Tabor Lake prospect reportedly produced 36 ounces gold and 4 ounces silver in 1935 (Beard and Garratt 1976). Patents on both of these former properties have been cancelled.

In the 1950s, as part of exploration programmes following discovery and development of copper and nickel deposits elsewhere in the Kenora District, the Canadian Nickel Company Limited and Falconbridge Nickel Mines Limited conducted geophysical surveys and drilling programmes in the map-area, the former company in 1952 on a reported gabbro body (Thomson 1933) on the northeast shore of Kawashegamuk Lake that reportedly hosted chalcopyrite and nickeliferous pyrrhotite, and the latter company in 1957 at Church Lake, and near the reported



LOCATION MAP

Scale: 1:1 584 000 or 1 inch to 25 miles gabbro body previously investigated by the Canadian Nickel Company Limited[1].

In 1965 and 1966, Dome Exploration (Canada) Limited carried out geochemical soil sampling, trenching, and 1710 feet of diamond drilling on a molybdenite prospect between Mennin and Oldberg Lakes[1].

Discovery of the Cu-Zn-Pb deposits at Sturgeon Lake in 1969 heightened interest in this part of northwestern Ontario. As a result a number of companies have flown airborne geophysical surveys over the general Manitou–Stormy Lakes area. Two general parts of the Kawashegamuk Lake map-area received considerable ground follow-up. One is in the northwest, northeast of the east end of Boyer Lake, where Asarco Exploration Company of Canada Limited (in 1970-71), Newmont Mining Corporation of Canada Limited (in 1975), and Selco Mining Corporation Limited (in 1976), reported having diamond drilled a total of four holes[1]. The other is in the north-central part of the map-area, between Church Lake and the south boundary of Melgund Township, where Lynx Canada Exploration Limited – Dejour Mines Limited (in 1970), Newmont Mining Corporation of Canada Limited (in 1974), Hudson Bay Exploration and Development Company Limited (about 1974), and Selco Mining Corporation Limited (in 1977-78) are known to have drilled a total of nine holes[1].

During the 1979 field season (month of July) Selco Mining Corporation Limited retained most of its claims in the area from Church Lake to the south boundary of Melgund Township, while staking was proceeding around the old Tabor Lake property for St. Joseph Exploration Limited. Falconbridge Copper Limited commenced a grassroots exploration programme in the general Kawashegamuk Lake area.

General Geology

The Kawashegamuk Lake area was previously mapped as part of a reconnaissance survey extending from Lower Manitou to Stormy Lake by Thomson (1933). The geology, as delineated by Thomson's survey, is incorporated in the current Kenora-Fort Frances compilation map (Davies and Pryslak 1967). The present map-area was also investigated (see Blackburn in Trowell *et al.* 1977), as part of a regional study (Trowell *et al.* in preparation), and resulting modifications to Thomson's interpretation are included in the revised Kenora–Fort Frances compilation map (Blackburn *et al.* in preparation). The present survey is part of a continuing programme of 1 inch to ¼ mile mapping (Blackburn 1976, 1979a,b), and also adjoins on its north side detailed mapping by Satterly (1960).

The present map-area is situated on the northeastern side of the Manitou–Stormy Lakes metavolcanic-metasedimentary belt, and straddles a major east to southeast-trending syncline. During the 1979 field season a 65 km^2 area well north of the fold axis was mapped in detail. The following discussion deals with this sub-area only.

Within the sub-area pillow tops indicate the volcanic sequence faces to the southwest. Basal mafic metavolcanics in the northeast are intruded at base by granitic rocks of the Revell Batholith (Satterly 1960). Overlying felsic pyroclastics vary from coarse, monolithic breccias in the north, to tuffs in the southeast, where minor clastic and chemical sedimentary rocks are interbedded. Their relationship to felsic porphyry in the west is presently uncertain, as is the extent of the porphyry body itself. The felsic pyroclastic unit is not delineated on Thomson's (1933) map which shows basic volcanic rocks, as does the currently available compilation map (Davies and Pryslak 1967). The felsic pyroclastics are intruded by irregular felsic porphyry dikes in the southeast. Preliminary chemical analyses indicate that overlying mafic metavolcanics are andesitic. A gabbro-diorite body intrudes the metavolcanic sequence at Church and Lowery Lakes.

Structural Geology

The Kawashegamuk Lake area straddles a major east- to southeast-trending syncline, previously shown on compilation maps (e.g. Davies and Pryslak 1967) and confirmed, but relocated, during regional studies by the present author (see Blackburn *in* Trowell *et al.* 1977). This is proposed to be named the Kamanatogama Syncline (Blackburn in preparation).

The area mapped during the 1979 field season lies on the northern limb of this syncline. No major folds or faults have been recognized to date in the sub-area.

Economic Geology

Gold

Geological reports, mostly dating from the 1930s and 1940s by government and company geologists on the Sakoose and Tabor Lake properties suggest that gold-bearing solutions originated from quartz porphyries in close spatial association with the deposits. Quartz veins reportedly filled fractures that pre-dated or were opened up contemporaneously with intrusion of the porphyries. The assumption was also made that the porphyries were contemporaneous with batholithic invasion. So far, insufficient mapping has been carried out by the writer to suggest alternative modes of deposition and concentration of gold. The presence of numerous irregular quartz porphyry bodies and attendant carbonatization, particularly near the Tabor Lake prospect, may suggest that exploration attention should be directed toward this environment and locality.

1 Information from Assessment Files Research Office, Ontario Geological Survey, Toronto.

Copper-Zinc

In the last decade, airborne geophysical surveys and ground follow-up have delineated numerous electromagnetic conductors, some with corresponding magnetic anomalies, in two general parts of the Kawashegamuk Lake map-area. In the northwest, northeast of the east end of Boyer Lake, traces of chalcopyrite and sphalerite are recorded from diamond drill holes[1]. The writer has not as yet mapped this part of the map-area.

In the north-central part, between Church Lake and the south boundary of Melgund Township, traces of chalcopyrite are recorded in three of the five diamond drill holes for which records are available. Assays from one hole yielded less than 0.05 percent Cu, less than 1 percent Zn, and a trace of Au[1]. The writer has mapped much of this part of the map-area: the conductors generally appear to be located where felsic pyroclastics occur in a mixed sequence of mafic to felsic pyroclastics and flows that have been intruded both by irregular felsic porphyry dikes and by gabbro-diorite bodies. Pyrite and pyrrhotite is found disseminated in the felsic rocks, in places with associated fuchsite. Most of the drilled conductors appear to be sulphide zones; other conductors have been attributed by exploration personnel[1] to graphitic metasediments and shear zones.

Despite the discouraging results to date the latter area is still potentially favourable for massive sulphide Cu-Zn-Pb deposits because of the volcanic environment. Not all of the known conductors appear to have been tested by diamond drilling.

Copper-Nickel

Thomson's (1933) map indicates at least three separate gabbro intrusives along a northwesterly trend between Kawashegamuk and Mennin Lakes. Exploration in the 1950s by the Canadian Nickel Company Limited and Falconbridge Nickel Mines Limited appears to have been directed toward these bodies as mapped by Thomson. The present survey has extended one of these, at Church Lake, suggesting that the others, as yet not mapped, may also be more extensive than shown by Thomson (1933). A number of electromagnetic conductors detected by Selco Mining Corporation Limited near Church Lake are within the gabbro-diorite body. These conductors do not appear to have been diamond drilled by Selco[1]. Although to date no economically significant mineralization has been reported, further prospecting is warranted in all these gabbro bodies.

Molybdenum

The molybdenite occurrence investigated by Dome Exploration (Canada) Limited southwest of Mennin Lake has not as yet been mapped by the writer. The work by Dome indicated ppm values for molybdenum in soil samples over a wide area of well-exposed granitic rock at the edge of the Revell Batholith. However, in the contact area between metavolcanics and granitic rocks, outcrop is minimal over a 300 m width. The soil samples collected in this contact zone, which was not further investigated by Dome, seem to indicate persistent, if low, ppm levels of molybdenum[1]. The source of this molybdenum warrants investigation, as does the rest of the contact zone of the Revell Batholith.

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1 Information from Assessment Files Research Office, Ontario Geological Survey, Toronto.

No. 9 Righteye Lake Area, District of Rainy River

S.L. Fumerton[1]

Location and Access

The area mapped is bounded by Latitudes 48°42′30″ and 48°50′N, and by Longitudes 91°41′50″ and 92°00′W. This area is included in parts of NTS Sheets 52B/13 and 52B/12. Asmussen, Baker, and part of the Freeborn Townships are contained within this area. Atikokan, the nearest town, lies some 5 km from the eastern boundary, and Highway 11, joining Thunder Bay, Atikokan, and Fort Frances, passes through the southern part of the map-area. Access by motor vehicle or canoe is relatively easy in the southern and eastern part of the area, whereas in the northwestern part, long canoe portages or the use of float planes are required.

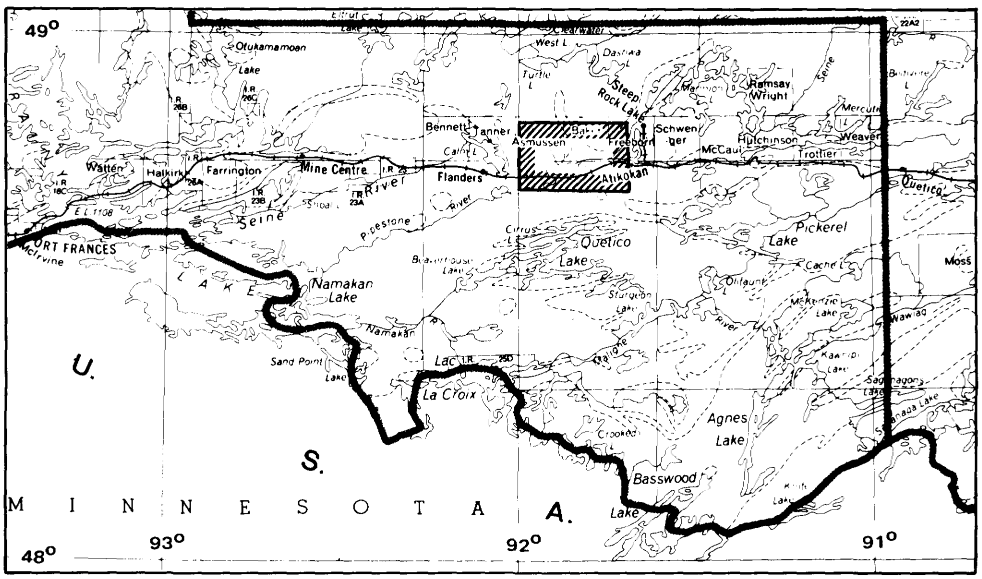
History of Mineral Exploration

Gold has been the principal metal of interest in the area since its discovery at the end of last century. The Harold Mine, a collection of small shafts, adits and pits operated by two prospectors (A.H. Wiley and F.N. Gibbs) was in production between 1895 and 1896, and 1131 tons of ore worth $11 236 were milled (Ferguson *et al.* 1971). Gold was discovered on the Elizabeth Mine in 1900 and development work was carried out during 1902 and 1903 by Anglo-Canadian Gold Estates Limited, but discontinued until 1912-1914 when some 50 tons of ore worth $400 were milled (Moore 1940). Development work was resumed between 1936 and 1939 by the Elizabeth Gold Mines Company Limited, however the mine was never brought back into production and work was discontinued. Stripping, trenching, and some diamond drilling on numerous gold prospects has been carried out in the past, but the record of exploration interest in the area for the last forty years is quite limited.

A copper-gold prospect at Law Lake was geologically mapped and a magnetometer survey was carried out by Moneta Porcupine Mines Limited during 1956. Diamond drilling on this prospect was carried out during 1966 by the Consolidated Mining and Smelting Company of Canada Limited (Cominco).

An asbestos prospect was discovered at Niven Lake

1 Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.



LOCATION MAP

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

during 1959. Geological mapping, geophysical work, and diamond drilling were carried out on the prospect by Steeprock Iron Mines Limited during 1960 and 1961. Work was discontinued because of the low grades encountered[1].

Geological exploration for iron deposits was carried out by Steeprock Iron Mines Limited principally during the fifties. However, nothing of significance has been reported to date.

Extensive diamond drilling has been carried out in the vicinity of Arnold Lake, and the north arm of Perch Lake by Stratmat Limited (2200 m) and R.R. Brown (650m) during 1956. No significant mineralization was reported from this drilling.

General Geology

The area is located astride the boundary between the Quetico Subprovince to the south and the Wabigoon Subprovince to the north. All outcrops mapped within the Quetico Subprovince consist of a monotonous sequence of metasedimentary rocks, whereas the Wabigoon Subprovince within the map-area is composed of mafic and felsic metavolcanics and intrusive granitic rocks. The mapping by Moore (1940) proved to be reliable for the distribution of the major rock types.

Metasediments of the Quetico Subprovince consist of interbedded wackes and mudstones that are gradational into each other. Bedding in these rocks is between 2 and 10 cm thick and preserved primary features indicate that these rocks comprise a turbidite sequence. These primary structures are evident in the north but are obliterated in the south by metamorphic recrystallization.

Highly sheared polymictic metaconglomerates of unknown affinity occur sporadically along the boundary between the Quetico metasediments and the Wabigoon metavolcanics.

The metavolcanics are predominantly mafic and exhibit a wide range of textural variation over short distances. Tuffaceous rocks, lahars, pillowed and fine- to coarse-grained flows are common but frequently impossible to correlate along strike. Carbonate and carbonaceous tuffs associated with the metavolcanics are uncommon. Extending northeast from Modred Lake is a unit of crystal felsic tuffs, lahars and lapilli-tuffs. This unit correlates with the arkose, conglomerate, and wacke sedimentary unit mapped by Moore (1940), Shklanka (1972), and Fenwick (1976). The difference in names can be attributed to the fact that the rocks to the southwest are primarily pyroclastic rocks whereas to the northeast there is a progressive increase in a detrital sedimentary component.

Granitic rocks intrude the metavolcanic rocks in two separate bodies, both of which contain a different suite of rock types. The internal distribution of the granitic rocks within these bodies is complex, but in both bodies there is a compositional variation between quartz diorite and granite.[1]

1 Regional Geologist's files, Ontario Ministry of Natural Resources, Thunder Bay.

Structural Geology

Faulting presumed to be related to the Quetico Fault is the dominant structural feature. Besides the faulting only two folds have been recognized both of which occur in the Wabigoon Subprovince.

The faulting does not consist of a single major fault or mylonite zone that separates the Quetico and Wabigoon Subprovinces, but rather consists of numerous minor to major zones of shearing or mylonitization. This shearing is primarily located within the metavolcanics adjacent to the contact with the metasediments. There are a large number of splay faults which mainly trend to the northeast, and some of these transect the Quetico metasediments. A notable exception to this pattern is a major fault that trends northwest from Harold Lake and separates metavolcanics to the southwest from granitic rocks to the northeast.

The hinge of the larger fold recognized is situated between Niven and Miranda Lakes. This is a closed fold and has a near vertical plunge. The smaller fold is a synform trending northeast from Modred Lake. The plunge of this structure is near horizontal and within the core there is the unit of pyroclastic rocks with a variable detrital component discussed above.

Economic Geology

All reported occurrences of gold in the area are in or adjacent to quartz veins. Most of these veins are located in metavolcanics but some are situated within granitic bodies. The two former mines (i.e. Harold and Elizabeth Mines) exploited a number of discontinuous quartz veins located near the granite-metavolcanic contacts. Preliminary assays of grab samples taken by the field party of some minor sulphide occurrences within the metavolcanics record only trace amounts of gold (Analyses by Geoscience Laboratories, Ontario Geological Survey).

The only significant base metal showing known in the area is the Law occurrence, where copper, gold, and silver occur associated with scattered veins of quartz or disseminated sulphides. These veins strike sub-parallel to the regional foliation and extend west of the map-area, and are located in the core of the large fold referred to above. Other scattered showings located away from this fold are associated with calcareous tuff and limestone lenses within the metavolcanic rocks and they are sometimes found associated with graphitic schists. The mineralization is erratic, sparsely disseminated and consisting of pyrite, pyrrhotite and chalcopyrite. Preliminary analyses show that lead, zinc and copper within selected grab sam-

1 The terminology used here follows the recommendations of the I.U.G.S. (Straeckeissen 1976).

ples collected by the field party are the only metals with any economic potential but even this is low (Pb $<$ 140 ppm, Zn $<$ 550 ppm, and Cu $<$ 480 ppm) (Analyses by Geoscience Laboratories, Ontario Geological Survey). However, extensions of these carbonaceous units may have more significant base-metal mineralization. Any exploration directed towards locating such extensions would be best achieved by detailed prospecting and electromagnetic geophysical surveys.

A number of ironstone-bearing units occur north of Perch Lake. Some are dominantly composed of disseminated pyrite and pyrrhotite whereas others are composed principally of hematite, amphibole and chlorite. In neither occurrences is the grade of iron high, and in both the ferruginous units are less than 1 m thick. Preliminary assays of grab samples collected by the field party show that of the economically interesting elements zinc and lead are present but only in marginally anomalous concentrations. Cobalt concentrations are 51, 8, and 6 ppm (Analyses by Geoscience Laboratories, Ontario Geological Survey).

Minor occurrences of asbestos and talc/soapstone have been reported in the mafic metavolcanics between Miranda and Niven Lake.[1]

1 Regional Geologist's files, Ontario Ministry of Natural Resources, Thunder Bay.

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No.10 Funger Lake Area, District of Thunder Bay

R.H. Sutcliffe[1]

Location

The area investigated covers a region bounded by Latitudes 50°23'00" to 50°37'30" North and Longitudes 89°07'30" to 89°20'00" West. The center of the map-area is approximately 30 km northwest of the town of Armstrong. The southeastern part of the map-area is accessible from Caribou Lake which can be reached via a 10 km gravel road from Armstrong. Smoothrock Lake and numerous smaller lakes in the area are accessible by float-equipped aircraft which can be chartered in Armstrong. A well developed system of portages connects Caribou Lake and Smoothrock Lake via the Caribou River.

Mineral Exploration

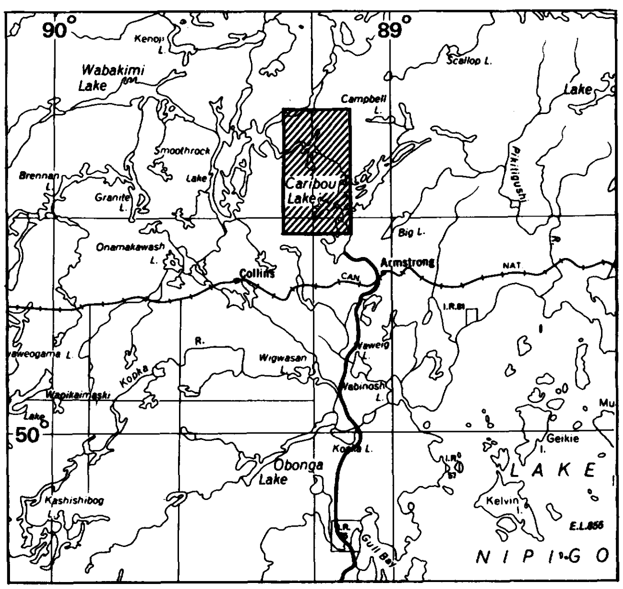
Mineral exploration within the map-area has been minimal. No work in the area has been recorded at the Assessment Files Research Office, Ontario Geological Survey, Toronto or in the Regional Geologist's files, Ontario Ministry of Natural Resources, Thunder Bay. Evidence of minor staking and subsequent trenching of pyrite and pyrrhotite occurrences in mafic metavolcanics was observed during the field mapping. No claims are currently held within the area. Precious metal and base metal exploration in the Caribou–Pikitigushi belt to the east has been intermittently active since 1954.

General Geology

The present map-area has been examined by Sage *et al.* (1974) as part of the Operation Ignace–Armstrong reconnaissance survey. Gussow's (1942) mapping of the Caribou Lake–Pikitigushi River metavolcanic-metasedimentary belt includes the eastern part of the area. Springer (1978) has compiled the geology and mineral occurrences of the region for the Armstrong mineral potential map.

The Early Precambrian rocks of the Funger Lake area consist of 1) amphibolite facies mafic metavolcanics and minor metasediments of the Caribou–Pikitigushi belt, 2) an early plutonic suite of biotite tonalite, 3) a northeast-trending swarm of amphibolite, gabbro, and gabbroic anorthosite dikes, 4) two gabbroic plutons which intrude the tonalite, and 5) a late plutonic suite of pegmatite and granite.

1 Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.



LOCATION MAP

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

The Caribou Lake–Pikitigushi River belt bifurcates into two east-west trending limbs to the east of the map-area. Within the area the northern limb passes through Rove Lake and is bounded by biotite tonalite to the south and the Pashkokogan Lake–Kenoji Lake fault zone (Sage *et al.* 1974) to the north. The belt is 200 m to 600 m wide, and appears to be continuous over a strike length of approximately 15 km. The belt is predominantely composed of mafic amphibolite schists and mafic garnet-diopside-amphibolite gneisses of probable volcanic origin. Silicate facies ironstone consisting of interbanded recrystallized chert and green amphibole with minor disseminated pyrite is exposed within the belt on an island at the eastern end of Lonebreast Bay of Smoothrock Lake. The southern limb of the Caribou–Pikitigushi belt passes through Saturday Island of Caribou Lake and north of Caribou Lake to Glen Lake. The southern belt, which has been extensively fragmented by the intrusion of the tonalite, is composed of massive to foliated mafic amphibolite and local zones of amphibolite with relic plagioclase phenocrysts.

Biotite tonalite is the most abundant granitoid rock within the area. The tonalite displays a wide spectrum of textural variation ranging from fine- to medium-grained, equigranular, hypidiomorphic to fine-grained, equigranular, recrystallized gneissic tonalite. Recrystallized foliated tonalite, often with quartz aggregates, predominates. The gneissic tonalite is common in the southern part of the area and is characterized by the development of in situ granite (*sensu stricto*) leucosomes. Minor hornblende diorite to tonalite is present in the vicinity of mafic supracrustal remnants.

An extensive swarm of fine- to medium-grained, massive amphibolite dikes and medium-grained hornblende gabbro dikes, trending 020° to 050°, discordantly invades the tonalite north of Outlet Bay of Caribou Lake and Caribou Bay of Smoothrock Lake. The dikes range from 1 m to 300 m wide and can be traced for strike lengths in excess of 1 km in areas of good exposure. Dikes of anorthositic gabbro having plagioclase phenocrysts up to 10 cm diameter occur on Outlet Bay of Caribou Lake (Sage *et al.* 1974) and northeast of Cowman Lake.

The crescent shaped, gabbroic Outlet Bay Pluton occupies 12 km by 8 km and dominates the central part of the map-area. The pluton is intrusive into biotite tonalite on its northern, eastern and southern margins and contains a central core of amphibolite facies mafic metavolcanics. The pluton is predominately composed of medium grained, massive to weakly foliated, hypidiomorphic hornblende gabbro with minor biotite and/or clinopyroxene. On the southern contact of the pluton, igneous layering, with rhythmic gradations from hornblende gabbro to plagioclasite, is locally present. Minor, sporadically distributed, clinopyroxenite occurs near the eastern and southern contacts of the Outlet Bay Pluton. Enclaves of amphibolite are also present within the pluton.

Amphibolite facies mafic metavolcanics occur centrally within the Outlet Bay Pluton. These metavolcanics are considerably less deformed than those of the northern and southern limbs of the Caribou–Pikitigushi belt and locally display relict pillow structures. Along the southern contact of the mafic metavolcanics, adjacent to the Outlet Bay Pluton, a 50 to 100 m wide zone of silicate facies ironstone and local recrystallized chert and quartzite is present. The ironstone is composed of interbanded recrystallized chert and green amphibole with disseminated pyrite and pyrrhotite.

On the southern margin of the area, a smaller, 6 km by 3.5 km, gabbroic pluton intrudes the biotite tonalite. This pluton varies from hornblende-pyroxene melagabbro to hornblende gabbro, diorite and plagioclasite. Hornblende diorite and plagioclasite predominate and the variation with other rock types is irregular and gradational. The intrusion is medium to coarse grained, massive to weakly foliated and hypidiomorphic. Minor biotite occurs with the hornblende or clinopyroxene. Alkali feldspar occurs as interstitial grains or as an alteration of plagioclase in the pluton.

An isolated lens of ultramafic rock occurs within the tonalite on Caribou Bay of Smoothrock Lake. The body, which appears to be an inclusion in the tonalite, has a minimum width of 50 m and varies from metapyroxenite to metaperidotite.

Medium grained, massive, equigranular garnet-muscovite biotite granite of the Smoothrock Lake Pluton (Sage *et al.* 1974) has intruded biotite tonalite in the northwestern part of the map-area. Numerous sills and dikes of garnet-biotite-muscovite granite pegmatite associated with the Smoothrock Lake Pluton invade all the Early Precambrian rocks in the northern and western part of the area.

Middle Precambrian (Keeweenawan) diabase sheets of the Nipigon Plate occur in the southeastern, southwestern, and northern parts of the area. The southeastern diabase outcrops east of Caribou Lake and is underlain by grey weathering gritty dolomite of the Sibley Group which outcrops 400 m south of the southeast corner of the map-area (Sage *et al.* 1974). Diabase dikes are numerous throughout the region and occur primarily as two sets trending at approximately 020° and 150°.

Structure

The absence of top indicators in the supracrustal rocks prohibits a conventional reconstruction of the stratigraphy of the area.

Metamorphic foliations in the biotite tonalite and mafic amphibolite of the Caribou–Pikitigushi belt trend parallel to the two limbs of the Caribou–Pikitigushi belt. These foliations generally dip steeply to the south. A zone of shallow south dips with a well developed subhorizontal lineation, defined by quartz aggregates, is developed in the tonalite through Alphonse Bay of Caribou Lake. The mafic intrusions have quasi-conformable relationships with the biotite tonalite, but locally contain inclusions of the latter, demonstrating that mafic plutonism postdates the tonalites. The Outlet Bay Pluton has a weak, steeply dipping primary foliation, defined by alignment of subhedral plagioclase crystals, which is developed in the eastern part of the intrusion and in the western limbs.

On the northern boundary of the map-area, intensive cataclasis occurs in an east-southeast-trending zone approximately 1.5 km wide. The cataclastic rocks are the eastern extension of the Pashkokogan Lake–Kenoji Lake fault zone. Cataclasis has resulted in the development of augen gneiss, mylonite, minor pseudotachylite and a strong foliation in the granitoids. Strike-slip movement has occurred but no consistent sense of direction of movement was obtained from structures in the zone. A minor zone of cataclasis in tonalitic rocks occurs along Outlet Bay of Caribou Lake. This fault has occurred prior to the emplacement of the Outlet Bay Pluton since the faulting does not effect the gabbro or amphibolite dikes.

Prominent 020° and 150° joints throughout the area control diabase dike emplacement and minor late block faulting which effects all of the rocks. Emplacement of shallow dipping diabase sheets appears to have been controlled by the Early Precambrian -Middle Precambrian unconformity in the eastern part of the area. In the west, the diabase has a semi-circular outcrop pattern and is intrusive into biotite tonalite. Where observed the contacts of the sheet dip toward the center of the structure suggesting that the emplacement of the sheet may be controlled by a ring fracture system.

Economic Geology

Supracrustal rocks of the northern limb of the Caribou–Pikitigushi belt, from Rove Lake to Lonebreast Bay of Smoothrock Lake, and in the central core of the Outlet Bay pluton have the highest potential for base-metal and precious metalmineralization within the area. Sulphide gossan and zones of disseminated to massive pyrite in silicified amphibolite up to 1 m wide are exposed on Lonebreast Bay and the south shore of Rove Lake. Selected grab samples of silicate ironstone and mafic metavolcanics with disseminated pyrite collected by the field party from Lonebreast Bay and Rove Lake yielded only traces of gold and no significant quantities of base metals[1]. Pyrite and pyrrhotite mineralization is widespread in the mafic metavolcanics exposed in the central core of the Outlet Bay pluton. The mineralization occurs as sulphide veins, disseminations and also is associated with quartz-carbonate veins. On the south shore of the southern extension of Caribou Bay of Smoothrock Lake an argillaceous interflow sediment containing up to 30 percent fine disseminated pyrrhotite and pyrite is exposed in mafic metavolcanics containing minor pyrrhotite mineralization. Silicified amphibolite containing up to 20 percent pyrrhotite occurs on the north end of a small island in the narrow channel connecting the southern extension of Caribou Bay with the main part of the bay. Analyses of selected grab samples collected by the field party from the above occurrences showed no significant base-metal or precious metal mineralization[1]. Disseminated pyrite and pyrrhotite mineralization is associated with the 50-100 m wide unit of silicate facies ironstone along the contact of the Outlet Bay pluton, south and west of Caribou Bay, but no significant mineralization was detected in analyzed grab samples collected by the field party[1].

The presence of igneous layering and local clinopyroxenite along the southern contact of the Outlet Bay gabbroic pluton indicates that this zone may have potential for metals associated with the early cumulate phases in the gabbro.

The Early Precambrian-Middle Precambrian unconformity has a potential for uranium. However, no significant radiometric anomalies were identified by the field party in the area in which the Sibley Group outcrops.

No mineralization of economic interest was observed in the abundant pegmatites associated with the Smoothrock Lake pluton.

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No. 11 Schreiber Area, District of Thunder Bay

M.W. Carter[1]

Introduction

The area, 246 km² in extent, is bounded by Latitude 48°55′30″ and the north shore of Lake Superior, and Longitudes 87°15′ and 87°30′W. It was mapped at a field scale of 1 inch to ¼ mile (1:15 840). Previous mapping was done in the area by Collins (1909), Tanton (1920), Hopkins (1921), Harcourt (1938), and Bartley (1938). Highway 17 crosses the southern part of the area, and an all-weather gravel road, the Zenmac road, crosses it in a northerly direction.

Mineral Exploration

In 1898 the McKellar brothers surveyed their claim on a gold occurrence located at the southeastern corner of Schreiber peninsula. Pitting and trenching began in 1900 and the claim was patented in 1903. W.L. Longworth optioned it and did exploration work on the property in 1921. In 1934 North Shores Gold Mines Limited built a 25-ton mill at Worthington Bay and began mining operations. The mine was operated by North Shores Mines Limited from 1936 to the fall of 1937. Development work consisted of surface trenching, pitting, drilling of 10 diamond drill holes of unknown length, the driving of two adits on the vein, sub-level work, and stoping. The mine was re-appraised in 1939 by G.L. Holbrooke who did not recommend re-opening it.

Between 1930 and 1936 surface sampling and diamond drilling were carried out on the Nicopor copper-nickel showing in gabbro, probably by Consolidated Mining and Smelting Company of Canada Limited(Cominco). Three holes were drilled for an unknown total length. In 1937 Nicopor Mines Limited optioned the property to Cook Lake Gold Mines Limited, during which time a ground magnetometer survey was carried out. From 1949 to 1950 ground magnetometer and geological surveys were carried out by Falconbridge Nickel Mines Limited. In 1953 the property was reported to be under option to Selco Exploration Company Limited. In 1956 it was optioned to New Athona Mines Limited who drilled 4 diamond drill holes totalling 1693 feet. In 1965 the property was re-staked by Zenmac Metal Mines Limited who carried out a detailed geological survey and drilled 5 short diamond drill holes totalling 200 feet. In 1969 the same company carried out a detailed ground magnetometer

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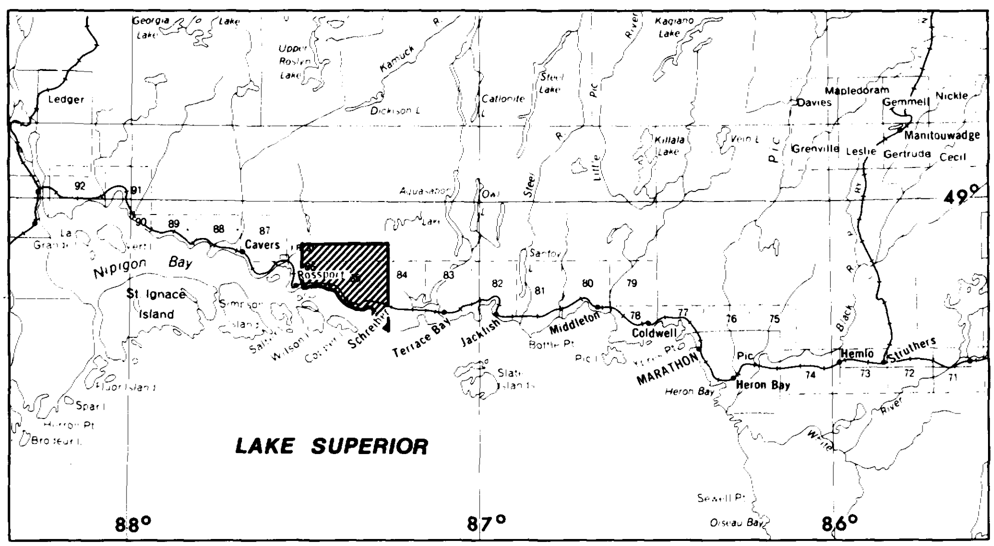

LOCATION MAP

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

survey followed by 2107 feet of diamond drilling in 8 holes. In 1970 Nicohal Mines Limited drilled 9 diamond drill holes for a total of 4040 feet.

In 1957 Elwood Mining Exploration Company Limited did ground electromagnetic follow-up of an airborne electromagnetic survey on their property at the southern end of Walker Lake. The ground survey located three linear conductive zones which correlated with conductors of the aerial survey. The ground survey was followed by pitting and geological mapping later in that year and pyrite, pyrrhotite, chalcopyrite, and molybdenite mineralization was located. Diamond drilling was done between 1957-1958 when 4 holes were drilled totalling 1507 feet.

In 1965 Dickenson Mines Limited diamond drilled one hole for 506 feet on the Halonen Option located at Ranger (Rongie) Lake. Copper-molybdenum mineralization was encountered in granite.

In 1970 an airborne electromagnetic survey was carried out by OJA Limited on the property of D.E. Gale located on the Schreiber peninsula. Several anomalies were reported.

In 1970 Briar-Court Mines Limited carried out a program of trenching, sampling and geological mapping on the Halonen copper-molybdenum showing northwest of Sox Lake. In 1971 Zenmac Metal Mines Limited optioned the property and carried out a detailed sampling programme. In 1979 Long Lac Mineral Exploration Limited drilled one diamond drill hole for 200 feet, and carried out geochemical surveying.

General Geology

The area is underlain by Early and Middle Precambrian rocks covered by thin, discontinuous Pleistocene and Recent deposits.

Early Precambrian rocks comprise a metavolcanic-metasedimentary sequence synclinally folded about an east-plunging, east-west axis located near the centre of the eastern part of the map-area. The volcanics form parts of four, mafic to felsic cycles. The sedimentary rocks comprise wacke, and its metamorphosed equivalents, and sulphide facies iron formation. The metasedimentary rocks are subordinate in volume to the volcanics. The mafic volcanics show well-developed pillowed structures and are associated with wackes with well-preserved primary sedimentary structures, which indicate that the volcanic-sedimentary sequence was laid down subaqueously. Fragmental volcanics are uncommon. These supracrustal rocks have been metamorphosed under amphibolite-facies conditions of regional metamorphism. The metamorphic grade increases northwards, and marked east-west foliation, gneissosity and migmatitic structures are developed in the northern part of the map-area. Diorite and gabbro units of small areal extent intrude the volcanic-sedimentary sequence. All these rocks are intruded by massive and porphyritic hornblende-biotite granite and syenite, which underlie about 75 percent of the map-area. Black, magnetic diabase and grey olivine diabase dikes of a predominantly west-northwest trend intrude these rocks and are particularly numerous on the Schreiber peninsula. A few dikes of north-northwesterly trend occur.

Middle Precambrian rocks comprise polymictic conglomerate, iron formation, and black shale of the Animikie Group intruded by diabase sills. They dip southerly at about 10 degrees and are restricted to the northern shore of Lake Superior, east of Winston Point.

The Cenozoic is represented by thin patches of sand and gravel best exposed along Highway 17 and the Zenmac road.

Structural Geology

The metavolcanic-metasedimentary rocks are folded about an east-trending synclinal axis plunging eastwards and located near the centre of the eastern part of the map-area. The axis cannot be traced westward. Foliation and gneissosity trend west-northwesterly in the central part and east-west in the northwestern part of the area.

Faulting is a major feature, the most important trend direction being northwesterly and north-northwesterly. Northerly, and curvilinear (convex eastwards) trends also occur. A major north-northeasterly fault forms the western boundary of Schreiber peninsula.

Economic Geology

Copper-Molybdenum

The Halonen copper-molybdenum showing consists of stringer and disseminated molybdenite and chalcopyrite in a migmatized contact zone between foliated amphibolite, biotite-feldspar schist and biotite granite. The mineralized zone is about 46 m wide, and the mineralization is concentrated in quartz veins, stringers, lenses and ptygmatic veins. Similar mineralization occurs 274 m to the south. Trenching and sampling of the (north) contact zone by Briar Court Mines in 1970 "returned values in five trenches over a 700 feet length ranging from 0.06-6.40 percent molybdenum and 0.11-5.52 percent copper . . . Work to the east of the trenching area has returned grab samples over a 100 feet width with values of 0.06 percent copper and 0.43 percent molybdenum" (Northern Miner 1971, p.14). Since this time Zenmac Metal Mines Limited carried out detailed sampling in 1971, and Long Lac Mineral Exploration Limited carried out drilling and geochemical sampling in 1979.

Copper-Nickel

Copper-nickel mineralization at the Nicopor Showing consists of chalcopyrite-nickeliferous pyrrhotite and pentlandite associated with magnetite, ilmenite, and pyrite in gabbro and granite. The showing was originally described as being 300 feet long and 3 feet wide at the surface and striking N47°E (Bartley 1938). Subsequent drilling by Zenmac Metal Mines Limited in 1965 and 1969 shows that "a sheet-like zone of nickel-copper mineralization extends to at least 400 feet down dip, where it has lengthened to at least 300 feet. It varies from 5 to 20 feet in thickness and dips at 34 degrees [east]" (Regional Geologist's files, Ontario Ministry of Natural Resources, Thunder Bay). The grade of the deposit was calculated to be "about 1.0 percent nickel and 0.3 percent copper over 5 to 15 feet" (Regional Geologist's files, Ontario Ministry of Natural Resources, Thunder Bay).

Copper-Zinc-Silver

Massive sulphide stratiform base metal mineralization in volcanic rocks consisting of massive pyrite, pyrrhotite, and chalcopyrite zones in sulphide ironstone occurs on the Elwood Showing located along Highway 17 at Walker Lake, and at the Morley Showing 2.4 km south-southeast of Schreiber. The mineralized zone at the Elwood Showing is 1600 feet long and 7 feet wide. "A representative sample of the mineralization yielded traces of zinc by spectrographic examination and, 0.24 oz. silver and 0.06 percent copper by assaying". (Regional Geologist's files, Ontario Ministry of Natural Resources, Thunder Bay). The Morley Showing contains mineralization at two places along a zone of strike length 305 m, the sulphide zone being 1 m wide. A grab sample taken from the southern pit by the author and assayed by the Geoscience Laboratories, Ontario Geological Survey, showed 0.03 percent copper.

Gold

Gold occurs at the former North Shores Gold Mines property located at the southeastern part of Schreiber peninsula, in a lensoid quartz vein 1-18 inches wide and 1700 feet long. The strike of the vein was N80°W and the dip 55° to the south. The vein occupied a fracture in felsic volcanics and hornblende syenite. Reported mineralization consisted of visible gold, pyrite, chalcopyrite, pyrrhotite, galena, arsenopyrite and tetradymite. A channel sample "across eighteen inches of quartz in which no gold could be seen, gave on assay $40.00 in gold per ton" (P.E. Hopkins 1921, gold at $22.69 per ounce, 1921 price). G.L. Holbrooke, after a partial appraisal of the mine in 1939, stated that there was left "about 75 tons per vertical foot of ore grading $18.00 or 10.00 dwt. across a width of 12 inches [amounting] to only 6.0 inch-ounces ..." (Regional Geologist's files, Ontario Ministry of Natural Resources, Thunder Bay, gold at $36.14 per ounce, 1939 price). A total of 1584 ounces of gold was produced yielding $32,744 (gold at $20.67 per ounce, 1936 price) from 3808 tons of ore milled. A total of 179 ounces of silver was also produced.

Silver

Silver mineralization occurs in a calcite vein at the Morley claim in the southeast of the map-area, in a fracture striking N10°E in what was described as rhyolite agglomerate. The vein occupied a fracture 225 feet long and up to 1 foot wide and mineralization consisted of bands of massive sphalerite, galena and chalcopyrite. "A grab sample of the material assayed 5 ounces silver and 0.53 ounces gold" (G.A. Harcourt 1939). About 1.2 km north-northwest of this occurrence a similar carbonate vein containing galena was reported to yield silver (G.A. Harcourt 1939).

Recommendations for Future Exploration

Copper-Molybdenum Mineralization

This is spatially related to the biotite granite-amphibolite, biotite-quartz-feldspar schist, biotite-quartz-feldspar gneiss contact zone in the map-area. It is recommended that these contact zones, which trend east-west in the northwestern part of the map-area, be prospected for such mineralization

Copper-Nickel Mineralization

Known mineralization of this type in the map-area occurs in the contact zone of syenite-granite and diorite-gabbro. Most of the units previously mapped as diorite or gabbro have been remapped by the author as amphibolite derived from mafic volcanics. Prospecting for this type of mineralization should be directed at the diorite gabbro units, and their contact areas and not the amphibolite derived from mafic volcanics.

Copper-Zinc-Silver Massive Sulphide Mineralization

This type of mineralization has been observed by the author in the map-area at the junction of mafic to felsic volcanic cycles at the felsic-mafic interface at the Elwood Showing on Highway 17 near Walker Lake and at the Morley Showing 2.4 km south-southeast of Schreiber, as described in the Economic Geology Section. The zones are marked by sulphide-facies ironstone containing massive pyrite and pyrrhotite and some chalcopyrite and are parallel to the trend of the rock units. It is recommended that these areas be prospected for stratabound massive sulphide base-metal mineralization in the eastern half of the map-area. Possible zonation of the base metals in such deposits may indicate that deeper drilling down-dip may be necessary.

Gold and Silver Mineralization

Gold and silver have been located in a quartz and a calcite vein respectively, occupying fractures in volcanic and syenitic rocks. The fracture containing the North Shores Mines Limited gold-bearing quartz vein parallels the regional trend of the volcanics, whereas, that containing the calcite vein was transverse. It is recommended that photo lineaments in the Schreiber peninsula area be carefully studied. This area is highly fractured and many of these features are mineralized with pyrite

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No. 12 Wawa Area, District of Algoma

R.P. Sage[1]

Location and Access

The center of the map area is approximately Latitude 48°00′ North and Longitude 84°30′ East. The area includes the town site of Wawa and this project is part of a two year programme to map Chabanel, Esquega, Lastheels,and McMurray Townships.

Highway 101 crosses the north side of McMurray Township, the southeast corner of Chabanel, and south central part of Esquega. A gravel road roughly bisects McMurray Township and dirt trails and unmaintained former logging roads along the Firesand River permit access to eastern parts of McMurray Township. Most areas of McMurray Township are accessible from one of the many trails or roads in the area. Supracrustal rocks exist only in the extreme western part of Lastheels Township and these can be reached only by a lengthy traverse east of the Firesand river system. During the past season mapping was concentrated in Lastheels and McMurray Townships even though selected parts of the remaining two townships were also mapped. This summary will therefore cover only McMurray and Lastheels Townships.

The combination of bad bush and locally rough terrain in these two townships make work in this area difficult. Large areas have abundant outcrop which in combination with the bad bush and rough terrain make mapping a slow process.

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Mineral Exploration

The area examined this season underwent intensive gold prospecting on several occasions, in particular immediately after 1895, and again in the 1930's. A number of gold properties were developed during these two periods of intense interest in gold, (Table 1).

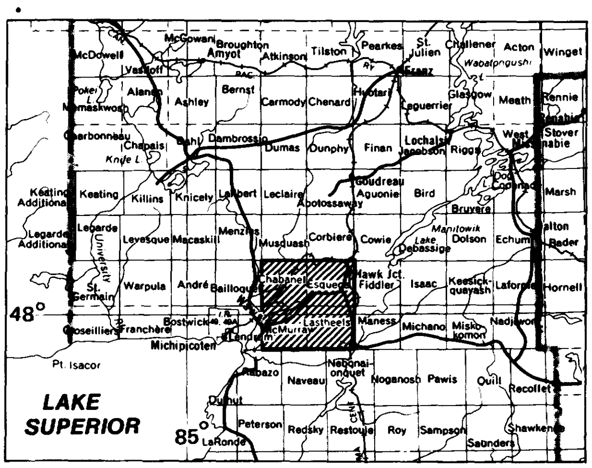
Exploration in McMurray township has been intensive and mainly for gold.

Table 2 lists the exploration work on record, completed in McMurray Township.

Due to the volume of data available, the reader should refer to the above files for details.

In Lastheels Township only one mineralized showing is known. This is the Peter–Quilty molybdenite showing which has had a long history of investigation. During the past season Amax Minerals Exploration completed approximately 600 m of trenching and stripping on the showing.

During the summer numerous old trenches and pits were encountered in the bush; most of this pitting is likely for gold and was completed around the 1900s or the 1930s. Records for this work are lacking, and most of the major work has been located by Rupert (1975).



LOCATION MAP

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

TABLE 1 SUMMARY OF GOLD PRODUCTION FROM MINES IN MCMURRAY TOWNSHIP, DATA FROM GEOSCIENCE DATA CENTRE, ONTARIO GEOLOGICAL SURVEY, TORONTO

Mine	Production Au (ozs)	Ag (ozs)	Date
Cooper (Ganley Vein)		Production with Minto	
Darwin (Grace) Mine	15,191	1,363	1902, 03, 07, 08, 10, 1923, 25, 30, 35, 36, 37, 40, 43, and 44.
Deep Lake Mine	1,633	57	
Golden Reed Mine	6		1908
Jubilee Mine	Production with Minto		
Minto Mine	37,678	1,123	1929-39, 1942-44
Parkhill Mine	54,301	2,896	1904,29, 1931-40, 1942-44
Stanley (Smith, O'Keefe)	84	3	1936
Pursides Mine (Cora, Surluga, Pango)	1,687	43	1968
Van Sickle (S.B. Smith)	1,536	75	1935-36

Fresh stripping and line cutting were encountered on several traverses and prospecting by persons unknown appears to be presently in progress. The author observed several Airborne Geophysical surveys being flown in the general Wawa region and is aware of several exploration companies working in the immediate area.

General Geology

The geology of McMurray and Lastheels Townships is complex. The supracrustal-granite contact that passes through Lastheels Township is poorly defined and is drawn where granitic rocks become dominant. The contact zone is in the area where access is limited to relatively lengthy traverses. The contact is largely intrusive whereby blocks and segments of supracrustals are enclosed in granitic rocks; in part the contact appears fault controlled. The granitic rocks are dominantly massive to weakly schistose trondhjemites which have been also intruded by later granodiorite to quartz monzonite rocks. The contact zone is an agmatite or mega-agmatite and the bordering supracrustal rocks display upper greenschist to lower amphibolite facies of regional metamorphism. The supracrustal rocks found in Lastheels Township are dominantly mafic to intermediate in composition. These rocks consist of flows, tuffs, lapilli tuffs and intrusives. Minor amounts of intermediate to felsic rocks occur in in the northwest corner of the township. These are tuffs, laminated tuffs, and minor subvolcanic quartz and quartz-feldspar porphyritic intrusives.

McMurray Township displays a much more varied geology than Lastheels. The epizonal Jubilee stock, located in the north-central part of the township, is a major geologic feature of the township. The intrusive is composed dominantly of diorite, quartz diorite, and granodiorite. The stock contains abundant xenoliths and blocks of supracrustal rocks. The contact of the stock with the supracrustal rocks is sharp and best described as an intrusive breccia. Little evidence of assimilation or extensive metamorphism of the supracrustal rocks was observed. East, south, and southwest of the Jubilee stock, tuffs, feldspar crystal tuffs, and lapilli-tuffs of intermediate composition (andesite to dacite) cover a broad area. Except where locally sheared, these rocks lack penetrative deformation and bedding is rare. When bedding is found it generally dips away from the Jubilee stock at angles ranging from 20 to 50 degrees. Northwest of the stock and immediately south of Wawa, quartz-feldspar crystal tuff occupies an extensive area. These tuffs locally contain zones of fragments, generally of lapilli size and rarely of block size. The presence of these fragmental zones distinguishes them from the intrusive quartz-feldspar porphyries. Bedding was not observed in the quartz-feldspar

TABLE 2: Tabulated data of exploration activities in McMurray township. Data from Assessment Library files, Sault Ste. Marie. Files for above producing properties have been omitted.

Company	Files	Commodity	Date
Algoma Ore Properties Ltd.	SSM 300,866 Rept. 10. 12	Fe	Various
Anderson Claims	SSM 301	Au	1966
Bohme, J.D.S.	SSM 2.282	Au	1971
Carleton, Blanche	Rept. 16	Au	1965
Consolidated Bellekeno Mines Ltd.	SSM 63.1201	Au	1962
Consolidated Mining and Smelting Company of Canada Ltd., The	SSM 625	Au	1964
Consolidated Morrison Explorations Ltd.	SSM 2.1671	U?	?
Henderson, S.	SSM 1753	Au?	?
Hillside Gold Mine	SSM 1691	Au	1955
Jalore Mining Company Ltd.	SSM 1263	Fe	1952
Lake-Osu Mines Ltd.	SSM 505, 63.1241	Au	1963
McMarmac Red Lake Gold Mines Ltd.	SSM 604	Au	?
Morrison, R.	Rept. 13	N5	1956
Teare, J.H.	SSM 1616	Au	1936
Tremblay Claims	SSM 309	Au	1936
Velleneuve, prospect	SSM 308	Au	1962

crystal tuffs. Both the intermediate tuffs and the more felsic crystal tuffs northwest of the Jubilee stock are interpreted by the author to be effusive products of magmas associated with stock emplacement.

East and southeast of the stock and in isolated patches south of the stock, quartz-feldspar intrusive rocks are present and form a somewhat discontinuous arcuate band around the stock. This crude ring-dike pattern may represent a series of caldera-like fractures peripheral to the Jubilee stock. The tuffs and stocks are intruded by massive dike-like bodies of fine to medium grained mafic rocks which display a general east-west or northwest-southeast trend (Rupert 1975).

East of the stock in the general area south of the Stanley mine a unit of polymictic clastic rock (lahar or debris flow) is present and immediately south of this a thick unit of flow-banded, quartz-porphyry, flow rock is present (Rupert 1975). While these units have a northeast trend, rare bedding in the clastic unit and flow banding in the flow unit display a north to northwest-southeast strike. These units probably occupy valleys on the flanks of the former volcanic structure marginal to the stock.

In the northeast corner of the township steeply dipping to vertically dipping pillowed mafic to intermediate rocks are present. These rocks are separated from the tuffs marginal to the stock by a quartz porphyry intrusion. All facing directions are to the north.

A mafic intrusion at Reed Lake is composed of gabbro, quartz gabbro, quartz diorite, and pyroxenite. On a line between the Jubilee stock and Reed Lake numerous

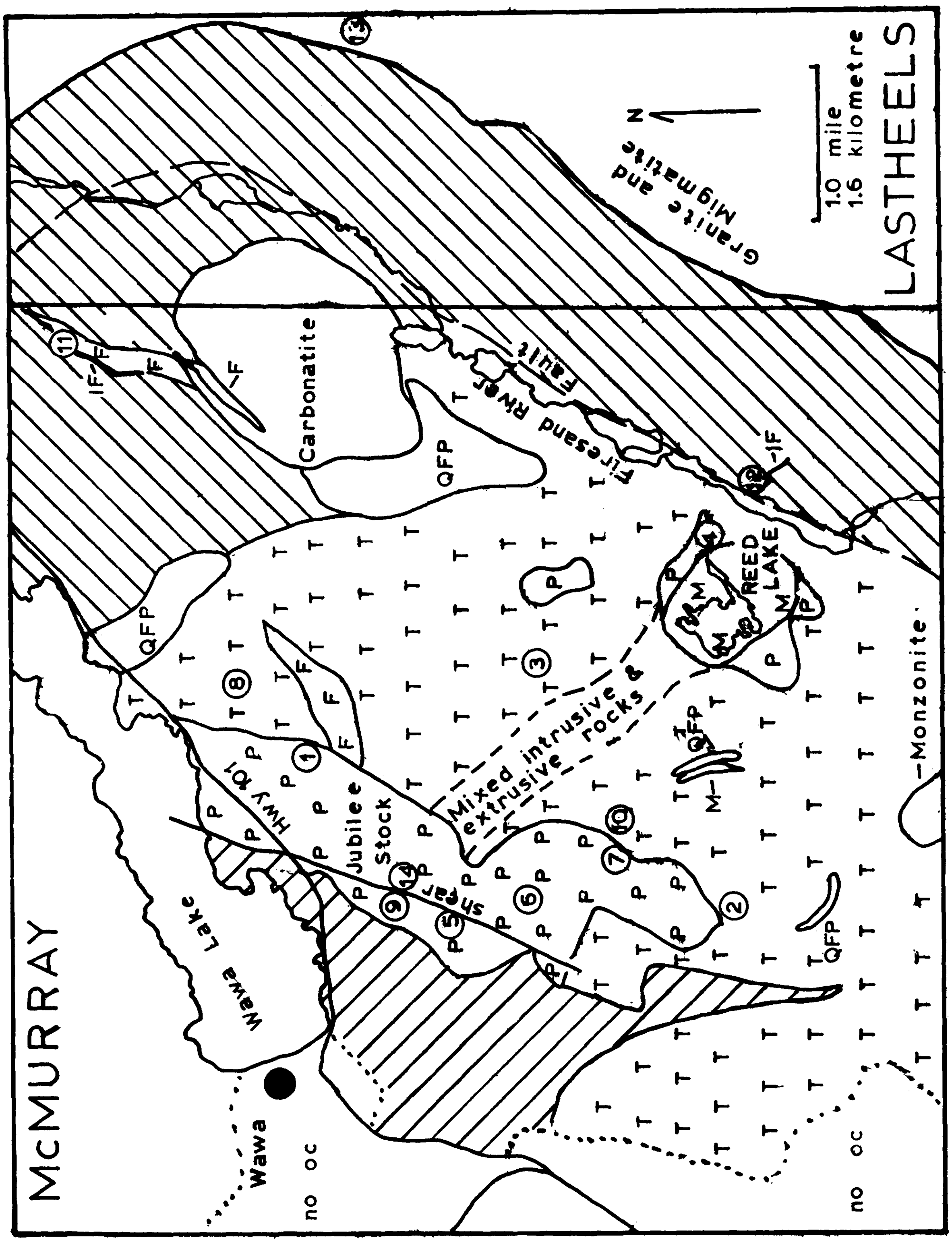


Figure 1—Sketch Map of the Geology of McMurray and Lastheels Townships.

exposures of diorite to granodiorite of the Jubilee Stock intrusive rocks are present, however the relationship between the stock and the Reed Lake mafic intrusion is unclear.

The Judith iron range lies south of Highway 101 towards the Firesand carbonatite complex. Pitting on the west end of the unit indicates a formation approximately 12 to 15 m. The iron formation overlies felsic tuffs and massive quartz porphyry flow units and in turn is overlain by massive mafic to intermediate rocks. Disseminated sulphides and local pods of massive sulphide up to 1 m wide are found on the south side of the iron formation above the felsic volcanics, and the sulphides are in turn overlain by banded chert with disseminated sulphides. Banded chert with local disseminated sulphides and isolated pods of massive sulphides is also abundant at the Adina Gold Syndicate property (Rupert 1975). The Judith iron range and Adina property have been extensively trenched and pitted, presumably in search of gold.

Diabase dikes are common to the area and are presumed by the writer to be Late Precambrian in age. The diabase dikes generally have a northwest trend.

Biotite-rich and olivine-rich lamprophyre dikes are common. These dikes are generally less than 1 m in width and have a northeast strike.

Straddling the McMurray and Lastheels Township boundary is the Firesand River carbonatite complex. This complex is approximately 2.4 km in diameter. The intrusion is enclosed in brecciated wall rocks and evidence of fenitization was observed by the author up to 1.6 km from the complex. The carbonatite has an outer ring of sovite and silicocarbonatite and a core of ferruginous dolomite. Ijolitic phases have been recognized by the author in thin section. The complex has been dated at 1048 m.y. by K-Ar techniques. (Wanless 1970).

In numerous road cuts along Highway 101, narrow (less than 0.3 m wide) rusty weathering, carbonate-rich dikes were noted. These dikes display from 4 to 10 times background radioactivity and the author correlates their emplacement with that of the Firesand carbonatite complex. The radioactivity is largely due to potash and thorium.

Structural Geology

The Jubilee stock may represent a caldera on the basis of the data previously cited. This interpretation suggests that the shallow dipping volcanics associated with the stock may be younger than those steeply dipping volcanics north of Wawa Lake, those in Lastheels Township, and those in the northeast corner of McMurray Township. A major fault is interpreted to exist along the Firesand river and on the basis of geophysics, faulting is thought to be present in the northwest corner of McMurray township (Rupert 1975). The quartz feldspar porphyry units appear to crosscut stratigraphy and appear fault controlled. The numerous lineaments found in Lastheels Township and south of Wawa Lake are likely faults and shear zones. The main intrusive phases of the Jubilee stock display a north to northeast elongation; a southeast trend is also suggested by the numerous outcrops of intrusive rocks of the Jubilee stock in a line southeast of the stock towards Reed Lake. These trends may reflect a fracture control for the emplacement of the stock which is now largely obliterated by intrusion and effusive products of the magmatic event.

The Jubilee fault, striking in a north to northeast direction bisects the west-central portion of the Jubilee stock and two former producing gold mines are situated on it. This structure dips 40-50 degrees to the east. A shear or fault zone may exist in Wawa lake but evidence for it is at present lacking. The quartz-feldspar tuffs northeast of the Jubilee stock display a shallow 15 to 30 degree south dipping schistosity.

Economic Geology

The numerous abandoned mines and abundant evidence of trenching and pitting attest to the vigorous search for gold in the past. For a description of the early development of gold deposits in the area the reader should refer to Gledhill, T.L. (1927); Moore, E.S. (1931); Frohberg, H. (1935); and Ferguson, S. (1971).

In recent times the Pursides Gold Mines Limited property has undergone extensive development. The property includes the former Cora (Surluga), Hornblende, Mackay point,Wawa Gold Fields, Cooper, Jubilee, and Minto groups. The Cooper, Jubilee and Minto are former producers.

The property was formulated in 1960 by Sutherland and Company which acquired the 8 claims of the Surluga (Cora) group. Sutherland carried out a diamond drill programme of 25 holes totalling 9,267 feet in 1960-61 and staked an additional 28 claims. Surluga Gold Mines Limited was formed by Sutherland and Company in March 1962 and acquired another 37 claims. Diamond drilling was completed in 1962-63 and partially outlined 5 mineralized zones totalling 225,226 tons grading 0.232 oz Au/-ton. The Consolidated Mining and Smelting Company of Canada Limited completed 14,000 feet of surface drilling in 1964. In 1966 a vertical shaft was sunk 950 feet with 7 levels. A mill operated for part of 1968 and until February 18, 1969.

In 1969 Pango Gold Mines Limited joined Surluga Gold Mines Limited in developing the Pursides property. Pango Gold Mines Limited discovered a peridotite body in 1969 with Copper-Nickel mineralization south of the Jubilee mine. At present data on this occurrence is lacking. Surluga Gold Mines Limited changed its name to Pursides Gold Mines Limited in 1973 and was forced into receivership in 1976. The property is currently dormant.

Gold mineralization in the map-area is restricted to quartz veins within the epizonal Jubilee stock and peripheral supracrustal rocks. The gold veins appear spatially related to the stock as demonstrated by Rupert (1975). Two mines, Jubilee and Pursides, occur in quartz veins within the Jubilee fault. Faulting or shearing is also reported in the former Parkhill mine (Moore 1931, p.40) and shearing and faulting commonly occur parallel to the walls of the veins (Moore 1931). Pyrite, pyrrhotite, chalcopyrite, and sphalerite are locally present in minor quantities within the veins.

Sulphide ironstone-pyritic banded chert of the Judith Iron range and the Adina Gold Syndicate location have been extensively pitted and trenched for gold. This work was likely completed in the 1930s. Examination of samples from pits on the Judith range disclosed minor chalcopyrite mineralization along fractures in the sulphide rich section. Sulphides of economic interest were not observed on the former Adina property but more detailed examination is warranted. Massive to disseminated sulphide mineralization within the map-area is associated with banded chert and is considered to be sulphide ironstone facies of iron formation by the writer.

In Lastheels Township the one mineralized showing of note is the molybdenite showing currently under examination by Amax Exploration Incorporated. This showing consists of medium-grained trondhjemite veined with milky quartz. The quartz veins are locally so abundant as to give the rock a sheeted appearance. The veins dip north 20 to 40 degrees. Molybdenite occurs as coarse grained rosettes within the quartz and as finer grained seams along quartz vein-trondhjemite contacts. Bright yellow ferri-molybdite is common on the weathered molybdenite. No molybdenite was observed in the trondhjemite. The area of mineralization has a red hue and appears to have undergone potash metasomatism.

The Firesand River complex contains niobium, uranium, and apatite (phosphate) mineralization which have not yet been found to occur in commercial quantities (Parsons 1961).

Recommendations to the Prospector

Pending future developments in the area there may be a need to re-evaluate the Judith iron range and the former Adina property for base metal content. A re-evaluation of these properties is warranted as a result of the current gold prices. The early prospectors have undoubtedly examined every quartz vein exposed at surface, however as economic conditions change many of the old diggings may be worthy of re-examination. On the basis of previous development, the gold-bearing veins are likely to have a vertical extent 2 or 3 times their strike length. Gold production to date has been generally from depths of less than 240 m and gold mineralization appears to display a close association with intrusive phases of the Jubilee stock. There is a more doubtful relationship between quartz veins and shearing. While shearing is present within most of the former mines it appears likely to post-date vein formation. The quartz veins likely occupy fractures within the stock and enclosing supracrustal rocks and the shear zones have followed the same planes of weakness.

Molybdenite appears to occur where fracturing of the granitic complex marginal to the supracrustal sequence has taken place. It is unclear as to whether the molybdenum mineralization is an Early or Late Precambrian event. Disseminated porphyry-type molybdenite mineralization was not observed.

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No.13 The Rotunda Lake – Percy Lake Map-Area, Districts of Algoma and Sudbury

B.C. Wilson[1]

Location

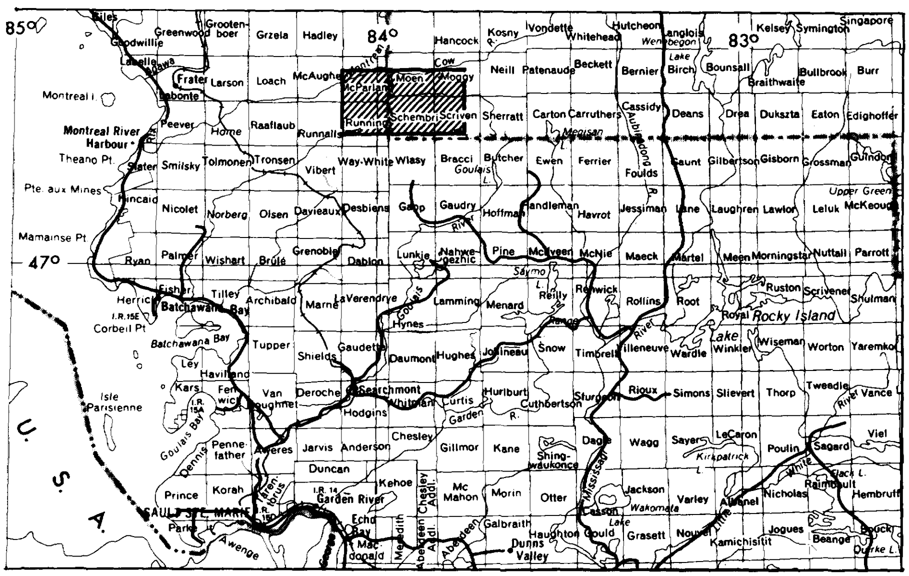
The Rotunda Lake-Percy Lake area lies about 100 km north-northeast of Sault Ste. Marie, Ontario, 96 km southeast of Wawa and 68 km southwest of Chapleau, just to the south of the junction of the Cow and Montreal Rivers. These rivers form, at this point, a reservoir contained by a power dam located on the Montreal River 40 km to the southwest. The area mapped is bounded to the north by Latitude 47°22′30″N and to the west by Longitude 84°05′W. Mapping extended southwest to Latitute 47°15′N, to the southeast just beyond the contact with the granitic rocks and to the east to a line about 2 km northeast of and running parallel to an Ontario Hydro power line. The map-area includes parts of Scriven, Moggy, Schembri, Moen, Running and McParland Townships (formerly Township 23, Ranges 15 and 16, Township 24, Ranges 15 and 16 and Township 25, Ranges 15 and 16 respectively).

1 Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.

Accessibility

The map-area may be reached by air, water or road. Fixed-wing service is available at numerous locations, notably Sault Ste. Marie, Wawa, Chapleau and Batchewana Bay. The reservoir contains thousands of floating logs and submerged stumps making landings often difficult but only rarely impossible. The water level drops close to 4.5 m during the field season and as the logs become hung-up on the shore they become less of a problem. Apart from the reservoir, Caesar, Percy and Pan Lakes are suitable for float-equipped aircraft. Helicopter service is available from Sault Ste. Marie and Timmins. There are many possible landing sites throughout the map-area, most of them beside the abundant small and often partially-drained lakes.

From Chapleau, the Sheppard and Morse road covers 100 km to the edge of the Cow River in Moen Township. Improvements completed during the summer of 1979 make this road suitable for ½ ton two-wheel drive vehicles except in the early spring. The Sheppard and Morse road provides access to the Ontario Hydro Line road running through the map-area. The reservoir may



LOCATION MAP

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

also be reached at its west end by way of a private road beginning near Montreal River Harbour on Lake Superior.

Travel by boat on the reservoir is frequently severely hampered by log jams, especially early in the field season. Landing sites, including the one at the Sheppard and Morse road, became logged-in and inaccessible. Prevailing southwest winds concentrate logs east of the narrows at the Sheppard and Morse road making boat travel there difficult or impossible throughout much of the field season. Other rivers within the map-area are not recommended for boat travel due to a large number of rapids and water-falls.

Mineral Exploration

Records of exploration activity may be found in the Assessment Files Research Office of the Ontario Geological Survey in Toronto and in the Resident Geologist's Files, Ontario Ministry of Natural Resources, in Sault Ste. Marie and Timmins. Running and McParland Townships are owned, and exploration and staking activity are controlled by the Algoma Central Railway (A.C.R.). Data on these townships may be found in the A.C.R. offices in Sault Ste. Marie.

Sporadic staking activity has occurred in this area at least since 1924. The earliest reported exploration was by the Rochefort Mining Syndicate (SSM 235)[1] working until around 1930 on 8 claims. The claim group followed a sizeable quartz vein near Quinn River in Running Township. Later prospecting in Running Township included geological, airborne electromagnetic, ground gravity and magnetic and silt and soil geochemical surveys run by Rio Canadian Exploration Limited (formerly Technical Mine Consultants) in 1956 (SSM 1211)[1]. Brief geological surveys were conducted by the A.C.R. in 1960 (SSM 1006)[1] and Golden Ashley Explorations Limited in 1966 (SSM 961)[1].

Work in McParland Township has consisted of two brief geological surveys by the A.C.R. in 1961 and 1962 (SSM 874)[1]. No work has been reported in Scriven Township.

Schembri, Moen and Moggy Townships have been explored somewhat more extensively between 1955 and 1974. An Algoma Ore Properties program (SSM 673)[1] included airborne magnetic, ground electromagnetic and magnetic, geological and water geochemical surveys and the diamond drilling of four holes with a total of 125 m. Sutherland and Associates (SSM 748)[1] drilled 13 holes totalling 1249 m in length near Pillow Lake in Schembri Township. Following an airborne magnetic and electromagnetic survey in 1973, Asarco Exploration Company of Canada Limited collared four diamond drill holes totalling 312 m to test four anomalous areas (SSM 1755)[1].

1 On file at the Resident Geologist's Office, Ontario Ministry of Natural Resources, Sault Ste. Marie.

As of April 1979 only two claims, both leased, were in good standing within the map-area. No exploration activity was noted by the author during the summer of 1979.

General Geology

Bedrock outcrops are abundant in the Rotunda Lake–Percy Lake area but the majority are thickly moss and tree covered showing only low vertical faces. A few scattered outcrops, especially those beside partially drained lakes, have good exposures and allow more detailed studies of surface textures. An excellent cross section of rock types is to be found along the power line and the power line road.

At present, the geology of the map-area is interpreted to comprise a relatively few Archean volcanogenic lithologies folded into a simple east-northeast trending syncline bordered to the north and southeast by unfoliated to gneissic granitic rocks. This syncline is expected to be continuous with one proposed by Grunsky (1979) immediately to the west. In the southwest corner of the map-area rock trends turn southward to join with units mapped by Siragusa (1978).

The most recent geological map of the area is a compilation by Giblin and Leahy (1977). The contacts between volcanic and plutonic rocks shown on that map have not been changed significantly by the present survey, however lithologies shown are much over-simplified. Rock types mapped by the author comprised dominantly massive and pillowed intermediate to mafic flows including gabbroic intrusives and possibly intermediate to mafic tuff, with much smaller proportions of felsic tuff and crystal-tuff, feldspar porphyry and rarer quartz-feldspar porphyry intrusives and metasediments consisting mainly of wacke and conglomerate. These rocks are cut by contemporaneous or younger felsic and younger mafic (diabasic) dikes and sills. Low grade metamorphism (Winkler 1976) is evident throughout the map-area with higher temperature conditions indicated locally.

A simplified stratigraphic section is interpreted by the author to begin with metasediments followed by intermediate to mafic and minor felsic metavolcanics and finally, close to the western edge of the map-area, felsic metavolcanics. Small amounts of metasediments are present throughout the section. A single very small occurrence of a younger conglomerate of unknown age was found filling a vertical fracture in gneissic granitic rock on the north shore of the Cow River.

The reader is cautioned that the geology presented here is subject to modification following laboratory investigations to be completed during the winter of 1979-1980.

Economic Geology

No deposits of economic significance have been found within the Rotunda Lake–Percy Lake map-area. Geophysical prospecting has indicated a number of anomalous areas, however, geological mapping and diamond drilling have located only minor amounts of magnetite, hematite, pyrite, pyrrhotite, chalcopyrite, galena, sphalerite, graphite, silver and gold. Hand specimens of most rock types often show small amounts of sulphides. Surface showings observed during the 1979 field season included a few bedrock outcrops of magnetite ironstone and chert and a small vein of specular hematite.

Based on the available data no suggestion for further exploration can be given by the author at this time.

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No. 14 Geology of the Jerome Area, District of Sudbury

G.M. Siragusa[1]

Location and Access

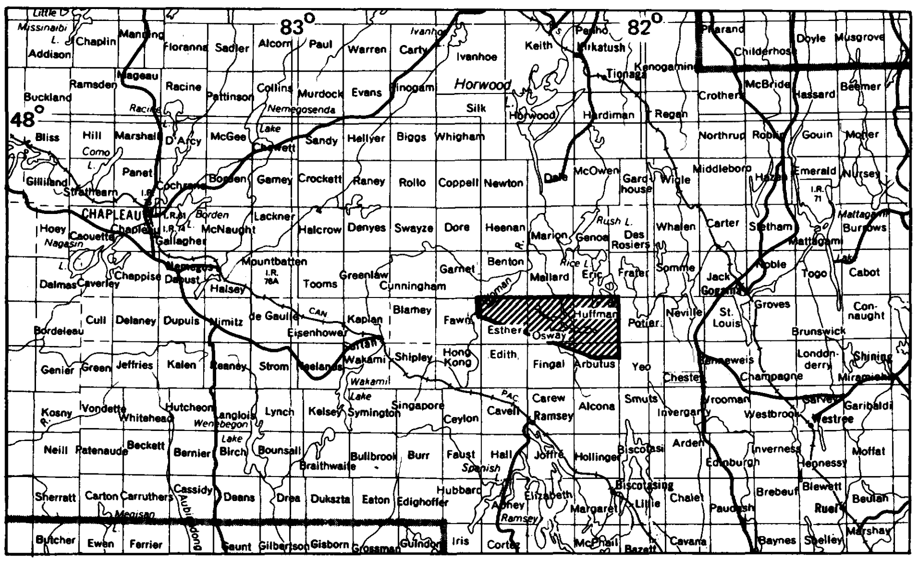
The map-area has a roughly trapezoidal outline; the northeast, northwest, southeast and southwest corners of the area have Latitudes of 47°40′07″, 47°40′07″, 47°34′25″, and 47°38′30″N, and Longitudes of 82°05′10″, 82°28′15″, 82°05′10″, and 82°28′15″W, respectively. The area includes most of Osway and Huffman Townships, and northern portions of Esther, Arbutus, and Fingal Townships for a total of about 295 km^2. The former Jerome gold mine is located on Opeepeesway Lake in Osway Township. A bush road connects Jerome with Highways 129 and 144 via a good gravel road which was formerly owned by Eddy Forest Products Limited, and was open to the public in 1978. In the summer of 1979 the Jerome bush road could not be used owing to a large washout which was located a few kilometers south of Jerome. Another bush road which connects Rush Lake with the gravel road mentioned above, gives access to the tip of the northwest arm of Opeepeesway Lake, and crosses the Opeepeesway River on a steel bridge located about 3 km north of the north arm of the lake; the distances from these points to Jerome are approximately 8.5 and 11 km by water, respectively. A third bush road connects the segment of the Jerome road north of the washout with the Rush Lake road; this road although narrow and locally rough may be used to reach Jerome. In the spring of 1979 a small log bridge had to be built to get across a local washout caused by partial collapse of a large beaver dam. The distance of Jerome from Chapleau via this road is about 129 km.

1 Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.

Mineral Exploration

Osway Township

In 1938 Bert Jerome, while prospecting for Mining Corporation of Canada Limited, discovered a gold-bearing vein zone. In 1939 Jerome Gold Mines Limited was incorporated and acquired 48 claims in Osway and Huffman Townships from the Mining Corporation of Canada Limited. During the winter and spring of 1939 exploration and drilling were carried out, a mining plant was installed, and shaft



LOCATION MAP

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

sinking begun in claim S 32070. In 1941 another 14 claims were acquired and a 500 ton cyanide mill was installed which operated until August of 1943. Underground operations ceased in June, 1945 at which time a three compartment vertical shaft had reached a depth of 346.8 m with levels at 61, 106.7, 152.4, 198.2, 243.8, and 335.2 m, with 6,401 m of drifting, 961.6 m of cross-cutting, and 1037 m of raising. Surface and underground drilling totalled 11 628 and 14 415 m, respectively[1]. In 1957 all the equipment was sold and the buildings were destroyed by fire, and in 1973 all the patented claims of Jerome Gold Mines Limited, including the mine, were held by Eddy Forest Products Limited.

Referenced data on diamond drilling other than that done by Jerome Gold Mines Limited are summarized in Table 1.

In 1946 Cipway Gold Mines Limited held 87 claims in central and western Osway Township, and Bi-Ore Mines Limited held 17 patented claims in southeastern Osway Township and in Huffman Township. Most of the work done by the former company was concentrated in the Monella Point and Cipway Point areas of Opeepeesway Lake, and consisted of stripping, trenching, and an unknown amount of drilling. About 4500 m of drilling had been completed on the Bi-Ore Mines property as of 1946; between 1946 and 1951 geological mapping, extensive trenching, and further diamond drilling were carried out on this property. The present writer concludes that about 9000 m total drilling was done on this property.

In 1964, 1966, and 1968 diamond drilling was done by Mr. M. Burton on two claims close to the eastern boundary of the township, and one hole was drilled in the same area by Falconbridge Nickel Mines Limited in 1973. In 1978 one hole was diamond drilled by Noranda Exploration Company Limited in a claim located in the northwestern part of the township.

During the summer of 1979 exploration activity consisted mostly of claim staking. As of September 6, 1979 a total of 74 claims were staked in Osway Township and recorded at the Timmins Mining Recorder's Office. Most of these claims form a large block on the south side of the northwest arm of Opeepeesway Lake. An exploration crew of Shell Canada Resources Limited was also active

1 Ontario Geological Survey, Geoscience Data Centre, Toronto, Source Mineral Deposit Record Files Osway Twp., "Jerome".

TABLE 1 SUMMARY OF RECORDED INFORMATION ON DIAMOND DRILLING IN OSWAY TOWNSHIP BY COMPANIES OTHER THAN JEROME GOLD MINES LIMITED.

Year	Company	Location(*)	Number of D.D. holes	Length meters	Reference
Before 1946	Cipway Gold Mines Ltd.	C, W	?	?	(a),(b),(c)
	Bi-Ore Mines Ltd.	SE	?	4500 (App. total)	(b)
1946 to 1951	Bi-Ore Mines Ltd.	S 32324	?	4500 (App. total)	(d),(e)
1964	Burton M.	S 120762	6	114.3 106.7 112.8 86.9 80.7 91.7	(f)
1966	Burton M.	S 120762	2	152.4 23.8	
1968	Burton M.	S 120771	1	156.7	
1973	Falconbridge Nickel Mines Limited	280376	1	152.7	(g)
1978	Noranda Exploration Company Ltd.	P 410872	1	116.7	(h)

(*) C, W, and SE mean central, western, and southeastern parts of the township. Numbers preceeded by S or alone are claim numbers.

Reference Code:
(a) Can. Mines Handbook, 1950, Cipway GML, p.339
(b) Moorhouse W.W., ODM Vol. 58, pt. 5, 1949, p.17
(c) Ontario Geological Survey, Geoscience Data Centre, Toronto, Source Mineral Deposit Record Files Osway Tp. "Cipway", (revised 1974)
(d) Ontario Geological Survey, Geoscience Data Centre, Toronto, Source Mineral Deposit Record Files Osway Tp. "Bi-Ore", (revised 1974)
(e) Can. Mines Handbook, 1952, Bi-Ore ML, p.222
(f) Timmins Assessment Files; File T-2177
(g) Timmins Assessment Files; File T-2133
(h) Toronto Assessment Files; Osway Tp. Drilling Rep. No.12

in the general area in the 1979 summer.

Huffman Township

Referenced data on diamond drilling in Huffman Township are summarized in Table 2. Most of the drilling was done on the Jess-Mac property which in 1951 included a group of 25 claims located on the north side of Opeepeesway Lake, to the east and along strike of the Jerome mine. The M.J. Gaffney and Jess-Mac Gold Mines Limited properties were largely overlapping; in 1966 Rio Tinto Canadian Exploration Limited optioned 16 claims in the area (Jess-Mac Option) and carried out electromagnetic and magnetometer surveys. The purpose of this work was to investigate the possibility of large masses of sulphide mineralization, but no further exploration could be recommended on the basis of the results obtained. Similar conclusions were reached in 1963 by Denison Mines Limited after geophysical work in the Huffman Lake area, southeast of the Jess-Mac property. In 1966 Falconbridge Nickel Mines Limited drilled 3 holes south of Opeepeesway Lake, and in 1971 carried out magnetometer and electromagnetic surveys over a group of 55 claims. Fifty one of these claims were located on the north side of Opeepeesway Lake in Huffman Township and the remaining four were in Osway Township. Apparently this work

TABLE 2 SUMMARY OF RECORDED INFORMATION ON DIAMOND DRILLING IN HUFFMAN TOWNSHIP.

Year	Company	Location	Number of D.D. holes	Length meters	Reference
1933?	Mining Corporation of Canada Ltd.	S 32386	1	30.5	(a)
1938	Sylvanite Gold Mines Ltd.	S 31759	1	54.2	(b)
Before 1945	Best Ore Gold Mines Ltd.	S 45683	1	220.9	(c)
		S 45680	1	125.6	
		S 40666	3	68.6	(d)
				96.6	
				83.8	
		S 32544	2	68.6	
				45.7	
		S 32545	2	60.9	
				53.3	
1947	Bi-Ore Mines Ltd.	S 40863	1	125.6	(e)
		S 40866	2	156.0	
				110.3	
Before 1949	Jess-Mac Gold Mines Ltd.	S 32619	2	?	(f)
		S 32618	1	?	
		S 34433	1	?	
		S 34432	3	?	
		S 37094	2	103.6	
				94.5	
		S 37094	2	?	
		S 57309	1	?	
		S 37095	1	166.1	
		S 50054	1	155.4	
1949	Swed Prospecting	S 52321	1	137.7	(g)
1950	Jess-Mac Gold Mines Ltd.	S 54290	2	153.6	(h)
				105.1	
	Swed Prospecting	S 52323	1	137.6	(g)
		S 52196	1	136.5	
		S 52321	1	191.1	
		S 52196	1	62.8	
1950/51	Jess-Mac Gold Mines Ltd.	S 54293	16	29.9	(f)
				89.9	
				121.3	
				90.8	
				108.5	
				119.5	
				47.8	
				166.7	
				134.4	

led to drilling of 2 holes in 1973, 1 hole in Huffman and another in Osway Township.

During the summer of 1979 the only apparent exploration activity in the township was claim staking. As of September 6, 1979 a total of 21 claims were staked in Huffman Township and recorded at the Timmins Mining Recorder's Office.

Arbutus Township

Referenced data on drilling in Arbutus Township are summarized in Table 3. Claims S 40872 and S 40873 were adjacent to the northern boundary of the township on the west side of it, and claims S 42524 and S 42532 were in the northeast corner of the township.

Esther Township

In May, 1979 a 37.5 m diamond drill hole was completed by Mr. M.L. Burton on claim P 473385 which is located in the northeast part of the township (Regional Geologist's files, Ontario Ministry of Natural Resources, Timmins, File T 1920). Claim staking also occurred in the area of the Burton drilling and as of September 6, 1979 eleven claims were recorded at the Timmins Mining Recorder's Office. Both these recent activities are in the general area of an old patented claim (claim S 32457) on which several trenches and a test pit were completed in 1928 by Northern Aerial Canada Golds Limited.[1]

1 Ontario Geolgical Survey, Geoscience Data Centre, Toronto, Source Mineral Deposit Record Files Esther Twp. "Northern Aerial".

Table 2 continued

Year	Company	Location	Number of D.D. holes	Length meters	Reference
				32.3	
				93.0	
				110.9	
				94.2	
				100.5	
				105.1	
				23.0	
1961	Gaffney M. J.	S 113748	5	131.7	(i)
				55.5	
				109.1	
				29.2	
				115.2	
	Gaffney T. J.	S 113855	3	195.3	(j)
				115.2	
				83.8	
		S 113861	6	151.2	(k)
				75.0	
				18.3	
				18.3	
				15.5	
				31.1	
1962	Worthinton Mines Ltd.	Jess-Mac property	?	?	(l)
1966	Falconbridge Nickel Mines Ltd.	S 32384	1	164.0	(m)
		S 127725	1	139.0	
		S 127729	1	106.2	
1973		280377	1	143.8	

Reference Code

(a) OGS, Toronto Assessment Files; Huffman Tp., Drilling Rep. No.15
(b) MNR, Timmins Assessment Files; File T-2136
(c) OGS, Toronto Assessment Files; Huffman Tp., Drilling Rep. No.16
(d) OGS, Toronto Assessment Files; Huffman Tp., Drilling Rep. No.18
(e) MNR, Timmins Assessment Files; File T-2002
(f) MNR, Timmins Assessment Files; File T-2134
(g) OGS, Toronto Assessment Files; Huffman Tp., Drilling Rep. No. 13
(h) OGS, Toronto Assessment Files; Huffman Tp., Drilling Rep. No. 14
(i) OGS, Toronto Assessment Files; Huffman Tp., Drilling Rep. No. 11
(j) OGS, Toronto Assessment Files; Huffman Tp., Drilling Rep. No. 12
(k) OGS, Toronto Assessment Files; Huffman Tp., Drilling Rep. No. 19
(l) The Northern Miner, June 28 1962, page 13, Worthington Drilling
(m) MNR, Timmins Assessment Files; File T-2133

TABLE 3 | SUMMARY OF RECORDED INFORMATION ON DIAMOND-DRILLING IN ARBUTUS TOWNSHIP.

Year	Company	Location	Number of D.D. holes	Length meters	Reference
1947	Bi-Ore Mines Ltd.	S 40872	1	190.5	Timmins
		S 40873	1	170.6	Assessment File T-2002
1949	Best Ore Mines Ltd.	S 42524	1	123.7	Timmins
		S 42532	1	185.0	Assessment File T-2001

General Geology

A northwest-trending belt of Archean metavolcanics and metasediments crosses the map-area and extends beyond it to the northwest and the southeast. Within the map-area these supracrustal rocks are in contact with regional granitic rocks in the northeast corner of Huffman Township, the southwest corner of Osway Township, and all but the northern part of Esther Township. In broad terms the metasediments form an elongated unit centrally located within the belt and bordered by metavolcanics at its northern, western, and southern margins. The contact relationships of the metavolcanic and granitic rocks are generally quite sharp.

The metavolcanics are dominantly basaltic flows interlayered with subordinate pyroclastic phases. The flows are uniform in texture, composition, and physical character, and are tentatively classed as iron-rich tholeiites. Pillowed flows are common but are deformed and of little value for top determinations. The pyroclastics consist of tuff-size to block-size clasts of porphyritic and pumiceous felsic metavolcanics, and to a lesser extent of chert or ironstone, embedded in a matrix of basaltic or andesitic composition. The proportions of matrix and clasts may vary considerably over short distances. A prominent pyroclastic unit of this kind was previously reported by the writer in southern Mallard Township (Siragusa 1978; p.87) and present mapping has traced it to the Little Rice Lake area of central Huffman Township. The area underlain by this unit is characterized by a rather pronounced linear aeromagnetic pattern (see ODM-GSC Map 2261 G).

The metasediments are dominantly metamorphosed polymictic conglomerate and conglomeratic arenite, with subordinate arenite and wacke, and lesser laminated mudstone and interlaminated ironstone and chert. Outcrops of coarse metasediments are mostly found along the northern and western shores of the main body of Opeepeesway Lake and along the southern shore of the east arm of the lake. Cross-bedding in a few outcrops on the lakeshore in south-central Huffman Township clearly indicates that the metasediments face north, and that in this area they are overturned. However, structurally significant evidence of this kind was found only in the locality just mentioned. The metamorphism of the supracrustal rocks is largely upper greenschist facies. Subvertical dips of foliation, shearing planes and primary layering are most common throughout the belt. Late Precambrian diabase dikes are common and lamprophyre dikelets are of rare occurrence in the supracrustal rocks.

Intrusive felsic porphyritic rocks that are variably metamorphosed and display concordant or discordant relationships with respect to the supracrustal rocks, are of local occurrence in the map-area and particularly in Osway Township. Owing to scarcity of outcrops the extent of the porphyritic bodies is largely interpretive. The porphyry is economically significant because the contact zones of porphyry and metasediments are a favourable environment for gold mineralization (e.g. Jerome Mine). In the past it has been suggested that the Jerome porphyry forms a lenticular body which has maximum width of 1.2 km and extends east of the Jerome Mine for a distance of 3 km (Brown 1948; p.438). During present mapping outcrops of porphyry were found at a few localities on the north side of east arm, and the easternmost of these is the wide part of the outlet of Little Rice Creek into east arm. The outcrops that were found are few and far apart, but their locations together with some data from old drilling suggest that porphyry may indeed underlie a large part of the east arm of Opeepeesway Lake in Huffman Township.

Economic Geology

Osway Township

During the period of operation the Jerome Mine produced 56 868 ounces of gold and 15 104 ounces of silver (Brown 1948, p.438). Molybdenite was also found as a minor constituent of the gold ore.[1] At the time work ceased the ore reserves ". . .... amounted to 344,000 tons averaging 0.19 oz. gold after allowance for dilution" (Northern Miner, December 26, 1968, p.13).

A mineralized zone was found by Cipway Gold Mines Limited in sheared and carbonatized mafic metavolcanics cut by quartz-feldspar porphyry dikes, about 800 m southwest of Cipway Point. Mineralization consisted of

1 Ontario Geological Survey, Geoscience Data Centre, Toronto, Source Mineral Deposit Record Files Osway Twp. "Bert Jerome".

". . ....quartz veining, pyrite, pyrrhotite, chalcopyrite and a little arsenopyrite. A character sample of mineralized material assayed by the Provincial Assay Office yielded 0.07 oz. gold per ton".[1]

Bi-Ore Mines Limited became idle in early 1951 (Canadian Mines Handbook, 1952, p.222); the only filed data of economic relevance on the work done by this company in Osway, Huffman, and Arbutus Townships (Tables 1, 2, and 3) refers to a shear zone at the contact of metasediments and metavolcanics located in claim S 32324 of Osway Township. The Zone is described as ". . .well mineralized with pyrite and arsenopyrite. . ." and". . ....has strike length of at least 300 ft., and averages more than 6 ft. in width, but varies up to 30 ft. locally. The gold values of surface exposures and drill hole sections were generally low, but one 5 foot section of massive arsenopyrite in a drill hole assayed 0.17 oz. gold per ton".[2]

The log of one of the holes drilled in 1964 by M. Burton in claim S 120772 reports ". . .hematite with Cu sulphides. . ." in a section of feldspar porphyry 4.5 m wide, and ". . .heavy sulphide mineralization. . ." in a section of the same rock about 1.3 m wide. The log of another hole in the same claim reports ". . .heavy sulphide mineralization. . ." in a section of feldspar porphyry about 1 m wide. The log of a third hole drilled in the same claim in 1966 reports a ". . .well mineralized. . ." (mineralization unspecified) section of arkose about 8 m wide (Regional Geologist's Files, Ontario Ministry of Natural Resources, Timmins, File T-2177).

The hole drilled by Falconbridge Nickel Mines Limited in 1973 in claim 280376 is in the same area of the Burton drilling. The log of the Falconbridge hole reports finely disseminated pyrite through much of a section of feldspathic metasediments 80 m wide, and disseminated pyrite and slightly magnetic pyrrhotite in a conglomeratic section about 30 m wide (Regional Geologist's Files, Ontario Ministry of Natural Resources, Timmins, File T-2133).

A cross-section of the hole drilled by Noranda Exploration Company Limited in 1978 shows a section of rhyolite 1.8 m wide variably mineralized by graphite, pyrite, chalcopyrite, sphalerite, and galena. The log of this hole would suggest that the best mineralization intersected consists of a graphitic section 45 cm wide which assayed 0.36 percent zinc, and 0.09 oz/ton silver, and is underlain by another graphitic section 61 cm wide that assayed 0.12 oz/ton silver, 0.027 percent copper, 2.90 percent zinc, and 0.65 percent lead (Assessment Files Research Office, Ontario Geological Survey, Osway Twp., Drilling Report No. 12).

Huffman Township

The log of one of the 9 holes drilled by Best Ore Gold Mines Limited before 1945 reports ". . .porphyry with mineralization. . ." (hole No. 6), but the section width is uncertain and the mineralization is unspecified (Reference (d) in Table 2); the log of the hole in claim S 45683 reports a section about 17 m wide of ". . .rusty iron formation changing to cherty iron formation and banded iron formation. . ." (Reference (c) in Table 2).

In 1949 J.E. Thomson visited the property of Jess-Mac Gold Mines Limited and reported that ". . .Mineralization is very sparse throughout the porphyry and is confined largely to fractured zones. There is a pronounced reddening of the porphyry near the mineralization. It consists almost entirely of very fine-grained pyrite and chalcopyrite. In hole No. 15 immediately under the lake bed the porphyry shows considerable oxidation along joints and fractures. In these areas the chalcopyrite has been altered to native copper and possibly some cuprite. The best copper assays are. . ."... shown in Table 4.

All other assays for copper and gold are from picked samples of the core and are not representative of grade over mining widths (Regional Geologist's files, Ontario Ministry of Natural Resources, Timmins, File T-2134). Thomson added that the property ". . .possesses more merit as a gold prospect than for copper. . .". In 1951 W.S. Savage visited the property and summarized the information obtained from drilling (Regional Geologist's files, Ontario Ministry of Natural Resources, Timmins, File T-2134) (Table 5).

The logs of the M.J. Gaffney, 1961 drilling are very sketchy. One of the holes in claim S 113861 (hole No. 7) intersected a quartz vein about 2 m wide which (or samples of which?) assayed 0.24 oz gold and 0.33 oz. silver; a sample (of altered porphyry?) about 1 m wide from one of the holes in claim S 113748 (hole No. 10) assayed 0.035 oz. gold (Regional Geologist's files, Ontario Ministry of Natural Resources, Timmins, File T-2132). The log of !one of the holes in claim S 113855 (hole No. 5) describes a 5.6 m wide section as ". . .Grey porphyry with quite a lot of Copper Pyrites. . ." (Reference (f) in Table 2).

Assay data from the drilling done in 1966 by Falconbridge Nickel Mines Limited south of Opeepeesway Lake is shown in Table 6 (Reference (m) in Table 2).

Arbutus Township

The log of the hole drilled by Bi-Ore Mines Limited in claim S 40872 mentions chalcopyrite but no better information can be extracted from this source (Regional Geologist's files, Ontario Ministry of Natural Resources, Timmins, File T 2002). The hole drilled by Best Ore Gold Mines Limited intersected a band of ironstone about 18 m wide (Regional Geologist's files, Ontario Ministry of Natural Resources, Timmins, File T-2001).

Esther Township

The mineralization on the old property of Northern Aerial Canada Golds Limited is described as follows: ". . .The main showing occurs in a rusty weathering, heavily carbonated zone in schistose quartz diorite. The zone trends east-west and has a width of about 40'. A quartz lens 30'

1 Ontario Geological Survey, Geoscience Data Centre, Toronto, Source Mineral Deposit Record Files Osway Twp. "Cipway".
2 Ontario Geological Survey, Geoscience Data Centre, Toronto, Source Mineral Deposit Record Files Osway Twp. "Bi-Ore".

TABLE 4 ASSAYS FROM DRILL HOLE No. 17, JESS-MAC GOLD MINES LIMITED.

229' - 302'	Au 0.03 oz/ton	Cu 1.58%
332.5' - 335'	Au 0.03 oz/ton	Cu 1.58%

TABLE 5 ASSAYS FROM DRILL HOLES, JESS-MAC GOLD MINES LIMITED.

Hole No.	Contact (feet)	Dip	Footage (feet)	Best Sample (feet)	Au Ozs.	Cu %	Ag Ozs.	Pb %	Zn %
28	Por-Sed 30	45° N	295	78-90	0.01				
29	Sed-Por 113	46° S	298	50-55	0.15				
				303-307	0.21	0.09	4.39	4.97	3.78
30	Abandoned								
31	Por-Sed 200	60° N	298	30-36	0.07				
32	Sed-Por 107	48° S	356	40-45	0.17				
				293-300	0.04		0.32	0.09	0.28
33	Sed-Por 162	47° S	392	71-72.3	0.02				
				330-335	0.02				
34	Porphyry	46° S	157						
35	Porphyry	60° S	547	498-500	0.04				
36	Porphyry	60° S	441	246-250	0.02				
37	Por-Sed 48	45° N	106	83-84	0.23				
				85-86	0.11				
38	Por-Sed 278	75° N	305	255-256.5	0.03		0.79	3.72	2.61
39	Por-Sed 335	70° N	364	290-290.5	0.02		1.06	1.37	3.42
40	Por-Sed 295	70° N	309	275-280	0.02		0.51	1.03	2.57
41	Por-Sed 301	70° N	330	286-289.5	T		0.44	0.31	0.93
42	Por-Sed 340	72° N	345						
43	Por-Sed 75	72° N	Drilling						

TABLE 6 ASSAYS FROM DRILL HOLES, FALCONBRIDGE NICKEL MINES LIMITED.

Hole No.	Host	Sample width (feet)	Ni%	Cu%	Au
1	Ironstone	5.0	0.04	0.05	0.02 oz/ton
	Graphite	1.1	0.01	0.47	
	Ironstone	4.0	0.02	0.46	0.01 oz/ton
	Ironstone	2.7	Tr.	0.47	
	Ironstone	2.0	0.02	0.10	
	Ironstone	1.4	Tr.	2.02	0.01 oz/ton
2	Ironstone	5.0	–	–	0.01 oz/ton

long and 3' in width in the schistose zone strikes N10°W and dips 45°W. The quartz is coarse and glassy and is heavily mineralized with pyrite and arsenopyrite. A grab sample with massive arsenopyrite yielded 0.63 oz gold and 3.46 oz silver per ton. . .".[1]

1 Ontario Geological Survey, Geoscience Data Centre, Toronto, Source Mineral Deposit Record Files Esther Twp. "Northern Aerial".

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No. 15 Larder Lake Synoptic Mapping Project, Districts of Cochrane and Timiskaming

L.S. Jensen[1]

Introduction

During the 1979 field season, as an extension of the stratigraphic synthesis of the Timmins–Kirkland Lake sheet (location map) by D.R. Pyke and the writer (Jensen 1978b) mapping by the writer was concentrated in the Larder Lake and Kirkland Lake areas (Area 2 and 1) at a scale of 1:63 360. A limited amount of additional mapping was carried out in the Englehart, Matheson, and Magusi River Areas (Area 3, 4 and 5 respectively).

With the regional mapping, a better understanding of the stratigraphy of the Ontario part of the Abitibi Belt has evolved such that areas of mineral potential can be better defined and studied; particularily in the Kirkland Lake part of the Abitibi Belt (Jensen 1978a, 1978b). As a result, two studies have been set up. The first involves a more detailed study of the alteration surrounding known mineralization using previously gathered chemostratigraphic information by the writer along with additional field work. This work was begun in the calc-alkalic volcanic rocks of the Ben Nevis area (Jensen 1975; 1978a) and will be extended to inc lude other groups of rocks associated with other types of mineralization (Grunsky, this volume).

The second study (Downes, this volume) resulted from regional work in the Kirkland Lake and Larder Lake area which showed that gold mineralization occurs in two

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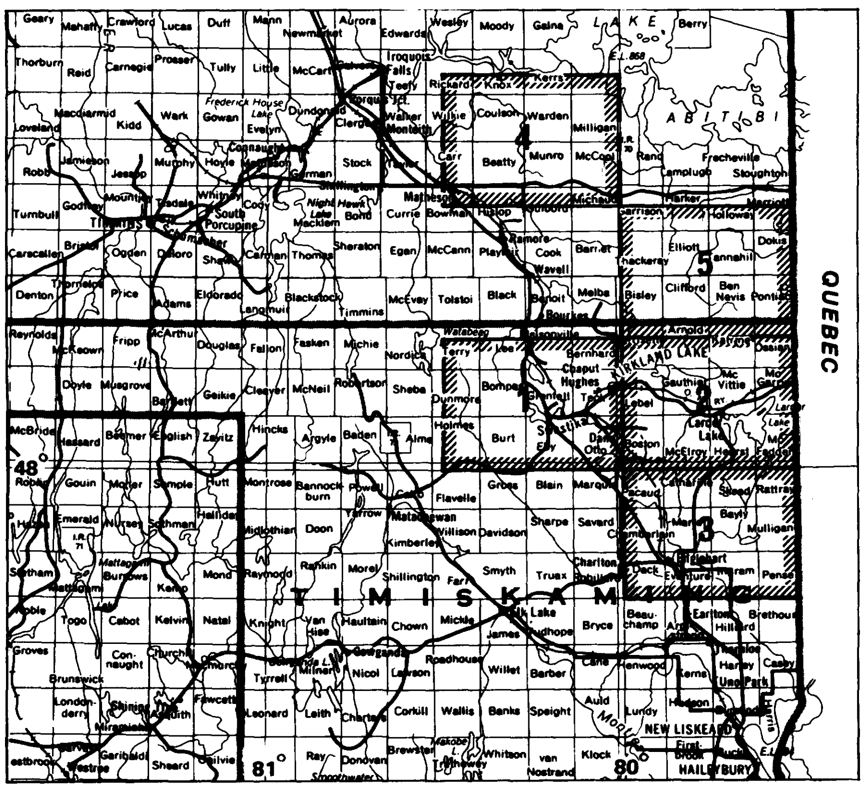

LOCATION MAP

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

distinct groups of rocks, an older group of sedimentary rocks associated with komatiitic volcanic rocks (Larder Lake Group) and a younger group of sedimentary rocks associated with alkalic volcanic rocks (Timiskaming Group) brought into juxtaposition by the faulting along what is believed to represent a late structural expression of the Kirkland Lake–Larder Lake Fault zone (Jensen 1978a,b). Previously, the two groups of sedimentary rocks were considered to be one group of rocks (Thomson 1943, 1949, 1950; Thomson and Griffis 1944; and Hewitt 1949). The study by Downes will concentrate on the stratigraphy, structure and alteration within both groups of rocks in an attempt to outline additional potential gold bearing zones.

Mineral Exploration

Gold was initially discovered in the vicinity of Larder Lake in 1906 (Thomson 1943, p.40). Shortly, thereafter, several gold mines were brought into production near Kirkland Lake, 24 km west of Larder Lake and numerous additional mines were brought into production during the period from 1920 to 1940. Much of this early exploration activity is described in geological reports on the area by the Ontario Department of Mines (now Ontario Geological Survey).

Between 1950 and 1975, the emphasis has been on the search for base metals, iron, and asbestos. Recent fluctuations in the value of gold and silver have spurred new interest in exploring the area for precious metals. For recent mineral exploration in the Kirkland Lake area see Lovell and Ploeger (1977; 1978; 1979).

The recent release of airborne magnetic and electromagnetic maps by the Ontario Geological Survey and the Ministry of Northern Affairs has spurred a further interest in the Kirkland Lake area (Barlow, this volume).

General Geology

Bedrock in the area consists of Early Precambrian (Archean) metavolcanic, metasedimentary and plutonic rocks. Middle Precambrian (Huronian) sedimentary rocks unconformably overlie the Early Precambrian rocks in parts of the area. Pleistocene deposits of till, esker deltaic sand and varved clay overlie the bedrock throughout the area (Baker, this volume).

In the Kirkland Lake area, the volcanic succession consists of successive volcanic piles composed of komatiitic rocks at their base which are overlain in turn by tholeiitic and calc-alkalic rocks and capped by alkalic volcanics. Two such piles plus the top of an older third pile are preserved in the Kirkland Lake area. The successive piles together form a stratigraphic section greater than 50 000 m thick, with the uppermost pile being in excess of 35 000 m thick. The volcanic succession is preserved in a large east-plunging synclinorium 80 to 120 km wide (Figure 1).

The stratigraphy of the north and south limbs of the synclinorium is shown on Tables 1 and 2 respectively. On the north limb of the synclinorium, the basal komatiitic section of the younger volcanic pile is called the Stoughton-Roquemaure Group. The Stoughton-Roquemaure Group (SRG) is about 10 000 m thick and disconformably overlies calc-alkalic volcanics (Hunter Mine Group) that belong to an older volcanic pile. Except for a few iron-rich tholeiitic basalts at the base and at the top of the SRG, the SRG consists of peridotitic komatiite, basaltic komatiite, and magnesium-rich tholeiitic basalt along with a few thin interflow units of cherty tuff and iron formation.

The komatiitic volcanic rocks of Munro Township (Pyke *et al.* 1973, Arndt 1975, and Arndt *et al.* 1977) form part of the SRG further west. Many of the komatiitic rocks in the Timmins area farther to the west (Naldrett and Mason 1968; Pyke 1970; 1975; 1978a; 1978b) are probably extensions of the SRG.

On the south limb of the synclinorium, the basal komatiitic section of the younger volcanic pile is called the Larder Lake Group (Jensen 1978b). The Larder Lake Group disconformably overlies calc alkalic volcanic rocks (Skead Group) of an older volcanic pile to the south. The thickness of the Larker Lake Group (LLG) is still unknown. It consists of peridotitic komatiites, basaltic komatiites and magnesium-rich tholeiitic basalts interlayered by turbiditic conglomerate, greywacke, argillite, carbonate and iron formation.

Both the SRG and LLG are conformably overlain by tholeiitic rocks belonging to the Kinojevis Group. The Kinojevis Group consists of magnesium-rich and iron-rich tholeiitic basalt with tholeiitic andesite, dacite and rhyolite toward its top. The Kinojevis Group is about 10 000 m thick.

Above the Kinojevis Group is a calc-alkalic sequence called the Blake River Group (BRG). It consists of magnesium-rich tholeiitic basalt plus calc-alkalic basalt, andesite, dacite and rhyolite flows and pyroclastic units derived from two or more volcanic centers represented by massive rhyolite domes at the center of the synclinorium. The BRG is about 10 000 m thick.

Unconformably overlying the Kinojevis Group, the BRG and possibly the LLG, is the Timiskaming Group. It consists of alkalic volcanic rocks interlayered by fluviatile sedimentary rocks about 3 000 m thick.

Economic Geology

North Limb

Disseminated chalcopyrite and pyrite occurs in many of the felsic tuffs and breccia dikes of the Hunter Mine Group in Rand Township and Western Upper Lake Abitibi areas. In the Stoughton–Roquemaure Group, asbestos occurs in Munro and Garrison Townships. In addition, the group has a high potential for nickel, and gold is known to occur in carbonatized zones in the ultramafic rocks where they have been affected by movement along the

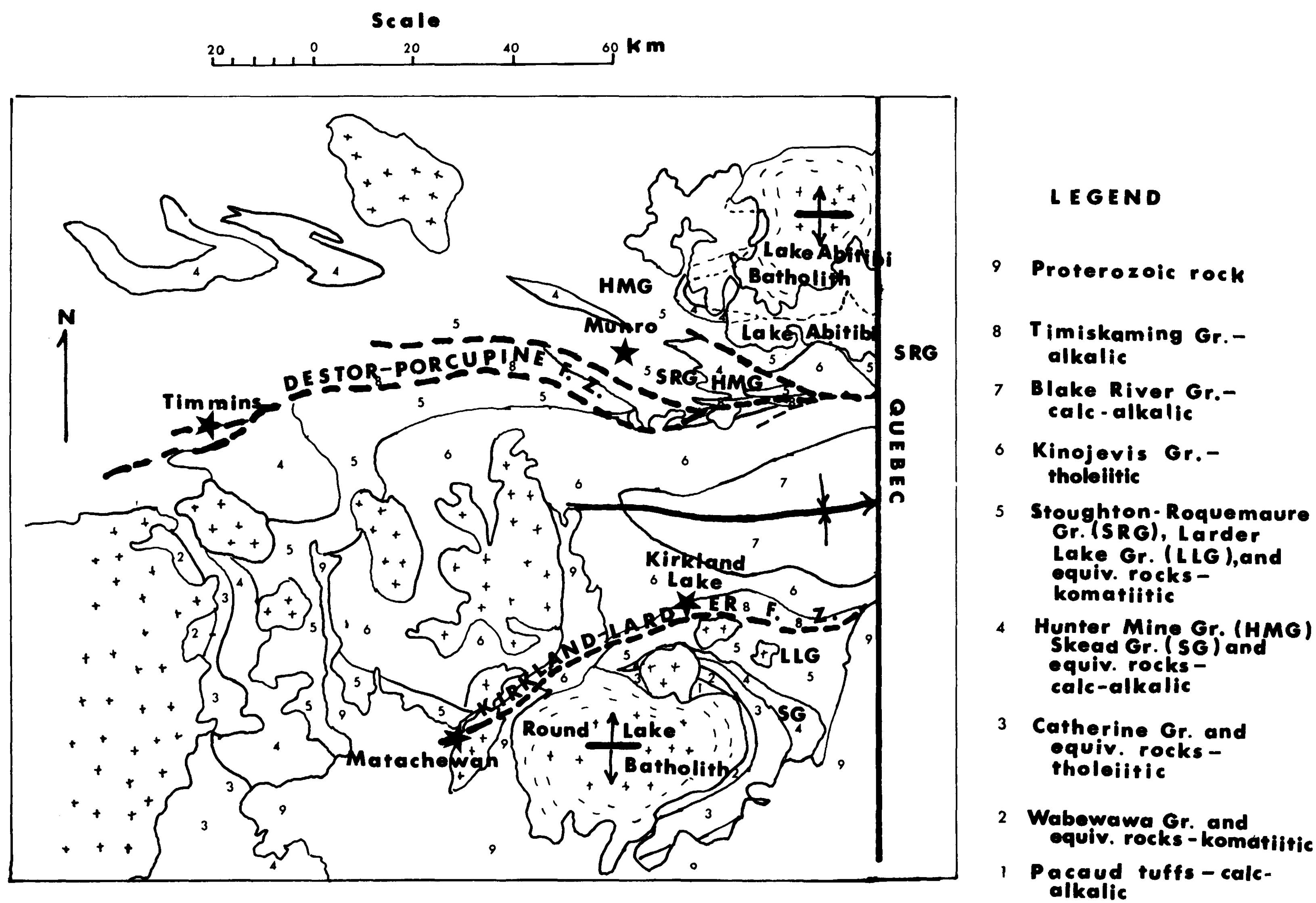

Figure 1 — Stratigraphy of the Kirkland Lake area (Jensen 1979).

TABLE 1	NORTH LIMB STRATIGRAPHY			
Group	Volcanic Rocks	Sediments	Intrusive Rocks	Relationship
Timiskaming Gr. Distor-Porcupine Fault Section 1000 m	Na-rich mafic to felsic alkali volcanic rocks	Turbidites-Congl. Gwke, Argillite Iron Formation	Mafic to felsic syenodiorites syenites	Faulted contact with SRG and KG
Blake River Gr. (BRG) 12,000 m	Calcalkalic basalt, andesite, dacite and rhyolite flows and pyroclastic rocks Minor Mg-rich tholeiitic basalt	Volcaniclastic Turbides derived by slumping off volcanic edifices	Gabbro, diorite quartz diorite and rhyolite domes	Conformably overlies KG
Kinojevis Gr. (KG) 10,000 m	Mg-rich and Fe-rich tholeiitic basalt with minor tholeiitic andesite, dacite and rhyolite flows	Hyaloclastite and argillite, chert and graphite	Gabbro	Conformably overlies SRG
Stoughton-Roquemaure Gr. (SRG) 10,000 m	Peridotitic and basaltic komatiite and Mg-rich tholeiitic basalt. Fe-rich tholeiitic basalt at base and top of group	Minor iron formation, chert and tuff	Dunite, peridotite pyroxenite and gabbro	Disconformably to unconformably overlies HMG or is intruded toward base by
Hunter Mine Gr. (HMG) 1,500 m	Calcalkalic basalt, andesite, dacite and rhyolite flows and pyroclastics	Distal tuffs, gwke, argillites, carbonates and iron formation	Rhyolite and dacite breccia dikes and trondhjemite	Intruded by trondhjemite of Lake Abibatholith

Destor–Porcupine Fault zone in Michaud, Garrison Harker and Holloway Townships. In the Destor–Porcupine Fault section of the Timiskaming Group, gold occurs in fractures filled by quartz-calcite veins, in feldspar porphyry and in strongly altered country rocks.

South Limb

In the Wabewawa Group and possibly in the Pacaud Group, chalcopyrite is associated with thin pyrite-rich layers in the felsic tuffs and sedimentary rocks as isolated occurrences and on strike with ironstones. In the Catharine Group, minor gold and chalcopyrite occurs associated with quartz veins and feldspar porphyry dikes and in the Skead Group numerous showings of massive to disseminated chalcopyrite, molybdenite, sphalerite with pyrite and minor gold occur in the volcanic breccias and tuffs which contain pyrite fragments in many places.

In the Larder Lake Group of komatiitic volcanics, calc-alkalic volcanics and sedimentary rocks above the Skead Group, gold at the Kerr Addison mine and iron at the Adams mine are the major economic deposits. At the Kerr Addison mine, gold is associated with carbonatized mafic and ultramafic volcanic rocks interlayered with sedimentary rocks that include conglomerate, wacke, argillite, and graphite. At the Adams mine, layers of magnetite ironstone alternating with chert form a sufficient thickness and grade to be economically mined. Calc-alkalic dacite and rhyolite tuff along with some pyrite and pyrrhotite occur in the leaner upper and lower parts of the ironstone deposit. Tholeiitic basalt occurs on the footwall and ultramafic komatiite occurs on the hanging wall of the ironstone deposit. Elsewhere in the Larder Lake Group numerous occurrences of zinc and lead sulphide mineralization with minor chalcopyrite occur with graphitic layers and disseminated chalcopyrite occurs in some limestones and dolostones.

In the Kinojevis Group, as in the Catharine Group, minor chalcopyrite and gold occur associated with quartz veins and feldspar porphyry dikes. Thin layers of ironstone and graphite with minor pyrite, sphalerite, and galena occur in a few places.

In the Blake River Group, massive to disseminated

TABLE 2 SOUTH LIMB STRATIGRAPHY

Group	Volcanic Rocks	Sediments	Intrusive Rocks	Relationships
Timiskaming Group (Kirkland Lake-Larder Lake Section) 3,000 m	Na andK-rich mafic to felsic alkalic volcanic rx and K-rich subalkalic felsic volcanic rx	Fluviatile congl. gwke and argillite of material derived locally and from LLG	Mafic to felsic syenodiorite and syenites	Unconformably overlies BRG, KG and in places LLG Mainly a fault contact with LLG
Blake River Group (BRG)		See North Limb Stratigraphy		
Kinojevis Group (KG)				
Larder Lake Group (LLG) Thickness unknown 5,000 m	Peridotitic and basaltic komatiite and MG-rich tholeiitic basalt minor Fe basalt calcalkalic rhyolite tuff toward base of Group	Turbiditic congl., gwke, argillite of material derived locally from komatiitic flows and distally from SR graphite, carbonate and iron formation	Dunite, peridotite, pyroxenite and gabbro	Disconform-overlies GS
		Pebble conglomerate with syenite clasts.	Syenite Intrusion?	
Skead Group (SG)	Calcalkalic basalt, andesite, dacite and rhyolite flows and pyroclastics	Cherts and Iron Formation	Rhyolite porphyries	Conformably overlies Catharine Group
Catharine Group (CG)	Mg-rich and Fe-rich tholeiitic basalt	Minor argillite	Gabbro	Conformably overlies Wabewawa Group
Wabewawa Group (WG)	Peridotitic and basaltic komatiite and Mg-rich tholeiitic basalt Minor rhyolite-tuff	?	Dunite, Peridotite pyroxenite and gabbro	Overlies calcalkalic tuffs (Pacaud tuffs)

Zn, Cu, Pb, Mo sulphide minerals and minor Au and Ag occur in Ben Nevis and Clifford Townships north of the map-area (Jensen 1975a).

In the Gauthier Group, gold and chalcopyrite mineralization occurs at the Upper Beaver mine (Thomson and Griffis 1944).

In the Timiskaming Group, gold occurs along fractures filled by quartz-veins and feldspar porphyry in the main mines of the Kirkland Lake mining camp. In addition, above background values of uranium and gold are present in some of the alkalic volcanic lava flows and tuffs.

In the intrusive assemblages, nickel and chrome silicates, oxides and some sulphide occur in the ultramafic to mafic intrusions in the unnamed group, Skead Group, Wabewawa Group and Pacaud Group. Asbestos fiber is also present in some of the larger serpentinized bodies.

The alkalic intrusions appear to have been responsible for the concentration of Au and Ag in the Kirkland Lake mining camp (Thomson 1950) and the Upper Canada mine in Gauthier Township (Thomson and Griffis 1944).

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No. 16 Alkalic Rocks Carbonatite Complexes

R.P. Sage[1]

Introduction

As a continuation of the alkalic rock-carbonatite project during the past summer, the author examined two alkalic rock-carbonatite complexes. These two complexes were sampled and on the basis of literature research during the past year, the author is recommending a third complex for additional work. The Borden Township carbonatite located in the Chapleau area was examined by the author and the core of the Nagagami River alkalic rock complex in the Hearst area was extensively sampled. The Martison Lake carbonatite appears to warrant testing for residual apatite accumulations as found overlying the Cargill carbonatite. The Martison Lake complex lies just within or at the very edge of the James Bay Lowlands and is one of many aeromagnetic anomalies found within the lowlands on which meagre data is available. A number of promising aeromagnetic anomalies lie beneath overburden and Paleozoic cover of the lowlands which have never heen tested.

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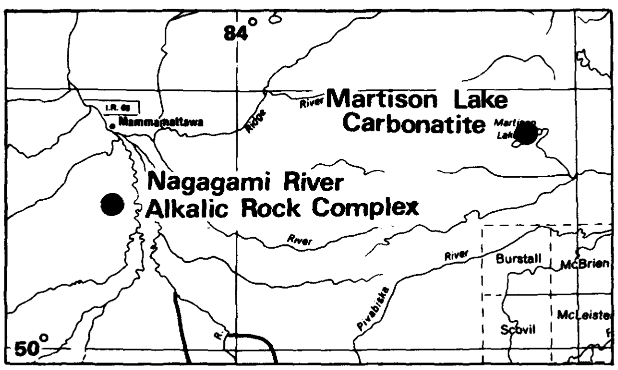


LOCATION MAP

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

Nagagami River Alkalic Rock Complex

Location and Access

The Nagagami River alkalic rock complex lies approximately at Latitude 50°10′N and Longitude 84°15′E. The area can be reached via canoe along the Nagagami River north from the tracks of the Canadian National Railway. The area can also be reached by float-equipped aircraft to Ping Lake (local name) which occurs close to the junction of the Otasawain River and the Nagagami River. Float-equipped aircraft can be obtained at Carey Lake west of Hearst.

The complex has no outcrop and largely lies beneath a cover of overburden and younger Paleozoic rocks. Once at the site, travel through the swampy thinly wooded area would be best made by tracked vehicle.

Mineral Exploration

An aeromagnetic anomaly over the area was first detected by Algoma Ore Properties Limited in 1961 (Assessment Files Research Office, Ontario Geological Survey, Toronto, File 83.1-41). In 1963 Hunting Survey Corporation Limited completed aeromagnetic survey over the anomaly for Algoma Ore Properties Limited. This survey detected two anomalies; a northern anomaly with a peak intensity of 5500 to 6500 gammas and a southern anomaly of 4200 gammas. Regional background is approximately 3000 to 3500 gammas. The northern anomaly has a diameter of approximately 13 km and the southern anomaly has a diameter of approximately 5 km. The smaller southern anomaly is at the periphery of the larger northern anomaly (Figure 1).

In 1964 Algoma Ore Properties Limited undertook a diamond drill program to test the anomalies. The company attempted drilling a total of nine holes of which seven reached the desired target (see Table 1).

The drilling disclosed an overburden thickness of less than 30 vertical feet to 127 feet over the anomalies. The drilling also disclosed a Paleozoic section of limestone and mudstone approximately 400 feet thick over the northern anomaly and less over the southern anomaly. Of 4,854 feet of drilling, 1,502 feet actually penetrated the alkalic complex.

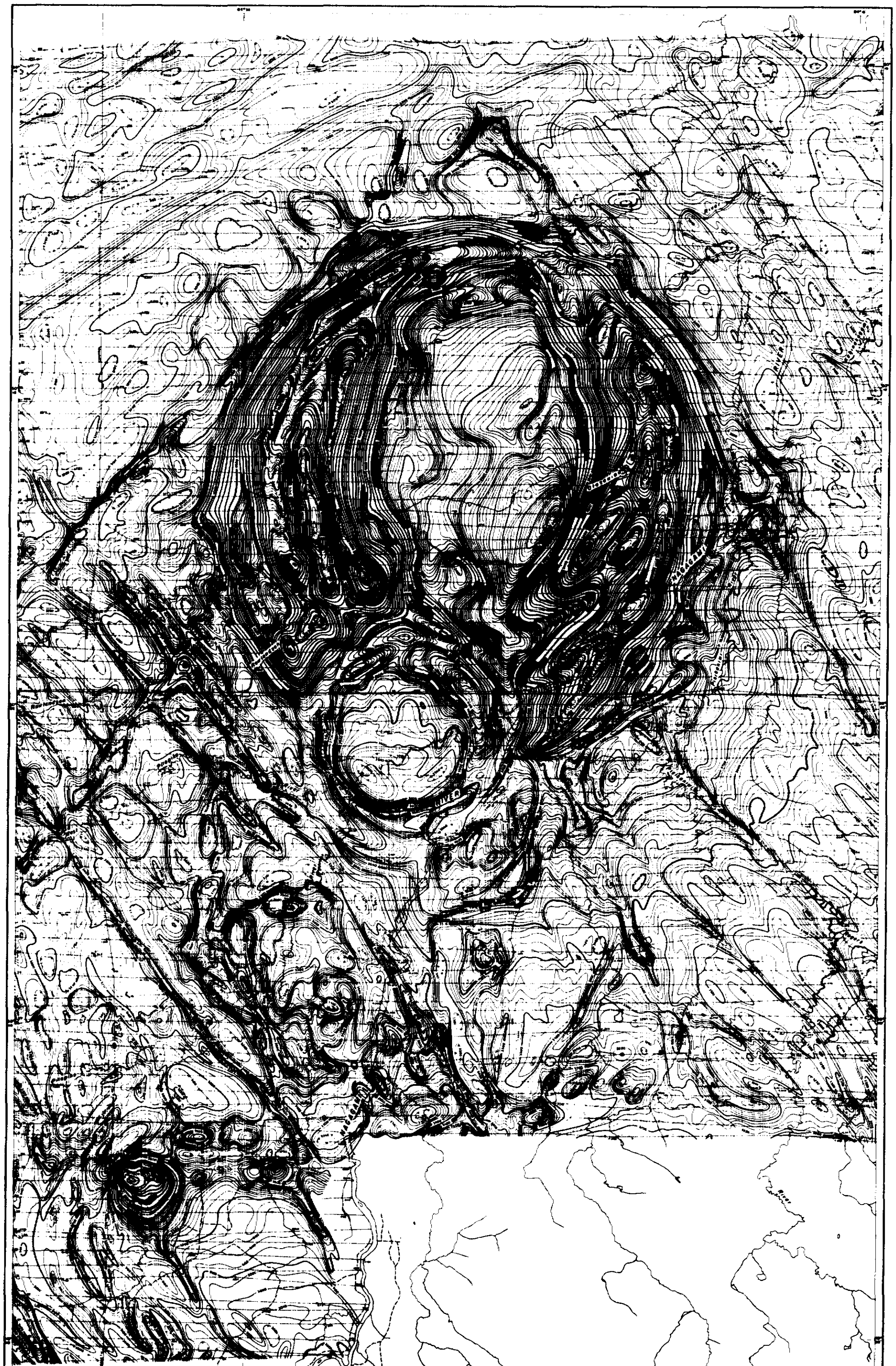


Figure 1—Aeromagnetic map of the Nagagami River Complex.

TABLE 1 TABULATED DIAMOND-DRILL HOLE DATA FOR NAGAGAMI RIVER COMPLEX. DRILLING BY ALGOMA ORE PROPERTIES LIMITED ASSESSMENT RESEARCH LIBRARY FILE 83.1-41, TORONTO

Hole	Dip	Overburden	Paleozoic	Complex	Target Rock
1	45°	34	635.5	10.5	Syenite & diorite
2	65°	90 plus	Abandoned		
3	90°	110	180	Abandoned	
4	90°	127	350.5	328.5	Syenite
5	90°	90	383	87	Syenite
6	90°	65	455	50	Syenite, granite
7	65°	65	467	280	Syenite
8	60°	50	230	347	Syenite
9	60°	50	0	399	Syenite

Intersections with footage

The core was sampled where possible. The dominant core type was medium- to coarse-grained syenite, probably from the northern anomaly. Core from holes eight and nine drilled in the southern anomaly would indicate the presence of nepheline syenite. Also associated with the northern anomaly is minor mafic syenite or diorite. The nepheline syenite contains altered bright red waxy hydronephelinite; fresh nepheline was not observed. Other than minor magnetite, which is likely the source of the aeromagnetic anomaly, no mineralization was observed.

General Geology

The Nagagami River complex is likely a ring complex similar to the Port Coldwell or Killala lake complexes. The presence of two anomalies suggest two intrusive subcentres with the smaller anomaly likely younger and superimposed on the larger. The weakness of the aeromagnetic pattern implies the absence of a gabbro outer ring as found at Port Coldwell and Killala lake. The northern anomaly appears to be largely a coarse-grained syenite while the southern anomaly is largely a coarse-grained nepheline syenite. Textures and mineralogy suggest a complex composed of syenitic rocks similar to that found within the Port Coldwell complex. The generally fresh and unmetamorphosed nature of these rocks in conjunction with similar rock types suggests to the author that the complex may be equivalent in age to Port Coldwell, approximately 1085 ± 15 m.y. (Bell *et al.* 1979).

The lack of outcrop prevents any meaningful assessment of regional structures that may control the site of the intrusion. A platey orientation of feldspars in some core samples suggests local development of a trachytic texture.

Economic Geology

The magnetite content of some phases of the intrusive suggests the possibility of a future source of low grade taconite ore. The presence of nepheline syenite in the two holes on the southern anomaly suggests that this subcomplex may have some economic merit. However, its altered nature may make it much less desirable or preclude its use altogether. The syenite was analysed for niobium by Algoma Ore Properties Limited without finding any significant concentrations. The best value reported was 0.05 percent Nb_2O_5, from hole 5 at a depth of 495 to 500 feet. (Assessment Files Research Office, Ontario Geological Survey, Toronto, File 83.1-41). The rock appears as syenodiorite on the drill log. The reader should refer to Assessment Files Research Office, Ontario Geological Survey, Toronto, File 83.1-41 for additional data.

Recommendations to the Prospector

Due to caving ground, most diamond drilling on the complex was vertical to near vertical in a complex in which igneous structures are expected to be vertical to subvertical. On the basis of existing data a meaningful economic evaluation is impossible.

It is likely that the body may contain a zone of unaltered nepheline syenite of potential interest. By analogy with the Port Coldwell Complex, the body may contain dike phases enriched in niobium, zirconium, uranium, and thorium. The dikes at Port Coldwell are not economic; and considering the depth of burial of the Nagagami River complex, it is not economically practical to search for this type of mineralization.

Martison Lake Carbonatite

Location and Access

The Martison lake carbonatite is located at approximately Latitude 50°15′N and Longitude 83°15′E, approximately 80 km northeast of Hearst, Ontario.

Introduction

On the basis of one diamond drill hole which encountered magnetite- phosphate rich sand, but failed to reach bedrock, the presence of a carbonatite intrusion has been suggested for the aeromagnetic anomaly on which the drill hole was sited (Satterly 1968).

Geophysics

The Martison lake Intrusion consists of two circular aeromagnetic anomalies whose centres are approximately 2.4 km apart; (ODM-GSC 1967) (Figures 2, 3). The south anomaly is 2.0 km in diameter and the north anomaly is 4.0 km in diameter. The drill test was on the southern anomaly.

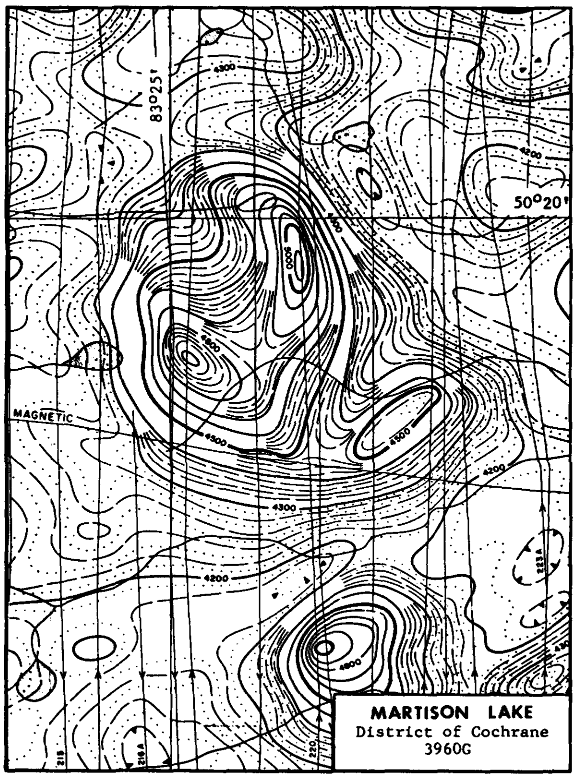


Figure 2—Aeromagnetic map of the Martison Lake anomalies. Scale 1 inch to 2 miles (Satterly 1968).

Economic Geology

Ferguson (1971) reported the presence of niobium and weathered titaniferous magnetite and phosphate. The drill hole was completed in 1965 as a joint venture between Falconbridge Nickel Mines Limited, Uranium Ridge Mines Limited, and Matachewan Consolidated Mines Limited.

Recommendations to the Prospector

The encountering of phosphate-bearing magnetite sand from 358 feet to 544 feet total depth suggests the possibility of a significant accumulation of residual apatite and magnetite over a carbonatite intrusion. The hole was completed in 1965, long before the potentially commercial residual apatite deposits were identified above the Cargill Complex located approximately 60.0 miles (96 km) southeast of Martison lake. The Martison lake carbonatite warrants retesting to determine if a situation similar to Cargill exists.

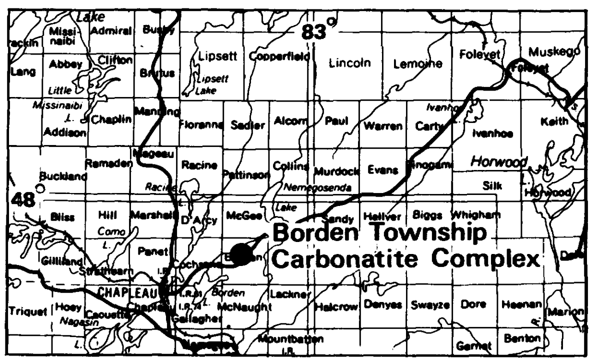
Borden Township Carbonatite Complex

Location and Access

The carbonatite lies within Borden Township and is accessible by bush road and trail leading west of Highway 101 approximately 21 km north of Chapleau, Ontario. The complex is approximately 3 km west of Highway 101.

Mineral Exploration

The complex was prospected by R. Cunningham for Dominion Gulf Company prior to 1954 and again by D. Crossley in 1954 (personal communication A.C.A. Howe International Limited, 1978). In 1959, G.E. Parsons,consulting geologist, Toronto, was employed by Falconbridge Nickel Mines Limited to investigate the complex. A grid was cut and geological and magnetome-



LOCATION MAP

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

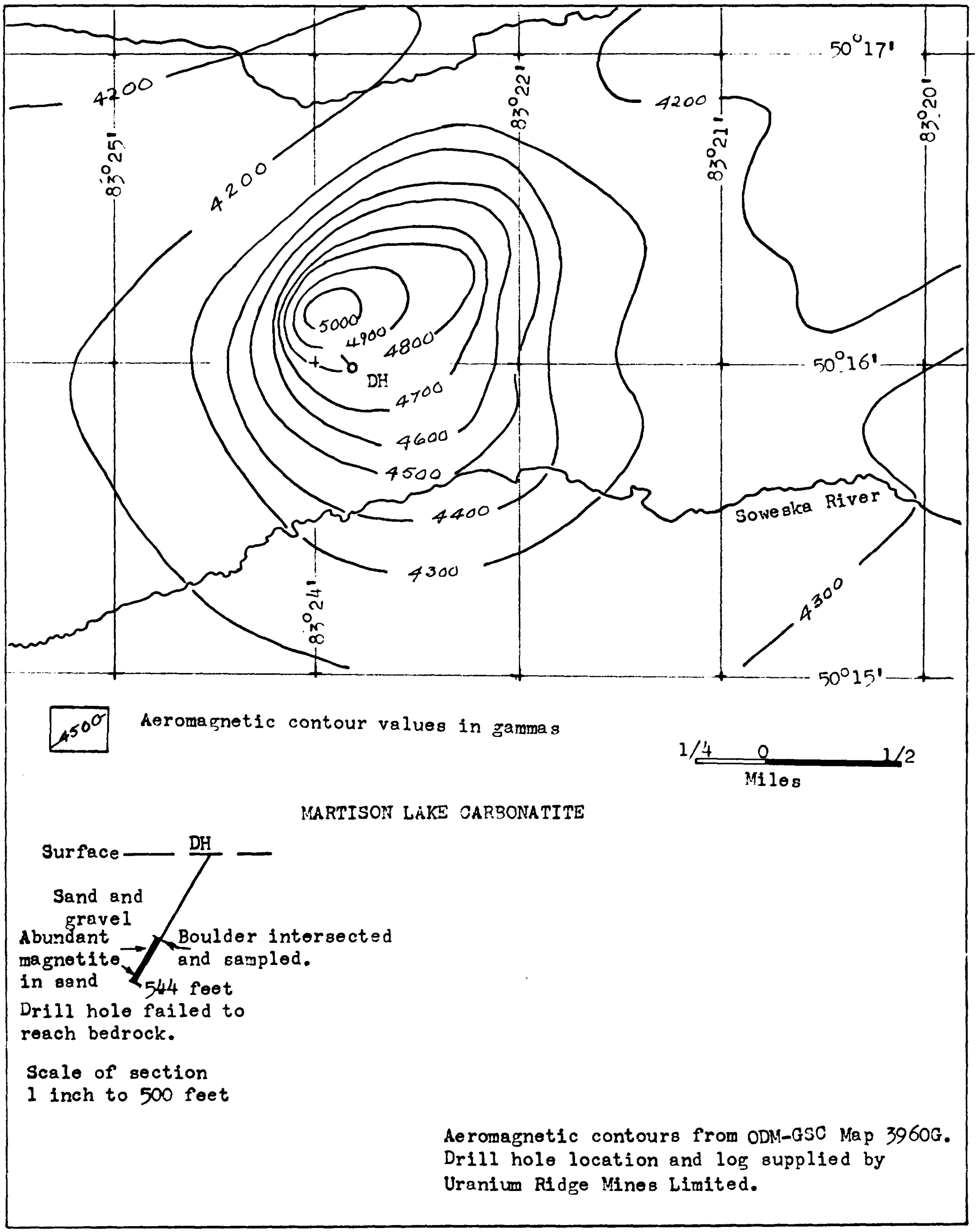


Figure 3—Sketch map of the work completed on the Martison Lake complex. Sketch map prepared by S. Ferguson.

ter surveys were completed. Some pitting was also done at this time.

In 1977, A.C.A. Howe International Limited was contracted by Hygrade Corrugated Containers Limited, owners of the mineral rights covering the intrusion to evaluate the mineral potential of the complex. The company cut a grid over the complex and completed radiometric, magnetometer, and geological surveys. Following the above surveys, bulldozer trenching and assaying of surface samples was completed.

In 1978, A.C.A. Howe International Limited supervised a diamond drill and sampling programme on the complex totalling 4,699 feet.

During the past field season, the author was granted permission to examine and sample the drill core for the purpose of thin sectioning and chemical analysis. The sampling was done in the presence of N. Brewster, representing A.C.A. Howe International Limited.

General Geology

The complex lies within the Kapuskasing subprovince of the Superior province of the Canadian Shield (Ayres *et al.* 1970) and displays a roughly circular aeromagnetic pattern approximately 1.2 km in diameter (ODM-GSC 1963). The carbonatite intrudes gneissic granite rocks and ortho-and para-gneisses of the subprovince. The intrusion is largely covered by glacial and recent deposits and weathered carbonatite is exposed in only a few trenches. The body contains syenitic rocks (possibly fenites), sovite, silicocarbonatite (greater than 50 percent silicate minerals) and beforsite (dolomitic dike rock). Drilling has indicated zones of coarse grained magnetite, rich in fine-grained colourless to pale green granular apatite.

Structural Geology

The complex is likely of Late Precambrian age. The assumed age is similar to most alkalic rock-carbonatite complexes found within this subprovince (Satterly 1968). The intrusion was probably emplaced within or along a fault zone that characterizes this subprovince. Post emplacement faulting is noted on drill logs (Private records, A.C.A. Howe International Limited).

Economic Geology

Drilling has identified several zones of magnetite-rich carbonatite and vermiculite both of which may be recoverable byproducts of any mining enterprise. Uranium mineralization with associated niobium has been identified in two drill holes. The uranium-niobium mineralization may be uranium-bearing pyrochlore.

Phosphate, as apatite, is abundant and will likely be a major if not a dominant contributor to the economic viability of any mineral extraction from the complex.

Recommendations to the Prospector

Additional work is required to determine the economic potential of uranium and niobium mineralization within the complex. Apatite occurs in sufficient quantities in the sovite, silicocarbonatite, and magnetite-rich sections of the body to warrant consideration as an important mineral commodity to be derived from the intrusion.

The complex warrants testing for residual accumulations of apatite, and pyrochlore in depressions on the weathered surface. The location of residual deposits or concentrates would greatly enhance the economic viability of this carbonatite intrusion.

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No. 17 Demorest, McConnell and Telfer Townships, District of Sudbury

B. Dressler[1]

Introduction

The area mapped by the author and his senior assistants J. Cass and C. Kerr includes two thirds of Demorest Township (Latitudes 46°58′13″ and 47°03′23″ North; Longitudes 80°33′46″ and 80°41′23″ West) and most of McConnell (Latitudes 46°53′26″ and 46°58′13″N, Longitudes 80°33′46″ and 80°41′23″ West) and Telfer (Latitudes 46°53′26″ and 46°58′13″ North; Longitudes 80°41′23″ and 80°49′03″W) Townships. The northeastern part of Demorest Township had been mapped by Card *et al.* (1973), and the southern part of McConnell and Telfer Townships by Dressler (1977; 1978a).

Sudbury lies about 50 km southwest of the map-area. The general access to the area is via a gravel road from Highway 545 just north of Capreol and a network of secondary bushroads. The northern part of Demorest Township requires helicopter service or canoe portaging.

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Mineral Exploration

Little exploration has been reported in the map-area. In 1969 Canadian Aero Service Limited carried out an airborne magnetometer survey of Demorest Township for Henry Last and Associates (Card *et al.* 1973).

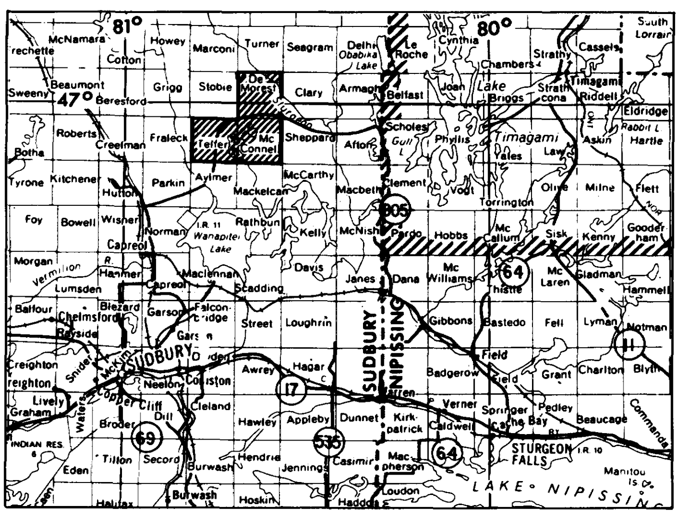
During field work several test pits were observed by the author's field crew in rusty weathering Nipissing gabbro near the contact with Huronian sedimentary rocks just east of central Dougherty Lake in Demorest Township.

Inco Limited presently holds a permit area that includes almost all the map-area. The company started a deep drilling programme in northern Telfer Township in August 1979.

General Geology

The map-area is underlain by Middle Precambrian sedimentary rocks of the Huronian Supergroup, Nipissing gabbro and olivine gabbro (Figure 1).

Sandstones of the Mississagi Formation are the oldest rocks in the area. They were observed by Card *et al.* (1973) in northeastern Demorest Township. Also polymictic conglomerate of the Bruce Formation, limestone and siltstone of the Espanola Formation, and sandstone and



LOCATION MAP

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

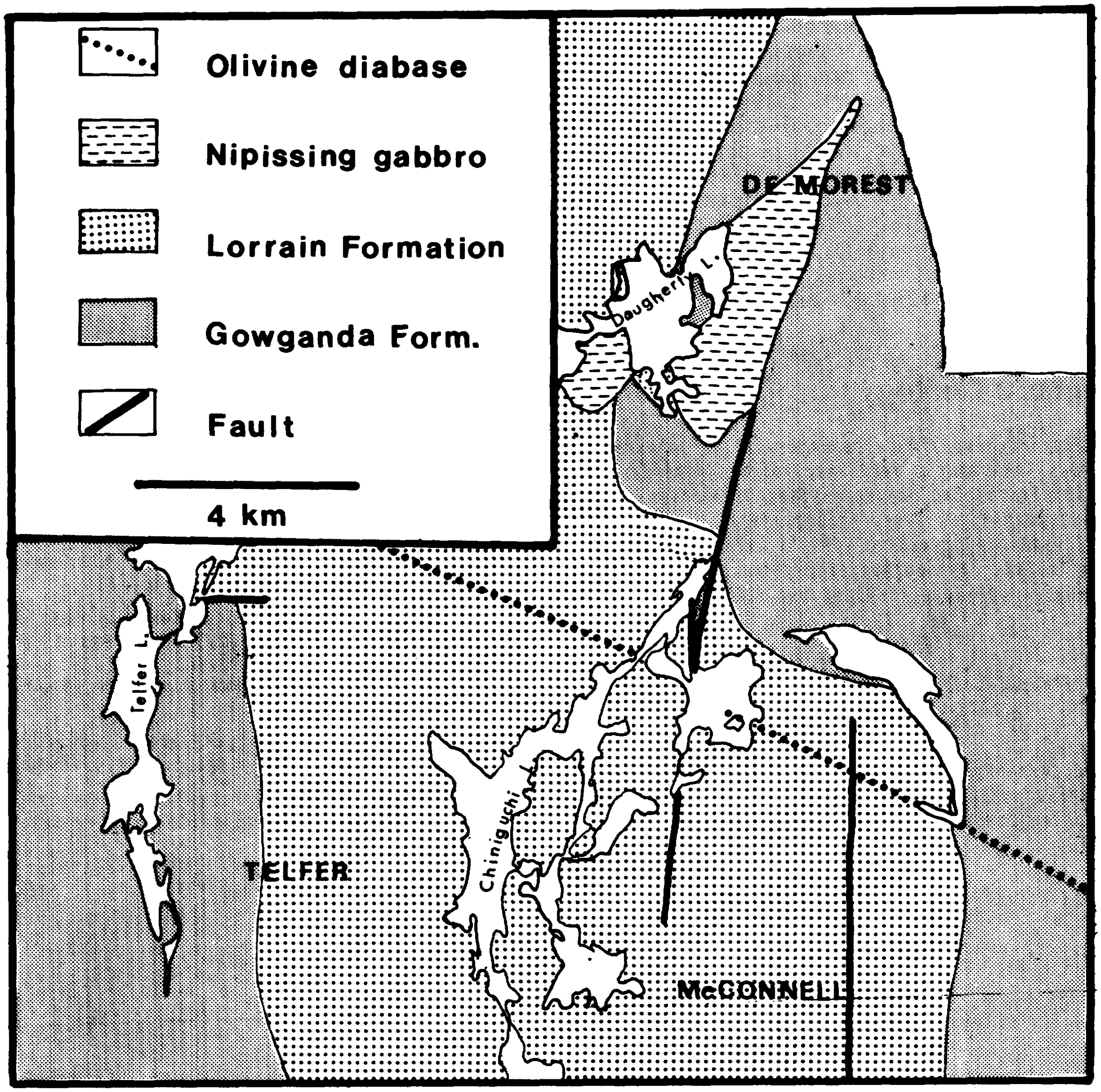


Figure 1—Geology of Demorest, McConnell and Telfer Townships. Northeast corner of map-area mapped by Card et al. 1973.

minor wackes of the Serpent Formation only occur in northeastern Demorest Township (Card *et al.* 1973). Most of the area is underlain by rocks of the Cobalt Group, the Gowganda Formation, and the Lorrain Formation. The Gowganda Formation consists of massive and laminated wackes and minor arkoses and paraconglomerate, the Lorrain Formation of arkose and quartz-arenite. Nipissing gabbro intrudes all the foregoing rock formations and occurs in Demorest Township near Dougherty Lake. Sudbury-type breccia is present in McConnell Township and is associated with two major north-striking faults. The breccia consists of rounded or subangular rock fragments that are a few millimetres to 2 or 3 m in size and which are set in a fine-grained or aphanitic matrix of crushed rock. Olivine diabase occurs in McConnell and Telfer Townships.

Cenozoic deposits comprise sand and gravel. They are found mainly in the East Wanapitei River valley.

Structural Geology

The Huronian rocks of the area in general are only weakly deformed. They form a large synclinorium in McConnell and Telfer Townships. The axis of the synclinorium strikes approximately north. The synclinorium is disrupted by several north-striking faults (Figure 1). In northeastern Demorest Township the eastern limb of the synclinorium is broken up by several faults (Card *et al.* 1973).

Economic Geology and Suggestions for Future Exploration

Minor copper-nickel sulphide mineralization in the Nipissing gabbro near contacts with Huronian sedimentary rocks were observed by the authors' assistants. This kind of mineralization and gold and gold-copper quartz vein mineralization are known to occur in many bodies of Nipissing gabbro in neighboring townships (Dressler 1977, 1978a,b,c). The author, therefore, believes that exploration of the Nipissing gabbro within the map-area and on a regional basis is warranted, also in view of large tonnage, low-grade copper-nickel deposits possibly associated with the Nipissing gabbro.

Uranium mineralization occurs in conglomerates of the Mississagi Formation south of the present area (Wanapitei Lake area; Dressler 1978a). Detailed exploration of the Mississagi Formation in Demorest Township, and by deep drilling in the other two townships could be rewarding.

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No. 18 Regional Geology of the Cobalt Embayment, Districts of Sudbury, Nipissing, and Timiskaming

J. Wood[1]

Introduction

Field work carried out in 1979 represents the first phase of a program designed to: a) outline stratigraphy and sedimentation of Huronian rocks within the Cobalt Embayment, b) outline the relative importance of sedimentary processes and other parameters such as basement geology and topography, igneous intrusions, and structure in the localization of mineral deposits in Huronian rocks.

There were three essential parts to the summer's activity: 1) a reconnaissance examination of lower Huronian rocks (formations below the Gowganda Formation) northwest of Lake Wanapitei; 2) a reconnaissance examination of the component parts of the Gowganda Formation, and the contact between the Gowganda and Lorrain Formation in the northern part of the embayment from the north end of Lake Temagami to Gowganda; and 3) a detailed examination of the Gordon Lake and Bar River Formations in the vicinity of McGiffin Lake.

General Geology

The reconnaissance survey of lower Huronian rocks northwest of Lake Wanapitei illustrated the complexity of

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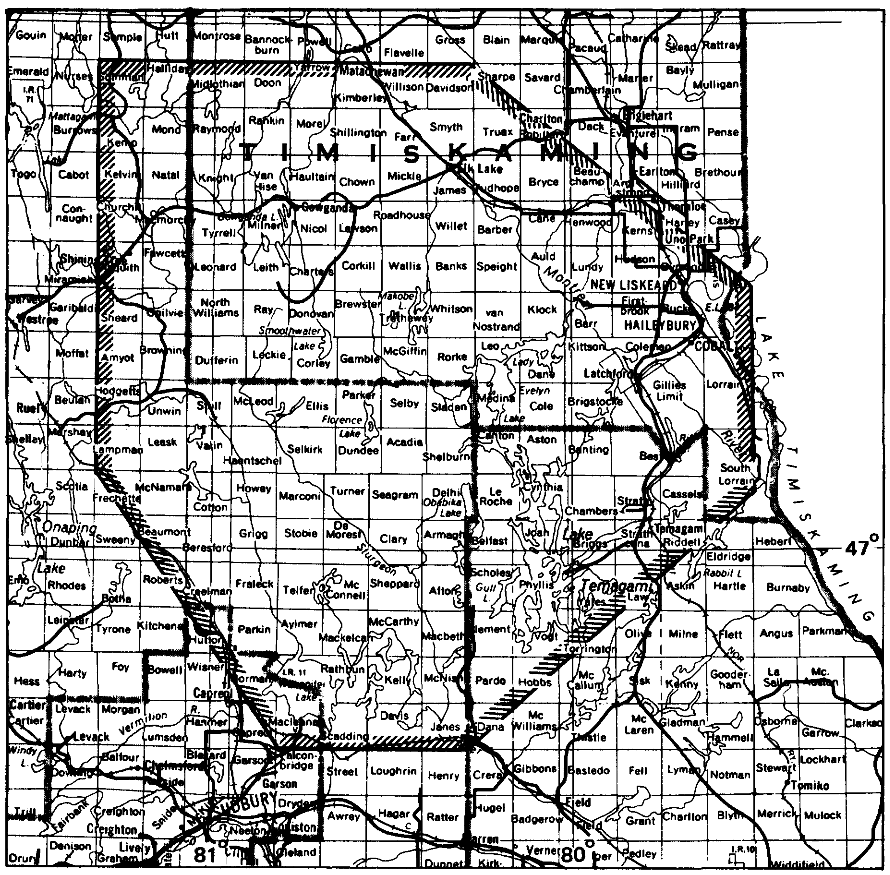

LOCATION MAP

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

geology in this part of the embayment. Archean basement and Huronian rocks have been affected by several periods of faulting; any one fault may have a history of multiple movement. Stratigraphic units as a result are difficult to trace. Basement–Mississagi Formation relationships in the southeast part of Roberts Township indicate fault movement during sedimentation; conditions that result in rapid facies changes. Further work will be carried out on facies changes in the Mississagi Formation and other formations, in conjunction with detailed stratigraphic studies of the lower Huronian formations in other parts of the embayment. Because of its potential for uranium and gold mineralization the Mississagi Formation is already under detailed scrutiny by H.D. Meyn (this volume).

Field work by the author (Wood 1978) near the town of Cobalt confirmed the twofold subdivision of the Gowganda Formation suggested by Thomson (1956; 1963a, b, c) who considered that the lower part should be called the Coleman Formation (conglomerate, sandstone and mudstone) and the upper part called the Firstbrook Formation (mudstone and fine sandstone). During reconnaissance examination of the lower Huronian formations northwest of Lake Wanapitei the Gowganda Formation was also examined and a simple twofold subdivision of the formation was not apparent. H.D. Meyn who has mapped much of the southwestern part of the embayment considers (personal communication 1979) that in the southwest, some 80 percent of the Gowganda Formation is interlayered sandstone and mudstone, and the remainder is either pebbly mudstone or pebbly paraconglomerate that is not restricted to the lower part of the sequence. In addition red beds–a characteristic of the upper part of the Gowganda Formation near the town of Cobalt are absent in the Gowganda in the southwestern part of the embayment.

A regional study of the Gowganda–Lorrain contact from Temagami to Gowganda showed that red-beds do not extend south of the north end of Lake Temagami. Near Gowganda there is an exposure of red argillite below the Lorrain Formation and above the conglomeratic part of the Gowganda Formation. This could be an equivalent to the Firstbrook Formation of Thomson (1956, 1963a, b, c). However in Bayly Township south of Larder Lake there are spectacular exposures of red mudstone and sandstone overlain by paraconglomerate, which this author equates with Thomson's Coleman Formation. From Larder Lake south to the north end of Lake Temagami there is a decrease in the proportion of conglomerate to fine-grained rocks as well as the change in position of the red-beds within the Gowganda Formation.

The Gordon Lake and Bar River Formations are preserved only in the vicinity of Smoothwater Lake and McGiffin Lake. In both localities the rocks are preserved in downfaulted blocks rather than in fold structures as shown by Card, *et al.* (1973) and Card and Lumbers (1977). The Gordon Lake Formation has a conformable and gradational contact with the Lorrain Formation the top of which is quartz arenite. The Gordon Lake Formation is a fine grained buff coloured feldspathic sandstone at the base grading rapidly up into a buff to red thinly bedded arkosic sequence that constitutes the lower part of the formation. The middle part of the formation is characterized by thinly bedded buff to light brown fine sandstone, interbedded with green to yellow-green very-fine grained siliceous mudstone that commonly forms intraformational breccia: ripple marks, sandstone dikes, and chert nodules are abundant. The upper part of the formation is composed of buff to white arkosic sandstone, quartzose sandstone, and light green siliceous mud that commonly is brecciated. The contact of the Gordon Lake Formation and Bar River Formation was not observed. The Bar River Formation composed of rippled, crossbedded, white or pink quartz arenite, is much more restricted in occurrence than shown on the maps of Card *et al.* (1973).

Structural Geology

Deformation within the Cobalt Embayment is dominated by faults. The intensity of faulting increases from northeast to southwest. Northwest of Lake Wanapitei the ubiquity of faults creates problems in the tracing and correlating of rock units. Intrusion of the Nipissing diabase which cuts the Huronian rocks may have been influenced, on a regional scale, by fault structures. Supratenuous folds are present where Huronian rocks lie unconformably on Archean basement rocks; hills in excess of 300 m local relief were present in some parts of the embayment, for example south of Cobalt, prior to deposition of the Gowganda Formation. Tectonic as distinct from compaction folds are open basin-and-dome structures that in the northern part of the embayment are related to faults. Folds in the southern part of the embayment may also be fault related.

The Gowganda Formation and Lorrain Formation are areally the most extensive in the Cobalt Embayment. The most easily recognizeable structures within the embayment are those resulting from deformation that postdated sedimentation of the upper Huronian rocks (Card and Lumbers 1977). However in most localities an unconformity separates the Gowganda Formation from underlying formations, for example, in some localities in Turner and Seagram Townships (Card *et al.* 1973) there is a strike separation of 90° and dip separation of 40° between rocks of the Mississagi Formation and rocks of the Gowganda Formation. These rocks of the lower Huronian formations had undergone a period of major deformation before the Gowganda Formation was deposited. From the viewpoint of exploration for stratabound mineral deposits in lower Huronian rocks, consideration should therefore be given to the possibility that the apparent basinal structures outlined by upper Huronian rocks (Card and Lumbers 1977) need not define original sedimentary basins for lower Huronian rocks.

Economic Geology

The Mississagi Formation in the area north and west of Lake Wanapitei contains uranium mineralization near its base. The uranium mineralization which can be readily detected by scintillometer occurs in a number of different rock types (Meyn this volume). On the basis of this reconnaissance study of the lower Huronian formations there would appear to be potential for economic uranium deposits. Any search for uranium should take into account the inter-relationships between uranium mineralization and host sediment types, stratigraphy, basement composition and topography, and structure. The mineralization occurs as heavy mineral concentrations. Consideration should therefore be given to the potential for other heavy minerals occurring either with the uranium or separately.

The silver-cobalt mineralization along the northern perimeter of the Cobalt embayment and the relationship between the mineralization and the association of Archean volcanic rocks, Huronian sedimentary rocks and Nipisssing diabase is historically well-known. Chemical analyses by the Geoscience Laboratories, Ontario Geological Survey, Toronto, of volcanic rocks collected by the author in 1978 from within the confines of the Cobalt mining area show anomalously high contents of Na_20. An alteration study of the analyses by G.E. Soucie of the Mineral Resources Branch, using techniques outlined by Beswick and Soucie (1978) suggests that the high Na_20 content of the rocks is the result of alteration rather than a primary characteristic. This may be useful in searching for other favourable areas of silver-cobalt mineralization.

Given the current favourable economic climate for silver and cobalt, there would appear to be considerable potential for further development particularly for cobalt within existing mining areas. Based on regional geological trends the most favourable area for cobalt and silver outside the known mining area is southeast of Shining Tree in the general area of North Williams, Browning, Dufferin, Hodgets, and Unwin Townships. Outcrop density is low in this area and exploration correspondingly more difficult.

Disseminated stratabound mineralization in Huronian rocks represents an as yet untapped exploration potential. Within the Cobalt mining area there are disseminated base metals in both coarse- and fine-grained rocks of the Gowganda Formation. There is copper in red-beds of the upper part of the Gowganda Formation near Rib Lake north of Temagami. In Aston Township near the north end of Lake Temagami there is up to 3 percent sulphide by visual estimation in paraconglomerate of the Gowganda Formations; although most of the sulphide is pyrite, fine-grained sphalerite may be present, and samples are therefore being assayed for base metals. In McGiffin Township very fine grained sulphides are disseminated throughout the middle and upper part of the Gordon Lake Formation. Because of the siliceous character of the rocks a gossan does not form on the outcrops. Samples are being assayed to determine the character and amount of the mineralization. These are a few examples of sulphide mineralization in Huronian rocks. Considerable potential would appear to exist for economic stratabound mineral deposits.

Most of the economic mineralization in the Cobalt embayment occurs in association with the Nipissing Diabase. A more detailed discussion of economic mineralization in the Cobalt embayment is given by Innes and Colvine (this volume).

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No. 19 The McGregor Road Breccia Zone, Plummer Additional Township, and Huronian Volcanism, Districts of Algoma and Sudbury

G. Bennett[1]

McGregor Road Breccia Zone

M.J. Frarey (1977) briefly described two areas of brecciated Cobalt Group sedimentary rocks in Plummer Additional Township about 5 km north of the Town of Bruce Mines. The breccia zones were sufficiently distinctive both in size and geological complexity to warrant a detailed examination. During the summer of 1979, the writer mapped the breccia zones at a scale of 1 inch to 300 feet (1:3600).

Location and Access

The McGregor Road breccia zone is centered around Latitude 46°20′20″N and Longitude 83°46′05″W. A second similar but much smaller and less complex breccia occurs about 5 km east of the McGregor Road breccia. It will not be described here. The area is easily accessible by Highway 561; the Caribou Road and the McGregor Road.

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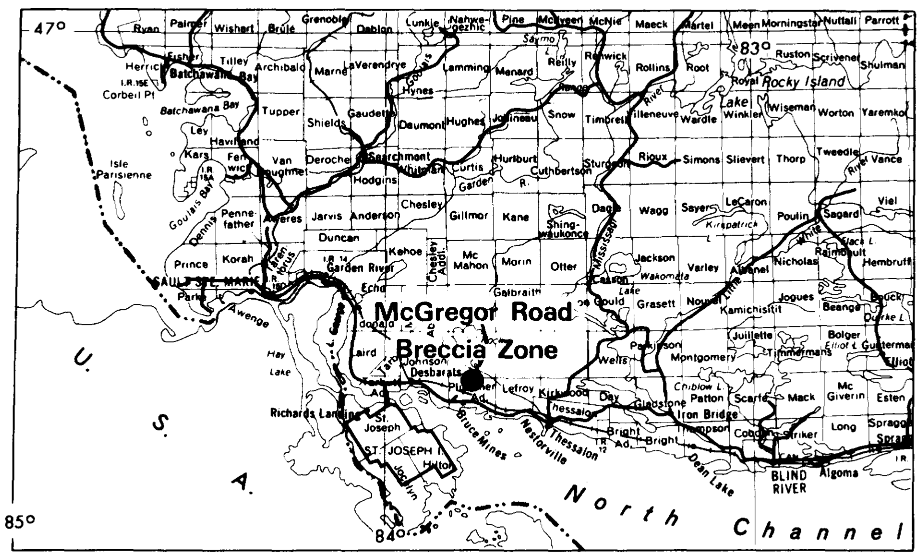
General Geology

The McGregor Road breccia zone (Figure 1) extends in a generally east-west direction from Highway 561 about 800 m north of the McGregor Road westward to about 400 m west of the Caribou Road. The overall observed length is about 5 km, and the maximum observed width is about 200 m.

The breccia is emplaced along the south side of a wedge-shaped, fault emplaced block of basal Lorrain arkose about 3 km long by about 800 m wide at its widest (eastern) end. The rocks surrounding the block of arkose are mudstone, siltstone, arkose, pebbly wacke, and conglomerate of the Gowganda Formation.

The McGregor Road breccias can be subdivided into



LOCATION MAP

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

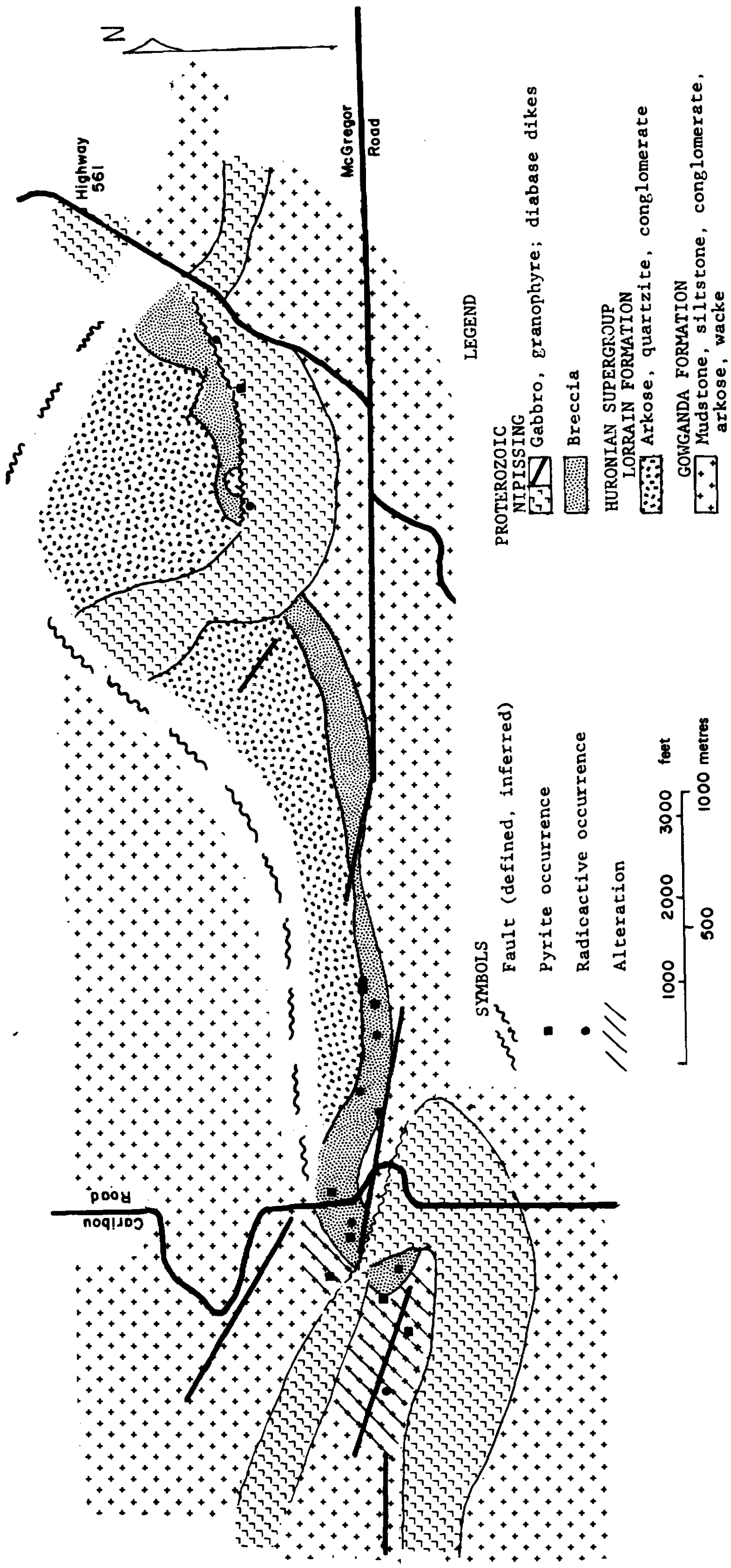


Figure 1—Geological Sketch Map of the McGregor Road Breccia Zone.

clast supported and matrix supported types. The clast-supported breccias are more or less monolithic, although polymictic types occur. The predominant lithologies are siltstone of the Gowganda Formation, arkose of the basal member of the Lorrain Formation, and quartzite with jasper-pebble conglomerate of the middle and upper parts of the Lorrain Formation.

Fragments in the clast-supported breccia tend to be angular to subrounded in a sparse sand-sized matrix. Matrix deficient breccias are cemented by interstitial quartz veins.

The matrix-supported breccias are comprised of an abundant (>30 percent) pink to dark grey matrix of sand-sized quartz, feldspar, and lithic fragments. Megaclasts are generally angular to rounded and include a mixture of lithologies from the Gowganda and Lorrain Formations, and rarely, diabase.

The matrix-supported breccias form dike-like bodies or irregular areas a few metres or tens of metres across within the clast-supported breccias. A few clasts of matrix-supported breccias were found within the clast-supported breccias.

The observed contacts between the breccia and country rocks are generally sharp and steeply dipping with no evidence of shearing. Wall rocks along the breccia zone are commonly fractured and veined by quartz.

Nipissing Diabase dikes intrude the breccia zone and in places contain isolated breccia clasts. The large, unbrecciated Nipissing gabbro-granophyre bodies show intrusive and fault contacts with the breccia which locally contains gabbro and granophyre fragments.

West of the Caribou Road, fractured mudstone of the Gowganda Formation surrounding the breccia zone is altered to a very hard, pale grey, bright pink, yellow or orange rock. D.G. Innes (geologist, Ontario Geological Survey, personal communication, 1979) reported that similarly altered mudstones from breccias in the Sudbury area were found to contain up to 17 percent Na_2O indicative of extensive albitization. The mudstones are also locally silicified and carbonatized.

The presence of apparently unaltered and highly altered clasts of mudstone side by side in the breccia suggests that some alteration has preceded the brecciation.

Economic Geology

Pyrite, as sparse, finely disseminated grains, blebs, and veinlets is present at several localities in the western half of the breccia zone and especially in the altered mudstone at the northwest end of the breccia. Two pyrite-bearing samples collected by D.G. Innes were analyzed by the Geoscience Laboratories of the Ontario Geological Survey, Toronto, and were found to contain 0.34 and 0.20 ounce per ton of silver respectively, along with trace gold. Additional analytical results are not available at the time of writing.

Seven occurrences of radioactivity from two to ten times background (uranium plus thorium) were found within the breccia and two occurrences were located in granophyre phases in the diabase. The radioactive zones are generally less than a few square metres in area.

Thin veinlets of specular hematite fill fractures in mudstone, arkose, and diabase in a few places near the breccia in the eastern half of the breccia zone. There is a tendency for pyrite to occur in the western half of the breccia zone and hematite in the eastern half of the zone.

During the summer of 1979 the author, in company with D.G. Innes and Dr. A.C. Colvine of the Mineral Deposits Section, Ontario Geological Survey, visited several mineral occurrences within the Southern Province. It was noted that many of these deposits occur in association with highly brecciated and altered rocks which share many of the features of the McGregor Road breccia zone.

Origin of the McGregor Road Breccia

An explosive or gas streaming origin for the breccia is considered unlikely because of the form of the breccia and the lack of breccia clasts from underlying formations.

It is tentatively suggested that local doming, perhaps as a result of emplacement of Nipissing magmas, resulted in tensional stresses with down-dropping of a central block. The relatively wide breccia zone along the fault may be the result of rock-bursting into the dilatant zone augmented by release of trapped fluids. The expanding and escaping pore fluids may promote local diatreme type breccias (matrix-supported breccias) which bore upward through brecciated Lorrain quartzite sloughing from the walls and moving down the fissure.

The association of pyrite and alteration with the breccia zone may reflect variations in thermal and chemical conditions along the breccia zone.

Huronian Volcanism

Part of the 1979 field season was spent re-examining areas of special interest within the Huronian volcanic rocks between Sault Ste. Marie and Sudbury.

Massey Area

The writer (Bennett 1978, p. 109) reported that a polymictic conglomerate within the Salmay Lake Formation of Shakespeare Township was found to contain boulders of gabbroic and anorthositic rocks similar to the major gabbro-anorthosite complexes which occur along the boundary between the Salmay Lake Formation and the Early Precambrian granitic terrain. A re-examination of that area has led to the conclusion that the "conglomerate" is a type of intrusive breccia or tectonic breccia, a much larger body of which was found on the boundary of Baldwin and Shakespeare Townships. An earlier conclusion (Bennett 1978; Bennett and Innes 1979) that the contact between the gabbro-anorthosite complexes and the Huronian supracrustal rocks is an unconformity cannot therefore be substantiated.

Thin sections of massive mesocratic rocks included as part of the Salmay Lake Formation on published geological maps of the May, Hallam and Shakespeare Townships indicate that they are mainly granophyric. It is possible that these granophyres are related to the gabbro-anorthosite complexes rather than the Salmay Lake Formation.

Morin, Otter, Haughton Township Area

In 1978 and 1979 the writer examined the sandstones at the base of the Huronian Supergroup in Morin, Otter and Haughton Townships. The sandstones are correlated with the Matinenda Formation by Chandler (1976).

The sandstones can be subdivided into, on the basis of lithologies, two contrasting sequences; an upper sequence of poorly sorted sandstone and oligomictic quartz-pebble conglomerate (units 5b, 5c, 5d, of Map 2331, (Chandler 1976) and a lower sequence of fine-grained well-sorted sandstone and locally granite cobble conglomerate (units 5a, 5e, 5f, of Map 2331, (Chandler 1976).

The lower sequence is lithologically equivalent to the Livingstone Creek Formation which underlies the Huronian volcanic rocks of the Thessalon Formation between Sault Ste. Marie and Thessalon (Frarey 1967, Bennett 1978), The upper sequence is more typical of the Matinenda Formation which overlies the Thessalon Formation (Bennett 1978). The contact between the upper and lower sandstone sequence is exposed on a hill above 400 m south of the northern boundary of Haughton Township where pyritic quartz pebble conglomerate of the upper sequence overlies fine-grained sandstone of the lower sequence. For a distance of about 2 m below the conglomerate the Livingstone Creek type sandstones weather a distinct apple green colour and in thin section feldspar grains are seen to be partly converted to sericite in contrast to the fresher, grey weathering sandstone at the base of the hill. The contact is probably an unconformity and shows that the Livingstone Creek Formation and the Matinenda Formation are not stratigraphically equivalent. It is possible that a considerable thickness of Thessalon Formation volcanics was eroded from this area prior to the deposition of the Matinenda Formation.

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No. 20 The Centre Lake Area, Haliburton and Hastings Counties

E.G. Bright[1]

Location

The Centre Lake area lies about 10 km west of Bancroft and includes parts of Cardiff, Harcourt, Herschel, Faraday, Monmouth and Dudley Townships, an area about 250 km². The area is bounded by Latitudes 45°00'N to 45°7'30"N and Longitudes 78°00'W to 78°15'W.

The area is readily accessible by Highways 121 and 648 and the many concession, recreation and logging roads that extend from these highways.

The region was first mapped at a reconnaissance scale of 1 inch to 2 miles (1:126 720) by Adams and Barlow (1910). The Townships of Cardiff and Faraday were mapped by Hewitt (1957) at a scale of 1 inch to ¼ mile (1:15 840) in 1954 to 1955; and Monmouth Township was mapped by Armstrong and Gittins (1968) at a similar scale between 1955 and 1968.

Mineral Exploration

Mineral exploration in the area was originally sparked by the discovery of molybdenite and fluorite near Wilberforce at the turn of the century. Since that time prospecting at numerous localities has been carried out on deposits of apatite, feldspar, fluorite, graphite, iron, mica, molybdenum, nepheline, pyrite, rare earth minerals, and uranium. Many of these deposits are small and are not of current economic interest. During the war periods some production was attained from deposits of molybdenum and fluorite. Uranium was first discovered at the Fission fluorite deposit in northwest Cardiff Township in 1922, however uranium mineralization did not become a serious exploration target until the early 1950s. Since this time most of the exploration has been concentrated in and near the more than 24 known uranium deposits. During 1975-1979, Kerr Addison Mines Limited carried out exploration programs on several uranium properties optioned from Cam Mines Limited in Cardiff and Faraday Townships. Since 1973, Imperial Oil Limited (Esso Resources Canada Limited) has explored several properties optioned from Amalgamated Rare Earth Mines Limited in Cardiff and Monmouth Townships. During the latter part of August 1979, Amalgamated Rare Earth Mines Limited and Esso Resources Canada Limited announced a proposal to bring three of the Rare Earth uranium deposits in the Bancroft area into production during 1980. The three proposed mining sites consist of the Halo deposit in northwest Cardiff Township, the Blue Rock deposit in southwest Monmouth Township, and the Cavendish deposit in central Cavendish Township.

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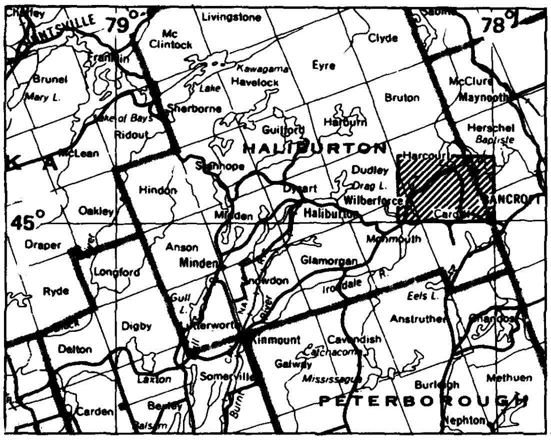

LOCATION MAP

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

General and Structural Geology

The Centre Lake area lies in the northwestern part of the Central Metasedimentary Belt of the Grenville Province of southeastern Ontario. Late Precambrian metasediments and metavolcanics of the Grenville Supergroup, together with a variety of syntectonic to late tectonic mafic to felsic intrusive rocks underlie the entire map-area. The supracrustal sequence unconformably overlies a Middle Precambrian basement gneiss complex which is not exposed in the map-area. The basement gneiss, mainly a biotite-rich sodic migmatite with gradational phases of migmatitic to locally homogeneous granodioritic-trondhjemitic gneiss (Bright 1976) is exposed as mantled gneiss domes in the Late Precambrian supracrustal sequence to the west and south of the map-area. The supracrustal sequence and co-magmatic mafic to alkalic intrusive rocks, together with the older basement gneiss complex were subjected to a Late Precambrian deformation and metamorphism under conditions ranging from middle to upper almandine facies rank.

The geology of the Centre Lake area is dominated by the Cardiff dome, a 10 km wide oval shaped center of unexposed basement uplift and granitic intrusion surrounding Deer Lake in northern Cardiff Township. The gentle to more steeply dipping flanks of the dome extend from its center at Deer Lake to Hudson and Gope Lakes on the northwest, Colbourne, Monk, and Centre Lakes on the south and southwest, and Jordan and Diamond Lakes on the northeast. A thick sequence of arenaceous metasediments, the lowest part of the Grenville Supergroup succession, structurally overlies and completely mantles an inferred basement gneiss complex in the core of the Cardiff dome. This basal sequence of coarsely recrystallized migmatitic arkose, arenite, with subordinate wacke and minor mudstone outcrops all along the flanks of the dome. Stratigraphycally younger metasediments and metavolcanics overlie these arenites in the center of the dome near Deer Lake. This arenaceous sequence has been correlated with the Anstruther Lake group recently mapped by the writer in the Echo Lake area to the south of the present map-area (Bright 1977). Similar arenaceous metasediments (Anstruther Lake group) also form a thick northeasterly to easterly trending sequence across the northern part of the map-area from Allen Lake through Straggle and South Elephant Lakes in Harcourt Township to central Baptiste Lake in Herschel Township. South of Baptiste Lake, the western margin of the Faraday granitic dome outcrops along the eastern boundary of the map-area. This anatectic granitic body, termed the Faraday granite by Hewitt (1957) has been developed in situ by a high degree of partial melting and subsequent recrystallization of the arenaceous metasediments of the Anstruther Lake group.

Stratigraphicaliy overlying the Anstruther Lake group is a sequence of coarsely recrystallized clastic siliceous to calcareous sedimentary rocks and mafic to alkalic volcanic rocks. The writer has correlated this sequence with the Hermon Group. These metasediments and metavolcanics form a broad envelope of tightly folded strata along the flanks of the Cardiff dome in Cardiff and southern Harcourt Township as well as the western flank of the Faraday dome in southwest Herschell and northwest Faraday Townships. The gently dipping Hermon Group metasediments and alkalic metavolcanics which underlie the central region of the Cardiff dome have been intruded by the co-magmatic Deer Lake biotite-hornblende syenite sill.

The lower part of the Hermon Group is predominantly biotite-rich and hornblende-rich metasediments (wackes and calcareous mudstone) with subordinate arenite and minor marble units. This passes upwards into mafic to alkalic metavolcanics, locally nepheline-bearing metavolcanics containing intercalated units of biotite hornblende-rich metasediments and marble; locally thin units of apatite-fluorite-pyroxene-rich marble, garnet-sillimanite gneiss and schist and black, pyrite-bearing carbonaceous schist. The alkalic metavolcanics are characteristically medium to coarse grained leucocratic to nepheline-biotite-hornblende-bearing, pink to grey, syenitic gneisses. These alkalic gneisses which form part of the controversial Haliburton-Bancroft region nepheline syenite belt are interpreted by the writer as originally a sequence of trachytic to phonolitic volcanic tuffs deposited penecontemoraneously with the clastic and chemical sediments. High concentrations of phosphorous, fluorite, and uranium were introduced into the basin of deposition at this time by co-magmatic hot spring activity. The upper part of the Hermon Group, particularly in the northern and western part of the map-area is predominantly metasediments with subordinate metavolcanic units. This sequence of mainly interbedded marble, quartzite, calc.siiicate gneiss and amphibolite gneiss has been correlated with the Tory Hill formation (Bright 1977) to the southwest of the present map-area.

Stratigraphically overlying the Hermon Group and structurally locallized in south-plunging synclines on the flanks of the Cardiff dome near Wilberforce and the Cardiff townsite is a sequence of predominantly impure marble containing thin subordinate interbeds of ferruginous arenite; minor amphibolite gneiss. This sequence has been correlated with the Mayo Group.

Prior to the onset of high rank regional metamorphism, gabbroic (some possibly alkalic) and syenitic sills were emplaced throughout the upper part of the Grenville Supergroup. At successive stages during and after culmination of this high rank metamorphism: 1) massive to foliated leucocratic quartz monzonite to granitic sills were emplaced, particularly within the arenites along the flanks of the Cardiff and Faraday domes; and 2) weakly metamorphosed layered ultramafic to mafic sills, particularly the 3 km long elliptical shaped sill between Allen and Scraggy Lakes in western Harcourt Townships. During the waning stages of this high rank metamorphic event, granite, locally syenite pegmatite sills and dikes (some spatially associated with uranium-thorium mineralization) were emplaced throughout the entire sequence of metamorphosed Late Precambrian supracrustal and intrusive rocks.

The entire metamorphic complex, including the late stage pegmatites are cut by regional NNE to E-trending thrust fault zones and younger N to NE-trending normal fault zones.

imanite unit was probably a black, carbonaceous, iron-rich pelitic sediment. This stratigraphic horizon, termed the Bicroft zone by Hewitt (1957) contains the Bicroft, Croft and Silver Crater uranium deposits.

Economic Geology

Uranium Mineralization

The regional stratigraphic and structural controls for the more than 100 known uranium deposits within the 1000 km^2 Eels Lake area, just to the south of the present map-area were described previously (Bright 1977). The main conclusions as to the origin and metallogenic controls for the Bancroft area uranium deposits are further supported by the field mapping and mineral deposit examinations carried out during the 1979 season.

Within the Centre Lake area, the uranium deposits are stratigraphically concentrated in the tightiy folded alkalic metavolcanics and metasediments of the upper Hermon Group along the flanks of the Cardiff and Faraday domes. On the west flank of the Cardiff dome, uranium occurs within or immediately adjacent to the contacts of those late tectonic granite and syenite pegmatite sills which intrude trachytic metavolcanic tuff containing thin intercalated units of apatite-fluorite-rich marble, pyrite-bearing black, carbonaceous schist, subordinate pyroxene-rich calc-silicate gneiss and biotite amphibolite. In places the uranium mineralization is localized in these coarsely recrystallized chemical-clastic sedimentary interbeds. These less competent units, in particular the apatite-fluorite marble, were strongly boudinaged and subjected to varying degrees of cataclasis prior to the emplacement of the pegmatite sills. Previous writers have described the deformed, cataclastic apatite-fluorite-marble interbeds as a system of late tectonic calcite-fluorite fissure-vein fillings. This environment which contains the Fission, Tripp, Halo, Cardiff Uranium and McLean-Hogan deposits is analogous with the environment of the Rexspar Uranium mine in British Columbia.

Similarly, in the east flank of the Cardiff dome and the west flank of the Faraday dome, the uranium-bearing pegmatite sills are localized in a distinctive sequence of trachytic metavolcanic tuff containing thin intercalated cataclastic units of garnet-sillimanite gneiss and schist, amphibolite, biotite amphibolite, subordinate apatite-fluorite marble and calc-silicate gneiss. The garnet sill-

Iron Deposits in Ultramafic Intrusive Rocks

A very pronounced ground and airborne magnetic anomaly is associated with a 3 km long, N-S trending elliptically-shaped, layered ultramafic sill complex between Allen and Scraggy Lakes in western Harcourt Township. Several thin magnetite-rich pyroxenite layers, locally minor pyrite and pyrrhotite were observed in the structurally lower part of this relatively flat lying late tectonic sill. Potentially economic deposits of magnetite and possibly associated base-metals either as primary magmatic segregation near the base of this sill or as contact metasomatic zones at the contact with the underlying marble could account for the strong ground magnetic attraction over the central part of this intrusive complex.

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No. 21 Sharbot Lake Area, Frontenac and Lanark Counties

J.M. Wolff[1]

Location and Access

The Sharbot Lake area covers 250 km^2 and is bounded by Longitudes 76°30′W. and 76°45′W. and Latitudes 44°45′N. and 44°45′30″N. The village of Sharbot Lake is located in the southwest portion of the area 2 km north of the southern boundary on Highway 38.

Road access to the field area is excellent via Highways 7, 38, and 509 plus a large number of secondary roads. Sharbot Lake and White Lake provide excellent water access in the southwest parts of the area.

In 1979 the writer completed detailed mapping of the Sharbot Lake Area as part of the continued detailed mapping of the Southern Grenville structural province (Central Metasedimentary Belt, Wynne-Edwards 1978), especially the Frontenac Axis frontier zone, Wolff (1978; 1979).

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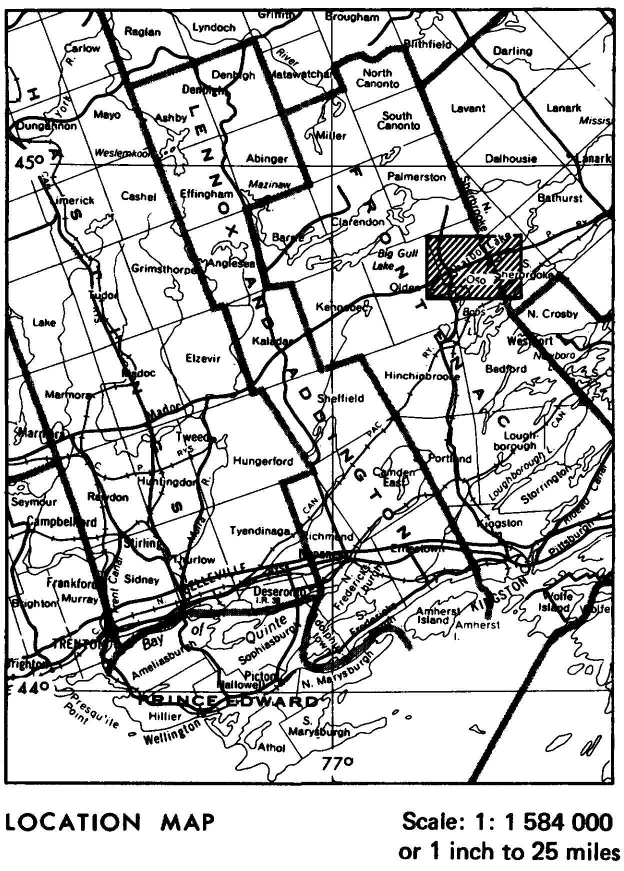
Mineral Exploration

Mineral exploration in the map-area has been active during five major periods. The first period *circa* 1900 saw the interest in vein-type apatite for phosphate extraction. This resulted in the operation of a number of small pits south of Silver Lake (Spence 1920; Harding 1947), which yielded 250 tons of phosphate. In addition the search for iron in this period indicated some small showings on the northeast shore of White Lake, but no economical concentra-



LOCATION MAP

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

tions were delineated (Harding 1947).

The second period *circa* 1910 was concentrated on the search for mica and feldspar. A number of small prospect pits of mica were sunk in the map-area, the largest of which yielded about 1 ton of marginal quality mica (Harding, 1947). A number of small prospect pits for feldspar were also examined at this time in the map-area, none of which became commercial (Harding 1947; Hewitt, 1964).

The third period of exploration *circa* 1940 saw the prospecting for gold in southeastern Ontario. A number of minor test pits were sunk in the map-area. Invariably these pits encountered pyritiferous late-stage quartz veins three of which contained less than 0.01 ounces gold per ton (Harding 1947). None of these showings produced economical concentrations.

The fourth period of exploration *circa* 1959 involved exploration for base metals and gold. Cremac Surveys Company Limited reported seven hundred feet of diamond drill core from two holes located in metasediments on the shore of Sharbot Lake. These indicated non-economic Ni,Cu, and Au values (Assessment Files Research Office, Ontario Geological Survey, Toronto).

The most recent period of exploration activity in the map-area is from 1977 to 1979. The focus has been centered upon potential uraniferous zones delineated by the joint Federal-Provincial Uranium Reconnaissance project (Geological Survey of Canada 1976, 1977). The zones of highest potential are indicated to lie just to the north of the present map area northwest of Clarendon Station.

General Geology

The bedrock of the area is composed of a number of different stratified and massive lithologies. The oldest rocks in the area are considered to be the metasediments and metavolcanics and high grade gneisses of similar mineral compositions. The gneiss units are comprised of well differentiated migmatites with a well defined stromatitic texture; granodiorite gneiss + augens + schleiren; hornblende-plagioclase-pyroxene diatexite; quartz-plagioclase-biotite-garnet gneiss; and gabbroic to dioritic gneiss. The supracrustal rocks which grade into the above gneisses are composed of three distinctive types, 1) mafic to intermediate metavolcanics, 2) clastic siliceous metasediments, and 3) carbonate metasediments. The supracrustal units form a distinctive series of rocks which pass northeastwards through Sharbot Lake, whereas the high grade gneisses are located southeast of these supracrustal rocks between Bolingbroke and Sharbot Lake.

The above gneissic and supracrustal assemblages have been intruded by several bodies of mafic and felsic intrusives. An early stage of felsic plutonism is represented by the Addington Pluton and Northbrook Batholith (Wolff 1978; 1979). These bodies are chiefly granodiorite to quartz monzonite, and trondhjemite, in the Sharbot Lake Area. These bodies are located in the very northwest corner of the map-area. Subsequent to these intrusives a period of mafic intrusion followed by a late stage felsic period is indicated by a number of bodies. The mafic intrusives are composed of two distinct, but likely contemporaneous bodies, the Lavant gabbro and the Lanark anorthosite. The Lavant gabbro is composed of fine grained gabbro and gabbroic anorthosite with carbonate material as large-scale inclusions which suggests that this is a high level intrusive with remnant roof pendants. The Lanark anorthosite, contains very minor amounts of gabbro (less than 15 percent exposed) and abundant anorthosite and gabbroic anorthosite. Textures of the Lanark body suggest it to be a deeper level intrusive than the Lavant intrusive. The felsic phase of the late stage intrusive event includes massive to weakly foliated rocks varying from granodiorite to quartz monzonite to granite, with granodiorite to granite pegmatite dikes and massive quartz veins.

Stratigraphic thicknessess are difficult to ascertain due to a high degree of infolding in the stratifrom rocks and preservation of few top indicators. The supercrustal rocks have been metamorphosed to the medium-high temperature fields of medium grade metamorphism, whereas the gneisses are metamorphosed to the low temperature field of high grade metamorphism (metamorphic fields after Winkler 1976).

Pleistocene outwash deposits including sand, silt, clay and till dot the area, with a rather prominent glacial outwash spillway being defined by the present day Bolton Creek Valley.

Structural Geology

The Sharbot Lake area contains a variety of structural components. The clastic siliceous and carbonate metasediments are exposed in a generally northeast-trending zone which extends from Mountain Grove (south and west of the map-area) to Maberly. The general strike trend of these units is northeast (N40°E to N60°E) with moderate dips 25°-55°S. This foliation is considered to be essentially parallel to the bedding. The units are folded into isoclinal folds which plunge shallowly (25°-35° northeast (N40°E) and are essentially axial planar to the major fold axis. In the vicinity of Sharbot Lake these units are warped by an intrusion of the late stage felsic episode into a shallow "S" shaped structure. Evidence for slippage during this deformation is indicated by the common presence of quartz and hornblende rodding lineations (130°/35°) which are essentially a dip-slip component. Boudinage coupled with bed fracture and severe rodding in the more quartz-rich units in these metasediments creates a number of outcrops which on superficial examination may be mistaken for conglomerate units.

The high-grade gneisses occur immediately south and east of the above metasediments and display a similar northeast-southwest trend. The mafic intrusives and late stage felsic intrusives are essentially structureless, except for local weak foliations parallel to country rock attitudes near the contacts.

The above rock types are structurally separated from the early stage felsic intrusives by a major late stage shear zone trending north- northeast and south-southwest. This shear zone contains protomylonites, mylonites and mylonite gneiss and is an extension of the shear zone which passes through Mountain Grove (Wolff 1978). This shear zone is important as it represents the eastern limit of the Clare River Synform (Schwertdner 1977; Wolff 1978). Results of the 1979 field season indicate this shear zone to clearly truncate the Clare River Synform, and thus the synform does not occur in the map-area. The movement on the shear appears to be primarily dip-slip with the relative movement being west side up, and east side down, (i.e. a normal, dip-slip fault). The shear zone strikes N5°E and dips 65°E.

Jointing is best expressed in the intrusive rocks and generally trends southeast-northwest, or north-south with essentially vertical dips. Minor faulting appears to be parallel to the southeast-trending joint set and late stage quartz veins are found to be parallel to both joint sets.

Economic Geology

Results of the 1979 field season suggest that the economic metallic mineral potential of the Sharbot Lake Area is not high.

Vein-type apatite bodies south of Silver Lake were completely exhausted by the earlier operations and no similar deposits occur elsewhere in the field area. Many of the gold- and base-metal-bearing test pits and diamond drill holes were typically located in metasedimentary units. The sporadic distribution of these units provides no indication of gold-bearing controls. The uranium anomalies are contained north of the map-area and equivalent rocks within the map-area show no anomalous values.The economic non- metallic mineral potential, however, is considered to be very high, especially for the minerals talc feldspar and garnet.

The field party discovered a unit of talc-tremolite-serpentine-calcite schist striking north enclosed by metasediments and metavolcanic units. This unit is located on the west-half of lot 25, concession II, Oso Township, just west of Pennick Lake. Preliminary investigation indicated the zone to be some 100 m in width with along strike dimensions reaching 500 m. This unit is readily accessible and well exposed and may prove to be a feasible body to exploit. A similar deposit is currently being extracted by Ram Petroleums Limited at the talc-tremolite plant south of Robertsville on Highway 509, north of Clarendon Station.

Possible economic deposits of feldspar are located in the very clean anorthosite parts of the Lanark anorthosite located on lots 6-13, concession VI, South Sherbrooke Township, Lanark County and lots 7 and 9, concessions VI and VII, Oso Township, Frontenac County. Large parts of this body are extremely feldspar-rich (95%) and further results are pending laboratory investigation of these units. It is well exposed and readily accessible by road.

Possible economic deposits of garnet are found in the gneiss units west of Bolingbroke. These gneisses contain well differentiated beds of garnet + biotite and quartz-feldspar (garnet locally 80% plus). Garnet units have a maximum thickness of 0.5 m but are continuous along strike over several hundred metres and beds often repeat within 5-10 m across strike. These units are located on the north half of lots 3,4 and 5, concession III, and the south half lots 3, 4, and 5 concession IV, South Sherbrooke Township,Lanark County, and lots 3 and 4 concession VIII, Oso Township, Frontenac County.

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No. 51 Lateral Lake Area, District of Kenora

R.O. Page[1]

Location and Access

The area mapped covers about 400 km^2 and is bounded by Latitudes 49°53′10″ and 50°01′52″ North and by Longitudes 92°16′35″ and 92°37′25″ West; the corresponding NTS grid numbers include 52 F/15, 16 and 52 K/1, 2. The map-area thus includes all of Echo and Webb Townships plus the eastern half of Drope Township, the southeastern corner of Breithaupt Township, and the southern halves of McIlraith and Lomond Townships. Dryden and Hudson are roughly equidistant from the centre of the area, being about 30 km southwest and northeast, respectively. Thunder Bay lies about 295 km air distance to the southeast. Access to the area is gained via Highway 72 (paved) which crosses the southeastern part of Echo Township, or by the Dryden–Hudson road (gravel) which connects these two towns. Access within the map-area is facilitated by several major gravel roads (Dryden–Hudson road, Kathlyn Lake road, and Ghost Lake road), and by a complex network of logging roads of variable condition.

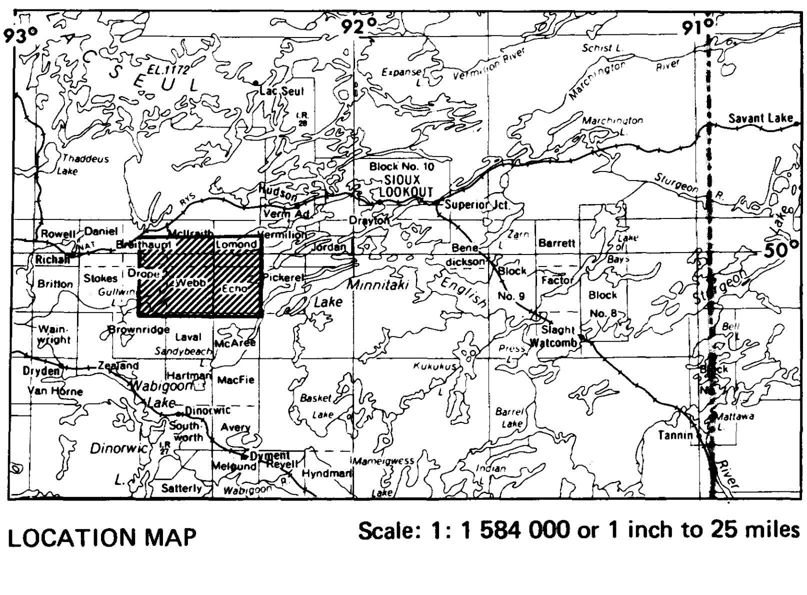
1 Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.

2 Assessment Files Research Office and Source Mineral Deposit Record, Ontario Geological Survey, Toronto.

History of Mineral Exploration

Exploration within the Lateral Lake area was of a very limited nature prior to the 1941 gold discoveries in Echo Township. Early work discussed by Hurst (1932), Armstrong (1951), and Harding (1951) is restricted to pits and trenches in molybdenite-bearing granitic intrusives, in quartz veins (with and without sulphide mineralization), and in sulphide-rich zones within metasedimentary and metavolcanic units.

Gold mineralization in southern Echo Township stimulated a major period of exploration in the area between 1946 and 1952, although no deposits were brought into production. Surface prospecting, trenching, ground geophysical surveys, and thousands of metres of diamond drilling were initially used to explore the deposits, and two were subsequently explored from underground workings (Windward and Newlund prospects, now held by Windfall Oil and Mines Limited and Goldlund Mines Limited, respectively). The Newlund prospect was extensively explored (15,000 feet of drifts and crosscuts, 20,418 feet of diamond drilling) through five levels via a 835 foot deep shaft. The first level (200 foot) of these workings extends for over 0.9 miles, connecting with the 222 foot deep shaft of the Windward prospect, and extending west about 262 foot into the Conecho prospect (now held by Rio Algom Mines Limited).[2]



LOCATION MAP

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

Virtually no work was done on Echo Township gold deposits between 1952 and 1973. Since the later date, however, Goldlund Mines Limited has rehabilitated their surface plant and conducted re-sampling of the 1st and 2nd levels (option agreement in 1973-74 with Rayrock Mines Limited). Test stoping of 3,000 tons of material in 1978 yielded a cut grade of 0.18 ounces gold per ton (0.20 oz/t, uncut)[1]. During the current field season, Goldlund Mines Limited were running diamond drills underground and on surface.

Exploration for molybdenum in the map-area was stimulated by the 1946 Ontario Department of Mines discovery of pegmatitic to stockwork molybdenite deposits in the east end of the Lateral Lake Stock (Armstrong 1950). In 1954, Detta Minerals Limited optioned ground from G.L. Pidgeon, drilled several flat holes, and drove a test adit 114 feet into the "north showing"; muck samples obtained from the adit (255 tons total) graded 0.24 percent MoS_2 (over 23.4 foot adit length) and 0.57 percent MoS_2 (over 25.8 feet) (Satterly 1960; Vokes 1963). Pidgeon Molybdenum Mines Limited and DeCoursey-Brewis Minerals Limited conducted major drilling tests of their respective deposits during 1957-58. In 1963, Denison Mines Limited evaluated adjoining ground with another major drilling program. Rio Algom Mines Limited, working through their controlling interest in Pidgeon Molybdenum Mines Limited, drilled an additional 9,840 feet in 1965-66 to fill in and extend knowledge of their main zone of mineralization. As of this writing, Rio Algom Mines Limited and Dickenson Mines Limited have initiated a joint venture which will investigate the whole eastern third of the Lateral Lake Stock for molybdenum potential, while also testing the bordering country rocks for base metal (Cu, Zn) potential (Northern Miner, 30 August 1979, p.24).

Base metal exploration in the map-area was not initiated to any extent prior to the mid-1960s. Phelps Dodge Corporation of Canada Limited optioned ground in east-central McIlraith Township in 1968, and drilled ten holes totalling 3,214 feet to evaluate copper mineralization in mafic amphibolites (Assessment Files Research Office, Ontario Geological Survey, Toronto). Between 1970 and 1972, Canadian Nickel Company Limited drilled 18 holes totalling about 5,478 feet to test conductive zones scattered in numerous claim groups in Echo, Webb, McIlraith, and Lomond Townships (Assessment Files Research Office, Ontario Geological Survey, Toronto). During 1976-77, Selco Mining Corporation Limited optioned claims in southeast Echo Township, conducting ground geophysical surveys and drilling a single hole (410 feet) to test a conductive zone (Assessment Files Research Office, Ontario Geological Survey, Toronto).

More recently (1978 to present), Rio Tinto Canadian Exploration Limited and Selco Mining Corporation Limited have conducted separate exploration programs in the map-area, following release of reconnaissance mapping by the Ontario Geological Survey (Breaks *et al.* 1976). These programs have concentrated on the unit of intermediate to felsic metavolcanics extending from Vermilion Lake west through Redhat and Bluett Lakes, and from Bluett Lake south and southeast through Gullwing Lake. Diamond drilling for these two projects to date totals over 3500 m in 37 holes (personal communication, A. Pryslak and W. Benham).

Exploration for uranium within the map-area is limited to airborne radiometric surveys flown in 1969 for C. Morton, covering a block of ground north of the east end of Gullwing Lake, and the 1968 sampling and drilling (three holes, 100 m total) of optioned claims in Drope Township by Conwest Exploration Company Limited[1].

Canol Metal Mines Limited (1964) investigated the lithium-cesium potential of a complex pegmatite dike located south of Tot Lake (Webb Township) by trenching and through several short drill holes[1]. Tantalum Mining Corporation Limited currently holds this ground and in 1979 drilled three additional holes (156 m total); a section of one hole assayed minor amounts of Ta_2O_5[2].

General Geology

Bedrock within the Lateral Lake map-area appears to be entirely of Early Precambrian age. Approximately one-half of the area is underlain by mafic, intermediate, and felsic metavolcanics which, excluding those units in the southwestern and southeastern parts, form the oldest units present in the area (Figure 1).

Significant revisions of Harding's (1951) mapping were first indicated in Ontario Geological Survey reconnaissance work several years ago (Breaks *et al.* 1976). Further revisions by the author of this work, plus revisions of Armstrong's (1951) mapping of Echo Township and Johnston's (1972) mapping in part of Lomond Township include:

a) Country rocks surrounding the whole of the Lateral Lake Stock consist of basaltic amphibolites (mafic metavolcanics) (cf Colvine and McCarter 1977).

b) Rocks in the Mica Point area of Gullwing Lake are partially to wholly serpentized pyroxenite and (garnet-) plagioclase-hornblende gabbro, which probably form a composite sill within the mafic metavolcanic sequence.

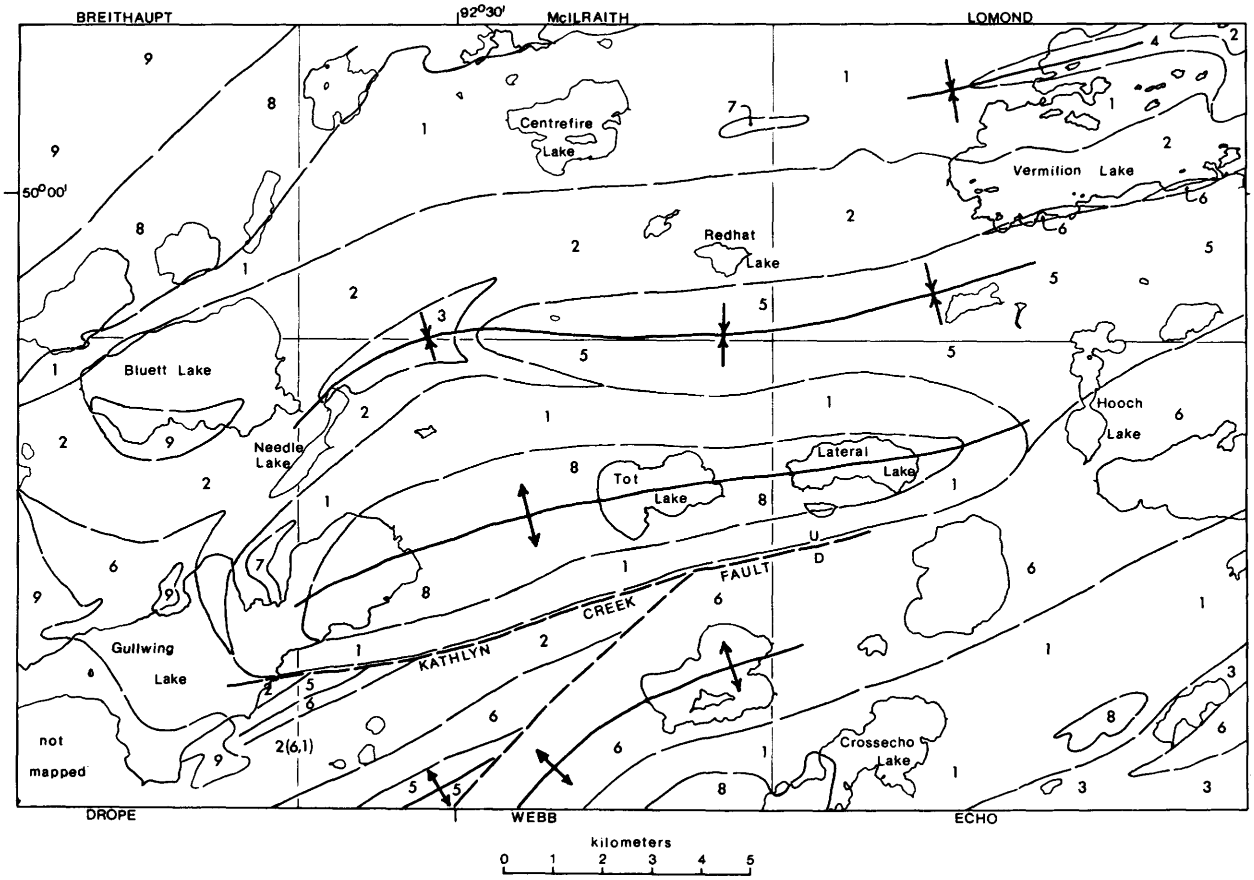
c) Much of the area west of Lindquist Bay, Gullwing Lake, consists of pegmatitic granitic intrusive rocks within garnet-biotite-quartz schists; minor magnetite-quartz-garnet-biotite schist also in this area probably represents a lean ironstone unit.

d) Areas south, southwest, and northeast of Bluett Lake consist mainly of intermediate metavolcanics which form the strike extension of the Bluett-Redhat-Vermilion Lakes unit.

e) Rocks exposed southeast of Highway 72 in southeastern Echo Township consist mainly of felsic metavolcanics; clastic metasedimentary rocks in this area are apparently restricted to the area south of Franciscan Lake and north

1 Northern Miner Press, 8 March 1979.

2 Assessment Files Research Office, Ontario Geological Survey, Toronto.



9 Late to post-tectonic intermediate to felsic intrusive rocks; includes minor migmatite phases in northwest and southwest corners of the map-area.

8 Syn - to pre-tectonic intermediate to felsic intrusive rocks; includes metamorphosed; foliated, and strongly foliated to cataclastic plutons; may include subvolcanic intrusives in Vermilion Lake area (not shown on Fig. 1) and in SE Echo Township.

7 Mafic to ultramafic intrusive rocks; gabbro, serpentinized pyroxenite.

6 Lithic wacke, quartzose lithic wacke, slate; equivalent to Minnitaki Group and Little Vermilion Formation (Walker and Pettijohn 1971; Turner and Walker 1973).

5 Feldspathic arenite, siltstone, polymict conglomerate; equivalent to Ament Bay Formation (Turner and Walker 1973).

4 Volcanic boulder and pebble conglomerate, lithic wacke, slate; equivalent to "Patara sediments" of Pettijohn (1935).

3 Felsic metavolcanics; pyroclastics, flows, and derived schists.

2 Intermediate metavolcanics; pyroclastics, flows, and derived schists; dacitic composition in the Bluett - Redhat - Vermilion Lakes unit, andesitic to dacitic composition south of the Kathlyn Creek fault.

1 Mafic metavolcanics; massive and pillowed flows, pyroclastics, and derived amphibolites.

Figure 1—Generalized Geology of the Lateral Lake Area.

of Franciscan Creek.
f) Some exposures of rocks previously mapped as "Patara metasediments" (Johnston 1972) in the western portion of Vermilion Lake are here re-defined as intermediate to felsic metavolcanics belonging to the Bluett-Redhat-Vermilion Lakes unit. Certain units also found in this area, previously mapped as "early intrusives", are probably flow or dome units related to the enclosing pyroclastic rocks. The present definition of lithologies exposed on Vermilion Lake essentially concurs with the original descriptions of Pettijohn (1935).

Structural Geology

Structure within the map-area is relatively simple on a regional scale (Figure 1), and may be subdivided into five major zones:
1) A northern homoclinal succession of subaqueous mafic metavolcanics which is overlain by intermediate and felsic metavolcanics, and complicated in the Vermilion Lake area by intercalations of metasedimentary rocks, folds, and shear zones and/or faults
2) The "map-centre" syncline, which is best defined southeast of Redhat Lake and, in general, is overturned on the north limb.
3) The Lateral–Tot–Gullwing Lakes anticline, cored by the Lateral Lake Stock, which is probably the combined result of doming during intrusion of the stock followed by later deformation which produced both cataclasis in the stock and created the Kathlyn Creek fault
4) The Kathlyn Creek fault and fold terrain which is bounded on the north by the Kathlyn Creek fault and on the south by Crossecho Lake (limited exposure in this zone limits efforts at precise interpretation)
5) Southeast Echo Township homocline, which is south-facing as in structural zone 1, but passes into complex fold and fault terrain near the southeast map corner.

Smaller areas within these structural zones suggest complex (probably faulted) structure and include: the area north of Centrefire Creek, 1 to 4 km west of Vermilion Lake (and under Vermilion Lake itself); the area under Lateral Lake, and extending northeast to 1-2 km east of Hooch Lake (possible extensions of the Kathlyn Creek fault); the area under, and extending up to 3 km east of Crossecho Lake.These small structurally complex areas may be more favourable locations for mineral exploration.

Economic Geology

A variety of metallic deposits (Au; Cu; Cu-Zn-Pb-Ag; Ag-Au; Mo; Ta) are present in (and close by) the Lateral Lake map-area. Most areas and types of mineralization are currently being investigated through major exploration programs (roughly 600 claims held in good standing), but considerable areas of apparently favourable ground are open to staking and, in some cases, have received scant attention.

Gold mineralization in southeast Echo Township is associated with laterally persistent, quartz-filled tension fractures which cut, and are generally contained by, northeast-striking granodiorite dikes, as in the deposits of Goldlund Mines Limited. Preferential concentration of quartz veining and gold may also be dependent on local, pre-mineralization faults. The major known dike occurs on the properties of Goldlund Mines Limited and Windfall Oils and Minerals Limited and is traceable in outcrop, underground workings, and drill holes for at least 3.1 km, varying between about 30 and 90 m in width and dipping 70° to 80° southward. Other, smaller and/or irregular dikes of similar type to the main dike are also known on the Goldlund property and are generally sub-parallel to the main dike. Exploration for gold in this area should place emphasis on locating granodioritic dikes and defining fracture-controlled quartz veining.

Base-metal deposits in the map-area occur as disseminated to thin, massive zones of pyrite and/or pyrrhotite, with local concentrations of arsenopyrite, chalcopyrite, and/or sphalerite. The majority of these deposits are located within the Bluett–Redhat–Vermilion Lakes intermediate volcanics, but several are present in mafic metavolcanics to the north, and in mafic metavolcanics bordering the Lateral Lake Stock (the latter two units are here interpreted as correlative).Much of the area covered by these units has been (and is currently being) investigated, but several areas merit further or renewed attention:
a) Mafic amphibolites surrounding the west end of the Lateral Lake Stock were investigated by Canadian Nickel Company Limited in 1970 and M. Woitowicz in 1973. A mineralized grab sample taken by the author from a shoreline trench (southeast shore, Gullwing Lake) yielded 650 ppm Cu and 2100 ppm (0.21 percent) Zn[1], suggesting that sphalerite rather than conductive sulphides may predominate if a larger sulphide mass were present. Further, rock fabrics in this area are generally linear, plunging 30° to the southwest, while planar fabrics rarely exceed 45° dip, suggesting a "vertical sheet" geophysical model is not applicable here.
b) Felsic breccias and associated tuffs and metasedimentary rocks northeast of Needle Lake have received some attention, but no recorded diamond drilling; a major synclinal hinge zone passes through this area and potential conductive zones may have been missed by airborne surveys using NW-SE flight lines.
c) Intermediate to felsic pyroclastic rocks and flows exposed on Vermilion Lake have apparently received only cursory examination; these rocks host a Au-Ag deposit (850 m east of the present map-area) as well as several sulphide occurrences and should be more thoroughly investigated (c.f. Trowell 1978).

Molybdenum deposits occur in the marginal portion of eastern end of the Lateral Lake Stock, intimately associated with simple pegmatites, aplitic dikes, and cross-cutting quartz veins. At the "main showing" of Pidgeon Molybdenum Mines Limited, mineralization occurs in outcrop and is traceable in drill hole over a strike length of at least 600 m across a zone (or zones) totalling 30 to 40 m wide.

1 Assay by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Additional molybdenum mineralization occurs along the southern and northern margin of the stock north and south of Lateral Lake. Molybdenite was also noted by the author in late pegmatitic rocks which cut both country rock amphibolites and the stock proper near the southern margin of the west end of the stock where only surface prospecting has been done. Colvine and McCarter (1977) have proposed that pegmatite-associated molybdenum deposits in this area are genetically related to the Lateral Lake Stock and were preferentially formed in the eastern end of the pluton. It is suggested by this author that the pegmatites (and associated molybdenite) are later than the stock and primarily structurally controlled. It is suggested also that the possibility of mobilization and concentration of molybdenum mineralization may have been affected by faulting associated with the Kathlyn Creek fault, especially where this effects the contact zone or margins of the Lateral Lake Stock. If the latter is valid, then untested, covered ground bordering Bluett Creek (northeast of, and under, Gullwing Lake) may include a structural environment similar to that exposed at the eastern end of the stock. Further exploration in the eastern end of the stock should consider the possible affects of local fault zones on molybdenum distribution.

Lithium-cesium-tantalum-bearing complex pegmatitic rocks are known from a single location in the map-area and have recently been re-investigated. The dike (180 m long by 1-10 m wide) is clearly a late, undeformed body and is interpreted as a fracture filling strucurally analogous to a quartz-filled tension fracture. While other dikes of similar mineralogy are not known to occur in the map-area, the ground north and southeast of Gullwing Lake appear to be favourable locations for such complex pegmatites on the basis of structural characteristics and regional mineralogical zonation of simple pegmatites thought to be genetically related to the complex dike. These areas should probably be more thoroughly investigated.

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No. S2 Klob Lake Area, District of Thunder Bay

S.E. Amukun[1]

Location

The map-area lies astride Trans-Canada Highway 11, and the center is located some 30 km east of Longlac and 320 km east of Thunder Bay.

Access within the map-area is excellent because, in addition to Highway 11, a system of numerous gravel logging roads was established during the current and past logging operations of Kimberly Clark Ltd.

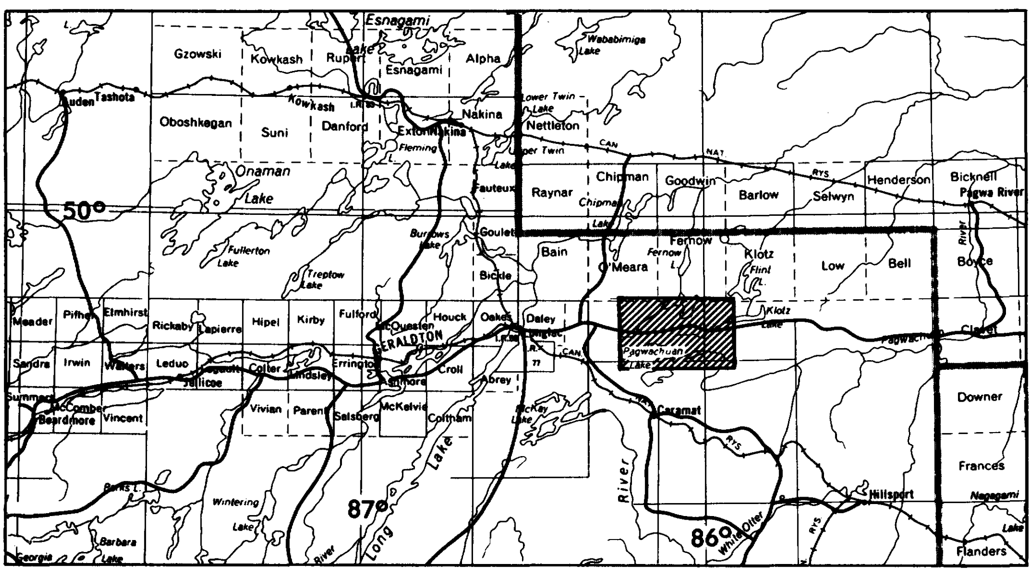
Klob Lake area covers an area of 390 km² and is bounded by Latitude 49°43′ to 49°51′ North and Longitude 85°55′ to 86°15′ West.

Mineral Exploration

The southern half of the map-area, and particularly the southeastern part was extensively prospected for gold in the 1930s following the discovery of gold properties in the adjoining Longlac area to the west (Bruce 1935, 1936; Fairbairn 1938). Several gold prospects were located by the activity of the 1930s, but none of these prospects has provided adequate economic gold deposits (Macdonald 1938; Evans 1945). Subsequent exploration work by Can-Fer Mines Limited (1958) Caramat Gold Miles Limited and Milestone Exploration Limited (1960s), D.J. Kemp (1955), H. Geno (1955), and C. Pettit–A.W. Adam (1963) were directed towards some of the old prospects and also elsewhere in the map-area in an effort to examine new prospects of gold, iron and base metals (Assessment Files Research Office, Toronto, and Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay).

Numerous recent exploration surveys including diamond drilling, airborne and ground geophysics and geological methods have been conducted over isolated parts of the map-area, and over some of the old gold prospects by Bellex Limited (1970), Canadian Nickel Company Limited (1971), Mattagami Lake Mines Limited (1978), Milestone Exploration Limited (1970), L. Morrow (1976), L.J. and H.H. Otto (1971-1979), Pacific Cyprus Minerals and/or Dora Exploration Limited (1977), and Hudson Bay Exploration and Development Company Limited (1973).This also included examination of other attractive conductor areas in search of base metals (Assessment

1 Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.



LOCATION MAP

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

Files Research Office, Toronto, and Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay).

During the field season, Shell Canada Resources Limited was conducting a systematic investigation of rocks of the map-area and the surrounding country in areas staked by this company. Most of this work involved ground geological-geophysical surveys as follow up to a previous airborne survey. New Jersey Zinc Exploration Company (Canada) Limited carried out a cursory examination of the entire map-area.

The present ownership of claims in the map-area includes patented claims of Milestone Exploration Limited (formerly Caramat Gold Mines Limited), and non-patented claims of J. Carre, B.H. Durst, E.M. Lyons, Mattagami Lake Mines Limited, H.H. and L.J. Otto, Placer Development Limited, G. Potter, Shell Canada Resources Limited, and Temagami Oil and Gas. During the field season Albert Onesime of Longlac staked six unpatented claims to the east of Adel Lake, astride the fault along Kamuck River–McKay Lake, outlined by Ayres *et al.* (1970) enclosing a surface exposure of sulphide and oxide-facies ironstone.

General Geology

The distribution of rock outcrop in the map-area is extremely poor and limits the amount of geological interpretation that can be made about the area. The area was mapped by Macdonald in 1937 (Macdonald 1938), and by Evans in his 1941 study of the geology along Highway 11 (Evans 1945). A geological compilation map at a scale of 1:253 444 (Innes *et al.* 1969) includes the map-area.

All consolidated rocks except for Middle to Late Precambrian (Proterozoic) diabase dikes are of Early Precambrian (Archean) age and comprise the easternmost extension of the east-trending Beardmore–Geraldton metavolcanic-metasedimentary belt (Pye *et al.* 1966). In the map-area, the belt is made up of two east-trending formations of mafic to intermediate metavolcanics and two metasedimentary units. The northern metavolcanic unit is about 12 km wide but has been divided into 2 bands by a granitic stock. The northern band is predominantly a submarine flow unit with pillowed, amygdaloidal/vesicular phases, and the southern band consists of pillowed flows and associated tuffs, pillow breccias, and medium- to coarse-grained flow breccias, with amygdaloidal/vesicular and spherulitic/variolitic phases. This band is intruded by a small porphyritic felsic subvolcanic body. Only a few outcrops of the 0.4 km wide southern metavolcanic unit occur in the map-area, and this unit is inferred to terminate at the fault along Kamuck River–McKay Lake which is outlined by Ayres *et al.* (1970). The two metasedimentary units are separated by the southern metavolcanic unit. The northern metasedimentary unit is 3 km wide and consists essentially of a turbidite sequence of interlayered wacke, mudstones and coarse-grained (gritty) sandstone with some metaconglomerate. The southern unit, in excess of 5 km width is highly variable,being made up of isolated and often interlayered zones of gneissic equivalents of the northern unit, arkose to subarkose, ironstone and minor felsic metavolcanics. Increase in metamorphic conditions and/or anatexis has given rise to an early stage of diatexis predominated by pegmatitic intrusion into the metasedimentary paleosome. True diatexites are developed further south just outside the map-area.

Intruded into the metavolcanics and metasediments are: 1) pre- metamorphic dikes and sills of gabbro and diorite that occur throughout the map-area, 2) three post-metamorphic stocks of granitic rocks which at the cores of the stocks are predominantly of granodiorite to quartz monzonite phase, but which are highly variable at the margins with the country rocks, 3) Middle to Late Precambrian (Proterozoic) diabase dikes that postdate all other rocks of the map-area.

Structural Geology

The most prominent structural feature is the 180 km long Kamuck River–McKay Lake fault (Ayres *et al.* 1970) which is located in the southern metasedimentary unit. Field mapping within the map-area records a dextral movement with an apparent offset of about 305 m.

The poor outcrop exposure within the map-area limits the amount of the other structural interpretation that can be made. However, several minor (later?) folding features such as drag folds and ptygmatic folds were recognized in some areas in the map-area.

The area of study is the easternmost exposure of the Beardmore–Geraldton metavolcanic-metasedimentary belt within the Wabigoon and Quetico Belts of the Superior Structural Province. In the map-area the Wabigoon–Quetico interface appears to be stratigraphic as has been described by Mackasey *et al.* (1974) in the area to the west.

Economic Geology

There are no past or present producing mines in the area. Nearly all of the past exploration activity was confined to only a few gold prospects which were thoroughly prospected for gold in the 1930s to 1950s. No significant gold deposits have been outlined to date.

Assessment work files indicate that most of the old gold workings were within sheared zones containing auriferous quartz-carbonate veins which in addition to gold, contained pyrite, pyrrhotite, arsenopyrite, and chalcopyrite. Assessment work files also indicate that several attractive conductor zones have been outlined by the recent exploration surveys, but that the conductive areas tested to date are due to graphitic zones of massive to disseminated pyrite, pyrrhotite with or without minor magnetite, chalcopyrite, arsenopyrite, and sphalerite. Cherty ironstones with trace to low values of base metals have also been intersected.

Exposures of felsic rocks within the map-area is rare and coarse (proximal) pyroclastic rocks appear to be absent. Since these rocks are considered useful guides to locating volcanogenic massive sulphide base metal deposits, the map-area does not appear to be a prime area for the search of this type of deposit. In the area to the west (Pye *et al.* 1966), the southern mafic metavolcanic unit has been reported to contain syngenetic and/or hydrothermal gold mineralization. This unit occurs only in the western part of the map-area and is poorly exposed.

The iron prospects investigated by Can-Fer Mines Limited are of low grade mineralization, and are extensively intermixed with the rocks of the southern gneissic metasedimentary unit.

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No. S3 Shawmere Anorthosite

L. Riccio[1]

Introduction

This report summarizes the results of detailed mapping of the northeastern half of the Shawmere Anorthosite Complex (Thurston *et al.* 1977). The complex is a highly deformed and metamorphosed layered intrusion of Archean age (K/Ar date of 2.51 b.y.; Watkinson *et al.* 1972) surrounded by biotite-rich garnetiferous paragneisses, quartzofeldspathic schists and amphibolites. The map-area is entirely within the Kapuskasing Structural Zone, a structural-metamorphic zone separating east-trending, weakly metamorphosed greenstone terrane from northeast to east-northeast trending highly metamorphosed schists and gneisses. The area is covered by ODM-GSC aeromagnetic maps 2247G and 2248G. It was previously mapped at a scale of 1:126 720 as part of Operation Chapleau (Thurston *et al.* 1977). The primary objective of this project was to evaluate the Cr and Al potential of the Shawmere Anorthosite.

Location and Access

The area investigated is centered at Latitude 48°15′ East, Longitude 82°35′ West, and covers about 300 km^2. It is located about 100 km west of Timmins and 90 km northeast of Chapleau. It includes Carty Township, the southeastern part of Lemoine Township, and small parts of Oates, Foleyet and Ivanhoe Townships.

Access to the southern part of the area is provided by a series of forest access roads branching off Highway 101 and extending 5 to 8 km to the northwest. The remainder of the area can be reached by float-equipped aircraft from nearby Ivanhoe Lake. The Shawmere river north of Shawmere Lake and the narrow, shallow stream connecting Wakagami and Carty Lakes are navigable by canoe.

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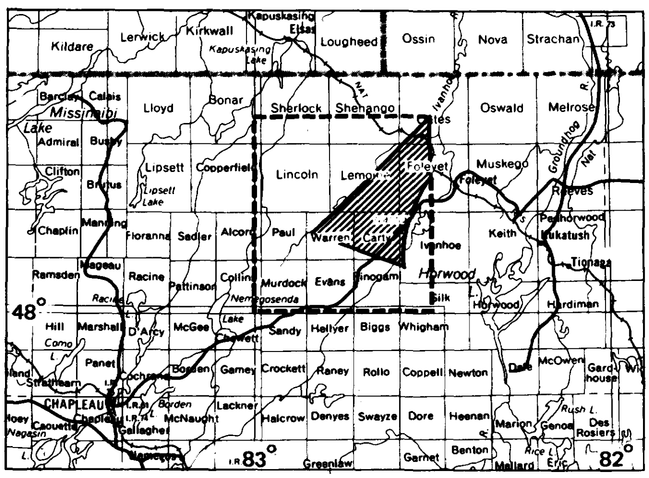

LOCATION MAP

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

Mineral Exploration

In 1964-65 Keevil Mining Group (now Teck Corporation Limited) carried out a magnetometer and electromagnetic survey on high-grade schists and gneisses within the Kapuskasing Structure in areas to the south of the map-area. A few EM anomalies were located and subsequently trenched and drilled. These anomalies proved to be caused by strong disseminations of pyrrhotite or pyrite and magnetite. The same company also staked 32 claims centered along the Fire Tower Road in Foleyet Township but no further work is on file.

Geology

The Shawmere Anorthosite Complex

The intrusion can be subdivided into zones of contrasting compositional and structural characteristics: a) Megacrystic gabbroic anorthosite[1] zone, b) Anorthosite zone, c) Banded zone, d) Border zone.

The megacrystic gabbroic anorthosite zone occupies the central portion of the anorthosite complex and extends to the northeastern margin of the intrusion. It is composed predominantly of gabbroic anorthosite with subordinate anorthosite, anorthositic gabbro and gabbro, and minor mela-gabbro. All rocks within this zone contain large (1 to 50 cm) cumulus plagioclase megacrysts embedded in a matrix of mafic minerals. Most megacrysts are internally granulated and totally recrystallized into aggregates of small (2-3 mm) plagioclase grains. Primary igneous plagioclase is best partially or totally preserved in rocks of gabbroic composition. In general the plagioclase megacrysts are deformed into prolate ellipsoids. In zones

1 Terminology from Buddington (1939) based on percentage of mafic minerals: anorthosite (0-10 percent), gabbroic anorthosite (10-22.5 percent), anorthositic gabbro (22.5-35 percent) gabbro (more than 35 percent).

of more intense deformation, the megacrysts are streaked out into discontinuous leucocratic layers alternating with melanocratic layers. Mafic minerals within this zone consist of amphibole-clinopyroxene-orthopyroxene, irregular clots of dark green amphibole, and of orthopyroxene surrounded by an inner shell of amphibole, or mixed amphibole-clinopyroxene, and an outer shell of granular garnet. At one locality the core of the coronitic assemblage is occupied by olivine.

In the northwestern part of the map-area, the megacrystic gabbroic anorthosite zone grades into predominantly anorthositic rocks with average mafic mineral content not exceeding 5 percent. The anorthosite zone is separated from the Border Zone by a thin (50-100 m) discontinuous unit composed of lineated clinopyroxene-rich gabbro. Anorthositic rocks in this zone are made up of granular aggregates of grey to reddish-coloured plagioclase, minor interstitial amphibole, and, occasionally, scattered garnet grains. Outcrops of otherwise almost pure anorthosite may also contain thin (2-5 cm) layers composed of equal amounts of plagioclase and amphibole or garnet-amphibole and minor plagioclase. Remnants of igneous plagioclase are rare in this zone.

Rocks of the Banded Zone occupy the southeastern margin of the Shawmere Anorthosite between Carty and Wakagami Lakes. The Banded zone is characterized by well developed small scale (1 to 30 cm) compositional banding, presence of deep-red garnet-rich layers, and lack of mafic clots and plagioclase megacrysts. Individual layers comprise pure anorthosite, lineated clinopyroxene-amphibole- plagioclase metagabbro, sphene-plagioclase-quartz-amphibole-garnet (up to 60-70 percent) rocks, and minor ultramafic rocks composed of orthopyroxene, amphibole, serpentized olivine and up to 5 percent green aluminum spinel. Thin quartzofeldspathic segregations are locally present in this zone. Most of the layers are isomodal and mineral-graded layers are rare. At one locality on the northeastern shore of Carty Lake mineral-graded layers rich in amphibole at the base and plagioclase at the top are size graded as well and can be used as top indicators. Structures strongly resembling graded bedding can be observed at Carty Lake. However, since the rocks in the area are tightly folded and the folds are isoclinal and recumbent, it is possible that the "cross beds" are in fact sheared folds.

The Border zone is a distinct lithologic unit, 50 to 100m thick, which separates rocks of the Shawmere anorthosite complex from country rocks. It outcrops almost continuously along the northwestern margin of the intrusion and in the Carty Lake–Harold Lake area. Structurally, the Border zone can be seen to underly and overlie anorthositic rocks. The Border zone is made up of a dense, dark-coloured, foliated garnetiferous amphibolite containing 5 to 20 percent, concordant to slightly discordant quartzofeldspathic layers, and at some localities, anorthositic layers. Border zone rocks grade into predominantly anorthositic rocks containing subordinate layers of garnet amphibolite. The contact between Border zone and country rocks can be sharp or transitional. Where transitional, the amphibolites become increasingly migmatized away from the anorthosite. The Border zone is interpreted as the metamorphosed equivalent of a gabbroic marginal zone formed by cooling the magma against the country rocks.

The Shawmere anorthosite complex is metamorphosed to the hornblende granulite subfacies of the granulite facies. This is substantiated by the occurrence of sapphirine associated with garnet, pargasite, and plagioclase in melagabbro from Carty Lake, the presence of green aluminum spinel in ultramafic layers, and the coexistence of garnet, pyroxenes, amphibole, and plagioclase in gabbroic rocks.

Country Rocks

The Shawmere anorthosite complex is surrounded by fine- to medium-grained quartzofeldspathic schists and gneisses, fine- to medium-grained semi-pelitic paragneisses, and medium-grained amphibolites and garnet amphibolites. All country rocks contain variable amounts of coarse-grained quartzofeldspathic segregations probably formed during anatexis and then deformed with the country rocks.

Quartzofeldspathic schists and gneisses are composed of quartz-feldspar-biotite-hornblende ± garnet, they occur as irregularly shaped masses within the southeastern part of the Shawmere Anorthosite, as discontinuous zones of variable width rimming the anorthosite, and as intercalations in semi-pelitic metasediments. The width of zones underlain by quartzofeldspathic rocks surrounding the anorthosite increases in a southwesterly direction along both margins of the intrusion.

The semi-pelitic paragneisses are quartz-biotite-plagioclase schists which may contain orthopyroxene and up to 30 percent garnet porphyroblasts. In the Shawmere Lake area, the metasediments display a well developed compositional banding. Individual layers, 2 to 5 cm thick and rich in biotite and garnet, alternate with equally thick layers poorer in both minerals.

Amphibolites are composed of amphibole and plagioclase, and may contain garnet, quartz, clinopyroxene, orthopyroxene and biotite. They occur as discrete outcrops, as rafts or boudinaged layers enclosed in quartzofeldspathic rocks, and as discontinuous layers within semi-pelitic metasediments. Amphibolitic rocks in the southeastern corner of the map-area may represent metamorphosed equivalents of mafic tuffs and lavas of nearby greenstone terranes.

Dikes

Rocks of the Shawmere anorthosite complex are cut by metamorphosed dikes and dikelets of gabbroic and anorthositic composition. Most of these early dikes are deformed and garnet-bearing. Pegmatitic leucodioritic dikes intrude the anorthosite and banded zone of the anorthosite as well as the quartzofeldspathic rocks surrounding the anorthosite. Undeformed pegmatitic dikes ranging in composition from granite to trondhjemite cut the country rocks and rare trondhjemitic dikes cut the anorthositic rocks. Late undeformed and unmetamorphosed fine- to medium-grained diabase dikes cut both the anorthosite and the country rocks. Diabase dikes trend predominantly east-northeast and less commonly northeast, west-northwest, northwest and north-northwest. They are widespread in the eastern and southeastern parts of the area and rarer further to the north and northwest.

Structural Geology

At last three phases of deformation can be recognized in the map- area. The first and most intense phase of deformation (F_1) produced the prominent north-northwest to northwest dipping schistosity-gneissosity as well as a set of mesoscopic close to tight isoclinal folds with shallow plunges to the south, west-southwest, and northwest dipping axial planes. The isoclinal folds are moderately inclined in the northern part of the map-area and strongly inclined or recumbent in the south. Folds with diverging limbs are very rare. Associated with the F_1 folds are widespread mineral lineations which include elongated plagioclase megacrysts and elongated aggregate of hornblende and clinopyroxene in "anorthositic" rocks, elongated biotite and hornblende in metasediments, and quartz rods in quartzofeldspathic rocks. Mineral lineations are especially prominent in hinges of mesoscopic folds.Mineral lineations are invariably parallel to fold axes of F_1 folds. The second phase of deformation (F_2) gave rise to large open folds with subhorizontal northwest-trending areas. Occasional reversals in the direction of plunge of mineral lineations are considered to be related to F_2 folding .Open folds related to D_3 can be observed in the Shawmere Lake area. There the gneissosity in metasediments is locally warped about axes plunging steeply to the north-northwest. It is suggested that the Shawmere anorthosite complex is folded into a major southwest-plunging asymmetrical overturned syncline with a steeper inverted limb and a shallower normal limb. This interpretation is based on: a)the occurrence at Carty Lake of mineral and size-graded layers facing north, b) the presence of a Border Zone rimming the anorthosite on both sides forming the base of the sequence, c) the relatively undeformed nature of the central part of the intrusion, d) the style and attitude of F_1 folds and related lineations.

North to north-northeast-trending shear zones characterized by intense mylonitization and development of pseudotachylite veinlets are common along the eastern margin of the Kapuskasing Structural Zone. The most prominent mylonite zone, up to 250 m wide, straddles the boundary between anorthosite and country rocks from the CNR railway to just north of the Fire Tower Road in Foleyet Township, a distance of approximately 11 km. Other major mylonite zones are exposed along the Fire Tower Road, at Wakagami Lake, west of East Carty Lake, and along Highway 101. Although the mylonite zones are late structures which cut across lithologic units and deflect the regional schistosity, they are in part developed along pre-existing faults. For example, the mylonite zone to the west of East Carty Lake separates high grade amphibolite and paragneisses of the Kapuskasing structural zone from greenstone terranes.

Economic Considerations

Cr and Fe, Ti

Anorthositic rocks are known to contain economically significant deposits of Cr-rich spinel, ilmenite, or magnetite-ilmenite.

Cr-rich spinels only crystallize from relatively undifferentiated basaltic liquids. Consequently chromites can only be expected to occur in anorthosite composed of highly calcic plagioclase. Ilmenite and magnetite, on the other hand, crystallize from more differentiated basaltic liquids and are usually found in anorthosite with plagioclase in the andesine-labradorite range. It is also known (e.g. Bushveldt Complex) and it has been experimentally shown (Hill and Roeder 1974) that basaltic magmas differentiating under normal oxygen fugacity conditions do not crystallize spinel phases during their middle stages of fractionation. Outcrops within the Shawmere anorthosite complex appear to be devoid of disseminations of either chromite, ilmenite, or magnetite. A few opaque minerals examined to date proved to be metamorphic aluminum spinels. On the basis of these field observations the potential for oxide mineralization in the Shawmere complex is poor. However a petrogenetic study of the complex would help substantiate the field observations and might explain the apparent lack of oxide dissemination.

Aluminum

Technologically it is possible to extract aluminum from anorthositic rocks and recover up to 98 percent Al_2O_3 (Quon 1977). As the world's bauxite reserves are slowly being depleted, the demand for aluminum increases, and some of the foreign governments that control bauxite supply are politically unstable, the long-range economic potential of large anorthosite masses as sources of low-grade Al_2O_3 should be considered. In the Shawmere complex, the best belt of anorthositic rocks with low mafic mineral content covers an area of between 4 and 7 km^2 extending from the CNR railway to just northeast of Lemoine Lake. This corresponds to reserves between 1.1 and 1.9 billion/tons to a depth of 100 m.

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No. S4 Capreol Area, District of Sudbury

T.L. Muir[1]

Location

The area is about 28 km north of Sudbury, covers approximately 220 km^2 and comprises Wisner and Norman Townships and that part of Capreol Township lying north of Latitude 46°41′ North. The town of Capreol lies in the central south portion of the map-area. Highway 545 from Sudbury continues north through Capreol and provides access to the western half of Norman Township. Access to the central and northeastern parts of Norman Township is not good. The Vermilion River lies in a north-trending, fault induced valley and effectively separates Wisner and Norman Townships. The Canadian National rail line lies close to the west side of the river, but is not easily reached at any point along its length. North of the town of Val Therese, some concession, cottage, and logging roads combine to give access to the southern parts of Wisner Township. The northern half of Wisner Township is poorly accessible.

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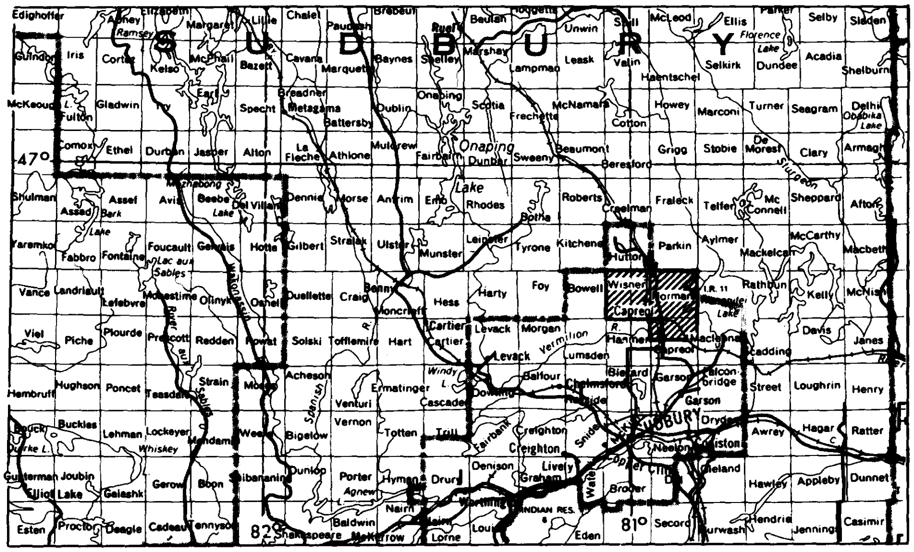
Mineral Exploration

Unless otherwise stated, the information on exploration activity reported here was obtained from the Regional Geologist's Files, Ontario Ministry of Natural Resources, Sudbury, or from the Source Mineral Deposit Records files, Ontario Ministry of Natural Resources, Toronto.

Mineral exploration in the Sudbury area dates back to the late 1880s. Although some recorded work in the Capreol Area dates to 1897, much of the assessment file material is post 1949. Exploration has been largely for nickel and copper, but work has been undertaken for iron (the Moose Mountain Mine lies to the north in Parkin Township) and for placer gold. INCO Limited and Falconbridge Nickel Mines Limited currently control much of the staked portions of the map-area through patented or leased claims. Many of the rock types of the Capreol area have been grouped together because of inherently similar macroscopic features, and as units, they extend completely across the map-area; exploration by some companies has therefore been widespread across the area and has occurred over a period of years.

The earliest referenced base-metal exploration dates back to 1897 on the Whistle Property. Stripping and trenching were undertaken by the Nickel-Copper Com-



LOCATION MAP

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

pany of Ontario Limited from 1900 to 1903. Between 1904 and 1912, Dominion Nickel-Copper Company Limited undertook considerable diamond drilling, sank a 15 m shaft, and constructed a 134 m adit. Although some ore was shipped to an American steel plant, plans for an on-site smelter were abandoned. The British America Nickel Corporation Limited extended development work, but halted work in 1913. In 1929, the property was purchased and is still owned by International Nickel Company of Canada Limited (INCO Limited).

Between 1943 and 1947 Dominion Nickel Mining Corporation Limited (later, New Dominion Nickel Mines Limited, 1953) diamond drilled eight holes for a total of 1056 m and outlined a broad chalcopyrite-pyrrhotite-pentlandite-bearing zone 305 m long and 91 m thick in north-central Norman Township. Two more specific mineralized zones dipping 50° south were outlined to a maximum depth of 112 m; one is 243 m long, 7.9 m thick, and assays average 0.70 percent Ni and 0.50 percent Cu, and the other is 67 m long, 7.6 m thick, and assays average 0.72 percent Ni and 0.45 percent Cu. Later work in 1955 by Jonsmith Mines Limited, which included 1120 m of diamond drilling from 74 holes, indicated reserves of 45 000 tons grading 0.9 percent Ni and 0.75 percent Cu. Further drilling indicated 2 percent Ni over 3.4 m at a depth of 213 m.

In 1950, Northbridge Mines Limited undertook diamond drilling on property in north-central Norman Township where previous geological and geophysical surveys by Falconbridge Nickel Mines Limited were done in 1934. Interest lay in testing the Parkin Offset (see Economic Geology section). In 1954, a geochemical survey was completed, but the property was left idle. In 1952, E.R. Black submitted the results of 3 diamond drill holes totalling 154 m on an eight-claim block in southeastern Norman Township. In 1953, D. McKay drilled two holes for a total of 17 m on a four-claim block in northwestern Norman Township. Also in 1953, Sudbury Northrim Exploration Company Limited drilled 343 m in two holes in Onwatin Lake in Capreol Township. In 1953, Fiveland Mines Limited held eight claims in east-central Norman Township, but reported no work.

In 1954, N. Lepage drilled four holes totalling 183 m in length on a group of eight claims in southern Norman Township. Prospectors Airways Company Limited held 34 claims in the southwest corner of Norman Township on which they conducted a magnetometer survey, the results of which did not warrant further work. Consolidated Orlac Mines Limited conducted a magnetometer survey on their ten-claim block in central Norman Township. Norsynco Mining and Exploration Limited undertook a geological mapping and a magnetometer survey that covered a group of 37 claims in the northwest corner of Norman Township. Work on the property carried over into 1955 when a spontaneous polarization survey was completed and three diamond drill holes totalling 624 m in length were sunk on one of the claims. The anomalies outlined in the two geophysical surveys were attributed to late diabase dikes and to large amphibolite inclusions within the granitic basement rocks. Also in 1955, New Dominion Nickel Mines Limited completed a magnetometer survey on a ten-claim block in northeast Norman Township; the results were negative.

In 1956, Cleveland Copper Corporation held three claim groups in eastern Norman Township. A magnetometer survey was conducted on each of the three groups; a 1189 m long anomaly up to 122 m wide was outlined on the south claim group. A follow-up electromagnetic survey was done in which a few relatively weak anomalies were outlined. Four diamond drill holes totalling 862 m in length were sunk to test some of the anomalies; granitic and amphibolitic rocks were encountered. El Pen-Rey Oil and Mines Limited conducted a magnetometer and electromagnetic survey on a 12-claim block in southeastern Norman Township. Follow-up diamond drilling totalling 1142 m in six holes encountered granitic and mafic rocks. Fallmac Nickel Mines Limited submitted the results of 50 m of diamond drilling from three holes on their four-claim group in northeastern Norman Township.

In 1957, E.G. Kelly conducted a magnetometer survey on a group of seven claims in northwestern Norman Township and completed a 68 m long diamond drill hole in granitic rocks. G. Polack submitted assessment work for 49 m of diamond drilling on an eight-claim group in the southeast corner of Norman Township. From 1960 to 1961, Ryanor Mining Company Limited held eight claims just north of Joe Lake in Wisner Township. During this period, a geological survey was made and considerable magnetometer and electromagnetic work was carried out. In addition, 28 diamond drill holes were completed for a total of 7102 m. A mineralized zone 305 m long was outlined, but work was terminated.

In 1961, R.C. Dennie blasted a small pit and completed two diamond drill holes totalling 20 m in length within Onaping pyroclastic rocks on a group of four claims in south-central Wisner Township. In 1968, R. Tincombe held a group of six claims in northeast Norman Township and completed 211 m of diamond drilling in dioritic rocks. In 1971, Canadian Nickel Company Limited held four claims in northeastern Norman Township and submitted the results of one diamond drill hole totalling 86 m in length which intersected volcanic and granitic rocks. In 1975, Sandex Developments Limited submitted the results of a geological survey on 47 claims in northwestern Norman Township. Later that year they completed a magnetometer and electromagnetic survey on the property.

A significant accumulated amount of work throughout much of the map-area has been undertaken by Falconbridge Nickel Mines Limited and INCO Limited (particularly the latter) at least since 1948 and 1946 respectively. Of the work recorded, magnetometer and electromagnetic surveys and diamond drilling have been done; the latter constitutes the bulk of the work submitted for assessment credit (Falconbridge Nickel Mines Limited: 1495 m in 31 holes; INCO Limited: 22 145 m in 60 holes).

During the 1979 field season, diamond drilling for INCO Limited was observed to be in progress within the north half of lots 9 and 10 of concession IV in Norman Township.

Limited exploration for iron has been done. In 1959, Copper-Man Mines Limited conducted a magnetometer survey on 13 claims in northwestern Wisner Township. No ironstone was found. In 1961, Ironco Mining and Smelting Limited acquired seven claims along the Norman-Parkin Township boundary. Numerous small outcrops of banded iron formation (magnetite ironstone layers up to 2.5 cm thick) occur within Archean metavolcanics. No work was recorded.

Gold exploration has been limited to the search for placer-type deposits within the glaciofluvial material in northwestern Norman Township (as well as Parkin and Hutton Townships to the north). In 1959, Concor Chibougamau Mines Limited held some claims in northwestern Norman Township and reported the presence of placer gold (up to 50 milligram pieces) in some glaciofluvial channelways. Some "churn drilling" was done but the property lapsed.

General Geology

Previously published mapping in the area has not been detailed. That part of the map-area east of Longitude 80°50′ West was mapped by B. Dressler[1] (in preparation). A few compilation maps are available: Card (1965, 1969) and Meyn (1966). Aeromagnetic maps (ODM-GSC 1965) are also available.

Major lithological divisions of the rocks within the Capreol map-area are fairly easily made and these major units are generally continuous throughout the map-area with the exception of northeastern Norman Township (see last paragraph, this section) which in some units amounts to a distance of 26 km (see Figure 1). On the other hand, the heterogeneity of some subdivisions of the major units causes considerable difficulty in tracing these subunits at the scale of the mapping undertaken (1:15 840). The following description is highly generalized.

The "lowermost" rocks (basement) consist of massive to gneissic, microcline-porphyritic quartz monzonite, granodiorite, and granite. A widely varying and poorly defined zone that roughly underlies the irruptive comprises a non-preferentially-oriented, complex mixture of gneissic and migmatitic rocks of granodiorite to trondhjemite composition that commonly contain small (less than 10 cm) to large (400 m - pendants?) xenoliths of amphibolitized mafic volcanic rocks, ironstone, and gabbroic, ultramafic, and sedimentary rocks. The granitic to migmatitic rocks have been intruded by massive and porphyritic Early Precambrian (Archean) diabase dikes. The proportion of mafic volcanic rocks (and to a lesser extent, diabase) sharply increases towards a zone presently known as the "sublayer" which immediately underlies the Nickel Irruptive. The mafic rocks locally form large, thin lenses up to 2.0 km long. In western Wisner Township, there is a thick 'lens' of magnetic gabbro as well as anorthositic gabbro and mafic volcanic rocks. Within the sublayer zone, which itself is a very complex irregular combination of mafic to felsic breccias of non-volcanic origin, is contained much of the sulphide mineralization which elsewhere around the Nickel Irruptive constitutes the ore that is mined for nickel, copper, platinum, and other metals.

Overlying the sublayer zone are the Sudbury Irruptive rocks which consist of norite succeeded by granophyre; the two rocks are separated by a poorly defined zone of rocks with characteristics transitional between norite and granophyre, hence the commonly used term "transition zone". Variations in texture and mineralogy are much more common in the granophyre than in the norite, and are generally not mappable as zones or lenses.

The Irruptive rocks intrude the overlying Onaping Formation which consists of the following members from lower to upper:

a felsic breccia (Basal Member) containing distinctive, peculiarly-textured granitic(?) fragments and blocks as well as quartz and Huronian quartzite fragments in a locally sparse matrix of unknown genesis that contains numerous small, felsic fragments, and minor mafic fragments;

light to medium gray, siliceous pyroclastic rocks (Gray Member) containing fragments of white Huronian sandstones, white granitic rocks, and peculiarly-textured granitic rocks (as already mentioned) as well as minor flows of intermediate composition;

and grayish green to greenish gray breccias (Green Member) that are probably of pyroclastic origin for the most part.

Numerous variations within this member with respect to fragment size, shape, type, and abundance are present; but not all changes are mappable as layers, although a poorly-defined zone bearing pink fragments of sandstone and granite may represent a time-stratigraphic layer. Some rocks appear to contain only fragments of Huronian sedimentary rocks and may not be volcanic in origin. The uppermost member (Black Member) of the Onaping Formation consists of dark green to black pyroclastic breccia, lapilli tuff, and tuff in which glassy shards, lapilli, and fragments and blocks of Huronian sedimentary rocks may be found. Granitic fragments may be found in all of the members.

The upper contact of the Onaping Formation is gradational and locally interbedded with the overlying Onwatin Formation which consists of medium to dark grey-black argillite, siltstone, and fine-grained sandstone all of which possess slaty cleavage.

Late Precambrian west-northwest-striking olivine diabase dikes intrude all of the above-mentioned rock types.

The northeast corner of the map-area is underlain by poorly exposed Archean, mafic, intermediate, and felsic metavolcanics, related ironstone, and some formations of the Huronian Supergroup, namely the Mississagi Formation (arkose, wacke), Bruce Formation (conglomerate, pebbly wacke, wacke), Espanola Formation (calcareous siltstone, limestone, calcareous wacke), and Gowganda Formation (laminated and non-laminated wacke, arkose). These units form a belt of rocks which trends northwesterly into Parkin and Hutton Townships.

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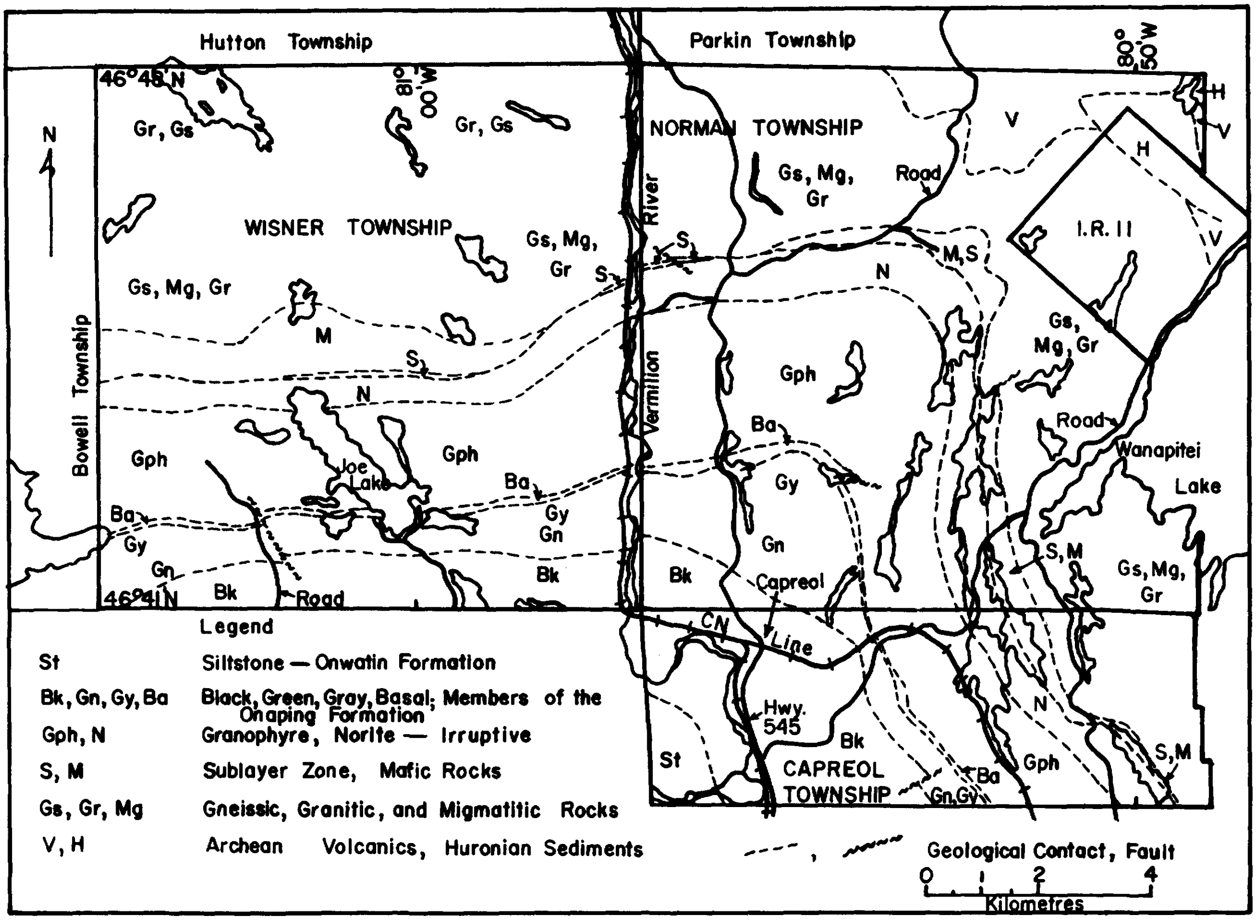

Figure 1—General Geology of the Capreol Area.

Structural Geology

The large-scale structure of the area is fairly simple; the map-area is situated at the northeast end of an east-northeast trending elliptical basin-like structure: the Sudbury Basin. A relatively sharp inflection in the outline of the basin occurs in central Norman Township. There are no structures by which measurements could establish true attitudes of units; bedding on an outcrop scale is not present in the Onaping Formation with the exception that it is poorly defined in the uppermost part of the Black Member tuffs and overlying Onwatin slates. A moderately developed north-northeast trending schistosity, however, is present within the Onaping Formation in southwestern Norman Township.

The disarray of relatively large inclusions and blocks within the gneissic and migmatitic basement rocks suggests a process of formation uncommon to many 'greenstone-gneiss' terrains.

The northeast corner of the map-area is poorly exposed; information on the structure is very sparse and highly interpretive.

Numerous lineaments are present throughout much of the map-area; some can be confidently attributed to eroded fault zones although horizontal displacement is commonly in the order of a few hundred metres or less.

Economic Geology

Although commonly present in very sparse amounts, sulphide mineralization is found throughout the map-area in nearly all of the rock types, differing in occurrence, type, and abundance from one to another. Since pyrrhotite and pentlandite cannot be consistently distinguished in the field, the use of both words in this report indicates that either or both minerals were identified. The Black Member of the Onaping Formation almost ubiquitously contains pyrrhotite, pentlandite, chalcopyrite, and pyrite as sulphide fragments (from <1 mm to 2 cm long) or as components of other fragments, especially those that are quartz rich. Sparser amounts of the same sulphides are found within the Green and Gray Members. Azurite and malachite are very minor and are locally present on some weathered surfaces.

Pyrite, pyrrhotite, pentlandite and chalcopyrite were found locally in small amounts within the granophyre and norite. Pyrite is locally common near the base of the norite. Strongly weathered pyrrhotite pentlandite, chalcopyrite, and pyrite are quite common within the sublayer zone breccia; these minerals vary considerably in total and individual amounts. Millerite and nickeliferous pyrrhotite are found in some of the Sudbury area mines and may be present in this area as well.

Amphibolitized mafic volcanic rocks near the sublayer zone locally contain rusty pyritiferous zones or small 'nodules' (also with minor pyrrhotite, pentlandite and chalcopyrite) and the granitic to migmatitic rocks contain local small clots, stringers, and crystals of pyrite (and very minor chalcopyrite) due to the complex nature of their components (ie. inclusions). Significant amounts of economic sulphides have been found in breccia-filled dikes known as offset dikes or offsets, that radiate outward from the sublayer zone and have matrices that are quartz diorite to norite in composition. A few small examples of these dikes were located during the field season, but major dikes were not observed in the map-area. A poorly exposed offset dike, known as the Parkin Offset occurs in south-central Parkin Township but is not exposed in Norman Township. It has been commonly assumed that the dike is connected to the sublayer but this has not been proven by diamond drilling. These offset dikes, together with the sublayer zone, are the focal points of most base-metal sulphide exploration in this area and probably will remain so. Most of the ground, however, is held by INCO Limited and Falconbridge Nickel Mines Limited.

Gold and iron, the two other previously sought commodities in this area do not appear to hold promise. Magnetite ironstone does not appear to be present in sufficient quantity. The gold (placer type) exploration was of a limited and ambiguous nature. Further work for gold, in the light of its current good market value, may be justifiable, although the geological environment is not comparable to the common gold occurrences of Shield areas.

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No. S5 Footwall of the Sudbury Irruptive, District of Sudbury

Burkhard O. Dressler[1]

Introduction

The author began a four year project involving a detailed study of the footwall of the Sudbury Irruptive and of the "Sublayer", the ore bearing unit of the Sudbury mining camp. The project involves a study of the structure, the metamorphism and petrography of the footwall and sublayer rocks, an investigation of the Sudbury breccias, and a synthesis of published data.

During the 1979 field season the author investigated the footwall and sublayer rocks in two sectors of the north range and in one sector of the east range of the Sudbury Irruptive (Figure 1).

General Geology

1) Windy Lake to Coleman and Strathcona Mines Area

This area (A, Figure 1) is underlain predominantly by granitic gneisses, hornblende-biotite gneisses, migmatites, and granitic rocks. Diabase and minor ultramafic rocks also occur. The gneisses, migmatites and ultramafic rocks occur in the vicinity of the Sudbury Irruptive, and the granites farther to the north. Sudbury breccias occur in all these rocks and are more abundant close to the contact of the footwall rocks with the Nickel Irruptive than farther away from it.

2) North of Nelson Lake

Here (B, Figure 1), the predominant pre-Irruptive rock types are granite and hornblende gneiss. Diabase and gabbro also occur. The area was mapped in detail to improve existing geological maps, and as in the other areas investigated, to show the distribution and orientation of Sudbury breccia bodies and to obtain structural and microstructural data.

3) Capre Lake MacLennan Mine

This area (C, Figure 1) had been mapped in 1978 (Dressler 1978). During the 1979 season, the author investigated and mapped in detail the sublayer rocks. As in the other investigated areas, a great number of rock specimens were collected for mineralogical and chemical investigation.

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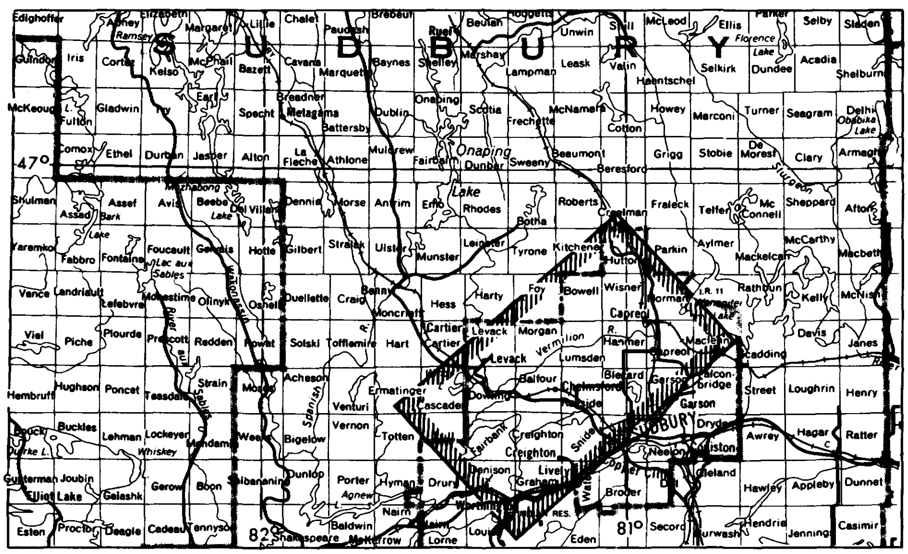

LOCATION MAP

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

Sublayer

The Sudbury copper-nickel ores are associated with a rock unit called "sublayer" (Souch *et al.* 1969; Pattison 1979) and with offset dikes that radiate outward from the main irruptive. Bodies of sublayer occur as sheets and lenses and underlie the Nickel Irruptive. The most common type of sublayer outcropping in the areas studied in 1979 is the "leucocratic breccia" (Pattison 1979), whereas the second type, the "igneous sublayer" (Pattison 1979), was observed by the outhor in only a few places.

The leucocratic breccia is well exposed just north of Strathcona and Coleman Mines, at Capre Lake and at Roland Lake, a small lake 1.5 km west of Nelson Lake. The rocks, generally speaking, consist of fragments of footwall rocks and of mafic and minor ultramafic rocks ranging in size from very fine to several metres. Sulfide ore may or may not be present. The matrix in which the fragments and the ore are inbedded is fine grained, light grey to pinkish grey, and is described by Pattison (1979) as mosaic-granoblastic metamorphic.

The igneous sublayer is exposed in only a few places in the areas investigated, the best exposure being about 1.5 km southwest of Strathcona Mine, about 400 m northeast of the gravel road that leads to Seal Lake.

The igneous sublayer is characterized by a great variety of mafic and ultramafic rock fragments and of minor footwall rock fragments inbedded in a medium-grained, gabbroic matrix. Rae (1975), in a study of the igneous sublayer from Strathcona Mine, described fragments of wehrlite, clinopyroxenite, websterite, lherzolite, dunite, harzburgite, orthopyroxenite, norite, gabbro, and footwall hornfels.

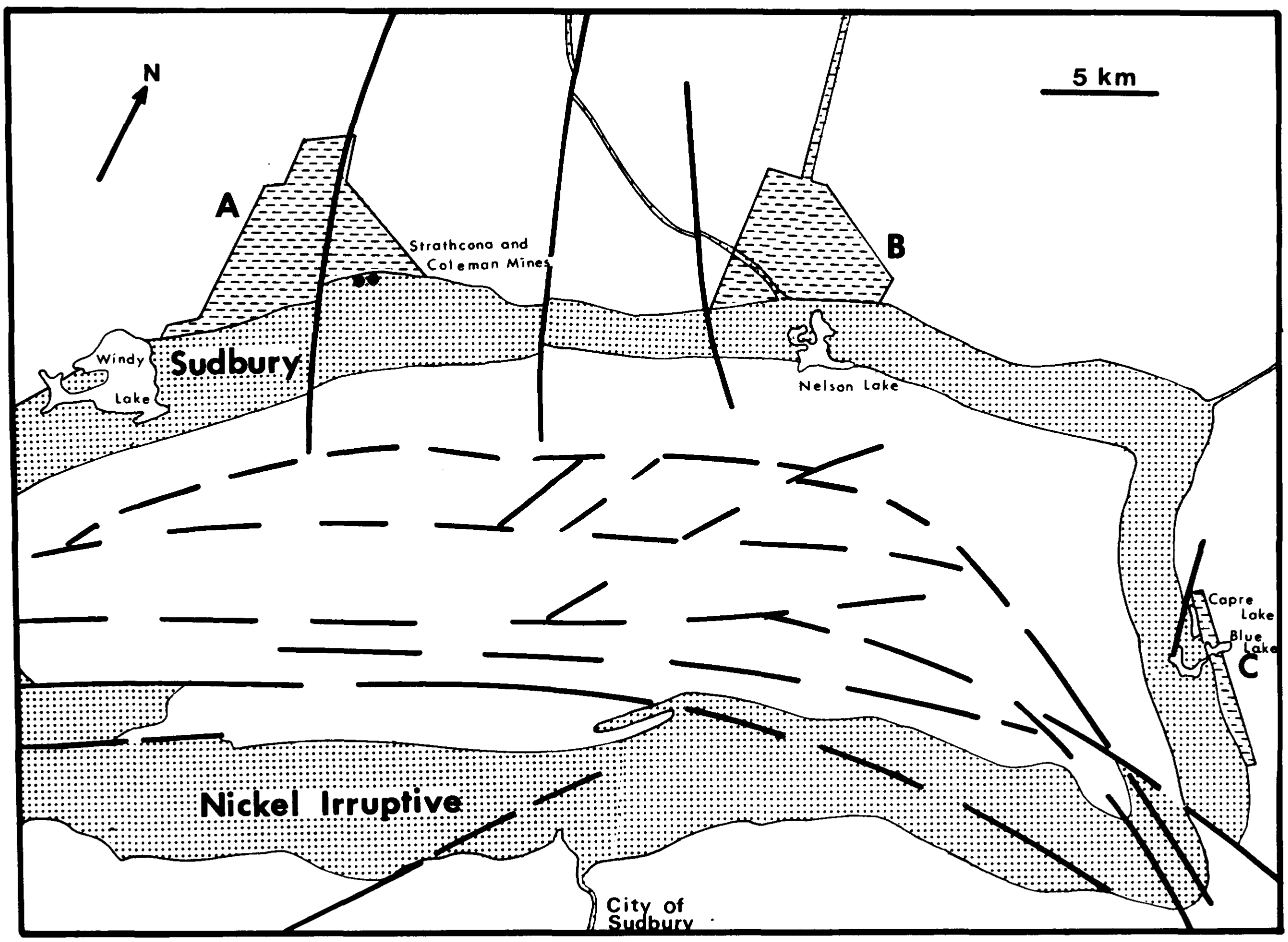

Figure 1—Sketch Map of part of the Sudbury Basin.

Sudbury Breccia

Sudbury breccia (or Sudbury-type breccia) has been observed by the author near the Sudbury Irruptive and up to 50 km away from it (Dressler 1975).

The breccias are characterized by host rock fragments and "exotic fragments", i.e. rock types not observed near the breccia occurrence, set in a fine-grained to aphanitic, grey, dark grey, or black matrix of crushed rock powder. The fragment size ranges from under 1 mm to several tens, possibly more than 100 m. Small fragments are angular, 1 m size ones are commonly rounded.

The shape of the breccia bodies is either very irregular or the breccia forms seams and dikes 1 mm to several metres wide. For mapping purposes, the dike-like breccias were called by the author pseudotachylites, the irregular-shaped breccia bodies, Sudbury type breccia *sensu strictu*. Both varieties, however, belong together and are of the same origin.

Economic Geology

The economic geology of the Sudbury Irruptive is discussed in a voluminous literature and no attempt is made to discuss it here. The economic copper-nickel ores are associated with the sublayer and the offset dikes. At Strathcona and Levack West Mines, chalcopyrite dikes (copper zones) exist in the footwall of the Irruptive. The aim of the present study of the footwall rocks is to come to a better understanding of the origin, controls, and potential variety of mineralization environments associated with the Sudbury area and provide direction for mineral exploration in areas in and adjacent to the Sudbury basin. This study is coordinated and is complimentary to projects under the direction of D.G. Innes and A.C. Colvine, Mineral Deposit Section, Ontario Geological Survey.

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No. S6 Firstbrook Lake Area, District of Timiskaming

G.W. Johns[1]

Location

Mapping at a scale of 1:15 840 (¼ mile to 1 inch) was carried out during the 1979 field season over 256 km² west of Haileybury and Cobalt, District of Timiskaming. The area examined is bounded by Latitude 47°22′30″-47°30′00″N and Longitude 79°45′-80°00′W and comprises Firstbrook Township, most of Barr Township, a 3.6 km strip in northern Kittson and northwestern Coleman Townships, lot 1, concessions I-VI Bucke Township, the south half of concession I of Lundy and Hudson Townships and a small corner of southwest Dymond Township. The centre of the map-area is 18 km west of Haileybury.

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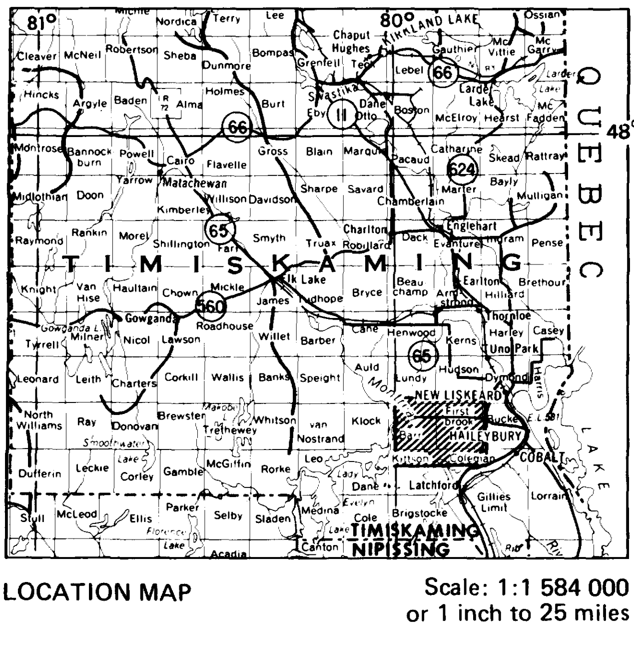

LOCATION MAP

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

Access

Highways 11 and 11B cross the extreme southeast corner of the map-area. Highway 558 (Haileybury West Road) extends east-west across the northern third of the map-area and provides access to the public landing at Mowat Landing on the Montreal River. A Ministry of Natural Resources Public Access road loops south and east from the west end of Highway 558 through the western third and southern third of the area and joins with the Loon Lake road which connects Highway 11 with Portage Bay on the Montreal River. Other all weather roads are found in the eastern portion of the area. Access to the area west of the Montreal River can be gained by boat from either the Montreal River or Lady Evelyn River.

Many new and old logging roads occur in the central part of the area. A fire line surrounding a 12 000 ha fire which burned south-eastern Barr and south-central Firstbrook Townships in 1977 may be walked or used as a winter road.

Mineral Exploration

The discovery of silver in 1903 in Cobalt, 5 km east of the eastern map boundary, prompted much prospecting and many old, undocumented, pits and trenches resulted from this activity. Although no economic deposits were discovered, several properties underwent underground development. The Cobalt-Kittson mine on Kitt Creek, Kittson Township was worked from 1927 to 1930 with the development of a 190 m shaft with attendant drifting on the 76 m, 136 m, and 181 m levels (Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake). In concession V, lot 1, Bucke Township, Mckinnon Mines Limited sunk a 45 m shaft on quartz carbonate veins in the Sharp Lake Diabase (Thomson 1964). On the NW ¼ S ½ of Lot 1, concession II, Bucke Township the Dotsee Mine (Seed Mine) was discovered in 1906 and development commenced in 1909 with the sinking of a shaft to a depth of 64 m. The mine was worked intermittently until 1939 with development of the 14 m, 38 m, 47 m, and 63 m levels (Thomson 1964).

Exploration within the map-area has been, for the most part, oriented towards the discovery of silver-cobalt mineralization and as such has been concentrated along the lower contact of the Nipissing Diabase sill in southern Firstbrook Township and along the lower contact of the Nipissing Diabase sill and vertical contacts of the Keweenawan Sharp Lake dike in western Bucke and eastern Firstbrook Townships. In 1948 and 1949, Colebucke

Mines Limited did geological and magnetometer surveys on ground in the northwestern lots of Bucke Township and southeastern lots of Firstbrook Township. The Walters claim group, north of Maggie Lake underwent a geological survey in 1948. In 1952 Harmon Oils and Minerals Limited sunk eight diamond drill holes for a total length of 542 m in Nipissing Diabase south of Charlotte Lake. Sapphire Petroleums Limited ran a geological survey in 1957 to cover the Nipissing Diabase and Lorrain Formation south of George and Charlotte Lakes. Lot 1 of Concession III, IV, and V, of Bucke Township had further geology and magnetometer work carried out on them in 1960 by Old Colony Securities Limited and in 1963 by Norite Explorations Limited. Norite Explorations Limited also drilled five diamond drill holes through the Sharp Lake diabase dike for a total of 952 m.

The discovery of a 0.5 km^2 Archean felsic metavolcanic inlier south of Maggie Lake prompted Copperfields Mining Corporation and Pickle Crow Explorations Limited to check for base metals by carrying out a geological, magnetometer, electromagnetic, and self potential survey in 1972.

General Geology

The map-area is underlain by the Middle Precambrian Gowganda and Lorrain Formations of the Cobalt Group of the Huronian Supergroup. The Gowganda Formation unconformably overlies Early Precambrian felsic metavolcanics and metasediments. Both the Huronian and Archean rocks are intruded by Middle Precambrian Nipissing Diabase and Late Precambrian (Keweenawan) diabase.

Although much of the surrounding area has been mapped previously, the map-area had not undergone a detailed geological survey before the current survey. Thomson (1956, 1964) mapped Bucke Township and wrote a description of the mining properties. The silver mining area around Cobalt has been mapped in detail by Thomson (1963a, b, c). In 1969, Card *et al.* (1973) completed a reconnaissance survey of the Maple Mountain area west of and adjacent to the current map-area. Lovell and Frey (1976) mapped in 1970, an area which includes the townships of Hudson and Dymond.

Early Precambrian metavolcanics and metasediments outcrop in two locations within the map-area. A 0.5 km^2 inlier of felsic tuffs, tuff breccia, feldspar porphyry, and volcaniclastic conglomerate cut by biotite lamprophyre dikes is found south of Maggie Lake in Firstbrook Township. Timiskaming conglomerate reported by Lovell and Frey (1976) is found northeast of Spring Lake in Hudson Township. Only the southern tip of this inlier is exposed within the map-area.

The flat-lying to gently-dipping Middle Precambrian sedimentary rocks of the Cobalt Group overlie the Early Precambrian Archean rocks with profound unconformity. The Gowganda Formation, as defined by Robertson *et al.* (1969), can be subdivided into two members, called formations by Thomson (1963a, b, c). The Coleman Member is the base of the Gowganda Formation and outcrops north of a line drawn through Mowat Landing to the southwest tip of Pike Lake. Locally, Coleman Member rocks are found metamorphosed along the upper contact of the Nipissing Diabase in northeastern Firstbrook Township and in Coleman Township and as outcrop in southeastern Hudson Township. The Coleman Member consists of grey, massive, thickly bedded, pebbly wacke and quartz wacke with minor clast-supported conglomerate, grey-green feldspathic arenite, salmon-coloured arkosic arenite, overlain and interbedded with grey-green, siliceous, thinnly laminated to massive argillite.

Overlying the Coleman Member with apparent conformity is the Firstbrook Member of the Gowganda Formation. The lower portion of the Firstbrook Member is black thinly laminated shaley argillite progressing up through dark grey to grey shaley argillite. The middle and most extensive portion consists of thickly laminated, red siltstone, brownish red shale, with discontinuous beds of dark, green lithic arenite. Continuing up section the siltstone, is gradually replaced with fine-grained red wacke which increases in bed thickness and amount and contain thin wispy red shale beds. The top of the Firstbrook Member consists of very thin to thin beds of red wacke with minor discontinuous shale and siltstone. Ripple marks and cross beds are common.

Lying conformably, but with a sharp contact on the Firstbrook member of the Gowganda Formation is the Lorrain Formation. The Lorrain Formation outcrops as follows: southwest of the Montreal River in southern most Barr Township; Kittson and Coleman Township; in an arcuate, concave south, discontinuous band in central Firstbrook Township; and overlying a roll in the Nipissing Diabase in Coleman Township. The contact between the Gowganda Formation and Lorrain Formation has been defined in this map-area, as to occur with the appearance of thickly bedded, red arenite. Where the contact has been observed, little or no interbedding of rock types occur between formations. The Lorrain Formation consists of a basal red arenite grading rapidly up into grey to grey-green, fine grained feldspathic arenites.

Middle Precambrian Nipissing Diabase occurs as an undulatory sill outcropping between Le Moyne Lake and Pike Lake and between Spring Lake and the eastern map boundary south to Moose Lake. The sill intrudes both Middle and Early Precambrian rocks. Map 2361 (Card and Lumbers 1977) and Map 2205 (Pyke *et al.* 1973) show that this is the same undulating sill complex. The Nipissing Diabase sill that outcrops in Coleman and eastern Kittson Townships has a vertical dike component associated with it and may resemble the configuration of a step-sided cone mentioned by Lovell and Frey (1976). The diabase sills are not mineralogically consistant as shown by Hriskevich (1968). Hypersthene diabase grades up into a mesocratic varied-textured transition diabase with a granophyric upper zone. Pegmatite and pure granophyre occur throughout the upper portion of the sills.

Late Precambrian (Keweenawan) olivine and epidotized diabase occurs as narrow dikes cutting all older rock types. The Sharp Lake dike occurring in Bucke

Township and northeastern Firstbrook Township is the most extensive and economically important.

Structural Geology

The Middle Precambrian sedimentary rocks are gently dipping to flat lying. The region east of the Montreal River is basin shaped and the strikes and dips, except for local irregularities, reflect this feature. The strikes and dips of the sedimentary rocks west of the Montreal River are more irregular, but the sequence tends to top to the south. The irregularities in the strikes and dips may reflect the underlying Archean topography.

Northwest trending faults of the Timiskaming Rift Valley (Lovell and Caine 1970) cross the map-area. The Latchford Fault (Map 2361, Card and Lumbers 1977) follows the course of the Montreal River. A continuation of the Montreal River Fault (Map 2361, Card and Lumbers 1977) is postulated to extend to Le Moyne Lake where shearing, jointing, and veining trend N45°W. The Cross Lake Fault (Map 2361, Card and Lumbers 1977) is projected through the extreme northeast corner of the map sheet. Younger, northeast trending faults (Card *et al.* 1973) are also documented. The Eagle Lake Fault (Map 2257, Card *et al.* 1973) is extended into the map-area along the Lady Evelyn River. A low angle north-northeast trending thrust fault, containing thick sheets of quartz, occurs south of the east end of McLennon Lake. A northeast-trending fault crosses Highway 558 at the Barr–Firstbrook Township line and curves off in an east-northeast direction and ends just east of Pike Creek. South of Highway 558 and north of Malcolm Lake a parallel fault to this one disrupts the stratigraphy. Numerous north-, northeast-, and northwest-trending vertical shears are found throughout the area and a north-trending fault disrupts the stratigraphy south of Pike Creek, north of Charlotte Lake.

Folding is not extensive within the map-area. The Lady Evelyn Lake Anticline (Map 2257, Card *et al.* 1973) is thought to pass through Mahon Lake north of Mowat Landing. Minor synclines, anticlines, and monoclines were seen.

Economic Geology

The Firstbrook Lake area has undergone much exploration for silver. Many old, undocumented, pits, trenches, and shafts attest to this. The two Early Precambrian inliers have been looked at for their base-metal and silver potential.

Cobalt and Silver

The Coblat-Kittson Mine on Kitt Creek in Kittson Township was developed along a narrow Nipissing Diabase dike and 272 kg of Cobalt was removed from the mine (Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake). Gold was reported from samples taken from the 136 m and 182 m levels and assayed at 0.08 and 0.20 ounce of gold per ton. No silver was reported from the mine (Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake).

The Dotsee Mine (Seed Mine) southeast of Moose Lake in Bucke Township was another cobalt prospect with minor silver. Available assays indicate 2.19 and 2.70 percent cobalt and 1.18 ounces and 0.96 ounces of silver per ton (Thomson 1964). Finely disseminated cobaltite occurred through the diabase in widths from 0.6 to 1.5 m. In 1930, 2865 kg of ore was processed; in 1938, 1 to 2 thousand tons were milled and in 1939, 2,000 tons were milled (Thomson, 1964).

The Mckinnon Mine was sunk to a depth of 45 m on the Sharp Lake dike just north of Highway 558. Small quantities of cobalt were reported (Thomson 1964).

The pits and shafts that are found around the Portage Bay Lodge are reported to have contained cobalt bloom (Albert Chitarroni, personal communication, 1979). Cobalt bloom was seen by the author in pits sunk along the Sharp Lake dike in northern Firstbrook Township.

Base Metals

Pyrite, magnetite, and minor chalcopyrite are common minerals associated along the diabase contacts. Detrital pyrite was seen in the Lorrain Formation and minor flakes of chalcopyrite were seen in the Coleman member, Gowganda Formation.

Finely disseminated, and local concentrations of chalcopyrite are found at the interface of the felsic metavolcanics and the Firstbrook Member of the Gowganda Formations. Local concentrations of chalcopyrite and bornite were caused by remobilization and contact effects of the biotite lamprophyre dikes cutting the metavolcanics (Assessment Files Research Office, Ontario Geological Survey, Toronto).

All samples collected during the field season were checked with a gamma ray spectrometer with negative results. John Wood (Geologist, Ontario Geological Survey, personal communication, 1979) reported chalcocite in the dark grey, finely laminated Firstbrook member of the Gowganda Formation outside the map-area. The possibility of disseminated stratiform sulphide mineralization of this type in the Gowganda Formation of the map-area should be considered.

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No. S7 Abitibi Alteration Study

E.C. Grunsky[1]

Introduction

Examination of altered and unaltered volcanic rocks is being undertaken in the Kirkland Lake portion of the Abitibi Belt of Ontario. At present, the study is being concentrated on the altered volcanic rocks belonging to the Blake River Group (Jensen 1978), in the area of Clifford and Ben Nevis Townships, north of Larder Lake. Precious- and base-metal mineralization has been noted by Jensen (1975a) and Wolfe (1977) in rocks of the same composition and age to those that host the mineralization in the Noranda Mining area to the east. The purpose of the study is to attempt to determine the amounts and types of alteration associated with volcanic rocks. Areas of alteration will be examined to determine its significance to base- and precious-metal mineralization in stratiform type and associated vein type deposits. The study will attempt to provide a useful tool by which potential exploration targets may be determined on the basis of bedrock geochemistry. It is a fact that many major base- and precious-metal deposits have extensive halos of alteration caused by the advection of hydrothermal brines rich in metallic ions (Sangster and Scott 1976). These metallic ions precipitate as sulphides to form local vein and massive deposits near and at surface. The advection of hydrothermal brines generally occurs 2 to 10 km from active volcanic vents (Jensen personal communication 1979). The associated halo of alteration does,however, tend to be several times larger than the mineral deposit and thus presents a greater chance of being located.

During the field season of 1979, the author examined parts of Clifford and Ben Nevis Townships. Samples were collected for chemical analyses, particularly in areas where alteration had been noted (Jensen 1975a; Wolfe 1977). Carbonatization of felsic volcanic rocks was noted in the Ranger Lake area of Ben Nevis Township and silicification together with carbonatization in the Verna Lake area on the Ben Nevis–Clifford Township boundary. Silicification occurs in the Pushkin Hills between Verna and Ranger Lake. Several aeromagnetic survey maps cover the area, the most recent being the OGS Electromagnetic and Total Intensity Magnetic Survey Preliminary Map P2554. The electromagnetic and magnetic profiles are nearly flat although there are known deposits in the area (Canagau Mines Limited, files *in* Assessment Files Research Office, Ontario Geological Survey, Toronto). This suggests that alternate methods are required to locate deposits that do not show up from geophysical surveys. Chemical studies that delineate alteration patterns would be a useful exploration tool.

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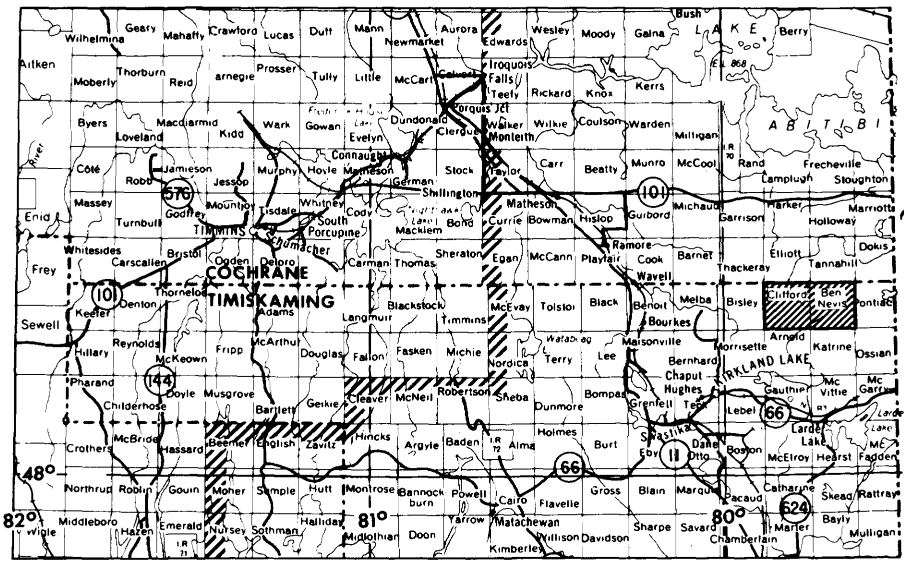

LOCATION MAP

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

Previous maps and reports of the Ben Nevis–Clifford Townships area have been given by Wilson (1901, p.119A-120A), Knight (1920), Gledhill (1929) and most recently by Jensen (1975a) and Wolfe (1977). Wolfe's study consisted of a bedrock geochemical investigation of Cu, Ni, and Zn concentrations that outline zones of mineralization and alteration in the area.

General Geology

Jensen (1975a) described the geology of Ben Nevis and Clifford Townships in detail and the reader is referred to that report for a full description. The volcanic rocks of the area have been included in the Blake River Group of early Archean volcanic rocks that conformably to disconformably overlies the Kenojevis Group of volcanic rocks to the south (Jensen 1978, p.70). The main source of the Blake River Group in this area is from two main volcanic vents situated in Pontiac Township (Jensen 1975b) and at the boundary of Clifford and Ben Nevis Townships. The vents lie along the axis of a large regional east-west trending synclinorium of which the Blake River Group lies at the top. The vents themselves occur as domes around which north-south and east-west anticlinal and synclinal structures have developed. The volcanic rocks of the Blake River Group consist of predominantly a calc-alkaline suite of basalt, andesite, dacite, and rhyolite that have been metamorphosed to low-grade regional metamorphism. Local higher grade contact metamorphism occurs around numerous granodioritic stocks in the Pontiac, Clifford, and Ben Nevis areas.

A cross section of the stratigraphy can be observed from east-central Clifford Township eastward to the Pushkin Hills. The diapiric effects of the granodiorite stock in Clifford Township has exposed a lower unit of calc-alkaline basaltic flows followed by overlying andesite- dacite flows and fragmentals overlain by rhyolite flows and fragmentals that is topped by andesite-dacite flows and fragmentals (Figure 1). Jensen (1975a, p.11) delineated an upper and lower felsic sequence. The lower unit occurs north of Verna Lake, lying above the lower calc-alkalic basalt and has been interpreted to reappear in the area north and west of Ranger Lake in east-central Ben Nevis Township. The lower unit of felsic volcanic rocks show extensive alteration due to carbonatization, and all of the known base-metal occurrences in Clifford and Ben Nevis Townships are within this unit. The upper felsic volcanic rocks form a belt north and south of the Clifford Township granodiorite stock on the flanks of an east-trending anticline plunging easterly that closes in the Pushkin Hills (Figure 1). The upper unit characteristically shows alteration features due to silicification and very few base-metal occurrences have been noted within this unit. Silicification extends upwards into the overlying andesitic unit. Wolfe (1977) showed that the trace-element distribution of Ni, Zn, and Cu are correlative with the lithologies and that the upper felsic unit is depleted relative to the enrichments of the lower felsic unit.

In the areas of intense alteration (north and west of Ranger Lake), recognition of the original rock type is nearly impossible due to the extensive amount of carbonatization. Presently within the areas of alteration, lithologies can be described in general terms. It is intended in the study to try and determine the original rock type on the basis of chemistry.

The study will attempt to determine the types of chemical profiles that are associated with altered volcanic rocks and associated sulphide mineralization. Several methods will be applied in order to determine the amount and type of alteration associated with economic mineralization and the host volcanic rocks. Much of this work will be performed on a computer-based system, using a large number of chemical analyses collected previously, and in addition, those collected by the author. Petrographic studies of the altered and unaltered areas will be carried out in order to aid understanding the nature of alteration. Presently, the scope of the study is being restricted to the Clifford–Ben Nevis Townships area. A regional study, however, will evolve following the preliminary investigation of the Clifford–Ben Nevis area.

Mineral Exploration[1]

Detailed description of occurrences and properties up to the year 1968 are given by Jensen (1975a, b), and the reader is referred to those publications for additional information.

More recently, Amax Exploration Incorporated performed work in both Ben Nevis and Pontiac Townships and Noranda Exploration Company Limited performed work in Clifford Township.

Amax Exploration Incorporated, from 1971 to 1973, worked on an area covering 230 claims in east-central Ben Nevis Township and Pontiac Township including an option on three patented claims of the Canagau Mines Limited property. Airborne electromagnetic surveys, induced polarization, geological, and bedrock geochemical surveys were carried out followed by putting down 11 diamond drill holes totalling 1263.4 m in length. Only one diamond drill hole produced any significant metal values. No further work was carried out.

Noranda Exploration Company Limited acquired in 1976 a block of 14 claims adjacent to the Croxall Property (Henrick Property). Magnetometer, induced polarization, and geological surveys were carried out followed by rock trenching and the diamond drilling of four holes totalling 227.9 m in length. The assay results from surface sampling and diamond drill core were considered low and no further work was reported.

Lovell *et al.* (1975; 1976) have compiled maps displaying exploration work as recorded at the Assessment

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1 Information obtained from the Assessment Files Research Office, Ontario Geological Survey, Toronto, and Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake.

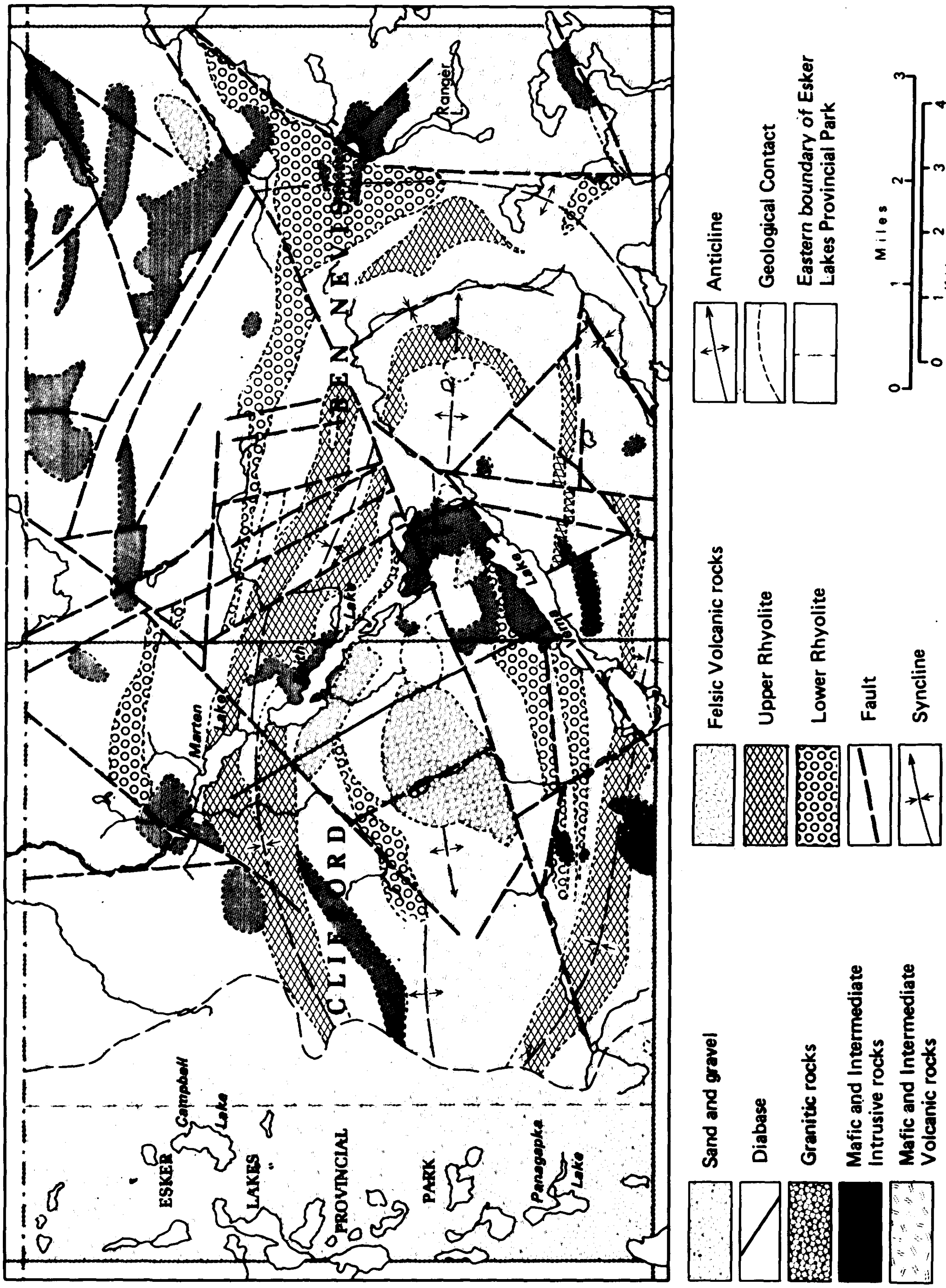

Figure 1—Geological sketch-map of Clifford and Ben Nevis Townships (modified from Jensen 1975a).

Files Research Office, Ontario Geological Survey, Toronto, and from the Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake.

Economic Geology

Economic mineralization in the Clifford–Ben Nevis–Pontiac Townships area is predominantly that of Cu-Zn-Pb-Ag-Au sulphide deposits interpreted to be of volcanic exhalative origin or related to exhalative processes associated with it.

Wolfe (1977, p.9-10) summarized the type of mineralization in a description of the Canagau Mines Limited deposits:

> The deposits in east-central Ben Nevis Township northwest of Ranger Lake are closely associated with strongly foliated, carbonatized, and sericitized rhyolite tuff, tuff-breccia, and lapilli-tuff of the lower rhyolite pyroclastic unit. The Canagua mineralization is localized near the hinge line of a south plunging anticlinal structure the core of which is occupied by the structurally thickened lower rhyolite pyroclastic unit. Sphalerite, galena, chalcopyrite, pyrite, pyrrhotite, silver, and gold occur in deposits described as veins or massive replacements in shear zones in altered rhyolite tuff, or as disseminated minerals in adjacent tuff. The main vein or shaft vein is exposed at surface in an outcrop of rhyolite tuff and can be traced over a length of 24 m (80 feet) with widths of 15 to 45 cm (6 to 18 inches). Surface and underground work suggests that the vein strikes east for 120 m (400 feet) and extends to a vertical depth of 99 m (325 feet), although geological plans and sections given by Jensen (1975a, p.38) indicate that the mineralization may more realistically be represented by a vein stockwork rather than a single vein. Extensive sericite, chlorite, talc, and carbonate alteration is developed in the mineralized rhyolite tuff near the Canagua shafts. South of the shafts, the sheared tuffaceous volcanic rocks along the axial trace of the major south-trending fold structure contain widespread disseminated sulphide minerals. The volcanic units flanking the central rhyolite core rocks to the south-west are highly chloritized and contain vesicle fillings of chalcopyrite and chlorite. The Canagau deposit has more similarity with stockwork stringer mineralizations in alteration pipes which underlie exhalative massive Cu-Zn-Pb-Ag-Au sulphide deposits than with vein-replacement mineralization.

All of the mineral occurrences or deposits in the area have associated with them, either pervasive quartz-carbonate alteration or quartz- carbonate veining.

Detailed descriptions of properties and occurrences existing previous to 1968 are given by Jensen (1975a, b).

Amax Exploration Incorporated, during the period of 1971 to 1973, drilled eleven diamond drill holes, all of them intersecting sulphide mineralization, but most sulphide consisted of pyrite. In one hole, 1300 m west of Ranger Lake, assay values of sulphides averaged 2.63 percent Zn, 0.40 percent Cu, 41.7 ppm Ag, and 0.008 percent Pb in core lengths of 1 and 2.3 m, intersected at a depth of 20.6 to 22.1 m. Two closely-spaced drill holes did not locate the extension of the mineralized zone. The mineralization occurs as pyrite, chalcopyrite, and sphalerite in veins and stringers of white quartz and carbonate filling a grey-green brecciated amygdaloidal dacite that grades downwards into a non-brecciated dacite. Sulphide mineralization in the area examined by Amax Exploration Incorporated, occurs within an area that has undergone pervasive carbonatization associated with the lower felsic volcanic unit.

Noranda Exploration Company Limited, in 1976, located several surface sulphide showings, north of Verna Lake in the area of the Henrick Prospect. The mineralization is comprised of 2-3 percent disseminated pyrite with sporadic occurrences of chalcopyrite and bornite usually less than 1 percent by volume. Assay values of Cu from surface values gave a maximum of 0.34 percent, averaging 0.14 percent. One assay value for Zn gave 0.25 percent, and only trace amounts of Au were found. Two other nearby occurrences contain pyrite with small patches and stringers of chalcopyrite over a width of 4.6 to 6.1 m. None of the surface values could be traced from their location. A diamond drill hole that was sunk on the later surface showing intersected sulphide mineralization at a depth of 2.0-4.6 m and assay values of Cu are 0.15 percent. The sulphide mineralization occurs with the lower unit of felsic volcanic rocks, which is comprised of rhyolite and dacite porphyry interbedded with pyroclastic tuff and lapilli-tuff. Dacite and andesite are intermittently interbedded. Silicification and carbonatization has pervasively altered the rocks in this area, and the sulphide commonly occurs as stringers and patches within zones of intense alteration.

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No. 58 Kirkland Lake Area, Stratigraphic Mapping, District of Timiskaming

M.J. Downes[1]

Introduction

Field work done in 1979 represents the first part of a three year program, under the Kirkland Lake Incentive Program (KLIP), to carry out stratigraphic mapping covering an area straddling the Kirkland Lake–Larder Lake 'break', from the Quebec border in the east to Highway 11 in the west. This first year covers that area within McGarry and McVittie Townships comprising the alkalic volcanic rocks and associated sedimentary rocks of the Timiskaming Group, together with the ultramafic volcanic rocks and sedimentary rocks north of Larder Lake.

Initiation of this program was an offshoot of regional and stratigraphic mapping of the Kirkland Lake and Larder Lake areas at a scale of 1:63 360 by L.S. Jensen (1978a and b).

The scale chosen for mapping was 1:4800 (1 inch to 400 feet) this also being the original scale of Thomson's (1941) mapping. Control was by air photos, enlarged from the ¼ mile series, together with Thomson's (1941) outcrop distribution which was found to be both reliable and accurate.

Kirkland Lake is primarily a gold camp, and the main impetus of this study is towards applying stratigraphic mapping to understanding the controls of gold mineralization. Additional attention has been paid to base metals and uranium (in the alkalic volcanic rocks).

The objectives can be summarized as follows:

(1) To what extent gold mineralization is controlled by.

a) Stratigraphy and lithology;

b) Alteration, by carbonatization and silicification;

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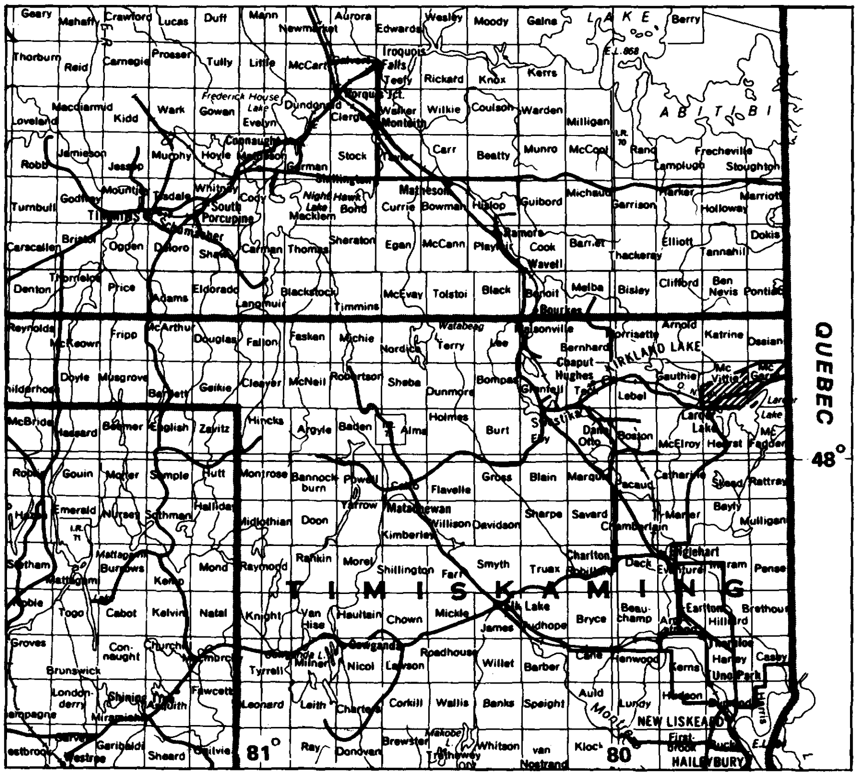

LOCATION MAP

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

c) Structure, by folding or association with fault zones.
(2) What are the relative age relationships of:
a) Rock units on either side of the 'break' and also the amount of displacement along the 'break';
b) The alkalic volcanic rocks and associated sedimentary rocks (Timiskaming Group) to the sedimentary rocks and associated ultramafic and mafic volcanic rocks around Larder Lake.

General Geology

Two stratigraphic packages have been distinguished, based on their associated lithologies and relative position to one of two structural discordances. Prior to discussing the stratigraphy these discordances will be outlined (Figures 1 and 2).

Structural Discordance A

This occurs between the southern limit of alkalic volcanic rocks with associated sedimentary rocks and a sequence in the south comprising turbidites with mafic to ultramafic volcanic rocks.
It is marked by:
1) Conflicting tops (back to back relationship) with no possibility of intervening fold closures;
2) Shearing and highly schistose rocks, in particular sericite schists.
This, then, is a lithological and structural discordance.

Structural Discordance B

A further major discordance occurs across what has previously been called the Kirkland Lake 'Break'. In the vicinity of Virginiatown, this is seen as east to northeast-plunging fold axes (both major and minor folds) on the north side and southwest-plunging fold axes on the south side of the east-west discordance. Both types of folds have approximately the same axial planar orientations and indicate probable rotation along the discordance. This is essentially a structural discordance as the lithologies on either side are stratigraphically related, whereas they are not in case A.

Stratigraphy

North of Structural Discordance A

Basal grits of the Timiskaming Group unconformably overlie tholeiitic basalts of the Kinojevis Group (Jensen 1978). A potassic calc-alkalic pyroclastic unit, the Gauthier Group, underlies the Kinojevis Group in the northern part of McVittie Township, Jensen (1976), Ridler (1976). In both McVittie and McGarry Townships the alkalic volcanics of the Timiskaming Group are dominantly pyroclastic breccias, but also contain monomictic conglomerates. In addition, some polymictic conglomerates and grits, within these volcanic rocks characteristically contain jasper and emerald green fuchsite bearing carbonate clasts.

Stratigraphy South of Discordance A

Kinojevis tholeiitic basalts lie at the base of the sequence, and are overlain unconformably by proximal turbidites in McGarry Township. The turbidites occassionally contain thin (10 to 50 cm thick) magnetite ironstone beds in a wacke rather than chert association. Above these sedimentary rocks lies a volcanic unit comprising from base to top; hyaloclastites of probable Fe tholeiitic basalt composition; variolitic pillowed basalts; hyaloclastites and palagonite tuffs with finely bedded cherts (probable felsic tuffs), pillowed Mg tholeiitic basalts, and ultramafic monomictic conglomerates containing dominantly polysutured ultramafic clasts, occasional spinifex-textured clasts, and rare felsic volcanic clasts. Ultramafic flows, *per se*, have not been observed in this area, but some massive polysutured ultramafic units may represent flow front talus.

Above the volcanic rocks lie distal, fine-grained and chloritic turbidites containing interbedded magnetite ironstones and occasional graphitic horizons, each being 10 to 20 cm thick. Near the Cheminis property (see Thomson 1941) there occurs a rhythmite consisting of thin 1 to 2 cm layers of magnetite ironstone and hematite ironstone spaced at regular intervals of 30 to 40 cm, repeated over about 5 m of fine-grained turbidites.

Other associated sedimentary rocks are arkoses, and conglomerates containing ultramafic clasts in McGarry Township. Near Larder Lake townsite, these sedimentary rocks contain pebble conglomerates with magnetite ironstone clasts and jasper clasts. In some cases, individual clasts contain interbanded jasper and magnetite ironstone. Lying above these are conglomerates containing banded magnetite ironstone-chert fragments, resembling units of the Boston iron formation at the Adams Mine. In addition, they contain some felsic volcanic fragments similar to the Skead Felsic pyroclastic rocks (Jensen 1978a and b). Intrusive syenites appear to have no spatial relationship to any particular part of the stratigraphic section.

Structure

In the rocks south of Discordance A, the dominant fold structure is a syncline, the northern limb of which follows Highway 66 through both McVittie and McGarry Townships with sediment tops facing south. The fold closure is within the Kerr Addision Mine site, and the southern limb strikes NE-SW, with sedimentary rocks and pillows topping to the NW. The axis of this fold plunges 45° to 60° to the SW. Just south of Barber Lake (McGarry Township), the turbidites are isoclinally folded, with four fold axes and associated bedding reversals observed over 46 m perpen-

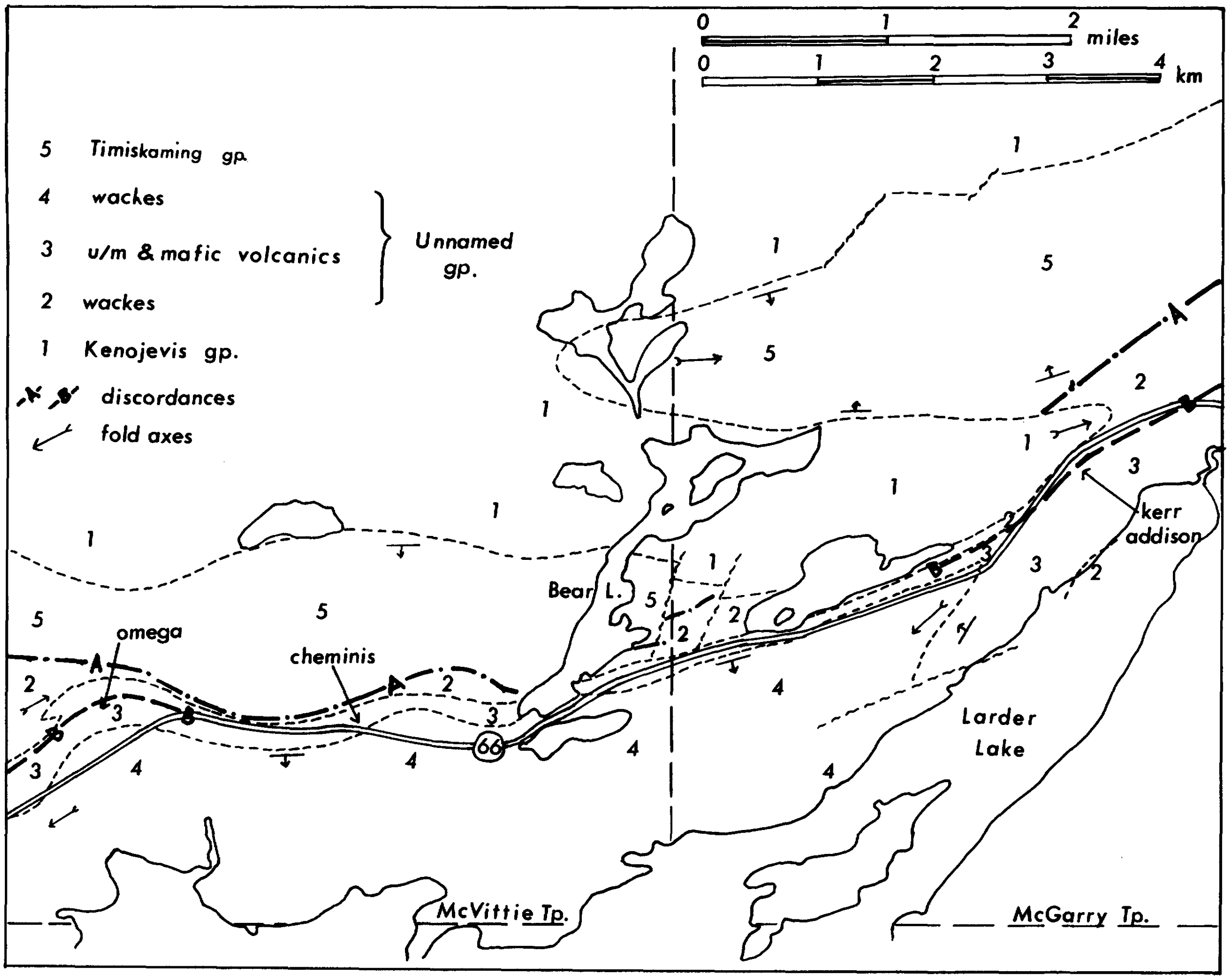

Figure 1—Part of map-area showing discordances and major units.

dicular to strike. This style of deformation is typical of the sediments and the form of these minor folds mirror the major structures.

Major synclinal and anticlinal structures to the north of Discordance A plunge about 60 to 70° to the east. Axial planar cleavage is well developed in the sediments throughout the area and demonstrates the presence of only one significant phase of folding.

Alteration Processes

1) Carbonatization

It has been the author's observation that the bulk of the carbonate units contain relict textures, making possible their assignment to respective ultramafic, mafic volcanic, and sedimentary units. The carbonate is primarily a ferro-dolomite with minor ankerite, magnesite and calcite (Tihor and Crocket 1977). It is possible to trace unaltered pillowed variolitic units and hyaloclastite units into carbonatized equivalents, where all the original textures are preserved. This indicates a major pervasive carbonatizing event crosscutting lithological boundaries.

The timing of this event can best be demonstrated by the following observations:

1) Ultramafic clasts in conglomerates stratigraphically overlying the carbonatized volcanic rocks in the Virginiatown area are unaltered;

2) The presence of fuchsite-bearing carbonate clasts in the Timiskaming indicates that the carbonatization was active or complete at that time.

3) In the area of Virginiatown, the carbonatization crosses Discordance B ('the break') from volcanic rocks on the south side to sedimentary rocks on the north side, suggesting that it may be contemporaneous with the development of the discordance. The sedimentary rocks on the

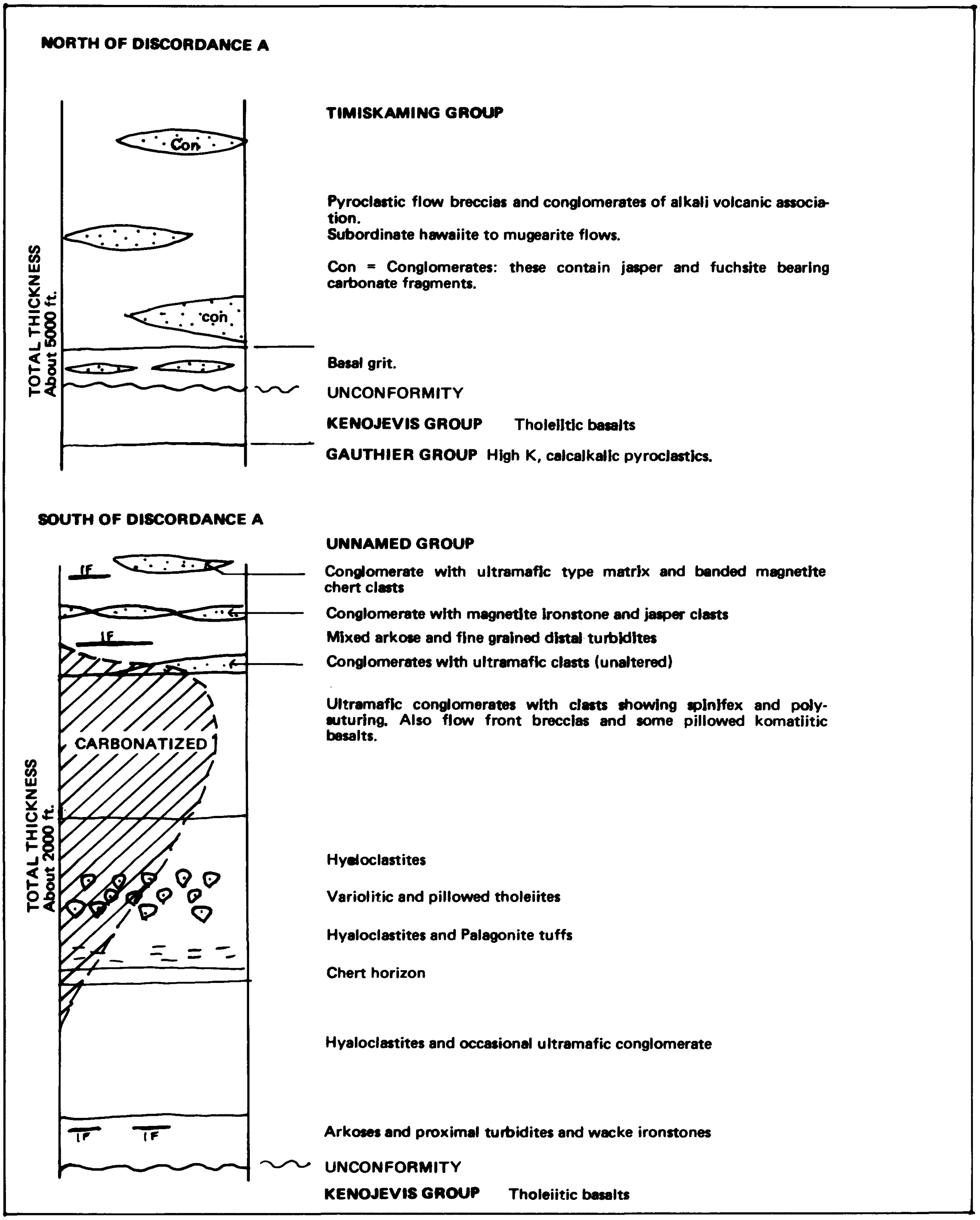

Figure 2—Stratigraphic sections north and south of Discordance A.

north side can be traced to unaltered equivalents.
4) At the Kerr Addison Mine, the main carbonate zone, which is composed of carbonatized ultramafic breccias and conglomerates, is spatially related to the hinge zone of the major southwest-plunging syncline, inplying a possible structural control.

It is important to note that the most common lithology to be carbonatized in the area is of ultramafic composition which gives an apparent lithostratigraphic appearance to the carbonates. Of problematic origin are some finely laminated carbonates. These may be primary bedded carbonates similar to those occurring at the Dome Mine, Fryer *et al.* (1979) and Kerrich and Fryer (1979).

2) Potassic Metasomatism

This takes the form of sericitization associated with the development of quartz veins, stockwork and ladder type veins within the carbonatized volcanics. A buff coloured sericite is common within shear zones throughout the alkalic volcanic rocks and sediments. Within the ultramafic volcanics (carbonatized) the sericite picks up enough chrome to form the emerald green mica fuchsite. It has been observed as an alteration zone extending away from the contacts of the quartz veins. Alteration widths vary with the width of the vein, and may be a few centimetres to several metres. This style of alteration is also observable in the Dome mine near Timmins and in altered ultramafics in S. Africa (T. Pearson, personal communication).

Gold Mineralization

At the Kerr Addison Mine, gold mineralization occurs in two main modes:

1) What has been described as green carbonate. This host is a fuchsite-bearing dolomitized ultramafic volcanic rock. The gold occurs as free gold in quartz veins related to the metasomatic alteration.

2) Flow Ores: This includes several lithological types, the only common denominator being that they are all pyritic and possibly silicified tuffs interbedded with mafic pillowed flows. Gold is hosted by the pyrite and varies in grade depending on the grain size of the pyrite, fine-grained higher grade, coarse-grained lower grade (Kerr Addison staff). At Barber Larder and Cheminis, ore zones are in a pyritic carbonatized hyaloclastite unit. Other hosts are cherty tuff where it is pyritic.

Conclusions and Recommendations

1) The 'green carbonate' is clearly an alteration effect as is the gold associated with it.
2) The pyritic ores are as yet problematic. Some pyritic zones (as at Barber Larder-Cheminis) appear to be strata-bound and confined to definite lithologies such as the hyaloclastite; others such as the flow ore appear more nebulous. These pyritic ores present a viable geophysical and drilling target, whereas the green carbonate does not.
3) The southern limb of the syncline containing the ultramafic rocks, strikes southwest into Larder Lake south of Discordance B. A profitable area to look for Kerr-type stratigraphy would be south of Larder Lake and possibly into Hearst Township (a conclusion also reached by Thomson 1941, p.19).

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Engineering and Terrain Geology Section

Summary of Activities of the Engineering and Terrain Geology Section 1979

Owen L. White[1]

The activities of the Engineering and Terrain Geology Section continued to expand in Northern Ontario with the aid of funds provided by the Ontario Ministry of Northern Affairs and through joint projects funded by both the Ontario Ministry of Northern Affairs and the federal Department of Regional Economic Expansion. Activities continued in southern Ontario with regional mapping of both the Paleozoic rocks and the Quaternary deposits and with the initiation of an engineering geology study in the Toronto area.

The Paleozoic rocks of central southern Ontario are being re-examined and re-mapped in view of developments that have occurred since geologists of the Geological Survey of Canada studied the area some 20-30 years ago. D.M. Carson mapped an area during this past year which is covered by eight NTS map sheets at the scale of 1:50 000 in the Peterborough–Campbellford area. The rocks, largely limestones and shales, are of Middle Ordovician age and lap onto the Precambrian rocks in the northern part of the map-area. Although the rocks are generally flat lying, several unusual fold structures are reported. The limestones are being quarried for use as crushed stone and in cement production. Many more quarries have operated in the past than are presently operating today.

M.D. Johnson commenced the mapping of the Ordovician and Silurian limestones, dolostones and shales of Manitoulin Island as part of a project to assess the resource potential of the limestone and dolostone on the island. The surface mapping is supported by subsurface drilling. In the Fall of 1978, 10 holes were drilled for a total of 543 m and in the Fall of 1979 an additional 168 m of core is expected to be recovered. Chemical and physical testing will follow. There is one dolostone quarry (in the Amabel Formation) at present operating on Manitoulin Island but the potential exists for possible further development of the rocks as a source of material for the construction or chemical industry.

Quaternary geology mapping in Southern Ontario continued with the completion of work in two areas: Owen Sound (B.H. Feenstra) and Markham (J.A. Westgate). A new project, initiated by W.D. Fitzgerald in the Wallaceburg, St. Clair Flats and Chatham area will help towards the completion of the surficial mapping program in that area.

The Owen Sound area includes a considerable expanse of bedrock with only a thin drift cover although in the east numerous drumlins are formed from sandy silt till in the vicinity of Bighead Valley. Sand and gravel deposits are numerous but generally small in extent. Many have been worked to depletion. Shorelines associated with glacial lakes Nipissing and Algonquin have been mapped in the area.

J.A. Westgate completed the mapping of the Markham area with stratigraphic studies along the Scarborough bluffs and the river valleys and indicates that Halton Till is thin over most of the area and underlain for the most part by sands and gravels. The outer limit of the till has been recognized just to the southeast of Aurora.

The Wallaceburg, St. Clair Flats and Chatham area is underlain largely by lacustrine and alluvial deposits but with a till plain present in the north and a sand plain and some sand dunes in the south. Only one outcrop of Paleozoic bedrock was noted over the whole area (shale of the Kettle Point Formation near Florence). The silt till, rich in black shale fragments, reported previously in the Sarnia area (Fitzgerald 1977) has been mapped at the surface south to near Dresden and is seen even farther south in river sections and excavations. Several multiple till sections are reported near Dawn Mills.

Apart from the lacustrine sediments blanketing the area, features possibly related to glacial Lake Algonquin and early Lake St. Clair are reported. Beach deposits are worked in

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several localities to supply small local requirements for sand and gravel. Otherwise sand and gravel deposits are generally lacking.

In mapping the Quaternary deposits in the Pembroke area in 1979, P.J. Barnett completed the mapping of an area covered by five map sheets in the Ottawa Valley.

Bedrock in the Pembroke area consists of Precambrian rocks with some small areas of Paleozoic outliers. Drift is thin in the western part of the area but, along the Ottawa Valley, thickens considerably. Erosional terraces have been cut into these thick drift deposits. Till occurs at the surface to the west and three morainal positions are reported. Champlain Sea deposits of silt and clay occur along the Ottawa Valley to north of Petawawa, but are restricted to elevations below 167 m above sea level. Several abandoned shoreline features are reported. A variety of glacial and glacial-marine deposits have been and are currently being worked for sand and gravel requirements. Resources appear to be adequate for local requirements.

In 1979 P.J. Barnett also completed the mapping of the Quaternary deposits of the Bancroft area. This area was mapped not only to provide information on the local stratigraphy and glacial history and for the identification of potential sand and gravel resources but also to provide guidance to persons involved in drift prospecting and environmental background studies.

The till in the area has a sandy texture and contains numerous cobbles and boulders. Indicators of the direction in which the ice moved are many and varied. Although thin and discontinuous in many places, the till thickens in other places to form drumlinized or fluted till plains. In many cases in the area, drumlins are rock cored. Varved and outwash deposits are reported in several localities. Five sand and gravel pits were operating in 1978 and others were operative on demand. Numerous small pits have been operated in the area over the years.

In Northern Ontario, Quaternary mapping parties were active in the Kirkland Lake-Ramore area, the Timmins area and in the Nassau Lake area. In addition, preliminary studies were initiated in the Atikokan area and studies started in the Red Lake–Ear Falls area in 1978 (Prest 1978) were concluded in the 1979 season.

C.L. Baker continued field mapping in the Kirkland Lake area and in 1979 completed the mapping of the Kirkland Lake and Ramore map sheets. Some additional time was spent at the end of the season in the Cobalt area in a preliminary review of sand and gravel resources.

The Kirkland Lake–Ramore map-areas are characterized by extensive areas of clay and sand deposition. The lacustrine sand deposits have been reworked into dunes with large areas of peat and muck between the dunes. Rock knobs protrude through the sand and clay where the deposits are thin. In several areas sand and gravel deposits are both thick and of large areal extent. Local tills are variable in texture and usually thin and discontinuous. Sand and gravel resources in the map-area are numerous and widely distributed. Most commerical operations are located in the esker complexes.

C.M. Tucker mapped the Quaternary deposits of the Timmins map-sheet. The area is characterised by three north-south esker ridges. Cobbly, sand till, probably correlated with the Adam Till of Skinner (1973) occurs in the eastern part of the map-area except where overlain by the glaciolacustrine deposits of glacial Lake Ojibway. No exposures of the silty clay Cochrane Till were found in the area. Sand and gravel deposits are to be found within the three eskers and several pits are currently operating therein.

The Nassau Lake area, 25 km west of Hearst mapped by M.L.T. Crosbie is characterised by a major southeast-trending esker complex which extends for 22 km through the northern part of the map-area. The esker complex rises to up to 90 m above the surrounding lowlands which are underlain by silty clay Cochrane Till or the silts and clays of the post-Cochrane lake phase. The glaciolacustrine deposits are often themselves covered by up to 50 cm of peat. The esker complex could be a significant source of local sand and gravel supplies but the high percentage of chert clasts that are present may reduce its potential for use in high quality concrete.

The northern Ontario project of the Ontario Centre for Remort Sensing (O.C.R.S.) entered its third year in 1979 and for the third time a member of the Engineering and Terrain Geology Section was attached to the O.C.R.S. party. E.V. Sado spent six weeks in a 100 000 km^2 area north of Latitude 50° north and Longitude 86° west inspecting and recording sections of Quaternary deposits along the main rivers in the area. The area surveyed extended the area reported on by R.G. Skinner of the Geological Survey of Canada in 1973.

The Northern Ontario Engineering Geology Terrain Study (NOEGTS) entered its third and final phase in 1979 with studies by James Neilson and Associates Limited and Gartner Lee Associates Limited. In an area in northwestern Ontario located between Latitudes 50° north and 51° north and between the Ontario–Manitoba border and Longitudes 86° west. Maps and reports for these areas will be issued in the same format as that proposed for Phases I and II (Gartner 1978). A similar study in Southern Ontario is currently under way by J.D. Mollard and Associates Limited in an area bounded by Latitudes 46° north and 45° north and Longitude 77°30′ west and 81° west.

In the Toronto area, D.R. Sharpe has initiated a project to prepare a compilation of the surficial geology of Metropolitan Toronto and surrounding area on a map at a scale of 1:50 000. This project has involved the collection and evaluation of data in geotechnical reports as well as additional field work in natural exposures and new excavations.

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No. 22 Quaternary Geology of the Wallaceburg (40J/9), St. Clair Flats (40J/10E), and Chatham (40J/8) Areas, Lambton and Kent Counties

William D. Fitzgerald[1]

Introduction

The Wallaceburg-St. Clair Flats-Chatham map-area is located between Latitudes 42°15′ and 42°45′N and between Longitude 82°00′W and the St. Clair River. The western boundary of the Chathan map-area consists of Lake St. Clair and Longitude 82°30′ in the southern quarter.

Quaternary geological mapping was begun during the summer of 1979. The Wallaceburg-St. Clair Flats map-areas were completed and the Chatham map-area was partially mapped. Completion of the Chatham area is scheduled for 1980.

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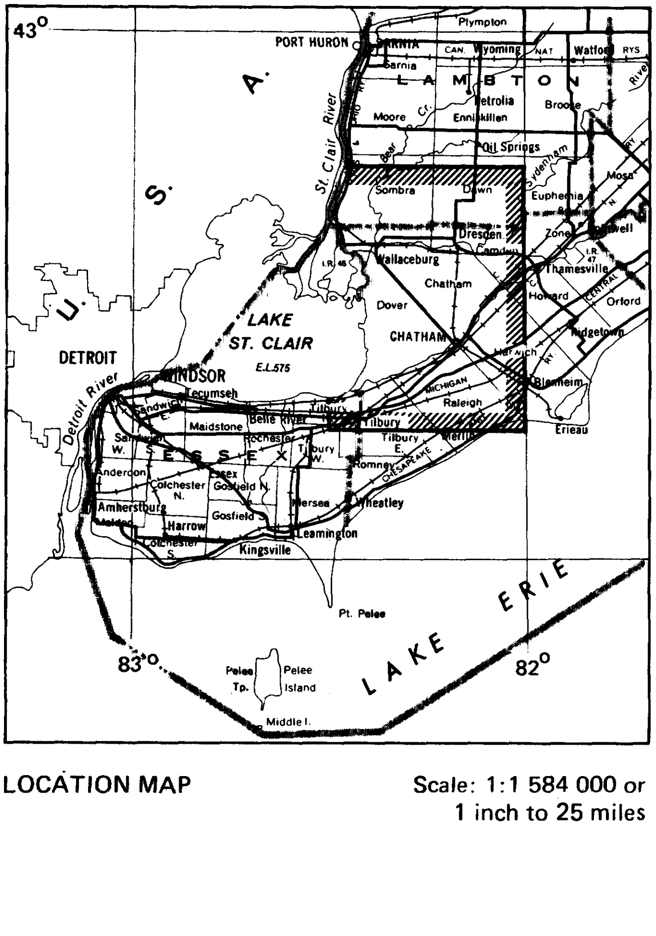

LOCATION MAP

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

Physiography

The Wallaceburg-St. Clair Flats-Chatham map-area consists of a till plain in the north, an area of poorly developed sand dunes in the southeast, and lacustrine and alluvial deposits in the remainder. The map-area lies entirely within the physiographic regions of the St. Clair Clay Plains and the Bothwell Sand Plain as described by Chapman and Putnam (1966). The St. Clair Clay Plains region is subdivided into the Chatham flats, Lambton clay plain, and the Essex clay plain of which only the first two are present in the area. The till plain in the northern area lies within the Lambton clay plain, an area of discontinuous, thin lacustrine silts and clays overlying till. Lacustrine and alluvial deposits cover the largest area and correspond to the Chatham flats. This area is an abandoned lake plain with numerous alluvial features. The alluvial features are the deposits of rivers that entered into a postglacial lake which occupied the St. Clair Basin at a higher level than present day Lake St. Clair. The southeastern area is part of the Bothwell Sand Plain, an area of medium-fine sands with weak development of sand dunes.

Paleozoic Geology

The map-area is underlain by: shale and limestone of the Hamilton Group of Middle Devonian age; shale of the Kettle Point Formation of Upper Devonian age; and shale and sandstone of the Port Lambton Group of Upper Devonian-Early Mississippian age. The Kettle Point Formation underlies the greatest part of the area with only scattered sub-crops of the Hamilton and Port Lambton Groups.

The bedrock is entirely overlain by thick deposits of Quaternary materials with the exception of one outcrop of Kettle Point shale in the Sydenham River south of Florence.

Quaternary Geology

Mapping of the Wallaceburg-St. Clair Flats-Chatham map-area has resulted in all of the surficial materials being interpreted as Late Wisconsinan in age or younger. The black shale-rich, clayey silt to sandy silt till described by Fitzgerald (1977) in the southern half of the Sarnia (40J/16) map-area has been traced southward to a point 3 km north of the town of Dresden where its presence is obscured by overlying lacustrine clay. In subcrop, this till can be traced farther south in river sections, ravines, and excavations. Multiple till sections have been found along the Sydenham River near Dawn Mills. The tills are thin and reflect the incorporation of associated sands and silts. This sequence of glacial and non-glacial units may reflect an oscillating ice front.

Processes of deglaciation, namely glacial lakes and associated rivers, have extensively affected the map-area. Lacustrine sands, silts, and clays, plus alluvial fine sand and silt cover much of the map-area. The postglacial lake history is well recorded in deltaic features, terraces, and lake shoreline features. A well-developed scarp, possibly a feature of glacial Lake Algonquin, can be observed at 183-184 m above mean sea level, near Charlemont and Becker. Possible Early Lake St. Clair features are present at 180 m above sea level near Wallaceburg and Port Lambton.

Economic Geology

The most important economic aspect of the geology of the Wallaceburg–St. Clair Flats–Chatham map-area is the production of oil and gas. The production of petroleum has been continuous for the past century, and exploration for new sources is still being carried out.

Sand and gravel deposits are small and for the most part, of poor quality. Beach deposits near Blenheim and buried gravel near McKays Corners are presently being worked for aggregate. Small operations, primarily for fill, are working alluvial deposits in the Sombra-Port Lambton, and Walpole Island areas.

Drainage tiles are produced from material obtained from a small clay pit north of Dresden.

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No. 23 Quaternary Geology of the Owen Sound (41A/10) Area, Grey County

B.H. Feenstra[1]

Introduction

The Owen Sound area is bounded by Longitude 80°30′ and 81°00′ west and by Latitude 44°30′ north on the south and Latitude 44°45′ north or Georgian Bay on the north. All of the area was mapped in 1979 except that occupied by the Canadian Forces Training Area, Meaford.

Paleozoic Geology

Large parts of the area consist of bedrock outcrop or bedrock covered by very thin drift. This bedrock is composed of Ordovician-Silurian shales of the Whitby, Georgian Bay, Queenston, and Cabot Head Formations, and Silurian dolostones of the Manitoulin, Fossil Hill, Amabel, and Guelph Formations (Liberty 1966; Liberty and Bolton 1971). These formations dip west to southwest and their erosion has produced a dissected cuesta landscape. The Fossil Hill and Amabel Formations cap the Niagara Escarpment and the Manitoulin Formation forms a secondary scarp and terrace at lower elevations. The Niagara Escarpment trends in a serrated fashion northwestward across the area. The Bighead River and the Owen Sound occupy large northeast-southwest, shale-based re-entrant valleys in the Niagara cuesta. Barren slopes underlain by shale of the Queenston Formation southeast of Meaford are intensely eroded with numerous gullies creating a topography resembling the badlands of arid climates.

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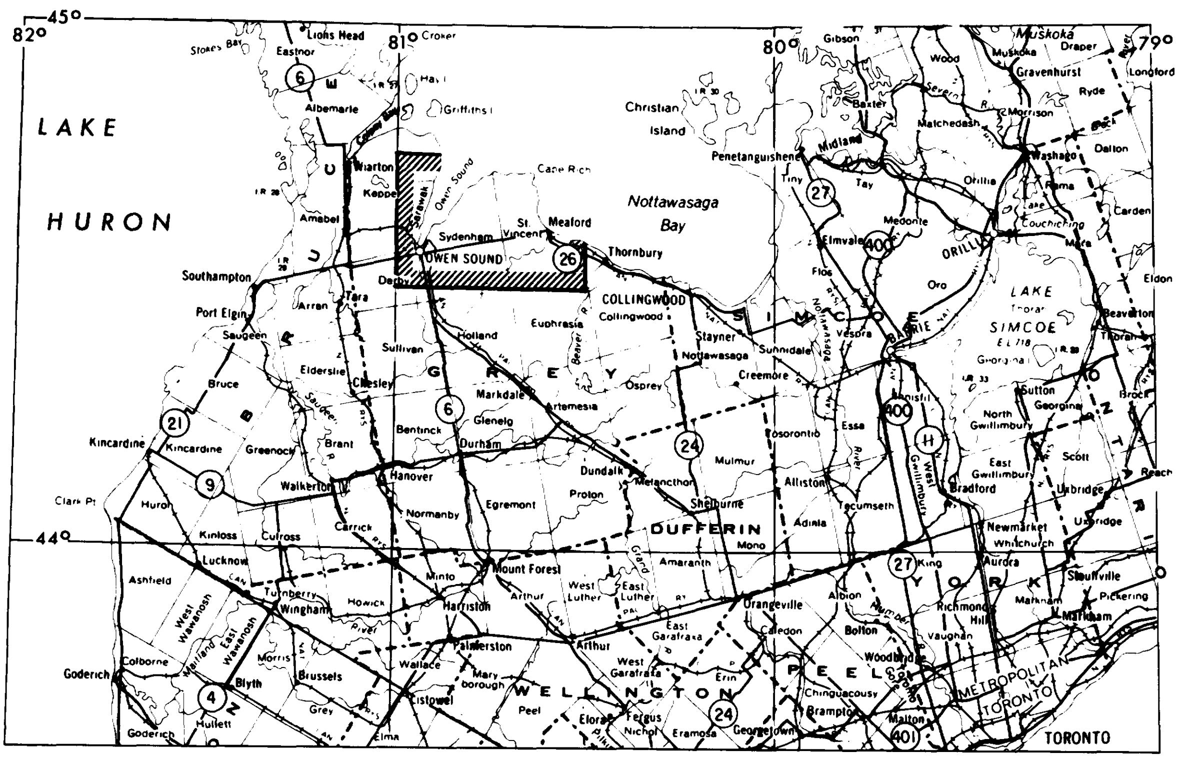

LOCATION MAP

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

Quaternary Geology

A gravelly, sandy to clayey silt till is the predominant surficial material in the area. It occurs mainly in the form of till plain which is extensively drumlinized. The largest drumlin field occurs in the Bighead Valley and surroundings. The drumlins indicate glacier ice movements to the southwest (parallel to Owen Sound) and south in the western part of the area and more to the southeast and south (across the Bighead Valley) in the east. The till represents glacial deposition during Late Wisconsinan (Nissouri–Port Huron Stadials) time.

Several ice-marginal features are associated with retreat of the glacial lobe from the area. A kame-esker-outwash sand and gravel complex occurs south of Owen Sound. Smaller deposits of kame sand and minor gravel are also mapped east of Owen Sound and near Bognor, Walter Falls, and Blantyre. Small eskers dot the area between Owen Sound and Bognor which also includes hummocky ablation till. A few small morainic ridges composed of till and/or ice-contact stratified drift are found in the Griersville–Blantyre and Woodford–Bothwell Corners parts of the map-area. Correlation of these ice-marginal positions across the area is a problem due to their sporadic nature.

Glacial retreat from the area was also accompanied by pondings of proglacial waters. Glaciolacustrine clay and silt deposits are mapped west and southwest of Owen Sound and southwest of Bognor in the Bighead Valley. Glaciolacustrine clay and silt also occurs northeastward in the Bighead Valley below younger lacustrine deposits.

The main lacustrine features in the map-area are those correlated with late glacial Lake Algonquin and postglacial Lake Nipissing. The shoreline of Lake Algonquin is predominantly an erosional bluff interrupted by baymouth bars south of Hogg, at Coffin Hill and Balaclava, and across the Bighead Valley south and west of Meaford. The Lake Algonquin terrace is mainly veneered by fine sands at Owen Sound and Meaford and vicinity, and by silts northeastward from Owen Sound to Balaclava. The baymouth bar across the Bighead Valley overlies a sequence of clay, silt, and sand deposited in the embayment. The nearshore sands at Meaford have been reworked by prevailing westerly winds. The Lake Nipissing shoreline, generally within one kilometre inland from the modern Georgian Bay shoreline, is also predominantly an erosional bluff. The Nipissing transgression is well illustrated at Leith where a post-Algonquin channel bog is buried below beach and nearshore sediments.

Sand and Gravel Resources

Resources of sand and gravel in the map-area (especially coarse aggregate) are limited and are essentially restricted to the sporadic occurrence of ice-contact and Lake Algonquin beach deposits. Pits have been developed in nearly all of these deposits but only a few were operating in the beach deposits near Meaford and East Linton during the field mapping. The sand and gravel resources of the baymouth bar across the Bighead Valley near Meaford are virtually depleted.

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No. 24 Quaternary Geology of the Markham Area (30M/14), York and Durham Regional Municipalities

J.A. Westgate[1]

Delineation of the areal distribution of surficial deposits and landforms in the Markham area commenced in 1978 (Westgate 1978) and has now been completed. In addition, further stratigraphic studies were carried out along the eastern part of the Scarborough Bluffs and along some of the major valleys. Compositional and geotechnical characteristics of each stratigraphic unit, including those mapped by Karrow (1967) at the Cathedral Bluffs section, will be documented using the detailed sample suites collected this year. It is hoped that these data will facilitate correlation of the sedimentary units defined in this study to those established by Karrow (1967).

Noteworthy observations made this summer include:

(1) The Halton Till is thin over most of the area and is almost everywhere underlain by thick proglacial stratified sediments, mostly sands and gravels, which are exposed at the surface in places.

(2) The major topographic elements of the area are developed in these stratified deposits and predate the Halton Till.

(3) The outer limit of the Halton Till is present in the northwestern corner of the map-area, just to the southeast of Aurora. Distinctive proglacial silts with discontinuous gravel lenses occur immediately to the north of this former ice-margin. These silts, whose provenance is probably to the north, are very susceptible to erosion, as can be seen in the extensive gulleying of recent excavation sites and the dissected nature of the topography.

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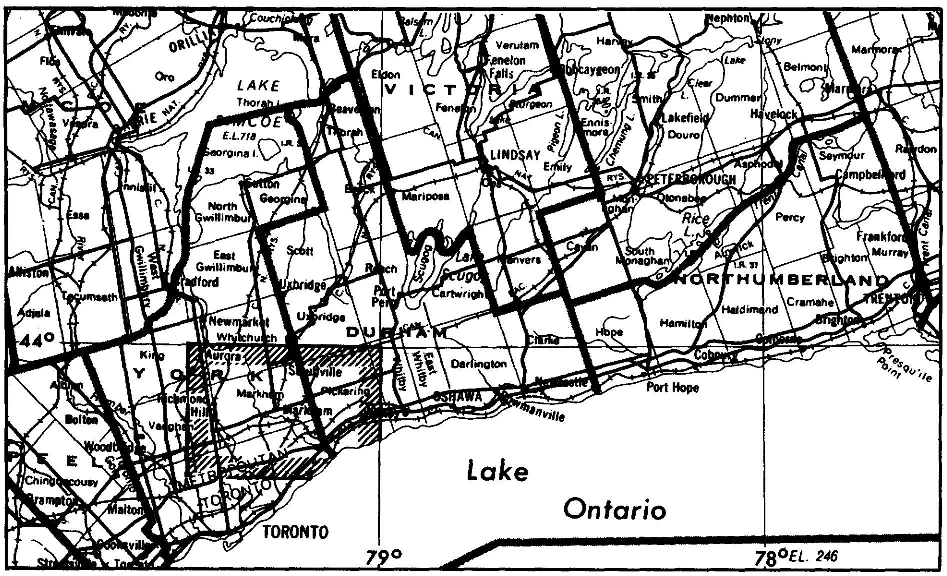

LOCATION MAP

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

No. 25 Quaternary Geology of the Bancroft (31F/4) Area, Hastings, Renfrew, Lennox and Addington Counties

P.J. Barnett[1]

Introduction

The Bancroft area is located between Latitudes 45°00′ and 45°15′N and Longitudes 77°30′ and 78°00′W. The communities of Bancroft, Maynooth, Boulter, McArthurs Mills, Hermon, and L'Amable are situated within its boundaries.

Field mapping commenced in the fall of 1978, and was completed during the spring of 1979. Particular attention was given to ice flow directional indicators, the stratigraphy, and sampling of the Quaternary materials for drift prospecting and environmental background information.

Physiography and Bedrock Geology

The area is located within the Haliburton Highlands physiographic region and contains numerous bedrock controlled knobs and ridges separated by flat bottomed valleys containing underfit streams and rivers. Most of the map-area is drained northward by the York and Little Mississippi Rivers and Papineau Creek. A small portion of the map-area in the southwest corner, is in the Lake Ontario drainage basin.

Local relief of 76 m is not uncommon and at Tower Mountain it exceeds 194 m. Over the entire area, total relief is greater than 227 m.

The area is underlain by a variety of Middle to Late Precambrian rocks. Clastic and carbonate metasediments, metavolcanics, and felsic and mafic intrusive rocks outcrop within the area (Freeman 1978). The Bancroft area is known for its variety and quality of mineral specimens and the community of Bancroft is called the Mineral Capital of Canada.

Quaternary Geology

Within the Bancroft area, direction of ice movement is recorded by drumlins, flutings, crag and tail features, grooves, striations, chattermarks and shear structures in basal till. The average direction based on 48 observation sites is 194° azimuth and ranged between 169° and 206° azimuth. Variations of up to 20° were observed at several sites, but no cross-cutting relationships could be found.

The till in the area is generally basal in origin; a stony, gritty, silty sand to sand till. Often stringers and lenses of sand can be observed within it. The till is usually loose

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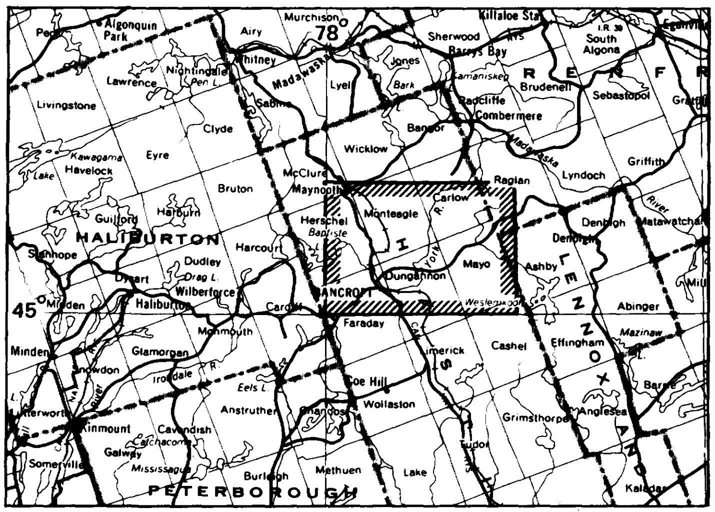

LOCATION MAP   Scale: 1: 1 584 000 or 1 inch to 25 miles

when observed at the surface and may become compact and fissile with depth. Road cuts and excavations one to two years old display a loose sand coating up to 0.3 m thick over the entire surface due to weathering processes.

The till occurs dominantly as ground moraine throughout the area. It is generally thin and discontinuous along the numerous rock ridges. In these areas, where bedrock is close to the surface, the land surface is stony and the till is a loose, poorly sorted sand, dominantly fine to medium grained. Till can be found locally concentrated on lee or stoss sides of the rock promontories, often of very limited areal extent.

In areas of greater till accumulation, drumlins or drumlinoid ridges and flutings are common. Small drumlinized or fluted till plains can be found in the area around Maynooth, Monteagle Valley, Fraser Lake, Ireland, Bronson, Waterhouse Lake, Beechmount, and southeast of Hermon. The drumlins in most cases appear to be rock cored in the Bancroft area.

In several exposures (three), two layers of till were observed separated by glaciofluvial or glaciolacustrine sediments. At several other localities till was observed overlying glaciofluvial or glaciolacustrine sediments. These occurrences are quite widespread and are presently interpreted to represent minor glacier fluctuations during retreat rather than a major re-advance across the map-area.

Ice marginal positions are marked by a few, small, very fragmentary moraines, which are very difficult to trace in the field and to correlate. These moraines appear to have an east-west trend. Several north-south trending eskers are present in the area surrounding Graphite.

Varved and laminated glaciolacustrine sediments are present at several localities below outwash sands, and at one locality rest directly on till. Most exposures of glaciolacustrine sediments are found in the York River basin east of Bancroft, and along the Little Mississippi River. Clay or silt is reported in water well records in the area around Birds Creek as well. Over 150 varves were counted along the York River in approximately 2 m of sediment with more than 3 m of additional varved sediments occurring below water level.

This glacial lake (or lakes) must have existed during retreat of the glacial ice northward from the Lake Ontario–Ottawa River drainage divide located just to the south of the map-area. Smaller proglacial lakes also existed along Papineau Creek at Maynooth, and along the York River north of Boulter.

In the valleys between rock ridges, the dominant surficial sediment is glaciofluvial outwash sands and gravelly sands. Outwash sediments generally occur below an elevation of 365 m above sea level. The exceptions being in valleys in areas of higher ground in the Maynooth area. Internal sedimentary structures indicate an overall southward flow with eastward and westward components depending on the orientation of the valley. Thicknesses up to 20 m can be observed along the York River, and deposits have been reported to be over 26 m thick by drillers in the Birds Creek area. Higher outwash terraces, in general, contain a greater percentage of gravel, while lower terraces are dominantly medium to coarse-grained sand.

Economic Geology

There are numerous inactive mines within the Bancroft area. Nepheline, feldspar, sodalite, graphite, phlogopite mica, iron, marble, and uranium are among some of the materials that have been mined in the past. During the fall of 1978, only the Madawaska Uranium Mine and the Princess Sodalite Mine were in production.

Numerous sand and gravel pits are located in the map-area. Five sand and gravel pits were in operation during the fall of 1978: Bancroft Brick Company pit, 1 km northeast of L'Amable; Maxwell-Evans pit, 1.5 km southwest of Bancroft; a pit operated by Faraday Township on Monck Road 46 km southwest of Bancroft. (The material was being used as fill at the sanitary land fill site); and a small pit on the south side of Bay Lake (fill). Three pits (west of O'Shaughnessy Lake, 2 km west of Musclow, 2½ km north of Rowland) were active on demand during the spring of 1979.

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No. 26 Quaternary Geology of the Pembroke (31F/14) Area, Renfrew County

P.J. Barnett[1]

Introduction

The Pembroke area is located between Latitudes 45°45′N and 46°00′N and Longitudes 77°00′W and 77°30′W. The communities of Pembroke, Petawawa (Ontario), and Chapeau (Quebec) are located within the map-sheet, as well as a large part of the Canadian Armed Forces Base, Petawawa.

Field mapping commenced in July of 1979 on the parts of this map-area located in Ontario. Areas of very thin drift, extensive rock outcrop, or poor access were mapped quickly, in order that emphasis could be placed on areas of thick drift accumulation.

Physiography and Bedrock Geology

The Pembroke area is located in the Ottawa-Bonnechere Graben. The northern wall of this graben crosses the northeast corner of the topographic sheet 3 km northeast of Chapeau. The bedrock consists of Precambrian rocks of the Grenville Province, except for a few Paleozoic outliers of Ordovician age. These outliers are associated with faults of the Ottawa-Bonnechere Graben.

The portion of the map-area in Ontario is essentially a terraced plain, abutting an area of bedrock highlands to the west. This plain has been divided into two physiographic regions by Chapman and Putnam (1966); the Petawawa Sand Plain and the Ottawa Valley Clay Plain.

Total relief in the area exceeds 250 m, however local relief in the bedrock highlands is commonly 23 to 45 m and as much as 174 m along the Indian River. In the plains, local relief is seldom greater than 8 m but 24 m of local relief can be seen along the abandoned river terrace at Petawawa.

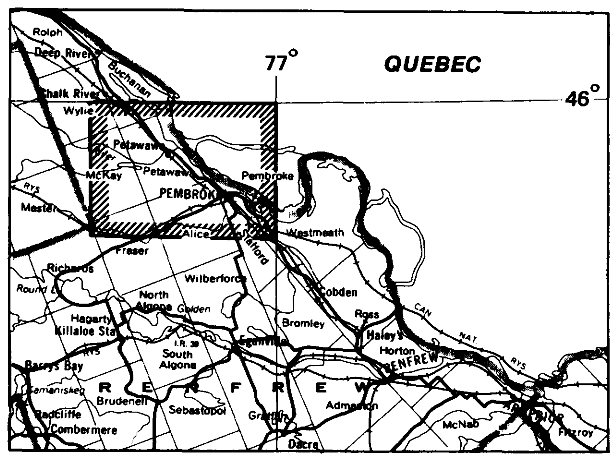
Quaternary Geology

Within the Pembroke area, the direction of ice movement, as recorded by striations, was generally towards the south-southeast. A range in striation orientation of 50° has been recorded throughout the map-area, however, no cross-cutting striae were observed.

The till is quite variable in appearance, in response to the variety of bedrock lithologies in the area, especially the presence of Paleozoic carbonate outliers. In the Precambrian bedrock terrain, the till is generally loose, stony, gritty, and very sandy. In Paleozoic bedrock areas it is usually a more compact gritty silty sand to sandy silt till.

The till occurs dominantly as ground moraine and has its greatest surficial distribution in the bedrock highlands of the west where it has not been buried by younger marine deposits.

Three ice marginal positions are indicated by morainic ridges composed of till and ice-contact stratified drift, and by ice marginal deltas. Two of these moraines are in the vicinity of Pembroke and the third, the Indian Point Moraine (Gadd 1963), is located north of Petawawa. Evidence for a local re-advance of the ice over marine sediments is present at several localities where a clayey till was observed. As the glacial ice retreated up the Ottawa Valley, the Champlain Sea expanded northwestward, was probably in contact with the ice, and inundated the low lying areas of the map sheet. Most surface deposits below an elevation of 167 m above sea level are the direct results of this sea, or were modified extensively by it.



LOCATION MAP

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

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Clay and silt deposited in the Champlain Sea are the major surficial deposits in the area south of Pembroke and these can be observed at depth in sections as far north as Petawawa. Thicknesses of these sediments greater than 15 m have been observed along the Indian River. The following composite sequence of glaciomarine and marine sediments was found within the Pembroke area:

6 - Sand; massive to laminated dominantly fine to medium grained.

5 - Interbedded sequences of silt, very fine sand and clay.

4 - Massive to faintly colour banded silty clay to clay, containing foraminifera in places.

3 - Faintly laminated silty clay to clay with silt laminations.

2 - Horizontally interlaminated (varved) to interbedded clay and fine sands; clay beds are colour banded in places; unit 2 can be highly contorted in places due to dewatering.

1 - Horizontally laminated to varved, gritty silt and clay with dropstones and occasional foraminifera (at only one locality in close association with till).

North of Pembroke, the deltaic to shallow water sands (unit 6 above) are the dominant surface sediment. North of Petawawa more fluvial sedimentary structures are present to greater depths in the sand, possibly indicating a valley train outwash in this part of the valley. The maximum northwestern extension of the sea is difficult to determine because of the gradual transition from outwash to marine shallow water sediments.

Several abandoned shoreline features of the Champlain Sea are present in the area. Ice-contact deltas, and shoreline features occur at elevations of 164 m and 160 m above sea level. At least four levels of the sea are recorded at one site between 156 m to 144 m, and at least three, at another location, between 144 m and 137 m above sea level. (some of these may be correlative if isostatic adjustments are considered).

Subsequent river terracing has developed, and French and Hanley (1975) have reported four levels of paired terraces along the Ottawa River at the following levels: 137 m, 128 m, 122 m, and 114 m.

Economic Geology

Sand and gravel deposits in the Pembroke map-area will probably be sufficient for local needs. In the past and at present, the following types of deposits are being excavated; outwash plains, moraines, ice-contact deltas, deltas, beach bars and spits. With the construction of the Highway 417 by-pass around Pembroke and Petawawa and with maintenance work to Highway 62, numerous pits were active during 1979.

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No. 27 Urban Geology of Metropolitan Toronto

D.R. Sharpe[1]

Introduction

The Ontario Geological Survey has initiated a project to compile and interpret the geology and engineering properties of the Quaternary strata within Metropolitan Toronto. This report outlines the progress to date.

Previous Work

The geological framework for Quaternary deposits in the City of Toronto has been well established for many years as a result of work by Hinde (1878), Coleman (1894; 1933; 1941), Watt (1954), Terasmae (1960) and Karrow (1967; 1969). Although areal mapping over the years provided complete coverage of the surficial deposits of the Metropolitan Toronto area (Coleman 1933; Watt 1957; 1968; Hewitt 1969; 1972; Karrow 1967; 1970; and White 1975) no one map covers the whole area. Futhermore, some of this mapping needs to be updated and subsurface data need to be incorporated. Work by Watt (1954), Lajtai (1961; 1966; 1969) and Pullen (1969) made good use of such subsurface data. Earlier programs to compile information from excavation sites etc. were attempted by A.K. Watt in the 1950s and P.F. Karrow in the early 1960s but these were not continued. In 1972 the Geological Survey of Canada initiated a program of geotechnical data collection in 29 cities (including Toronto) across Canada which was eventually assembled into the Urban Geology Automated Information System (U.G.A.I.S.) (Scott 1973; Belanger 1974). No new data have been added to this system since the original collection, nor are the collected data yet available for machine processing.

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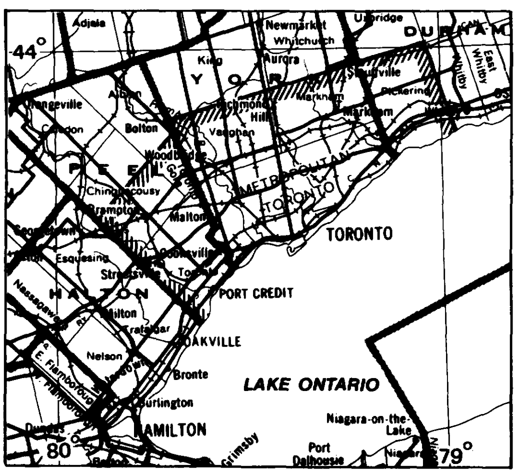

LOCATION MAP Scale: 1: 1 584 000 or 1 inch to 25 miles

The Present Project

The present project is directed at the production of a geological map of Metropolitan Toronto and environs to provide in one place a framework for further geological and geotechnical studies and investigations throughout the area. The aim is to provide a preliminary map in a short period of time which could be refined as necessary as the great mass of available data was processed.

An emphasis is placed on the collection and processing of subsurface data available in reports of site investigations for construction projects to supplement and complement the geological mapping done in the area over the past 50 years. Field investigations are being conducted whenever possible either at natural exposures or in temporarily exposed excavations.

Thousands of data points covering all the built-up areas of the region are potentially available together with numerous data points along the routes of service facilities in less well developed areas. Thus, initial work in the Toronto area is concentrated on setting up an efficient methodology to assist in determining such questions as:-
What information is available?
How accessible are the data?
How good is the information? and
How fast can the information be obtained?

The answers to these questions depend very largely on the characteristics of the two basic sources of information:-
a) public agencies or jurisdictions and
b) private sources such as geotechnical consulting firms.

Each of these two sources has its own particular characteristics which have significantly affected the data collection and processing procedures.

Public Agencies

Good co-operation was received from the public agencies which include Ontario Hydro, Ontario Ministry of Transportation and Communications, Metropolitan Toronto and Region Conservation Authority, Metropolitan Toronto Works Department, Metropolitan Toronto Roads and Traffic Department, City of Toronto Works Department and the Toronto Transit Commission.

There were special features which made collection and use of these sources very effective. First, the Ministry of Transportation and Communications data were already on microfilm, so that almost 500 geotechnical reports were obtained with only one day's effort. The information from Ontario Hydro, Toronto Transit Commission and the Metropolitan Toronto Works Department involved transects across parts of the Toronto area and cross-sections were readily constructed. The City of Toronto Works Department had current excavations so that our field checks could be compared with their borehole records for quality control. An opportunity to obtain samples of the strata as well as records was a particular feature of co-operation afforded by the Conservation Authority.

Geotechnical Consulting Firms

The geotechnical consulting firms hold sub-surface data acquired for both public authorities and private companies and individuals. However no data is obtained from the consultants until the actual owners of the information have given written permission to acquire same. The necessity to obtain this permission naturally imposes extra delay and cost in the data acquisition but the obtaining of the owners permission is considered a vital part of the overall process.

In the current project, initiated in the spring of 1979, most efforts at acquiring privately held data for the Toronto area have been directed through one geotechnical consultant, Golder Associates of Cooksville, who have been very generous with their co-operation.

Reports were selected from the Golder files, owners (i.e. Golder's clients) were contacted and asked to provide permission for access to the data and when an appropriate number of release forms were received, the reports were microfilmed. In some instances when the Golder client was a general engineering consultant, a further step was required to contact the actual owner of the subsurface data. Microfilming activities were concentrated to ensure that reports were not absent from the Golder office for more than three days.

The report from the geotechnical consultants cover most parts of the area concerned and can be expected not only to provide information to close gaps along the transects provided by the data from the public agencies but may also provide data to greater depths and in more detail at specific sites.

Evaluation

A somewhat similar program to compile geotechnical data in the Twin Cities of Minneapolis–St. Paul, Minnesota is at the map production stage based on the efficient compilation of 4,000 of the best 186,000 boreholes. These records were obtained exclusively from public sources (Walton 1977). However a review of data available from public agencies in the Toronto area revealed that gaps in the data were sufficiently large and numerous that data from private sources would have to provide a significant part of the compilation.

In recognising the six stages involved in obtaining a final product (maps with text), viz.:-
a) data collection,
b) recording data — on microfilm, photocopies, field notes,
c) processing
d) analysis and interpretation
e) preliminary presentation, and
f) final presentation of maps with cross-sections,
time and resources were allocated for each stage in consideration of the data obtainable from each prime source.

Thus the final product will be:-
a) A map of the Quaternary geology at a scale of 1:50 000 compiled from pre-existing mapping and covering the area not only of Metropolitan Toronto but including substantial portions of the Regional Municipalities of Peel, York and Durham. Wherever possible field work will be used to complement the compilation.
b) A series of stratigraphic cross-sections prepared from data obtained largely from the files of public agencies but supplemented by selected data available from the files of geotechnical consultants. Again, field inspections of current construction activities will be used to assist in the preparation of the cross-sections.

Although the data are more costly to obtain from private sources, the character and areal extent of the data makes the data well worth obtaining provided some initial selectivity is applied to that collected.

A preliminary review of the progress to date indicates that field work remains the best source of information and can provide a very useful check on the quality of information obtained in the borehole records. Experience so far indicates that the invariability of the Quaternary subsurface materials will permit only gross correlation across the city — on a level of sediments of Late, Middle and Early Wisconsinan origin except for some specific units such as the Sunnybrook Till and the organic rich facies of the Scarborough Formation.

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No. 28 Physiography and Surficial Geology of the James Bay Lowland, District of Cochrane

E.V. Sado[1]

Introduction

The Ontario Centre for Remote Sensing (O.C.R.S.) (Ontario Ministry of Natural Resources, Lands and Waters Group), completed field work in 1979 for a physiographic and wetlands classification in northern Ontario. The area covered adjoins work reported previously by Cowan (1977) and Cooper (1978). The 1979 area extends north of Latitude 50° north to the James Bay shore and west from the Ontario–Quebec border to Longitude 86° west, a total area of some 100 000 km^2.

The Ontario Geological Survey supported this program and contributed a geologist to accompany the field party. The members of the field party consisted of four staff members from the O.C.R.S. plus a botanist, a soil scientist, and a geologist.

The field program lasted six weeks and was conducted with a Bell Jet Ranger Helicopter. Landings and traverses were made at predetermined locations to collect samples and gather ground data. Additional data was gathered along access roads within and south of the map area.

Objectives

The program objectives were to gather field data regarding the physiography and biophysical character of this previously unmapped portion of the province. Standard Panchromatic airphotographs (scale 1 inch to 1 mile) plus several forms of satelite imagery (Landsat) are being used to analyse and interpret the field data. Maps of these northern areas are to be produced at a scale of 1:500,000 accompanied by short reports. Additional information regarding this program may be obtained from Dr. Simsek Pala, Ontario Centre for Remote Sensing, Ontario Ministry of Natural Resources, 880 Bay Street, Third Floor, Toronto, M5S 1Z8.

Physiography and Quaternary Geology

The Lowland has a very low relief, the average seaward gradient is 0.75 m per km. It is best described as one continuous swamp covered by a thick water-soaked blanket of mosses. Stunted black spruce is the dominant tree cover, the best growth being found along river banks and on higher, better drained areas. Glacial sediments are exposed only along river valleys. River bank sections are continuous but often slumped. The thickest sections (30 m) occur overlying Paleozoic sedimentary rocks within the basin. Over Precambrian rocks south of the fall line they are thinner and less continuous.

Skinner (1978) has presented a detailed stratigraphy for the Moose River Basin. The author was able to identify some of these stratigraphic units west and south of Skinner's area. A composite stratigraphic section for the James Bay Lowlands consists of, from bottom to top: Till I; intertill sediments I-II, Till II, intertill sediments II-III, Till III; interglacial Missinaibi Formation; Adam Till; Friday Creek glaciolacustrine and glaciofluvial sediments; Kipling Till; and late and postglacial glaciolacustrine, marine and terrestrial units.

Noteworthy, is a previously unreported exposure of the Missinaibi Formation along the Ridge River 30 km upstream from its junction with the Kenogami River (UTM co-ordinates 297500E, 5597300N). It is shown on the following cross-section.

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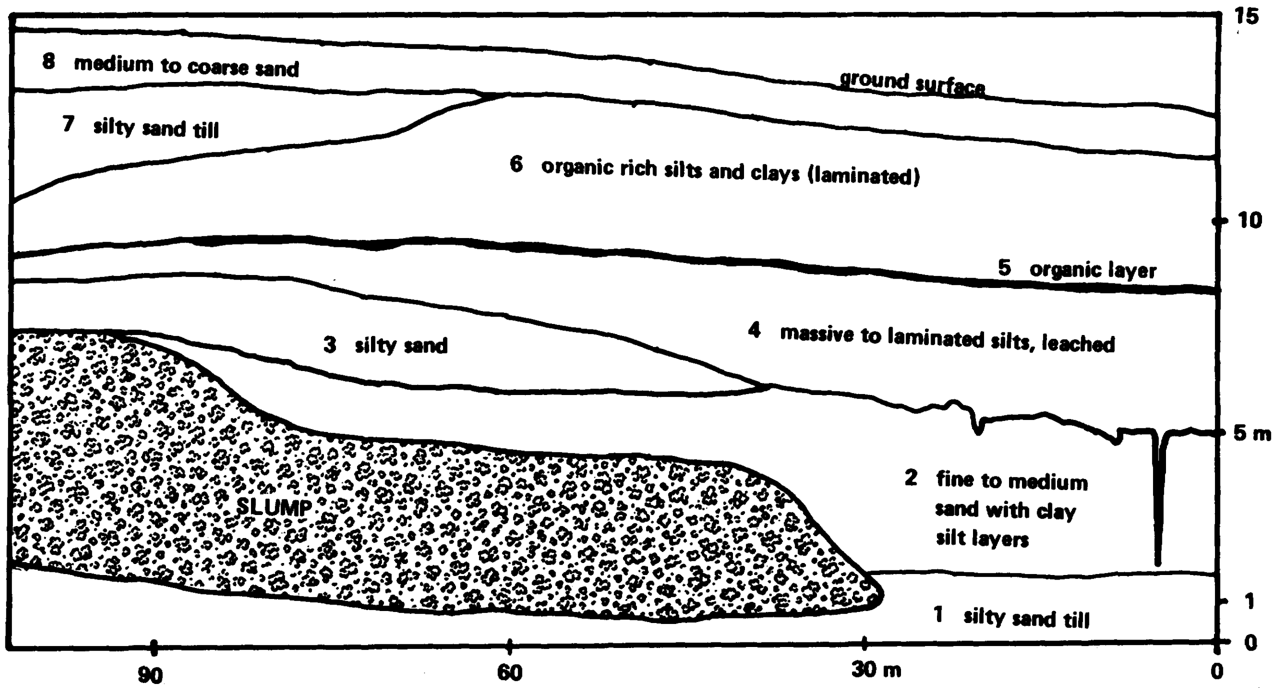

UNIT	THICKNESS	UNIT DESCRIPTIONS
8	1-2 m	Fluvial sand - medium to coarse grained with fine gravel seams, leached soil profile 0.25 m.
7	0-2.5 m	Silty sand till, massive.
6	1-3 m	Laminated, organic silts and clays, organic content increases with depth. Lower 1 m totally black, very compact with some deformation of bedding (sheared, convoluted), secondary carbonates along joints.
5	2-8	Organic layer containing fibrous leafy material, mosses, twigs, and flattened tree logs
4	1-3 m	Silt, greenish grey to grey, massive to faintly laminated, totally leached of carbonates except in pockets containing partly decomposed limestone fragments, organic remains common in laminated portions, likely to represent a buried soil, several deep weathering roots penetrating into lower unit.
3	0-2 m	Silty greenish grey sand (fine to medium grained), high carbonate content.
2	3-5 m	Fine to medium sand with silt and clay layers, disturbed laminations, high carbonate content, oxidized bright reddish-orange seepage zones in coarser lenses. Large (2-3 m) weathering roots from unit 4 found in this unit.
1	0.5-3 m	Silty sand till, very compact, high carbonate content.

Figure 1—Ridge River Section–Smokey Falls, N.T.S. 42J.

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No. 29 Paleozoic Geology of the Peterborough–Campbellford Area, Southern Ontario

D.M. Carson[1]

Introduction

Mapping of the Peterborough–Campbellford area involved the re-examination of eight map sheets previously mapped by either B.A. Liberty (1960; 1963) or C.G. Winder (1954; 1955) for the Geological Survey of Canada. Since the time of the original mapping, the lithostratigraphic nomenclature applied to Paleozoic rocks of upper New York State and southern Ontario has undergone much revision and debate. The terminology used in the present report follows that proposed by Liberty (1964; 1969).

Location

During the summer and early fall of 1979, geological mapping was completed for the Burleigh Falls (31D/9), Peterborough (31D/8), Rice Lake (31D/1), Port Hope (30M/16), Bannockburn (31C/12),Campbellford (31C/5), Trenton (31C/4), and Consecon (30N/13) (formerly Presqu'ile) map-areas. This region is bounded by Latitude 44°45′N and the Lake Ontario shoreline and by Longitudes 77°30′ and 78°30′W.

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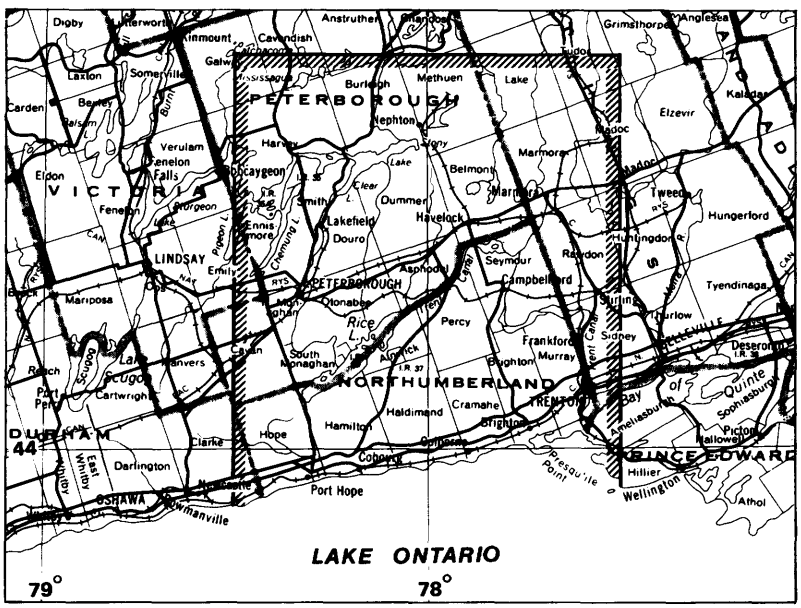
General Geology

The major outcrop areas in the region occur along the Precambrian-Paleozoic boundary in the southern portion of the Burleigh Falls and Bannockburn map-areas where numerous Paleozoic outliers occur on the Canadian Shield, along the Trent River in the Trenton map-area, and in Prince Edward County in the eastern portion of the region. Major outcrops on the remaining map sheets occur primarily along larger rivers, specifically the Otonabee and Indian Rivers in the Peterborough map-area and the Trent and Crowe Rivers in the Campbellford map-area, as well as along the shores of the Kawartha Lakes and Lake Ontario. No bedrock exposures exist in the Rice Lake map-area or the western portion of the Trenton map-area. Waterwell records are currently being examined for possible use in the compilation of a drift thickness map of the Rice Lake map-area.

Strata in the project region are generally flat lying except where they drape over irregularities in the Precambrian basement. "Pop-up" structures occur in three areas in the region, the most extensive of which is found 2 km northwest of Young's Point in the Peterborough map-area in the Gull River Formation. This feature extends for approximately 1.5 km in a northwest-southeast direction, with a maximum relief of about 2 m. A similar structure



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

within the Bobcaygeon Formation at King's Mill in the Campbellford map-area attains a maximum relief of close to 3 m, but is not as laterally extensive as the structure at Young's Point. The third and smallest structure, also within the Gull River Formation, is found near Woodview in the Burleigh Falls map-area. Maximum relief of this feature is less than 1 m. Joint sets are common in outcrops of the Gull River Formation, especially on outliers in the Burleigh Falls map-area. These joints generally trend northeast-southwest. An unusual fold structure occurs within the Bobcaygeon Formation 2.5 km northwest of Warsaw in the Peterborough map-area.

The Paleozoic stratigraphy of the Peterborough-Campbellford area is summarized in Table 1. Precambrian rocks outcrop throughout the northern parts of the region, and surround Paleozoic outliers in the southern parts of the Burleigh Falls and Bannockburn map-areas. A belt of granite extends southeast of Marmora along the Moira River in the northeast portion of the Campbellford map-area. Two small granitic inliers occur in the northern parts of the Peterborough map-area. A larger inlier is exposed near the Town of Preneveau in the Campbellford map-area. Unconformably overlying the Precambrian rocks are the red and green shales, siltstones, sandstones, and arkoses of the Ordovician Shadow Lake Formation. These strata are generally massive to irregularly bedded and locally contain abundant large quartz pebbles. The Shadow Lake Formation outcrops as thin belts around the margins of the Paleozoic outliers of the Burleigh Falls and Bannockburn map-areas and discontinuously along the Precambrian–Paleozoic boundary. The only completely exposed section of the formation is in the Marmoraton Mine near Marmora. The formation is also exposed in contact with the Precambrian in a small outlier north of Lovesick Lake (Burleigh Falls map-area).

The Gull River Formation of the Simcoe Group consists primarily of massive pale to medium grey-brown lithographic limestone which displays common development of stylolites and "birdseye" texture. Cephalopods and stromatolites are also common on bedding surfaces in the Gull River Formation. Outcrops of the formation are abundant on Paleozoic outliers where the formation commonly forms the core of these structures. The Gull River Formation is also common in outcrop along the Precambrian–Paleozoic boundary. Again, the only completely exposed section of the formation is in the Marmoraton Mine.

The Bobcaygeon Formation consists of light to dark brown and grey calcarenites, finely crystalline limestone and bioclastic limestones, with rare lithographic limestones. The formation is unevenly bedded and commonly flaggy. Fossils, specifically brachiopods, are abundant. Fist-size nodules of black chert are common near the base. The formation outcrops throughout the central and northern parts of the Campbellford map-area, the southern portion of the Burleigh Falls map-area, and the northeastern part of the Peterborough map-area. No complete sections of the formation are exposed in the region although thick sequences occur in larger road cuts near Marmora.

The Verulam Formation in the project area consists of interbedded limestones and shales that form non-resistant, rubbly outcrops. The limestone is bioclastic and is generally pale to medium brown and pale to medium grey with small white pods and stringers giving the rock a "salt and pepper" appearance. The shales are predominantly pale grey. Fossils are abundant throughout the formation and include various brachiopods, bryozoans, crinoids and rare trilobite fragments. The Verulam Formation outcrops in the eastern and northwestern portions of the Campbellford map-area and in the northern and eastern portions

TABLE 1 GENERAL STRATIGRAPHY OF THE PETERBOROUGH-CAMPBELLFORD AREA.

Middle Ordovician	Simcoe Group
	Lindsay Formation (Limestone)
	Verulam Formation (Limestone and Shale)
	Bobcaygeon Formation (Limestone)
	Gull River Formation (Limestone)
	Basal Group
	Shadow Lake Formation (Shale, Sandstone, Arkose)
Precambrian	undifferentiated igneous and metamorphic rocks.

the Trenton map-area, specifically along the banks of the Trent River. The formation also underlies much of the Rice Lake map-area, but no outcrops have been reported. No complete sections of the Verulam Formation are exposed in the project area.

The Lindsay Formation is the youngest formation in the region. It generally consists of pale to medium grey, nodular crystalline limestone in shaly and rubbly outcrops. Some grey bioclastic beds are interbedded with these strata. The formation is sparsely fossiliferous. It underlies much of the Peterborough, Rice Lake, and Port Hope map-areas, but is rarely exposed. A small outcrop occurs in the Ganaraska River within the town of Port Hope. It also underlies much of the southern part of the Trenton map-area, but outcrops only in the extreme southeast in Prince Edward County and along Dead Creek between the towns of Trenton and Carrying Place where it forms a ridge up to 3 m in height. In the Consecon (Presqu'ile) map-area, the Lindsay Formation is exposed along the shore of Lake Ontario at Colborne, on the Presqu'ile Peninsula, and in Prince Edward County. No complete sections of the formation have been reported, but about 40 m of Lindsay strata are exposed in the Ogden Point limestone quarry operated by the St. Lawrence Cement Company of Colborne.

Overlying the Simcoe Group are the shales of the Whitby Formation of the Nottawasaga Group. Although the Whitby Formation does not outcrop in the project area, it is exposed above the Lindsay Formation at the St. Mary's Cement Company quarry near Bowmanville, about 15 km west of the project area.

Economic Geology

At present, two stratigraphic units in the project area are being used as an industrial mineral resource. Material from the Gull River Formation that was removed from the Marmoraton Mine as waste rock is being processed for use as crushed stone by Armbro Limited at Marmora, and several small operations are quarrying similar material for the same purpose near Buckhorn in the Burleigh Falls map-area. The St. Lawrence Cement Company is currently quarrying the Lindsay Formation at Colborne in the Consecon map-area for use in the manufacture of cement. Numerous abandoned quarries exist in these two units as well as in the Verulam Formation, for example the Lakefield Quarry near Lakefield in the Peterborough map-area.

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No. S9 Quaternary Geology of the Kirkland Lake (42A/1) and Ramore (42A/8) Areas, Districts of Cochrane and Timiskaming

C.L. Baker[1]

Introduction

Quaternary mapping undertaken in the second year of the Kirkland Lake Initiatives Program (KLIP) involved the completion of work in the Kirkland Lake (42A/1) and Ramore (42A/8) map sheets. As such, the area is bounded by Latitudes 48°00′ north and 48°30′ north and Longitudes 80°00′ west and 80°30′ west. Extensive ground checking of materials exposed in road and creek cuts as well as in man made excavations was supplemented by information gained from Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake, and other public and private institutions. A small percentage of the Kirkland Lake sheet was completed during the 1978 field season with the remainder and the entire Ramore map sheet having been mapped in the summer of 1979.

The project included the outlining of the various Quaternary deposits with an emphasis on noting the extent, characteristics, and local variation of basal till. Such information is of use in the assessment of aggregate resources and to engineering and geochemical exploration studies in addition to township and timber planning and preservation of unique geological sites.

Concurrent projects involved the monitoring of the overburden-basal till sampling program in the Larder Lake-Englehart area, and maintaining contact with the Engineering and Lands personnel of Ministry of Natural Resources, Swastika District Office with regard to potential sources of aggregate material for road construction.

Bedrock Geology

The field area is wholly within the Superior Province of the Canadian Shield and contains numerous rock types in a complicated geologic setting. The oldest basement material is Early Precambrian mafic metavolcanics which underlie much of the map-area. A metasedimentary-metavolcanic series parallels Highway 66 from the Town of Kirkland Lake to Kenogami Lake, this having received much attention due to its association with major gold de-

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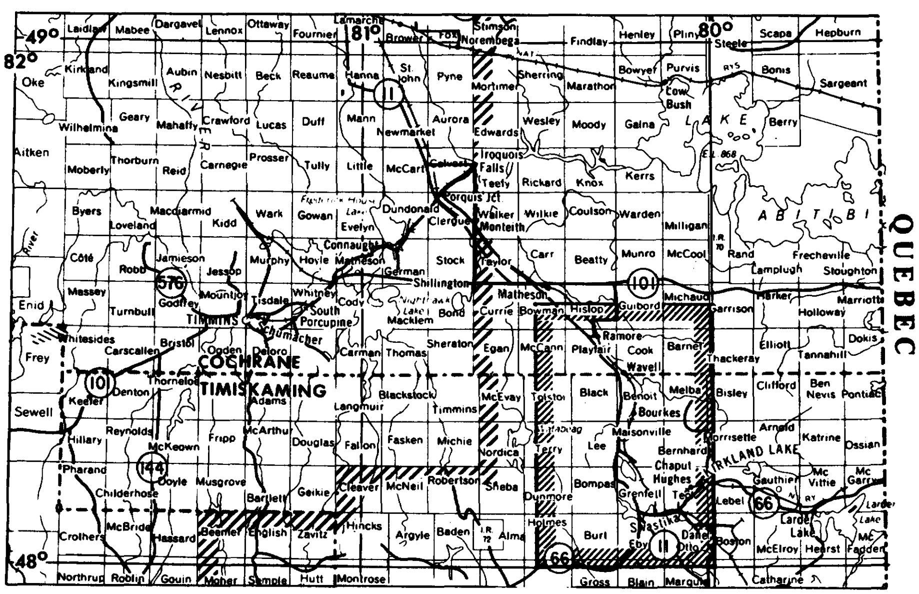

LOCATION MAP

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

posits. Areas of mafic intrusives, generally of limited areal extent, occur discontinuously in a zone through Black, Maisonville, and Teck Townships. Other small occurrences of this rock type are found in northeast Eby Township and along the Holmes–Burt Township Line. The youngest rocks of Early Precambrian age are felsic intrusives that are primarily granitic and syenitic in composition. Again, several occurrences of limited areal extent are present across the field area with larger areas located in Otto and Marquis Townships and in a strip along the western edge of both the Kirkland Lake and Ramore map-areas. Cobalt Group rocks of Middle Precambrian age are located in a north-south swath, of varying width, from McCann Township to the southern edge of the area. The youngest rocks are diabase dikes, generally trending north to northeast, which transect all other rock types.

Two gold mining operations are presently being worked in the map-area. The Macassa Mine in Kirkland Lake and the Ross Mine in Holtyre.

Physiography

The distribution of Quaternary materials and the area's topography allow for the division of the area into four physiographic units: I) a shallow water lacustrine sand plain with subsequent eolian development; II) A deep water lacustrine clay plain; III) eskers and associated glaciofluvial deposits; and IV) rock outcrops. Sand dunes created by remobilization of the underlying shallow water lacustrine deposits occur on both sides of the Englehart River in the Kirkland Lake sheet and along the western side of Terry and Tolstoi Townships in the Ramore map sheet. In places, shallow peat and muck deposits are located in the relatively level areas between the dunes.

Both the Great and Little Clay Belts are represented within the study area. The former includes most land to the east of Highway 11, excepting Bernhardt Township, on the Ramore sheet, and a large percentage of Playfair and Bowman Townships. The Little Clay Belt, found to the south of the continental divide, is most evident in Eby and Otto Townships and to a lesser extent, Grenfell Township. In all areas of this unit, rock outcrops protrude through the clay and provide relief in an otherwise level to gently rolling surface.

Esker and glaciofluvial material is present in notable amounts in, I) Bowman and McCann Townships; II) the vicinity of Butler Lake; III) an area centred on Lillord Lake; IV) along Highway 11 between Sesekinika and Kenogami Lakes and hence southward following a township road; and V) along the Bernhardt–Morrissette Township Line north of Goodfish Lake. Surficial expression of this material ranges from well defined esker crests through hummocky topography to wave washed plains.

The largest physiographic unit is composed of rock outcrops with thin discontinuous drift cover. Contained within the valleys and depressions in the rock are accumulations of sand, clay, and till often with such a limited areal extent that the deposits cannot be represented at the present scale of mapping. Relief in this unit may exceed 100 m, particularly in the area to the north of Kirkland Lake, however, local relief of 30 m to 50 m is more common. Near vertical cliffs are a notable feature of the Cobalt Group rocks in Black and Lee Townships.

Quaternary Geology

The Wisconsinan glacial movement across the map-area is recorded by the presence of a silty sand to sandy silt till. Due to the highly variable bedrock geology and topography, numerous facies changes occur over short distances. The till is discontinuous on rock outcrops (partly as a result of wave washing), but where encountered is usually 0.2 m to 1.0 m thick. Occurrences of till sections several metres thick, however, are not uncommon and serve to ilustrate the marked difference between dense, unoxidized till and its overlying oxidized, loose-weathered equivalent. Striae measurements indicate ice advance through the field area toward S10°E.

Several north-south to northwest-southeast trending esker complexess are located within the map-area. Their orientation appears to be controlled by preglacial valleys developed along faults, in the case of the larger systems, or along valleys between bedrock highs in the case of the smaller eskers. Esker length varies from 1 km to more than 20 km. Width, particularly of the larger eskers, is highly inconsistent due to the formation of deltas at ice marginal positions during ice retreat. Two large southward-fining deltaic deposits, both of which have ice-contact slopes on their northern sides, are located near Lawgrove Lake, Morrissette Township, and at the south end of Butler Lake in Black and Benoit Townships. Another larger area of glaciofluvial-deltaic sediments is located in southern and central McCann Township. Small kame and kame terrace features are found on the rock highlands, these being of a limited size and thickness.

The effects of glacial Lake Barlow-Ojibway, which fronted on the ice during its northerly retreat include wave washed outcrops up to an elevation of approximately 380 m, the highest lake level, and the reworking of glaciofluvial deposits into beach and bar deposits. Indications are that Lake Barlow-Ojibway fell quickly from its maximum level with only brief stabilizations. The highest beach scarp observed within the map-area is located in Bernhardt Township at roughly 350 m above sea level. A series of at least four beaches have been identified in Bowman Township in the 297 m to 320 m elevation range. In the southeastern corner of the Kirkland Lake map sheet, erosional features indicate a beach at the 305 m level.

The most extensive deposits of Lake Barlow-Ojibway are the varved clays and silts which occur as plains and as an interconnected network surrounding rock outcrops. Thicknesses in excess of 30 m have been reported from diamond-drill holes in Guibord and Michaud Townships. The upper limit of the deep water lacustrine sediments is 320 m except along the continental divide where they occur at slightly higher elevations.

Shallow water lacustrine deposits, sand, and minor gravel, are a result of the reworking of till and glaciofluvial material. In the former instance, the deposits are thin and discontinuous overlying rock, and in the latter case the material is found circumjacent to the ice-contact sediments and may be several metres thick. The sand deposits in the Englehart River valley appear to have developed as a result of a southward migration of sand eroded from large esker complexes to the northeast. Some areas of a shallow water lacustrine sand have been modified by eolian activity with large well-developed dune fields present along the western edge of the map-area. Eolian processes commenced after the lake level dropped, thus exposing the sand.

Spillway deposits resulting from the reworking of sand and gravel deposits during lake drainage are present in Burt, Bompas, and Lee Townships. These drainage channels would have operated for only a short period of time during the regression of the lake before being abandoned for lower outlets.

Upon emergence of the land, accumulations of organic matter, in the form of peat and muck, began in swamps and along stream courses. Large swampy areas have developed on the poorly drained, impermeable clays in the northeast quadrant of the Ramore sheet and in Eby and Blain Townships of the Kirkland Lake map sheet.

Economic Geology

The large volume of aggregate material present in glaciofluvial and spillway deposits is capable of supplying the demand of the Kirkland Lake–Ramore area for the foreseeable future. The majority of sand and gravel used for construction purposes is extracted from pits developed in esker complexes, particularly the esker followed by Highway 11. In this esker complex, reserves in the majority of pits are moderate to high with few of the pits being worked frequently. Further development of this esker is possible, especially the esker-delta complex in Eby Township. The Watabeag Esker in Bowman Township and associated glaciofluvial materials to the south hold very high potential for large reserves, as does the area around Butler and Malloch Lakes and that area of the Airport Esker in the northeast corner of the Kirkland Lake map sheet. Esker and spillway deposits in the Burt, Sarsfield, and Tomwool Creek valleys may also contain significant aggregate deposits, although the shallow depth of the water table may create problems for extraction.

Kames, kame terraces, and thin glaciofluvial material over bedrock are often used as a local source of aggregate. Reserves are usually small and the material tends to be irregular necessitating careful monitoring if specific product grades are required. The distribution of such features across the map-area does, however, eliminate the need for long haulage distance to clients.

Shallow water lacustrine and eolian sand has in several cases been used as fill during construction through bogs. Its use is often limited by the percentage of silt present in some areas and by problems with compaction.

Basal till also has potential as road base material where it occurs in sufficient volume, and where it does not contain a large volume of boulder size material. Size analysis should be carried out to determine the silt percentage in order to avoid use of locally fine facies of the till which is susceptible to frost heaving.

No commercial extraction of peat is taking place in the Kirkland Lake–Ramore map-area. The Ontario Ministry of Natural Resources, has a peat cutting operation in Dunmore Township which supplies material for the Swastika Tree Nursery, Burt Township.

The extensive clay deposits of the area have not been used in the manufacture of brick or ceramics, being in general too limy. Whether site specific testing might find material of a suitable composition is not known.

Engineering and Environmental Geology

Few engineering problems that cannot be overcome by standard procedures occur in the map-area. Construction of roads may entail blasting of rock in order to obtain acceptable grades and straight roadways as well as the excavation of peat and muck for replacement with fill in low lying or swampy areas.

Two landslips were noted on the Black and Pike Rivers resulting from the failure of varved clay sediments. In both cases a very small volume of material was involved and faces in which they were developed were nearly vertical.

The common practice of placing sanitary landfill sites in abandoned sand and gravel pits or in highly permeable lacustrine sediments allows for the possibility of rapid migration of leachate. In order to prevent contamination of local or regional groundwater flow systems, detailed stratigraphic and hydrogeologic studies should be undertaken at each proposed site in order to assess the impact of pollution. Monitoring and testing of groundwater about existing sites may be required.

No. S10 Quaternary Geology of the Nassau Lake Map-Area, District of Cochrane

M.L.T. Crosbie[1]

Introduction

The Nassau Lake map-area (NTS 42F/9) is located between Latitudes 49°30′ and 49°45′N and Longitudes 84°00′ and 84°30′W, and is situated 25 km west of Hearst and 2.5 km east of Highway 631. Highway 11 crosses through the northernmost portion of the map-area.

The surficial deposits of the area were discussed as part of a regional study by Boissonneau (1965; 1966). The map-area is also included within the Calstock sheet of the Northern Ontario Engineering Geology Terrain Study (McQuay in press). Dean (1956) described geomorphic features in similar terrain immediately to the east of the map-area.

The major goals of this project were to provide an inventory map of the surficial geology, to determine potential aggregate resources in the area, and to describe the glacial history and the glacial deposits.

Mapping of the surficial geology at a scale of 1:50 000 was carried out during the summer of 1979 using aerial photographs at scales of 1:15 840 and 1:50 000. Detailed studies of natural and man-made exposures were augmented by vehicle and foot traverses along logging roads.

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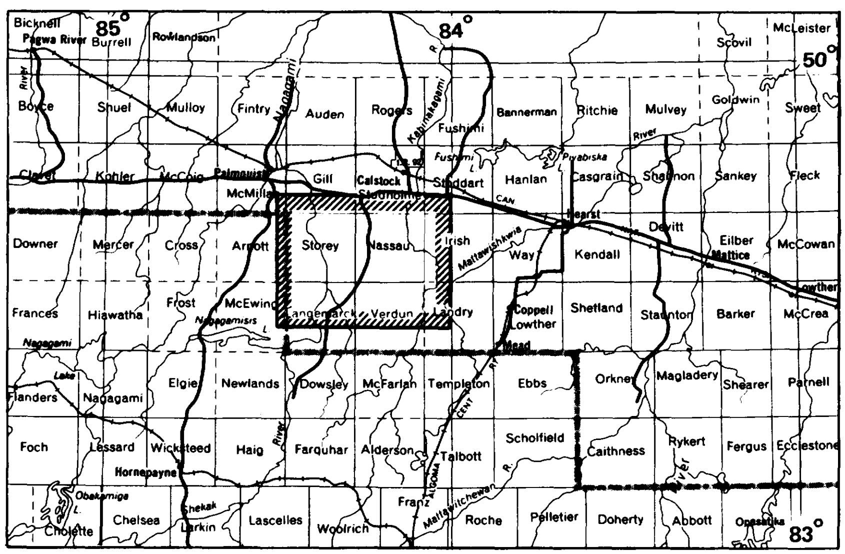
Bedrock Geology

The geological compilation map for the Caramat-Pagwa River Sheet (Innes and Ayres 1969) shows that the map-area is underlain mostly by Early Precambrian migmatites and felsic intrusive rocks and minor areas of metavolcanic and metasedimentary rocks. Numerous northwest-trending and several northeast-trending diabase dikes have been mapped from their aeromagnetic expression. Lineaments and fracture traces are common and impose some control on drainage.

The depth of the overburden has severely limited the number of bedrock outcrops within the map-area. Well records indicate overburden thicknesses of 17.9 m, 23.8 m, and 25.6 m in the central area. The mapped outcrops are generally limited to the northern and southern edges of the map sheet, except along the major river courses.



LOCATION MAP

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

Physiography

The major topographic feature within the map-area is a southeast-trending esker complex, herein termed the Nassau Esker. Although previously mapped as an interlobate moraine and esker by Boissonneau (1966), detailed investigations have shown that it is an esker with channels and peripheral deltas of sands and gravels which developed subaerially during successive stages of ice recession. The esker complex rises to a maximum elevation of 350 m which is 90 m above the surrounding terrain and has a maximum breadth of 11 km.

The esker itself is a continuous, sinuous ridge (approximately 0.5 km in width) extending for 22 km within the northern half of the map sheet. There are numerous elongate kettle holes and ice block depressions along its flanks. Evidence (discussed below) exists to suggest that the esker was subsequently overridden by Cochrane ice. The Nassau Esker is thought to be a continuation of the esker in Rogers Township, 10 km to the north, and it is thought that in the southern half of the map-area the esker either terminates or is more completely buried beneath till and lacustrine deposits.

On both sides of the esker complex there are broad, flat lowlands ranging from 250 m to 275 m above sea level. The surficial material is comprised of glaciolacustrine silts and varved silts and clays. The varves are typical of those attributed to the post-Cochrane lake phase (Hughes 1965). The glaciolacustrine areas are poorly drained and predominantly covered with more than 50 cm of peat. These lowland areas have a fluted surface which is enhanced by elongated lakes and variations in the natural vegetation. The southeast trending flutings and the underlying bedrock influence the local drainage patterns. Also apparent on the air photos are microrelief features such as: circular features in organic terrain (Usik 1966), 325-650 m in diameter which reflect vegetational differences and may be the result of periglacial processes (Dean 1956); and oval-shaped depressions which may reflect localized pondings during the post-Cochrane lake phase.

In Storey Township, within the western lowland area, there are two short, south-trending eskers. Their surface deposits were reworked during the postglacial lake phase.

Located in the southwestern corner of the map-area is a portion of an extensive interlobate moraine which extends into Arnott and McEwing Townships (Boissonneau 1966). The characteristics exhibited by this deposit are not known in detail; however, the material appears to be sandier than the Cochrane Till, which overlies it.

Exposures of Cochrane Till of at least I m in thickness are found atop the northern and southern ends of Nassau Esker. The Cochrane Till found in these areas is calcareous, with a silty clay matrix which is blocky, and has numerous, small, angular clasts. Areas of reworked or washed Cochrane Till occur east and west of the esker complex where the elevation of the bedrock limited deposition of glaciolacustrine sediments over the till. In these areas the till is calcareous, slightly sandier, more stoney, and less cohesive. It is commonly found interbedded with glaciolacustrine deposits.

Quaternary Chronology

Field evidence suggests that the physiographic features of the map-area are related to two glacial events: the Late Wisconsinan ice advance and the succeeding Barlow–Ojibway lake stage; and the Cochrane readvance and the post-Cochrane lake phase.

The Nassau Esker is attributed to the recessional stage of the Late Wisconsinan glaciation because the younger Cochrane Till overlies it in many places, and because Cochrane ice is generally considered to have been of insufficient duration or magnitude to have given rise to such a depth of well-stratified, sandy, cobbly, and bouldery esker deposits. The short esker complexes to the west may also date from the Late Wisconsinan for the same two reasons.

The map-area was subsequently overridden by Cochrane ice advancing from the northwest. This is documented by Cochrane Till found in the upland areas and overlying the esker deposits, as noted at several vertical exposures. The southeast-trending fluted lowlands to the west, south, and east of Nassau Esker imply unimpeded ice flow over the esker complex. Striae on outcrops in each quadrant of the map sheet also indicate that Cochrane ice advanced from the northwest.

As the Cochrane ice lobe melted, a lake was impounded along the ice margin and glaciolacustrine silts and varved silts and clays were deposited in the lowland areas. In the upland areas the till and/or glaciofluvial deposits were reworked. Some of the delta formations were left as isolated remnants detached from the esker core and their slopes were dissected.

Following the postglacial lake drainage, extensive accumulations of fibrous peat have developed in the poorly drained lowland areas where the clay-rich till and glaciolacustrine deposits predominate.

Economic Potential

Local needs for aggregate material can be met during the foreseeable future, but the quality and use of the aggregate may be limited by the high content of chert clasts which were derived from the Paleozoic bedrock of the Hudson Bay Lowlands only 26 km north of the map-area.

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No. S11 Quaternary Geology of the Timmins Map-Area (NTS 42A/6), Districts of Cochrane and Timiskaming.

C.M. Tucker[1]

Introduction

The mapping of the surficial deposits in the Timmins area (at a scale of 1:50 000) was completed during the 1979 field season. The field area (Figure 1) contains approximately 1083 km^2 of territory and is bounded by the following co-ordinates; Latitudes 48°15′ and 48°30′N and Longitudes 81°00′ and 81°30′W. Approximately 15 weeks were spent in the area describing surficial deposits, measuring indicators of ice movement, and recording Quaternary stratigraphy. Previous investigations of Quaternary deposits which are of significance to the Timmins area were conducted by Hughes (1955, 1956, 1960a,b, 1961, 1965); Boissonneau (1966), Skinner (1973), Brereton and Elson (1979) and Lee (in press).

Bedrock Geology

The bedrock geology of the Timmins area is described in reports and maps by Ferguson *et al.* (1968); Leahy (1972); Pyke (1974; 1975) and Pyke *et al.* (1973; 1979). Volcanic and sedimentary rocks belong to the Superior Province, and with the exception of a few northeast-trending diabase dikes and minor Middle Precambrian sediments, are of Early Precambrian (Archean) age. The metavolcanics are divided into two groups, the Deloro and Tisdale Groups, which are separated by the Destor–Porcupine Fault. Metasediments which form the Porcupine Group are equivalent to the upper portion of the Deloro Group and the entire Tisdale Group (Pyke *et al.* 1973; 1979). Ferguson *et al.* (1968) have described gold-bearing veins and mines of Tisdale Township and Carlson (1967) has noted those in Ogden, Deloro and Shaw Townships. According to Pyke *et al.* (1979), 32 mines, four of which are still operating, have produced approximately four billion dollars worth of gold since the start of production around 1910. Also, considerable quantities of silver and minor scheelite have been obtained from these veins. Small quantities of copper are mined in Tisdale Township, and a nickel operation located in Langmuir Township is scheduled to re-open in the near future.

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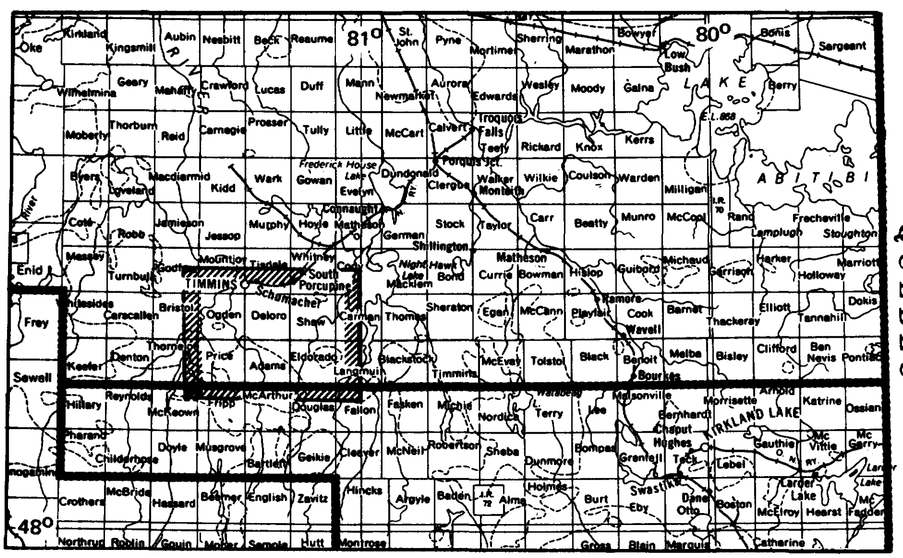

LOCATION MAP

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

Physiography

The Timmins map-area lies north of the Hudson Bay–St Lawrence drainage divide and forms part of the Great Clay Belt. Much of the terrain is a low lying, undulating plain underlain by varved clay and nearshore sands. Elevations range from 290 m to 410 m above sea level with most of the terrain being confined to elevations below 320 m. In fact, the map-area contains only two hills of any significant height above the norm. These are Fire Lookout Hill located immediately south of Schumacher which rises 366 m above sea level and the northern extension of Rat Mountain in Fallon Township which rises 412 m above sea level. A broad area of high ground exists in the southwest corner of the map-area between Chesterfield Creek and Grassy River. Elevations in this area are approximately 350 m above sea level.

On the western half of the map sheet, drainage is to the north. The main water course is the Mattagami River which flows from Kenogamissi Lake. The Grassy River similarily flows towards the north and merges with the Mattagami River approximately 4.5 km northeast of Kenogamissi Lake. The largest water body in the eastern half of the map-area is Night Hawk Lake which is located along the northeast margin of the map-sheet. Major sources located on its western perimeter include Night Hawk River, Forks River, Redstone River, and Goose Creek. Night Hawk Lake is surrounded by varved silts and clays which are generally less than 4 m in depth.

Quaternary Geology and Surficial Deposits

Morphologic indicators such as crag-and-tail hills and roches moutonnées along with striae measurements and till-clast lithologies indicate that the last ice movement to affect the area was in a general southerly direction. Exposures of till are largely confined to the eastern half of the map-area, specifically to Adams, Eldorado, Langmuir, Douglas, and Fallon Townships. Farther west, till is visible in McKeown and Fripp Townships. Other sites are highly localized and generally occur on the distal end of crag-and-tail hills which have been masked by glaciofluvial and glaciolacustrine deposits. A good example of this situation is located on the Fripp-McArthur Township line, 1.8 km south of the Price-Adams Township intersection. All tills are cobbly with a silty sand matrix and strongly reflect local bedrock lithologies. They are considered to be correlative with the last major flow of the Laurentide ice sheet which is referred to as the Matheson Till by Hughes (1955) and the Adam Till by Skinner (1973). There are no outcrops of Cochrane Till in the Timmins map-area, however,good exposures are found less than 13 km to the north on Highway 655.

Glaciofluvial deposits are concentrated in three north-south oriented esker ridges. The largest of these is located along the east bank of Grassy River and crosses the Mattagami River near Waterhen Lake. The second occurs in the west-central portion of the map-area, and is visible as a prominent ridge north of Gillies Lake and as beaded esker remnants along Papakomeka Lake Road. The third esker ridge is found near the town of Porcupine immediately south of Bob's Lake and is capped by glaciolacustrine sediments derived from proglacial Lake Barlow-Ojibway. Coarse-grained glaciolacustrine delta material is located at Whitney-Shaw Township line on the Langmuir road and grades into distal bottomset sands 2 km farther south.

Essentially, most of the terrain below 298 m is covered by glaciolacustrine varved silts and clays. Near Night Hawk Lake thicknesses are variable, but 9 m is considered to be a representative depth. On the Mattagami River just south of Waterhen Lake, more than 20 m of stratified lacustrine material was measured in one section. Large tracts of nearshore sands occur along the flanks of the Grassy River and Papakomeka eskers. Beach sands and wave-sorted pebble gravels are concentrted along the eskers as well as around prominent bedrock knobs. Two major still-stands of Lake Barlow-Ojibway are recorded at approximately 295 m and 335 m above sea level. Because the area is planar, beach levels between these limits were difficult to separate into distinct sets. They are dominantly estuarine bay mouth bars and spits representative of a shallow water environment. Much of the nearshore sand found on the southeast sides of the eskers has been reworked into northwest-southeast oriented parabolic dunes as the deposits were exposed by falling water levels during postglacial times.

Alluvium is generally silty to sandy in nature, except along Grassy River, where coarser eskerine sands and cobble gravels act as the source material. Because the area is so poorly drained, organic materials are a significant deposit in terms of areal extent if not in thickness. The greatest concentrations are found in the northeast quadrant of the map-sheet, namely in Whitney, Cody, Shaw, and Carman Townships.

Within the city of Timmins, silty, fine sand tailings piles form an important part of the landscape. Some cover as much as 1.9 km^2 of territory and contain more than 2.9 x 10^7 m^3 of material.

Economic Deposits

Major sand and gravel deposits are concentrated in the three previously mentioned eskers which along with associated outwash, are currently being worked. Future operations might be located in the various Lake Barlow-Ojibway beaches. Although these deposits are of limited extent, their proximity to appropriate construction sites would make them suitable for short term extraction.

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No. S12 Limestone-Dolostone Assessment Study Manitoulin Island

M.D. Johnson[1]

Location

During the summer of 1979, the geological mapping of the Paleozoic rocks and other data collection was completed for the southern and eastern parts Manitoulin Island. This area is covered by 1:50 000 N.T.S. map sheets of Little Current (41H/13), Manitowaning (41H/12 and 41H/11), and Providence Bay (41G/9).

The mapped area comprises the mainland mass of Manitoulin Island, and is thus bounded by the shorelines of North Channel, Georgian Bay, and Lake Huron, with the western boundary of the area being defined by Longitude 82°00'00" and 80°30'00"W and Latitude 45°45'00"N.

General Geology

Manitoulin Island is abundant in Paleozoic outcrops, particularly in the southern part, where large tracts of bare rock are exposed. The rocks range in age from the Middle Ordovician Lindsay Formation to the Middle Silurian Amabel Formation (Table 1).

Previous mapping of the island by Liberty (Liberty 1954-57, published 1972) suggested the youngest formation present to be the Guelph Formation.

The Lindsay Formation is the oldest Ordovician unit exposed on the main landmass of Manitoulin Island and consists of a grey, fine to sublithographic limestone with minor dolostones. This is overlain by the Whitby Formation, a shaly unit comprising soft brown shales in its upper part and black fissile fossiliferous shales with minor dolostones in its lower part.

Overlying the Whitby Formation is the Georgian Bay Formation; this unit being composed of lower and upper members, the latter being divided into two sub-members. The lower member of the Georgian Bay Formation is the Wikwemikongsing which consists of bluish-grey shales. The upper member, lower sub-member of the Georgian Bay Formation is the Meaford. This is a bluish-grey fine grained argillaceous dolostone with the overlying Kagawong (upper sub-member) being a brown and grey finely crystalline dolostone.

Evidence of Silurian deposition begins with the Manitoulin Formation, a brown to bluish-grey fine to sublitho-

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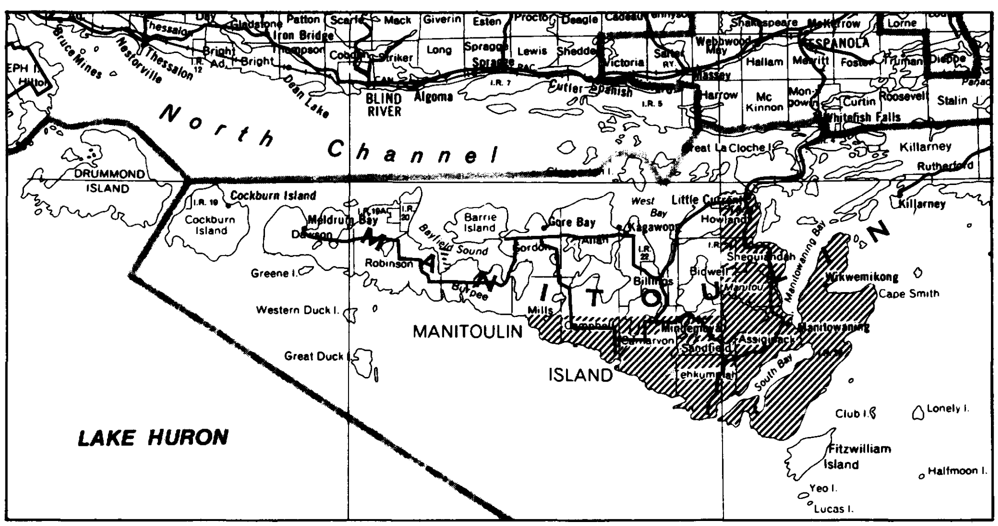

LOCATION MAP

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

TABLE 1 | PALEOZOIC STRATIGRAPHY OF MANITOULIN ISLAND (MAIN LAND MASS ONLY) AFTER LIBERTY (1968)

Formation	Members	Age
Amabel Formation		MIDDLE SILURIAN
Fossil Hill Formation		MIDDLE SILURIAN
Mindemoya Formation		MIDDLE SILURIAN
Cabot Head Formation	- St. Edmunds member - Wingfield member - Dyer Bay member - Cabot Head member	LOWER SILURIAN
Manitoulin Formation		LOWER SILURIAN
Georgian Bay Formation	- Upper member - Kagawong beds - Meaford beds - Lower member - Wikwemikongsing	ORDOVICIAN
Whitby Formation	- Upper member - Sheguiandah beds - Lower member - Collingwood beds	ORDOVICIAN
Lindsay Formation		ORDOVICIAN

graphic dolostone. This formation includes reefal (biohermal) and thin inter-reefal (platform) deposits.

The Manitoulin Formation is overlain by the Cabot Head Formation, which contains four members (nomenclature of Liberty 1968). These are the Cabot Head (restricted) Member, a green and red shale; the Dyer Bay Member, a bluish finely crystalline dolostone with shales; the Wingfield Member, a brown sublithographic dolostone interbedded with green shales; and the uppermost St. Edmunds Member, being a massive brown and grey, fine to medium-grained crystalline dolostone.

The overlying Mindemoya Formation is a predominantly thin bedded, pale grey to light brown, sublithographic to finely crystalline dolostone. Overlying the Mindemoya Formation is the Fossil Hill Formation, a buff to grey-brown, fine to coarsely crystalline unit. This formation is rich in coral, algal, and brachipod remains with beds of chert nodules in its upper part. The contact with the overlying Amabel Formation is gradational.

The Amabel Formation consists of a blue-grey to buff, fine and evenly crystalline dolostone. Both reefal and inter-reefal beds are present. This formation possesses a number of thin chert rich zones, these being concentrated in the lower part of the formation.

1979 Field Work

The field work was designed to collect data which would permit assessment of the limestone and dolostone resource capacity of eastern Manitoulin Island. To this end, a detailed study was made of 1744 localities. At each of these points, collected data included outcrop and lithologic description, faunal analysis, and representative samples. Those samples considered most representative are currently being analysed for major and trace elements. Lithological and petrographical analysis is being used to develop correlations between the outcrops.

Road accessible localities were inspected, described, and sampled wherever possible, and foot traverses were used in areas of no road access. Road and foot traverse lines were arranged so that individual lines were 3 km or less in separation, with samples on those lines being taken at a spacing of 0.3 km, outcrop permitting. In all, 2380 hand samples were collected. Less field time was spent on the Ordovician than Silurian rocks because of the lower economic potential of the Ordovician rocks which result from their lower purity and greater overburden cover.

1978 Drilling Activities

During the Fall of 1978, ten diamond drill holes (Table 2) were cored on Manitoulin Island. These are continuous cores with 543.1 m of HQ (2½ inch) core being recovered. The cores are intended to augment the field work by providing vertical sectional data. Selected intervals from all ten cores are currently being chemically analysed for major and trace elements, and three cores (numbered 78-01, 78-03 and 78-07) are undergoing physical testing for engineering standards. A detailed lithological description is being made of all the cores and this will be released as an Open File Report.

TABLE 2 | 1978 DRILLING ACTIVITIES

Hole Number	Location	NTS Map	UTM Coordinates	Depth	Formations Encountered
78-01	Mississagi Lighthouse, 0.35 km northeast of lighthouse on the access road.	41 G/14	329675 mE 5086350 mN	203'2"	Amabel Fossil Hill
78-02	Burnt Island, approx. 0.4 km east of fork in the main road and intersection Hydro lines	41 G/15	348950 mE 5075600 mN	198'10"	Amabel Fossil Hill
78-03	Poplar - 0.4 km north of main intersection at Poplar (west side of road)	41 G/16	384850 mE 5069625 mN	199'0"	Amabel Fossil Hill Mindemoya
78-04	Kagawong West Quarry - 0.4 km east of Ice Lake on Highway 540 (north side of road)	41 G/16	399475 mE 5083200 mN	150'5"	Manitoulin Georgian Bay
78-05	Billings Hill, 1.8 km due south of Billings.	41 G/16	405250 mE 5076050 mN	298'11"	Fossil Hill Mindemoya Cabot Head Manitoulin Georgian Bay
78-06	Big Lake - approx. 0.4 km west side of Big Lake on Highway 542 (north side)	41 G/9	417500 mE 5066375 mN	140'10'	Fossil Hill Mindemoya Cabot Head
78-07	South Baymouth - east side of Highway 68, about 0.5 km north of South Baymouth.	41 G/9	420950 mE 5046750 mN	101'11"	Amabel
78-08	Fossil Hill - 1.6 km west of Hilly Grove on Highway 68 (north side of road, on top of road cut)	41 H/12 and 41 H/11	429725 mE 5058450 mN	150'9"	Fossil Hill Mindemoya Cabot Head
78-09	Manitowaning 0.5 km south of Manitowaning on Highway 68 (west side of road on top of road cut)	41 H/12 and 41 H/11	435300 mE 5062500 mN	151'5"	Manitoulin Georgian Bay
78-10	Ten Mile Point South - 10.2 km south of Sheguiandah on Highway 68 (west side of bend)	41 H/13	433625 mE 5077325 mN	186'11"	Georgian Bay

1979 Drilling Activities

During the fall of 1979 six holes (Table 3) are to be drilled on Manitoulin Island. These holes are anticipated to yield 167.6 m of core in southeastern Manitoulin Island which will be used to determine unit thickness and variation within the 1979 field study area.

Economic Geology

The main land mass of Manitoulin Island has, at present, one dolostone quarry located near South Baymouth. This quarry (Leason Quarry) has produced both massive block and cherty dolostone aggregate from the lower Amabel Formation.

TABLE 3 | 1979 DRILLING ACTIVITIES

Hole Number	Locality Description	NTS Map	UTM Co-ordinates		
79-11	Providence Bay Adj. to Coast Raod 0.1 km east of Government Fish Dock	41 G/9	401325 mE	-	5056600 mN
79-12	Mindemoya Adj. Highway 1.2 km N of Rd. to Mindemoya from Highway 542A, Providence Bay Road	41 G/9	409175 mE	-	5057875 mN
79-13	Michaels Bay 2.1 km east of Hammond Pt., on the northern coast of Michael Bay	41 G/9	413750 mE	-	5049900 mN
79-14	Wikwemikong Indian Reserve 0.8 km down rd. leading to farm, off Jacko Rd. 3.85 km down Jacko Rd. to Farm Road.	41 H612 and 41 H/11	43450 mE	-	5050650 mN
79-15	Wikwemikong Indian Reserve 1.9 km west of Little Bluff 3.3 km North of Owen Island	41 H/12 & 41 H611	436625 mE	-	504425 mN
79-16	Manitowaning 0.7 km West, down Bidwell from Highway 68 intersection, adj. to Rd.	41 J/13	433175 mE	-	50672 mN

The dolostones of the Amabel Formation are particularly attractive as a source of future construction material because of their overall homogeneous nature, high purity, and typically thin overburden.

Petroleum exploration on the island was particularly active during the early part of the century with 104 recorded wells being drilled. These led to at least nine producing oil and gas wells, none of which are presently active.

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1972a: Little Current Area, Ontario Division of Mines, Map 2247, scale 1:63 360.

1972b: Providence Bay Area, Ontario Division of Mines, Map 2248, scale 1:63 360.

1972c: Manitowaning Area, Ontario Division of Mines, Map 2249, scale 1:63 360.

Geophysics/Geochemistry Section

Geophysical, Geochemical and Geochronological Surveys, 1979

R.B. Barlow[1]

Uranium Reconnaissance Program

The results of two Federal-Provincial airborne gamma-ray spectrometer surveys covering parts of northwestern Ontario and northeastern Ontario were released in August and September, 1979 (No. 1 and No. 2 on Location Map). The northwestern Ontario survey covered an area of approximately 90,000 km^2 and consists of: NTS sheet 53G, Makoop Lake; NTS sheet 53B, North Caribou Lake; NTS sheet 53A, Wunnummin Lake; NTS sheet 52O, Lake St. Joseph; NTS sheet 52P, Miminiska Lake; and NTS sheet 52I, Armstrong. The northeastern Ontario survey covered an area of approximately 75,000 km^2 and consists of: NTS sheet 42B, Foleyet; NTS sheet 42A, Timmins; NTS sheet 32D, Noranda–Rouyn; NTS sheet 41O, Chapleau; NTS sheet 41P, Gogama; and NTS sheet 31M, Ville-Marie.

The results of a Federal-Provincial lake sediment geochemical survey covering the eastern shore of Lake Superior were released in May, 1979 (No. 3 on Location Map). The multi-element survey covered an area of approximately 34,000 km^2 at a sample density which averaged approximately one sample per 13 km^2 and included parts of NTS sheets 41K, Sault Ste. Marie; 41N, Michipicoten; 42C, White River and 42F, Hornepayne (south half). During the summer of 1979 a lake sediment geochemical survey was completed over part of northwestern Ontario. The survey covered approximately 20 000 km^2 and included the Ontario part of NTS sheets 52B, Quetico and 52C, International Falls (no. 4 on Location Map). This project is funded entirely by the Province of Ontario with management being currently the responsibility of the Resource Geophysics/Geochemistry Division, Geological Survey of Canada.

The Federal-Provincial Uranium Reconnaissance Program was officially terminated in September, 1978. Related co-operative programs will follow in future years, however the scale of projects and related financing will be reduced by approximately 50 percent.

Gravity Program

During the 1979 season, staff of the Geophysics/Geochemistry Section carried out a gravity survey in the Shining Tree–Gowganda area in northeastern Ontario. This project is the second year of a three year program to obtain gravity data over a 26 300 km^2 area which covers the Cobalt embayment to the north and the Grenville Front to the south. A detailed interpretation of the complete survey area will follow in year four.

Geochemistry

During the 1979 summer season the staff of the Geophysics/Geochemistry Section supervised two geochemical projects in northern Ontario.

A four year study of the geochemistry of the till units in overburden was successfully started this summer in the Kirkland Lake Area. The two objectives for the field program are, firstly, to obtain uniform reconnaissance coverage over high potential zones within a larger 28 township area using drilling equipment which has the capability of obtaining a large volume of sample material, and secondly, to carry out detailed research over known mineral occurrences with regard to small scale equipment performance and geochemical dispersion patterns.

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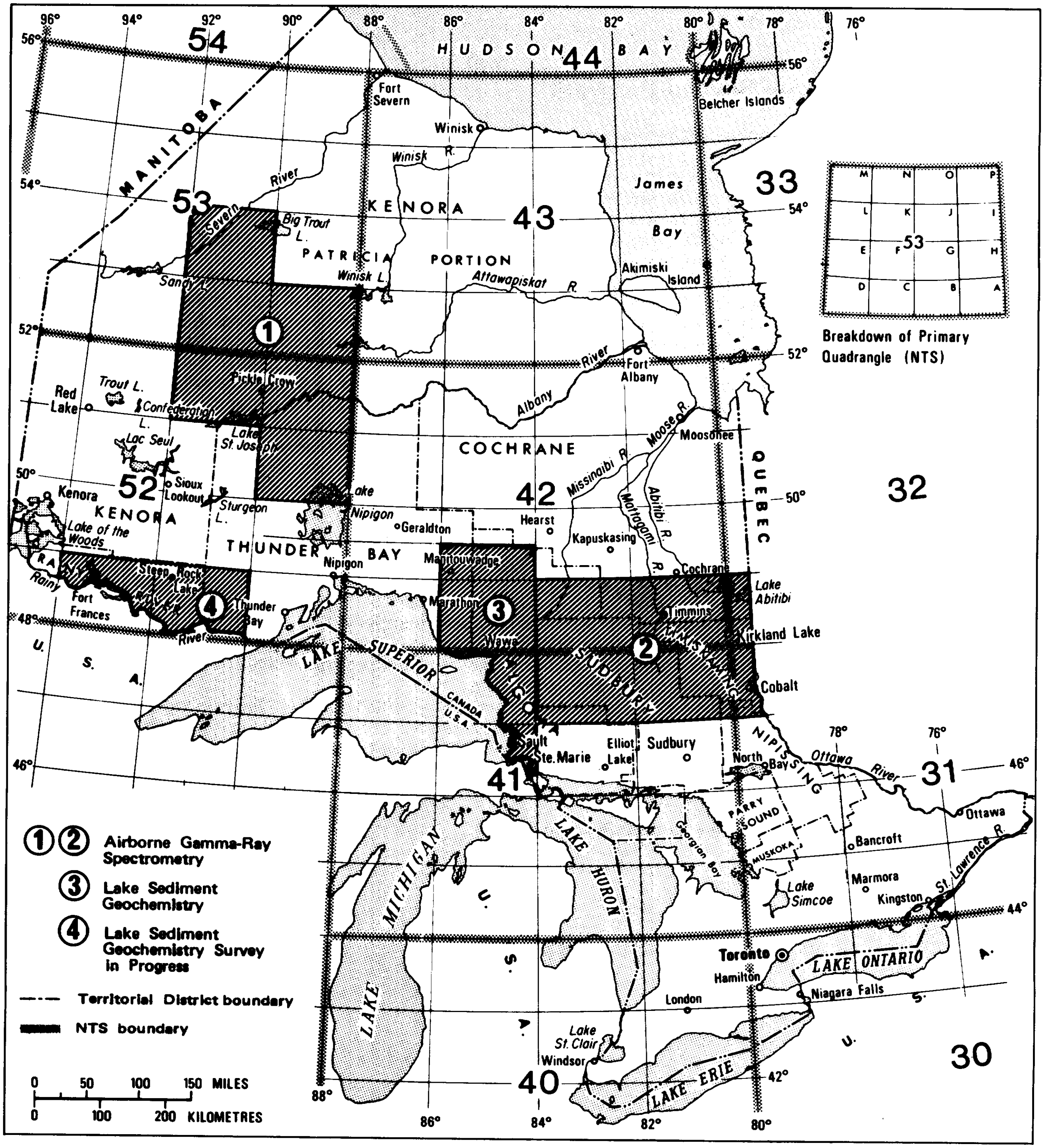
1 Chief, Geophysics/Geochemistry Section, Ontario Geological Survey, Toronto.



LOCATION MAP

Uranium Reconnaissance Program

An airborne geochemistry test program began in July to evaluate the effectiveness of recent modifications of the SURTRACE[1] System over forest covered areas which are typical of conditions encountered over the Canadian Shield. Two survey targets were chosen so that both massive and disseminated sulphide mineral occurrences would be represented in the test program.

Airborne Survey Program

The results of three separate airborne geophysical surveys were released during the summer field season.

A total of 11 867 line km of magnetic data were completed by Northway Survey Corporation Limited over a 2350 km^2 area located near Marshall and O'Sullivan Lakes. Results of the survey will be used to extend geological features in areas of sparse outcrop. Recent geological mapping by the Ontario Geological Survey and mineral exploration carried out by mining companies has enhanced the mineral potential of this area.

A total of 8000 line km of multifrequency electromagnetic data were compiled by Scintrex Limited over an 8000 km^2 area covering the southern and eastern parts of the Cretaceous Basin, James Bay Lowlands. The data have been obtained for the purpose of mapping the electrical properties of the subsurface unconsolidated material and related lignite occurrences within the area. The survey technique was designed on the basis of results of a previous research project carried out over the Onakawana lignite field located between Cochrane and Moosonee, Ontario and represents the first large scale attempt to use multifrequency data obtained in the audio frequency range for terrain mapping.

A total of 12,355 line km of time domain electromagnetic data were compiled by Questor Surveys Limited over a 2455 km^2 area covering 28 adjoining townships in the Kirkland Lake area. The survey results were well received by mineral exploration companies and caused an impressive amount of staking activity in this area.

Geochronology Program

The Uchi-Confederation Lakes project has now been completed and a report authored by P.D. Nunes and P.C. Thurston is nearing the publication stage. This study has uncovered new information on the duration of volcanic activity during Precambrian time and represents an important contribution to Precambrian geology.

The analysis stage of a geochronology study being carried out by D. Davies in the Sturgeon Lake-Vermilion Bay area is now nearing completion. A report, describing the geochronology of the area will be produced by D. Davies, N.F. Trowell and C.E. Blackburn.

1 Registered Trade Mark, Barringer Research Limited.

No. 30 A Gravity Survey of The Gowganda, Shining Tree And Gogama Areas, Districts of Timiskaming And Sudbury

V.K. Gupta[1] and D.R. Wadge[2]

Introduction

A gravity survey of Gowganda, Shining Tree, and Gogama areas was completed during the 1979 field season as part of a three year project. In 1980, the final year of the program, the gravity surveying will be continued southward. During the first year of the program, gravity surveying was carried out in the North Bay-Cobalt- Englehart, and Elk Lake areas (Gupta and Wadge 1977).

Location

The survey area is bounded by Latitudes 47°20′ and 47°55′N and Longitudes 80°30′ and 81°45′W covering an area of approximately 6100 km^2. The hamlet of Shining Tree is approximately in the centre of the survey area. Access by motor vehicle in the region is provided mainly by Highway 560 which is connected with numerous lumbering, mining, resource, and recreation access roads. Excellent water access is provided by an extensive lake system and many rivers. Access to the remote areas during the summer is restricted to float- equipped fixed-wing aircraft and helicopter.

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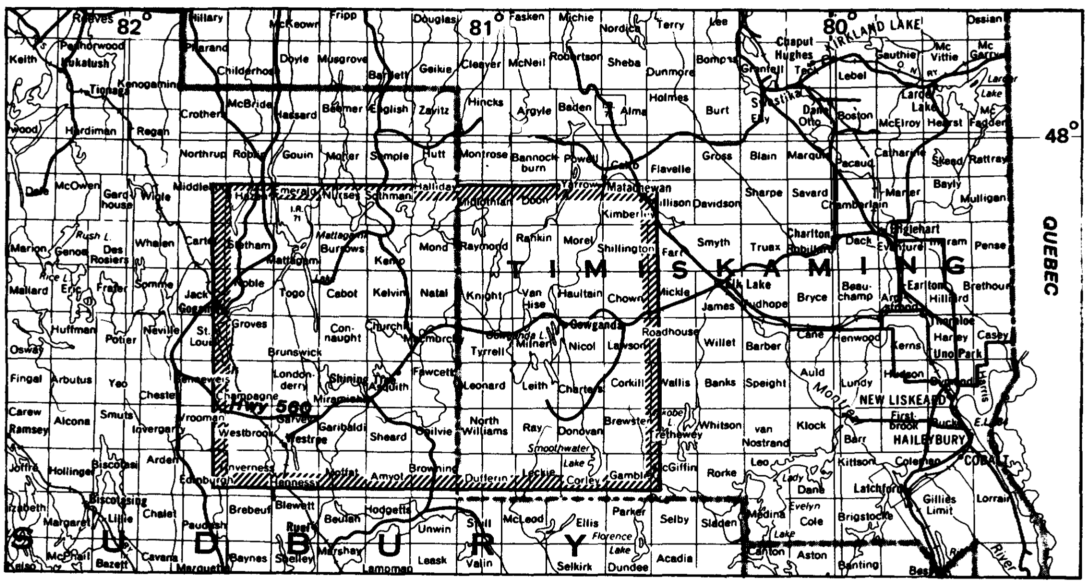
Gravity Survey

In a land gravity survey, the following primary data are recorded at each station: the time of observation in Greenwich Mean Time (GMT); the observed gravimeter scale value; and the elevation of the station with reference to mean sea level and the grid coordinates. During the summer of 1979, an eight man field party, utilizing fixed-wing aircraft and helicopter support, established over 1700 land gravity stations using three Lacoste-Romberg gravimeters, numbers G-294, G-329, and G-417. In addition, 200 gravity stations were established in the Round Lake Batholith area. The average gravity station distribution over the entire area was approximately 1 station per 4 to 6 km^2.

The gravity observations were tied to control stations established by the Earth Physics Branch, Ottawa, at Elk



LOCATION MAP

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

Lake, Gogama, Matachewan, New Liskeard, and Kirkland Lake. These stations form part of the National Gravity Network which is tied to the International Gravity Standardization Net 1971. The Lacoste-Romberg meters which are relatively drift-free, were read at control stations every day at the beginning and end of each traverse. The meters had an average daily drift of less than 0.04 mgals.

Elevations

Vertical control for most of the survey was provided by lake levels, with gravity station elevations being recorded as secondary elevations relative to lake levels. The elevation of many lakes close to the bench marks (Geodetic Survey of Canada and Ontario Ministry of Transportation and Communications) were established by precise levelling from these bench marks. Other larger adjacent and interconnected lakes were levelled from these precision levelled lakes. The elevations of certain other lakes and river systems were established using data from Ontario Hydro and Ontario Ministry of Natural Resources dams. Lake levels for the remaining less accessable lakes and elevations for points on roads were determined using Wallace and Tiernan altimeters in pair. Appropriate corrections for temperature and humidity variations were applied, and elevation control was provided by occupying a point of known elevation at least once every one to two hours. Some bench marks on the highways and railways were used for altimetry control.

Horizontal Control

The gravity stations were established at identifiable sites and were located on 1:50 000 scale air photographs. The station positions were then transferred onto NTS topographic maps (scale 1:50 000) with a six degree UTM grid superimposed. The gravity stations were digitized with a precision of ±40m.

Rock Densities

Nine hundred and fifty density measurements were made on fresh rock samples collected from outcrops at or near gravity station sites. The rock samples were soaked in water for about one hour and agitated to remove air bubbles. The porosity and permeability of the rock types in the area is low and therefore the measured densities should approximate closely the field densities. Mean density values will be assigned to the major rock units of the area under investigation.

Data Reduction

The gravity survey was carried out to the specifications of the Gravity Division (1976), Energy, Mines, and Resources, Canada. The field data is now being processed at the Gravity Division, Ottawa.

References

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Gupta, V.K. and Wadge, D.R.
1977: Gravity and Magnetic Susceptibility Surveys of the North Bay–Cobalt and Englehart–Elk Lake Areas, Districts of Nipissing and Timiskaming; p.172-173 *in* Summary of Field Work, 1977, by the Geological Branch, edited by V.G. Milne *et al.*, Ontario Geological Survey Miscellaneous Paper 75, 208p.

No. S13 An Airborne Geochemistry Test Program, Marshall–O'Sullivan Lakes Area and Marathon Area, Northern Ontario.

Ian Thomson[1]

Introduction

During July 1979, the Geophysics/Geochemistry Section conducted experimental airborne geochemical surveys at two locations in Northern Ontario. This program, carried out in the Marshall Lake and Marathon areas, employed the Barringer Research SURTRACE[2] System. This proprietary technique was originally designed by Barringer for use in desert and grassland areas. During 1978 and 1979 Barringer Research perfected modifications which permit use of the system over forested ground. The present surveys are a test and evaluation of the technique under Ontario conditions and represent the first application of the system over northern forests.

Essentially, the SURTRACE sampling equipment comprises a system which vacuums loose particulate material from the leaves and bark of trees and deposits a sample onto adhesive tape. Samples impacted onto the tape are later analysed for up to twenty four elements by means of a proprietary laser pyrolysis technique—LASERTRACE[2].

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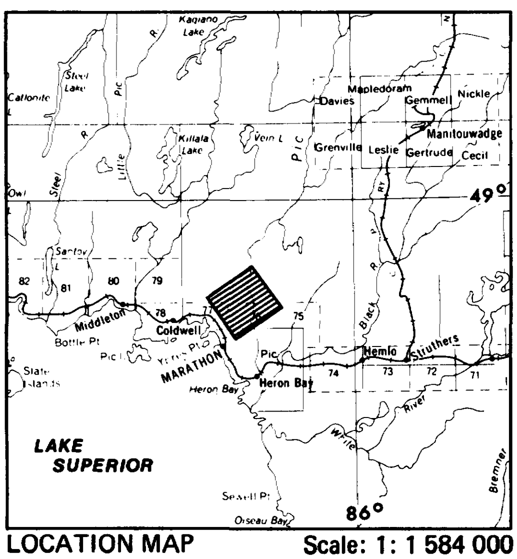
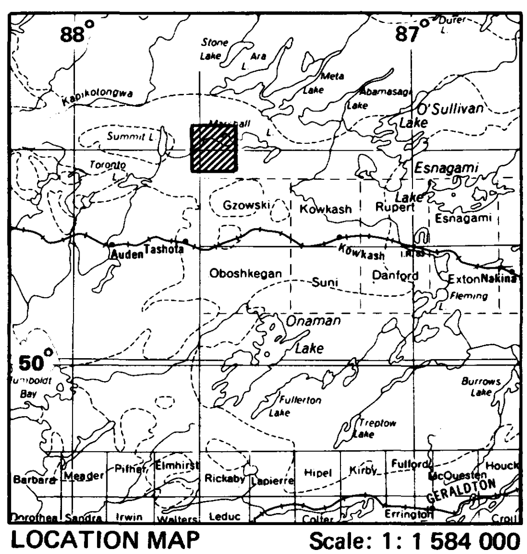
To achieve sample collection the SURTRACE equipment is mounted in an Allouette 11 helicopter which provides the power and manoeuvrability needed to operate just above the tree tops. A probe designed specifically for work in Northern Ontario and mounted beneath the helicopter is trailed through the trees to obtain the sample material. The sample acquisition point at the tip of the probe was modified from earlier models for use in trees and special safety features were introduced to prevent snagging and probe loss endangering the safety of the helicopter. Barringer Research has developed the SURTRACE technique for the collection of samples from the soil-air or vegetation-air interface. Barringer (in press) notes that this interface consists of a microlayer of particulate material composed of a mixture of organic and inorganic constituents. Barringer (in press) further reports that studies have demonstrated a close relationship between the chemistry of the microlayer and mineral occurrences. The SURTRACE sampling equipment is designed to collect a specific size fraction of the surface microlayer which has been found to carry the most diagnostic geochemical information.

For survey work the helicopter traverses at tree-top height trailing the probe. Collection of the particulate matter is a continuous process and a constant loading device is employed to ensure continuity between the samples



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



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

collected on the tape. By this means an average of five samples are collected per line km of flying with the helicopter travelling at an average speed of 30 km/hr. Samples cannot be collected over lakes, streams or swamps. Operationally, the system was found to be uniformly effective over the wide variety of terrain conditions encountered in the two areas. Flying began in the late morning after the dew had left the ground and continued until nightfall. Survey work was halted by rain, which stopped sample collection, and by winds above 20 km/hr which threatened the safety of the helicopter operating close to the trees. The field operation, including test work and some re-flying was completed in ten days.

The present surveys, which were of relatively limited extent, sought to examine the capabilities of the Barringer SURTRACE system by tests carried out in areas where extensive pre-existing geological, geophysical and geochemical data provide the control necessary for fair assessment. At Marshall Lake numerous copper-zinc sulphide occurrences are known and at one location a substantial tonnage of ore grade material has been defined. A total of 255 line km were flown in this area. At Marathon where 155 line km were flown, the intrusive rocks of the Coldwell Complex provide an interesting geochemical target together with known copper-nickel sulphide mineralization in the gabbroic rocks at the margin of the Complex.

In addition to the airborne work, some 20 km of ground traverses were completed along which soil and vegetation samples were collected to complement the flying.

The results of the study will be published in 1980.

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No. S14 A Geochemical Reconnaissance Basal Till Survey and Related Research in the Kirkland Lake Area, District of Timiskaming.

I. Thomson[1] and D. Guindon[2]

Introduction

In May 1978, the Geophysics/Geochemistry Section initiated a four year program of investigation into the geochemistry and mineralogy of the till sheets and associated Quaternary sediments of the Kirkland Lake district. This work forms part of the Kirkland Lake Initiatives Program (KLIP) a joint federal-provincial project, under the management of the Ontario Geological Survey, designed to provide a comprehensive geoscientific data base for the area.

This year's work was carried out in two phases. A systematic reconnaissance geochemical survey using deep overburden drilling was started in July. In addition, a detailed study was completed to examine the relative effectiveness of a man portable percussion sampling rig for use in complex glaciated terrain.

The study area lies at the southern margin of the Abitibi Clay Belt, a major lake basin during the retreat stage of the Pleistocene glaciation. In areas such as the Kirkland Lake district, where there is an extensive cover of glaciolacustrine clay and/or glaciofluvial sediments, conventional geochemical techniques (soil or silt sampling) do not work. Practical experience has shown, however, that beneath the cover of exotic sediments, glacial till of essentially local derivation is preserved. Drilling through the cover and sampling of the till sheets beneath is a proven method of evaluating the mineral potential of such areas. (Thompson 1979).

Reconnaissance Survey Program

This year's one month field program marked the first part of a project which will ultimately include all the drift covered parts of the KLIP area. The work comprises drilling at a reconnaissance density (15 to 20 drill holes per township), continuous profile sampling through the unconsolidated overburden, and sampling of the bedrock beneath. Chemical and mineralogical studies will be undertaken on the samples obtained, paying particular attention to the composition of the till sheet, with a view to obtaining information of value in assessing the mineral potential of the drift covered areas. Following an evaluation of existing equipment, the dual-tube, reverse circulation

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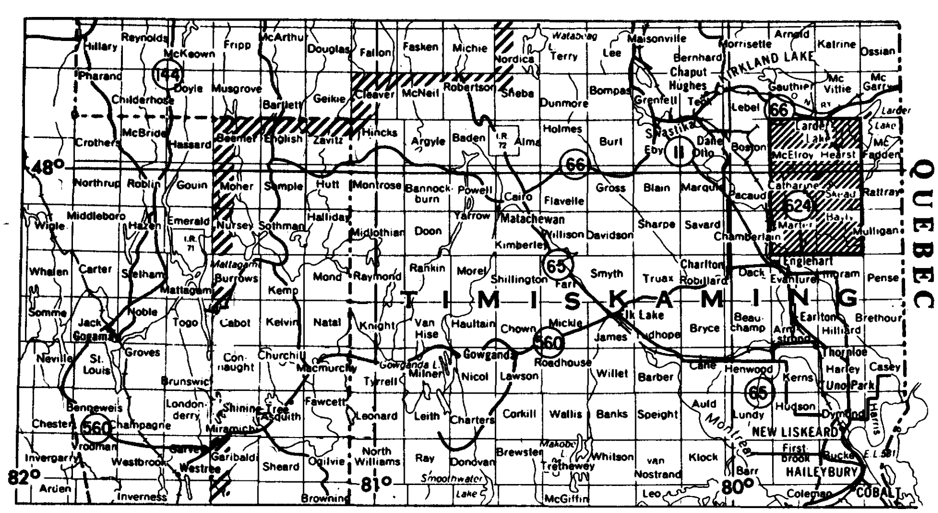

LOCATION MAP

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

rotary drilling technique was selected for the program. The objectives of the work include:
a) To determine the distribution and concentration of indicator elements, minerals, and rock fragments in the till sheet as a means of evaluating the mineral potential of areas where bedrock exposures are sparse or absent.
b) To determine the composition, thickness, and distribution of the unconsolidated cover with a view to; i) aiding the interpretation of the geochemical data, ii) further elucidating the Quaternary history of the area and qualifying existing maps of these surficial deposits, and iii) identifying subsurface conditions which might affect the interpretation of airborne geophysical surveys.
c) To provide further information on the composition of the bedrock, depth to bedrock, and bedrock topography as an aid to geological studies, diamond drilling, and ground geophysical surveys.

During the present work period 44 drill holes were completed in the southern part of the KLIP area for a total of 1098 m of drilling. The holes are set out on a 3.25 km grid modified locally to account for access and overburden/outcrop relationships. Drilling was undertaken by Heath and Sherwood, Kirkland Lake, using a reverse circulation rig mounted on a Timber-Jack. Management of the program was provided by Overburden Drilling Management Limited, Ottawa. Procedures employed are similar to those described by Skinner (1972) and Thompson (1979) with modifications to meet the requirements of the project. At this time, no geochemical or mineralogical data are available. Consideration is therefore given to the field program itself.

The reverse circulation rotary drilling equipment performed well. Productivity was found to be related to the depth and composition of the overburden and also the distance between drill sites. The field operation is essentially an exercise in logistics to ensure that the drill, support equipment, spares and personnel are mobilized expeditiously between holes. Careful onsite supervision is required so that the technique is truly cost-effective, free of sampling errors, and also sample contamination. When the drill is in operation, material from the overburden or bedrock is delivered continuously from the drill bit, as a slurry in water and air, to a sampling site on the Timber-Jack. Here, samples are collected in buckets and the stratigraphic section logged in detail. For the present program samples were taken from each lithology encountered up to a maximum of 5 m of continuous section in any one lithology. Drilling was continued for 1.5 m into bedrock to establish the nature of the solid geology. In practice, a minimum of 9 kg of material could be obtained from even the shortest section.

The Timber-Jack mobile drilling platform was found to be ideal for work in this southern area where there is an extensive road network. The Timber-Jack is faster than a Nodwell along roads and very maneuverable; a considerable advantage in a reconnaissance program where distances between holes are quite large. The one disadvantage of this equipment is that it requires a firm base to travel on, being less mobile than anticipated in swamps and wet clay areas. The unit bogged down easily if one wheel slid off the road bed into soft material. It could, nevertheless, be extracted or towed by a tracked bulldozer which was also used for road building and site clearing.

In the southern parts of the area covered by the drilling (Marter Township) the overburden is 30-60 m thick beneath a broad clay plain. An extensive basal till layer, usually less than 3 m thick, is covered by thick glaciolacustrine and glaciofluvial sediments (clays, silts and sands). Surface relief, apart from the deeply incised rivers, is slight, whereas the bedrock topography was found to be quite variable.

To the north and east (Catherine, Skead, and Hearst Townships) the surface relief becomes more pronounced with ridges of solid rock or esker gravels. Outcrops become more frequent and bedrock topography is locally severe (greater than 30 m). In this area the overburden is generally thinner (less than 30 m) and discontinuous. A 0.3 to 3.0 m thick till was normally encountered beneath glaciolacustrine and glaciofluvial sediments. The till is thickest in bedrock depressions with a local maximum of 15 m found in one hole.

During the fall and winter of 1979 chemical and mineralogical studies will be undertaken on the samples collected. Initially, attention will be concentrated on the nonmagnetic heavy minerals in the till samples. Some work will be undertaken on the rock samples; work will be undertaken on other density and size fractions of the till, coarse material (fragments of cobbles and boulders) from the till and also other clastic units (gravels and sands) encountered in the drilling. The geochemical, mineralogical, and geological data, together with all stratigraphic information will be published in 1980.

Detailed Investigations

Concurrently with the reconnaissance survey, a detailed study was completed using a man portable percussion sampling unit to examine the local dispersion of trace elements and indicator minerals in till sheets about known mineralisation. For this work, a gasoline powered jack hammer was used to drive a flow-through bit sampler through the cover sediments into the till beneath. Geochemical data from the project are not available at this time. Attention is therefore given to operational features of the drilling equipment employed.

The equipment, described more fully below, is similar to that successfully used in Finland, Ireland, and Saskatchewan. The unit is easy to operate, requiring only semiskilled labour, and provides an inexpensive method of deep sampling in areas where conventional surface geochemistry does not work. The equipment is lightweight and portable enough for use by a two-man crew. It is compact, and can be successfully deployed along a normal cut grid line.

After careful appraisal of equipment commercially available, the following items were acquired for the project. Power for the unit is provided by a Wacker BFH-30S jack hammer purchased from Wacker Canada. This unit is economical, easy to start, and virtually maintenance free. It has a centrifugal clutch which allows it to run continuously throughout the drilling operation. Drilling equipment was obtained from Helake, Finland, and comprised 1m x 25mm drill rods and a two lever jack and holding dog for lifting the rods. A forged driving rod which engages with the Wacker and screws onto the top drill rod was custom made by Wacker Canada. Two models of 25mm diameter flow-through sample bits were used. Both are modifications of the Holman sampler developed in Ireland. An oversize Holman sampler, provided by Barymin Explorations Limited, Toronto, with a sample capacity of approximately 150 g was tested. Also employed were smaller samplers with a capacity of approximately 80 g made by Helake, Finland. The Barymin sampler has a smooth cutting edge while the Helake sampler is toothed. The latter is claimed to have better penetration in stony till; a feature that could not be verified in the present study.

In open areas, the drill was operated by a two-man crew working from the tail gate of a four-wheel drive vehicle or the platform of a Muskeg Carrier. In dense bush, the drilling was completed using the same crew and equipment operating from a collapsible tripod stand built to our specifications.

More than 50 drill locations were established and almost 1100 m of drilling achieved in the present program. The maximum depth attained was 42.5 m, at which point drilling was terminated because all available rods were in use. Over 95 percent of the samples sought were recovered intact and only once was no sample returned. During the period of the present study, no equipment was lost down the hole, although four bits and two rods were damaged beyond repair. One Helake bit was used for a total of 550 m of drilling and remains serviceable. The average working life of the drill rods and other equipment remains unknown. There are few expendable items, and the drilling must be considered inexpensive in terms of equipment and hardware.

Both the Helake and Barymin samplers were used. Regrettably only limited experience was obtained with the Barymin equipment because of mechanical problems with the adaptors made to link the Irish bits with the Finnish drill rods. Both bits appeared to be successful as samplers. From the limited experience gained, it is suggested that the Barymin sampler might be more effective because it retrieves a larger sample and also seems to respond better or give more "feel" for the materials encountered by the drill. Changes in the composition of the overburden can be recognised by changes in the penetration rate of the drill. The rate of penetration for a particular material appears to change very little with depth over the range examined (up to 30 m). Penetration rates for the Helake bits were determined to be:-

a) Unsorted sands — 15-30 sec per metre

b) Clays (varied and unvaried) — 45-90 sec per metre

c) Till — 60-90 sec per metre

d) Well sorted sands — more than 90 sec per metre

The bit and rods frequently bound or stalled in well-sorted sands which are effectively impenetrable with the equipment described here. Till could generally be distinguished from clay because deflection of the bit by cobbles in the till could be felt by the driller. An unsuccessful attempt was made to penetrate esker gravels. Pebbles often blocked the bit, or cobbles would be encountered which stop the bit. With experience, the field crew could reliably identify the composition of the overburden being drilled.

A two-man crew could complete 80-100 m of drilling per 8 hour day. Average drilling rates are 2 minutes per metre (including 45 seconds for adding rods). Rods can be retrieved at an average rate of 1 to 1.5 minutes per metre using the two lever jack. The equipment could be disassembled, man carried 80 m on a grid line, and reassembled in about 20 minutes. The number of holes drilled per day is essentially a function of the depth and composition of the overburden, the distance between holes and the transportation employed (man carried, truck mounted, etc.). In the areas studied, the bedrock topography below the clay plain was found to be very rough. Local bedrock relief of 20 m over a horizontal distance of 60 m was common and greater extremes are to be expected.

Bedrock was not reached in every drill hole. The sample bit could be stopped anywhere in or above the till by boulders or cobbles. Attempts to verify the depth to bedrock using hammer seismic equipment proved fruitless. Response from the bedrock was invariably masked by reflections from layers in the Quaternary sequences. In all cases, the depth achieved by the drill was greater than the apparent depth to bedrock indicated by the seismic equipment. In practice, the nature of the material sampled was determined by inspection and by noting the penetration characteristics of the drill.

The rods and sample bit were recovered using a two lever jack and forged holding dog. The latter is heavy and awkward to transport. It was ultimately replaced with a lightweight friction "flapper plate" custom made from a design provided by V. Sopuk of the Saskatchewan Research Council. Unfortunately, the effectiveness of the flapper plate could not be fully evaluated this year.

In addition to gasoline and miscellaneous hardware the following equipment was also necessary:-

a) A push rod to remove the sample from the flow-through bit.

b) Two 15 inch crescent wrenches for changing rods.

c) A 410 shotgun cleaning brush for cleaning the threads of the drill rods.

On the basis of the field work completed this year, it is concluded that the flow-through bit sampler driven by the Wacker power pack is a cheap and effective method of deep sampling in areas with a cover of till, clay, and unsorted sand. The unit could also be used to identify the stratigraphy of unconsolidated deposits. Where the cover is well sorted sand or gravel, the sampler is at best only marginally effective. The greatest practical limitation is, however, the effort required to lift the rods by hand. In the future, attempts will be made to mechanize the retrieval of the rods and sampler using hydraulic or other lifting devices.

Following examination of the geochemical and mineralogical data from the samples collected in the present program, a more complete report will be published.

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No. S15 Aeromagnetic Survey, Marshall-O'Sullivan Lakes Area, District of Thunder Bay.

D. H. Pitcher[1]

An aeromagnetic survey, covering 2350 km^2 in the Marshall- O'Sullivan Lakes Area, was completed in the Winter of 1978 for the Ontario Geological Survey by Northway Survey Corporation Limited. The survey was funded by the Ontario Ministry of Northern Affairs and was planned and co-ordinated by the staff of the Geophysics/Geochemistry Section. The purpose of this airborne geophysical survey is to provide information about the Precambrian stratigraphy and structure which is presently unobtainable due to the scarcity of outcrop in this area.

A total of 11 867 line kilometres of data was collected at a terrain clearance of 120 m using a line separation of 200 m. The magnetometer used was a Gulf Mk III D digital fluxgate total field instrument with a 1 gamma sensitivity. The survey aircraft was a Britten-Norman Islander with a compensated stinger assembly.

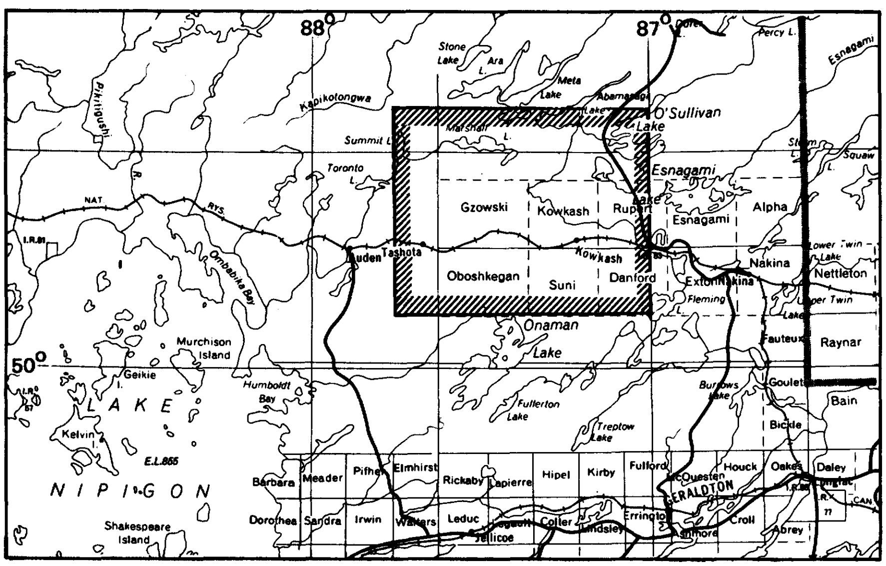
After correction for diurnal variation, a first order approximation of the International Geomagnetic Reference Field (IGRF) was subtracted from the total field data. The residual magnetic values were gridded and contoured by computer using software developed by Northway Survey Corporation Limited.

The survey results were released June 7, 1979 on twenty maps (OGS 1979) of equal area showing contour lines at 10 gamma intervals of the residual total magnetic field intensity, superimposed on photo-mosaic base maps.

1 Geophysicist, Geophysics/Geochemistry Section, Ontario Geological Survey, Toronto.

References

OGS
1979: Aeromagnetic Survey, Marshall-O'Sullivan Lakes Area, District of Thunder Bay; Ontario Geological Survey, Preliminary Maps P.1588 to P.1607 Inclusive. Geophysical Series, scale 1:15 840 or 1 inch to ¼ mile. Survey and compilation spring and summer 1978.



LOCATION MAP

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

No. S16 Airborne Electromagnetic-Magnetic Survey of the Kirkland Lake Area, Districts of Timiskaming and Cochrane.

D.H. Pitcher[1]

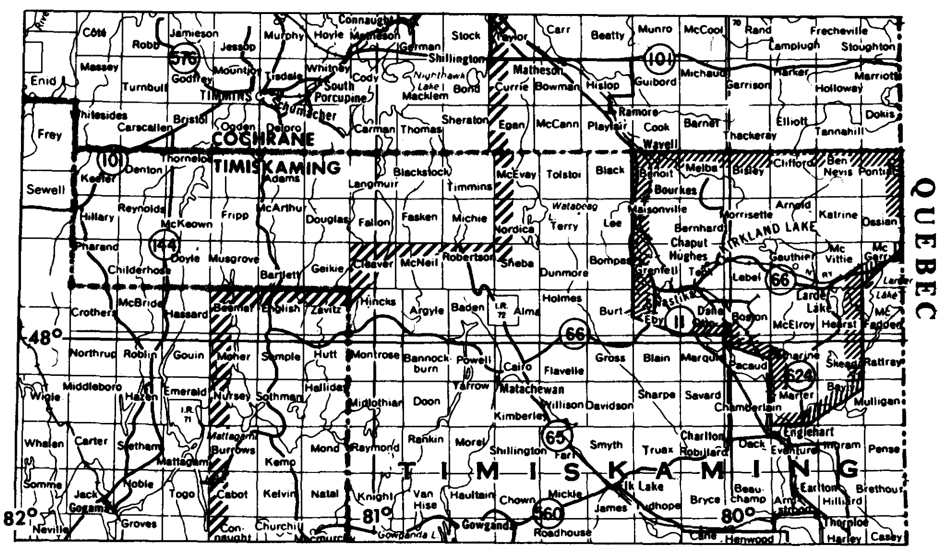
In January and February 1979, an airborne electromagnetic-magnetic survey of the Kirkland Lake portion of the Abitibi Greenstone Belt was flown for the Ontario Government by Questor Surveys Limited. The survey is part of the Kirkland Lake Incentives Program (KLIP) which is sponsored by the Federal Department of Regional Economic Expansion and the Ontario Ministry of Northern Affairs under the Community and Rural Resource Development Subsidiary Agreement. The results of this aerial reconnaissance survey have enchanced the overall geoscience data base for the area and have outlined a number of high-priority targets with mineral potential. Approximately 2455 km^2, covering 28 adjoining townships in the Kirkland Lake Area were surveyed employing a Barringer/Questor Mark VI INPUT[2] airborne electromagnetic system and a Geometrics G-803 Proton Precession Magnetometer.

1 Geophysicist, Geophysics/Geochemistry Section, Ontario Geological Survey, Toronto.

2 Registered Trade Mark of Barringer Research Limited.

Airborne electromagnetic surveys of this type should be flown perpendicular to the strike direction of the target which is normally aligned parallel to the formational strike. The main variation in the response of a steeply-dipping conductor which is not at right angles to the flight direction, is a reduction in the anomaly amplitude and an increase in its width. Airborne magnetic surveys also should be flown perpendicular to the geological strike to facilitate a more accurate machine contouring of the data because of the better line to line correlation. Hence, the area was divided up into five different blocks, on the basis of known geological information, and a different flight direction was selected for each block to satisfy the requirement of flight lines crossing at high angles to formational strike. In most cases, the flight direction was properly chosen, but in such a large survey area, smaller sections of the individual blocks were compromised. Hence, in certain areas with complex geology of variable strike direction, such as parts of Teck and Hearst Townships; it may be useful to re-fly those areas with a different flight direction using the existing geophysical data as well as detailed geological maps.

A total of 12 355 line kilometres of data was collected at a terrain clearance of 120 m, using a line separation of



LOCATION MAP

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

200 m. The INPUT system will respond to conductive overburden and near-surface horizontal layers in addition to bedrock conductors. Discrimination of conductors is based on the rate of transient decay, magnetic correlation, and the anomaly shape, together with the conductor pattern and topography. Some 1544 anomalies were detected, of which 15.7 percent were 6-channel responses, 10.5 percent were 5-channel responses, 17.7 percent were 4-channel responses, 30.9 percent were 3-channel responses, and 25.2 percent were 2-channel responses.

The relatively small percentage of 6-channel responses, as compared to the Red Lake Area where 52.3 percent were detected, may be indicative of a smaller number of conductors associated with graphitic schists. The INPUT response due to a graphite schist generally shows up on 5 or 6 channels and across several flight lines because of the long-strike-length and relatively high electrical conductivity of this type of body. Conversely, a high percentage of the anomalies are only 2, 3, and 4 channel responses which occur on a single line or 2 to 4 lines scattered in clusters throughout the survey area. This type of response can sometimes be associated with poorly to moderately conducting near-surface sulphide mineralization (e.g. sulphides containing a high percentage of sphalerite) or moderately to highly conducting deeply buried sulphide mineralization. In summary, fewer strong anomalies were detected in the Kirkland Lake survey than in the Red Lake survey, but a greater percentage of the anomalies that were detected have the correct geophysical expression to be associated with sulphide mineralization.

The electromagnetic anomalies and total intensity magnetic contours were released on photo-mosaic based maps (OGS 1979) on September 27, 1979. Parts of four townships were flown in two different directions resulting in two maps for each of the four areas. These are Preliminary Maps P.2262A, P.2262B, P.2263A, P.2263B, P.2274A, P.2274B, P.2275A, and P.2275B. Each preliminary map contained data relating to an individual township. The following table (Table 1) gives a breakdown into seven categories of the number of electromagnetic anomalies in each township that were plotted on the preliminary maps.

Reference

Ontario Geological Survey
1979: Airborne Electromagnetic and Total Intensity Magnetic Survey, Kirkland Lake Area, Districts of Cochrane and Timiskaming; by Questor Surveys Limited for the Ontario Geological Survey, Preliminary Maps P.2250 to P.2277, Geophysical Series, Scale 1:20 000. Survey and compilation February and March 1979.

TABLE 1 NUMBER OF EM TARGETS IN EACH TOWNSHIP BROKEN DOWN INTO SEVEN CATEGORIES

TOWNSHIPS	NUMBER OF EM TARGETS IN EACH INDIVIDUAL TOWNSHIP
Clifford, Ben Nevis, Pontiac, Bernhardt, Arnold, Katrine Catharine	0-5
Melba, Bisley	6-10
Morrisette, Ossian Pacaud, Marter, Bayly	11-20
Benoit, Lebel, McGarry	21-40
Teck, McVittie, Eby, Boston, McElroy	41-80
Maisonville, Grenfell, Gauthier, Otto, Skead	81-160
Hearst	161-320

No. S17 Multifrequency Airborne Electromagnetic Survey, Cretaceous Basin Area, James Bay Lowlands.

D.H. Pitcher[1]

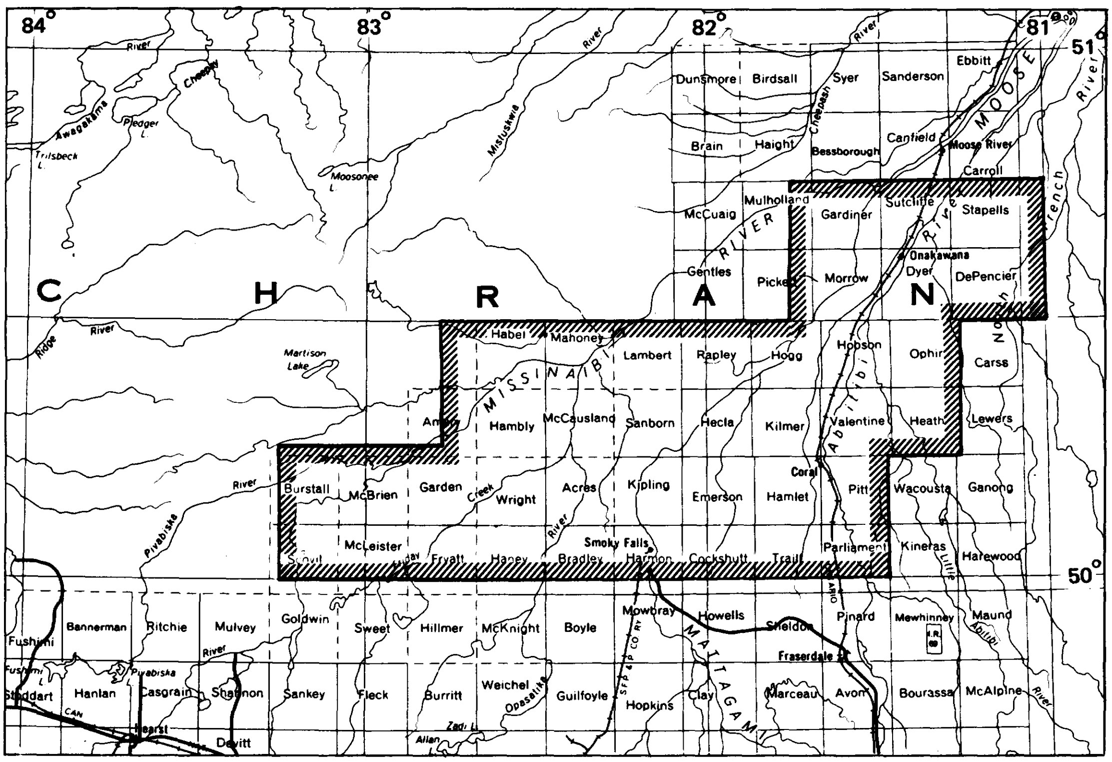
The Geophysics/Geochemistry Section, Ontario Geological Survey, assisted by funding from the Ontario Ministry of Northern Affairs, initiated an aerial multifrequency electromagnetic survey, which was flown in April 1978 over the southern and eastern parts of the Cretaceous Basin, James Bay Lowlands, District of Cochrane. The primary purpose of this reconnaissance survey was to map the electrical conductivity of surficial material as an aid to lignite exploration in the area.

The method utilizes the conductivity contrast between conductive lignite-clay units and the surrounding generally less conductive clays, sands, and gravels. Multifrequency electromagnetic systems can be used for mapping purposes provided the following two conditions are met. The sampling frequencies must be widely-spaced to allow for discrimination between rocks having a wide range of electrical conductivities. The transmit/receive coil configuration should couple with flat-lying conductors in order to generate an appreciable response over a multilayer conducting earth.

On the basis of these two considerations, the survey was contracted to Scintrex Limited, who employ a Tridem[2] system installed in a Kenting Earth Sciences Limited PBY–Canso aircraft. The Tridem system simultaneously measures in-phase and quadrature components of the secondary field at 500, 2000 and 8000 Hz. A vertical coaxial coil configuration is employed with an average separation of 25.3 m between the transmitters and receivers. A

1 Geophysicist, Geophysics/Geochemistry Section, Ontario Geological Survey, Toronto.

2 Registered Trademark of Scintrex Limited.



LOCATION MAP

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

Gulf Mk III magnetometer, included with the system, is particularly useful in this area for mapping the structure of the Precambrian basement. Terrain clearance is measured by a radar altimeter.

The survey area was divided into nine sections and contours of apparent depth to the upper surface of the more conducting horizon as well as its apparent conductivity were released on photomosaic-based maps (Ontario Geological Survey 1979) on June 21, 1979. Computer plotted profiles consisting of the multifrequency data and the interpretation thereof, the altimeter and magnetometer recordings, accompanied by a description of the interpretation technique employed, were also released (Pitcher and Barlow 1979) on June 21, 1979.

References

Ontario Geological Survey
1979: Airborne Electromagnetic Survey, James Bay Lowlands, Cretaceous Basin Area, District of Cochrane; by Scintrex Limited, for the Ontario Geological Survey. Preliminary Maps P.1986 to p.2003, Geophysical Series, scale 1:50 000. Survey and compilation Spring through Fall 1978.

Pitcher, D.H. and Barlow, R.B.
1979: Multifrequency Airborne Electromagnetic Profiles and Interpretation, Cretaceous Basin Area, James Bay Lowlands, District of Cochrane; Ontario Geological Survey, Open File Report 5270, 8p., 1 table, 7 figures, 188 charts.

Mineral Deposits Section

Summary of Activities of the Mineral Deposits Section, 1979

C.R. Kustra[1]

The Mineral Deposits Section continued its basic program of research on metallogenic concepts. As some mineral deposit studies are approaching completion, new programs are being developed to cover the broader yet more comprehensive aspects of the study of ore deposits. One such program, coordinated by D.G. Innes and A.C. Colvine of the Mineral Deposits Section, is a multi-year, integrated study of the metallogeny of the Southern Province between Sault Ste. Marie and Cobalt. Geological and mineral deposit studies were started this year in cooperation with the Precambrian Section (Wood, Dressler, this volume) and the Northeast Region (Bennett, this volume). Innes and Colvine (this volume) discuss metallogenic development of the Southern Province; Meyn (this volume) describes uranium deposits associated with the Wanapitei Basin, and Patterson (this volume) reports on the mineral deposits of the Cobalt area. The development of metallogenic concepts from this program will provide guidelines for mineral exploration in the Southern Province.

Field work on Operation Pembroke was completed in 1978 (Gordon *et al.* 1978) and reports by Carter *et al.* (1979) and Vos and Storey (1979) have been published. Reports on the uranium deposits and industrial minerals are in progress.

As a result of the work of Carter *et al.* (1979), further field studies were conducted on base-metal associations within the Grenville Province (Carter and Colvine, this volume).

M.A. Vos initiated a five year, ten-component industrial minerals program in Northern Ontario. Three components currently underway include a study of the talc-magnesite deposits of ultramafic rocks in the Timmins-Kirkland Lake Area;the derivation of geochemical methods for lithium exploration; and a sectoral inventory of industrial minerals.

A study of the building stones of the Sudbury area has been completed by M.A. Vos and a report is in preparation. An Open File Report on the lithium-bearing pegmatites of Ontario, prepared by M.A. Vos, is in preparation.

P.J. Whittaker completed a study of chromite deposits in Ontario and discusses the chromite association of various mafic to ultramafic intrusive types, with emphasis on the Puddy–Chrome Lakes area (Whittaker, this volume). A report is in preparation.

A detailed study of uranium mineralization in the immediate Bancroft area was initiated by S. Masson and J.B. Gordon.

D.G. Innes completed phase one of the nickel inventory program. Characterization studies and stratigraphic section mapping of the Southern Range Nickel Irruptive and basin sediments were completed. Studies on the North Range will be continued.

S.J. Wilkinson (this volume) reports on the results of field work examining gold deposits in the Atikokan area, a study begun by MacRae (1978).

Colvine and Sutherland (this volume) continued a multi-year study of Early Precambrian "porphyry" type deposits, describing the High Lake, Canoe Lake, and Pickerel Arm bodies of Northwestern Ontario.

Fyon and Crocket (this volume) report on geological and geochemical guidelines to gold exploration in the Timmins area. This work is the result of a study initiated by Karvinen (1976) and continued by Fyon and Karvinen (1978).

Ongoing work on deposit classification, mineral potential, and reserve/resource analysis, and province-wide inventories of various mineral commodities continued. Base programs were supplemented by a number of projects, sponsored by the Ontario Ministry of Northern Affairs and carried out by regular and contract staff.

J.A. Robertson, Section Chief, Mineral Deposits Section, took up a special assignment on behalf of the Mineral Resources Group, to upgrade Ontario's uranium data base relative to Canada and the world. Uranium deposits in Saskatchewan, the United States and Australia have been visited.

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1 Acting Chief, Mineral Deposits Section, Ontario Geological Survey, Toronto.

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No. 31 Metallogenetic Development of the Eastern Part of the Southern Province of Ontario

D.G. Innes[1] and A.C. Colvine[2]

Introduction

The purpose of this project is to investigate the metallogenetic development of the eastern part of the Southern Province of Ontario (Figure 1) and hence provide both general and specific guidelines for further exploration in this area both for already known deposit types and others heretofore unrecognised. Much of the field work related to this project has involved examination and characterization of the geological association and complete mineral content of the wide variety of mineral deposits in this area. In addition, specific study areas were examined (Meyn, Patterson, this volume) to investigate particular aspects of the development of mineralization. The work is being closely coordinated with other Ontario Geological Survey projects in progress in the area (Bennett, Dressler, Gupta, Johns, Muir, and Wood, this volume).

Preliminary work over several years preceding this field season consisted of a comprehensive compilation of all known mineralization within or spatially, and possibly, genetically related to Nipissing-type diabase intrusions. Card and Pattison (1973) suggested a metal zonation pattern in Nipissing intrusions in the Sudbury–Cobalt area. In this study, all known diabase showings (more than 800) were considered, even those with minor concentrations, since from a metallogenetic rather than an economic standpoint, all are important deposits. These demonstrate clearly that distinct and well-defined metal distribution patterns do exist (Figure 1). The defined zones are roughly symmetrical about Sudbury, northeasterly and westerly. Interestingly, each of the zones contains at least one representative producer, present or past.

Before the significance of these patterns can be discussed further, several features of the Nipissing Diabase and associated mineralization must be clarified:
- Around Sudbury, diabase bodies are steeply dipping to vertical and are dike-like; outwards from Sudbury they become more flat-lying and sill-like.
- The Sudbury area diabase bodies are dominantly undifferentiated gabbros; outwards they contain granophyric phases due to differentiation and/or assimilation.

The Sudbury area therefore may have been the centre or focus of Nipissing magmatic intrusive activity.

- The diabase-associated mineralization around Sudbury is principally disseminated sulphides within the intrusion and is probably magmatic in origin.
- Outward from Sudbury, the mineralization is of an open space-filling style, as veins within the diabase and wallrocks, and in breccia zones and probably formed from hydrothermal fluids.
- The gangue associated with the mineralization varies systematically outwards from the Sudbury area from quartz to quartz-ankerite to ankerite-quartz to dominantly calcite/dolomite.
- The metamorphic grade of the Huronian rocks around Sudbury is amphibolite facies and decreases outwards to lower greenschist facies.
- Bennett and Innes (1979) have demonstrated clearly that the Sudbury area was a major centre of uplift in earliest Huronian times and that it also contains the thickest sequence of volcanic rocks in the Huronian section.

The zonation of mineralization, metamorphism, and the diabase configuration are consistent with the Sudbury area having been eroded to a deeper crustal level.

The mineralization of the Sudbury area is largely magmatic in origin. The spatial association of open space vein, fracture, and breccia mineralization, with dominantly carbonate gangue with diabases in areas away from Sudbury, indicates a genetic relationship of mineralization to diabase emplacement. However, the diabase probably acted only as a heat source, and through ground preparation by arching and fracturing; metals, and water were derived from the dominantly sedimentary wallrocks. There is little evidence that the diabase magma was capable of introducing the diverse metal suites found throughout this area.

If this premise is valid, then a suitable metal source was present in the wallrocks, prior to diabase emplacement. To test this hypothesis, a compilation of all known showings (more than 400) in the Huronian, apparently not associated with diabase, has been largely completed. While distribution is less dense, and zone boundaries therefore less well defined, the metal distribution patterns are virtually identical to the pattern of mineralization associated with Nipissing Diabase. For example, good sedimentary copper mineralization is present in the Lorrain Formation close to the copper vein deposits of the Bruce Mines–Desbarats area, and good evidence for partial assimilation of mineralized wallrock into granophyric diabase was observed at several locations. A stratabound, possible paleo-placer gold concentration is associated with gold in quartz veins in Nipissing Diabase, east of Sudbury; and the Cu-Ni and Ni-Cu-Pt zones are represented as dis-

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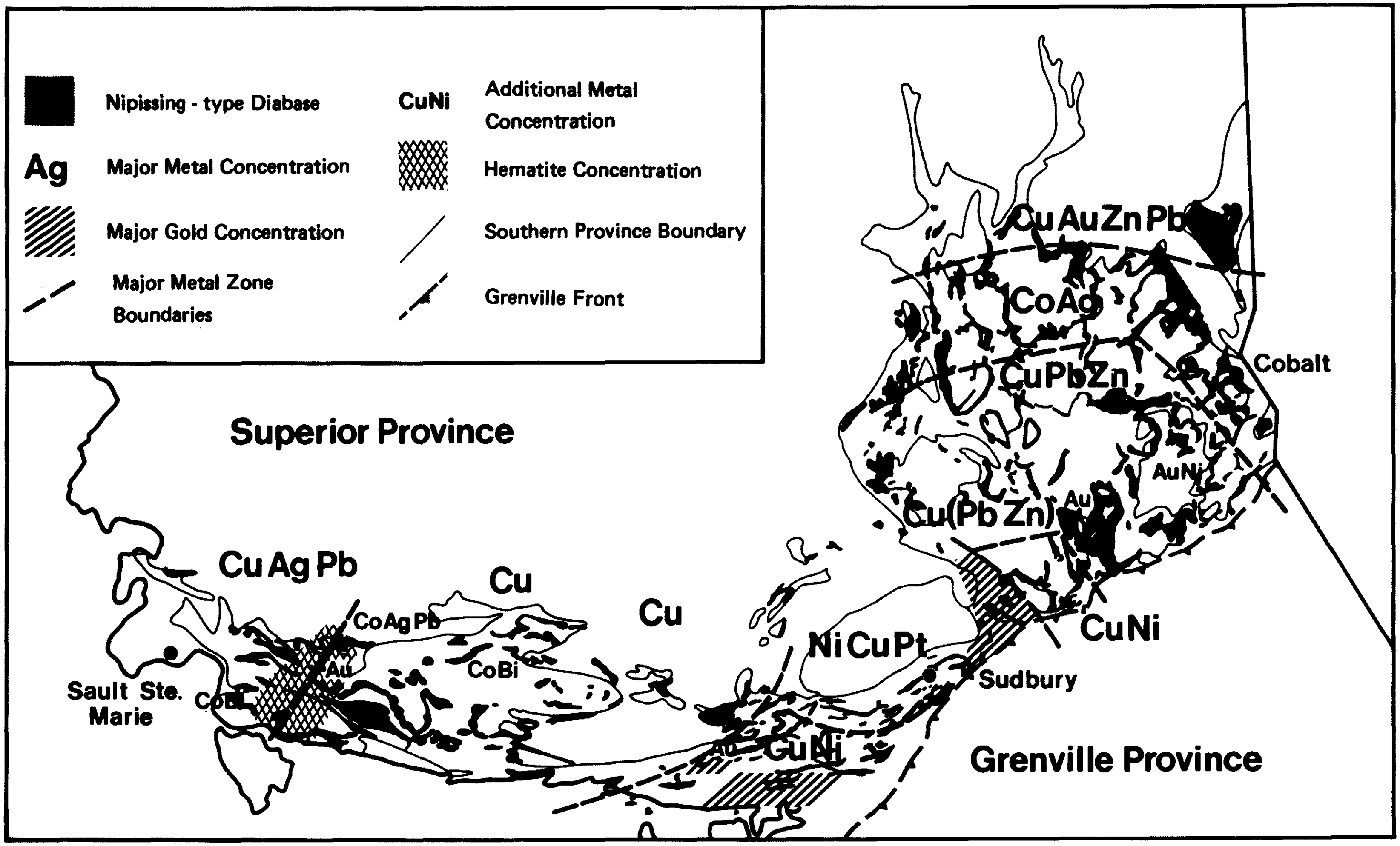

Figure 1—Metal distribution associated with Nipissing-type Diabase.

seminated mineralization in the Huronian Salmay Lake Volcanics near Sudbury. The only Huronian association not extensively re-concentrated into Nipissing veins is the Elliot Lake-type sedimentary uranium mineralization.

The presence of metal zones in the Huronian rocks pre-dating the diabase intrusion and repeated in the diabase-related mineralization, substantiates the hypothesis that the majority of Nipissing mineralization is formed by hydrothermal reconcentration from wallrocks.

While most diabases intrude Huronian sedimentary rocks, in places they cut Early Precambrian rocks. In these areas, the Early Precambrian mineralization is reflected in the Nipissing vein systems, although a more selective re-concentration of the pre-existing polymetallic suite appears to have taken place. For example, the base metal-bearing veins of the Cobalt area are enriched in Co-Ag; the veins of the Temagami area contain base metals and gold, with some nickel concentrated in those close to Early Precambrian Ni-Cu-Pt deposits; the areas south of Gowganda and north of Sault Ste. Marie also exhibit similar reconcentrated mineralization. Huronian sedimentary rocks are adjacent to most of these areas, substantiating their suggested importance as a source for water in the hydrothermal system.

The distribution of mineralization in Early Precambrian rocks, however, is important not only for direct Nipissing re-concentration, but also because these rocks were the source for Huronian sedimentary rocks. With a knowledge of sedimentary processes and paleocurrent directions in Huronian rocks, the primary metal distribution in the Early Precambrian should be reflected in, but not identical to, the sedimentary mineralization in the Huronian. The compilation completed to date of more than 400 Early Precambrian showings demonstrates a well defined metal distribution pattern which can be directly correlated with that of the Huronian strata. This can also be correlated directly with granite-"greenstone" distribution: granitic areas are Cu-U sources while "greenstones" are Cu, Pb, Zn, Au, Ag, Fe sources. Further, it is clear that subdivisions of metal distribution occur within each of these two types. For example, radiometrically high areas are present to the north (up stream) from the Elliot Lake, Agnew Lake, and Wanapitei uranium areas. A "greenstone" sequence, in part at least, is essential for paleo-placer Au concentration; this is not present in the Cartier Batholith forming the source for Elliot Lake. Different styles of mineralization (and volcanism) within a "greenstone" sequence appears to be reflected in subsequent mineralization; for example, there is a very sharp and distinct termination of silver vein showings southwest from Cobalt and southward from Gowganda and Elk Lake. The recognition of distinct styles of mineralization and related volcanism is one of the first steps necessary to a better understanding of primary processes of development of mineralization in the Early Precambrian. Further, distribution of mineralization in the Early Precambrian and a knowledge of paleocurrent directions may point to areas of sedimentary mineralization heretofore unrecognized; similarly the re-concentration of sedimentary mineralization, by the Nipissing Diabase, may also provide evidence of its existence and distribution.

The tectonic development of the eastern part of the Southern Province was characterized by east-west intracratonic rifting, uplift, and basin development (Card 1978; Innes 1977; Bennett and Innes 1979). As part of the development of, and in response to, this early east-west Middle Precambrian rifting, major faulting, and graben development occurred northwards from the Agnew Lake Basin extending through the Benny Greenstone Belt and northeastward to form the northwest margin of the Cobalt Plate. As well, a major northwest structure through Lake Wanapitei is suggestive of graben style tectonics forming the west boundary of the Cobalt Plate. These major tectonic zones exerted strong control on Huronian sedimentation as evidenced by the nature of the contained sedimentation (for example fluviatile environment, see Meyn, this volume), and by paleocurrent directions down (southward) the northeast and northwest structures into the main Huronian Basin. Furthermore, the numerous carbonatite, fenite, and breccia pipe structures found in the Southern Province are restricted to these possible graben structures. Where these structures intersect the main east-west rift, sedimentary basins are developed (for example south of Lake Wanapitei, and in the Agnew Lake area).

An understanding of the tectonic development of the Southern Province, largely through investigations of volcanic and sedimentary processes is essential to the understanding of the metallogenetic development; future studies of these will constitute a major thrust of the overall program.

Although this program is at a preliminary stage, a substantiated interpretation has been made of the development of mineralization through at least 600 m.y. of the geological development of this area. Primary metal distribution in the Early Precambrian has been outlined and the sedimentary redistribution during the Huronian, and subsequent re-concentration during Nipissing emplacement largely explained. These processes have been related in part to the tectonic development of the area. This work is being correlated with investigations of the geological-tectonic development of the Sault Ste. Marie–Sudbury (Bennett and Innes 1979) and the Sudbury–Cobalt (Wood, this volume) portions of the Southern Province. In addition, specific studies of Early Precambrian areas (Patterson, this volume) will add to the understanding of processes operating at this time.

Mineralization younger than the Nipissing intrusions also forms patterns similar to those already described, indicating continuing metallogenetic development through time. The Sudbury Nickel Irruptive, which formed 300 m.y. after the emplacement of the Nipissing Diabase, hosts major concentrations of the same metal suite that already existed in that area; this observation has significant implications for the development of the Sudbury Basin itself, which is presently a principal topic of investigation. Similarly, the volcanogenic mineralization within the Sudbury Basin is consistent with the processes expected in this area. Keweenawan, Grenville, and Paleozoic mineralization also require further investigation. Interestingly, one of these processes is active today as is evidenced by the development of recent placer gold in the Vermilion River–Wanapitei River drainage system.

This work therefore constitutes a comprehensive metallogenetic study from which delineation of metallogenetic provinces related to geological and tectonic development is possible. Work in all aspects of this area is continuing to better define the nature and associations of mineralization and to explain the specific conditions leading to metal concentration.

Outlined below are guidelines for further exploration for specific mineral deposit types in particular areas which describe their nature and associations. Analytical work is preliminary at present, and allows reasonable definition of only a few of these areas. These recommendations do, however, point out significant new areas of potential mineralization, and provide geological definitions previously unrecognised for known areas.

Guidelines for Exploration

A major implication from this study is that much of the primary introduction of metals into the crust took place during the Early Precambrian. This introduction of metals is particularly related to volcanism, and that these metals were redistributed or reconcentrated by subsequent sedimentary, magmatic, and tectonic activity. Huronian sedimentary rocks derived from the Archean craton carry paleo-placers of Au, Cu (Pb and Zn) and U. Nipissing-type diabase sills and dikes are intrusive into these sediments where skarn deposits of Fe, Cu, Pb, Sn, Mo, and W and open space vein-type deposits of Cu, Pb, Zn, Au, Ag, and Co are commonly developed. In addition, these mafic intrusive bodies introduce magmatic deposits of Cu, Ni, and Pt group metals. Faulting, brecciation, and diatreme activity related to the tectonic development of the Southern Province resulted in additional metal concentration (and introduction), primarily of Au and Cu.

As a consequence of this implication, these later "Proterozoic" mineral deposits point to Early Precambrian source areas which may not be presently recognized. This relationship is most evident in the Cobalt mining camp where Early Precambrian polymetallic volcanogenic sulphide mineralization is present throughout volcanic rocks (see Patterson, this volume). The widespread Ag-Co mineralization throughout the Ag-Co zone (Figure 1) to the north and west of Cobalt (including the Elk Lake and Gowganda Camps) implies the presence of similar mineralization in an Early Precambrian volcanic belt underlying this area, which is largely covered by Huronian sedimentary rocks. To a lesser degree, other Cu, Pb, Zn zones (Figure 1) may give some indication of unexposed Early Precambrian type base-metal deposits, particularly within the Cobalt Plate.

The potential for discovery of significant paleoplacers of Au, Ag, Cu and Pb, Zn is considered to be high. Metal concentration occurs by multiple episodes of erosional reworking into placer accumulations through degradation of a thick section of uplifted cratonic rock. These types of placers would be restricted in time and space to regions of tectonic instability where sequential hydraulic concentrations and erosion at active fault scarps played the major role in controlling and developing the placers. The fluviatile, deltaic, and near shore environments of the Mississagi, Serpent, and Espanola Formations in the Lake Wanapitei area are of particular interest (see Meyn, this volume), as hosts to placer Au and Au-U deposits (Au Zone, Figure 1). Exploration for this type of deposit may require the reconstruction of paleo-drainage systems with subsequent studies of local gold and heavy mineral (Mt, U, Zr, Cr, Py) distribution patterns. Similarly, the paleovalley associated with the Agnew Lake basin is of interest. This association (Au-U) would not necessarily hold for the Elliot Lake Basin as no cratonic source for Au is evident. The Au Zone shown southwest of Sudbury (Figure 1) is essentially an Au-Nipissing Diabase association. However, the geology of the zone suggests some strata control in the Huronian sedimentary rocks (Gowganda Formation). Significant Au and Ag (up to 0.50 oz per ton of Au and 1.39 oz per ton of Ag) values were found (this study) associated with sedimentary hematite concentrations in Huronian sedimentary rocks (Lorrain Formation) in the Desbarats–Bruce Mines area.

Polymetallic sulphide paleo-placers associated with the basal Huronian rocks are evidenced in the Cobalt area (see Patterson, this volume; Jambor 1971), and may be applicable to other areas of base metal concentration proximal to the Huronian–Early Precambrian (Archean) unconformity. Lithologies of the Upper Gowganda and Lower Lorrain Formations are potential hosts for sedimentary Cu deposits such as those described by Pearson (1979) in the Desbarats area. Significant values of Au and Ag have been found associated with some of these lithologies in the Desbarats, Flack Lake, and Cobalt areas. Several other occurrences of this type were observed, including one area of the Bar River Formation. The possible association of Co with this type of mineralization (especially in the Ag-Co Zone, Figure 1) should be further investigated. In the Cobalt area, sedimentary type Cu-Pb-Zn mineralization is present in argillites and laminated siltstones of the Gowganda Formation, (Jambor 1971). In addition to these, significant disseminated Cu mineralization occurs in sandstone, laminated siltstone and arkose of the Gowganda Formation. The spotted chlorite alteration (Jambor 1971) common to the Cobalt area mines, and to a lesser extent in the Elk Lake and Gowganda areas, appears to have some association with this type of mineralization. From this study, where disseminated Cu, Co, and Ag mineralization was observed in the argillites and laminated siltstones, these chlorite spots were best developed along the mineralized horizons. In one sample, the chlorite formed a halo about disseminated grains of Co- arsenides cored by native silver; in another sample without visible silver mineralization, an assay of 173.40 oz per ton Ag was obtained. It must be noted, however, that many areas of chlorite spotting were barren of mineralization. In the mineralized arkose and sandstone, chalcopyrite grains are surrounded by a very distinct bleached alteration halo. Exploration for mineralization of this type is warranted with close attention being paid to alteration phenomena.

The common association of Nipissing Diabase Cu and Ag-Co vein deposits with mineralized sedimentary rocks implies a direct genetic relationship. Therefore, the rocks hosting Nipissing Diabase with associated Cu and Ag-Co vein deposits should be carefully examined for sedimentary concentrations of these elements.

Extensive areas of brecciation which may have formed in response to the intrusion of Nipissing Diabase or fissure type diatremes along major faulting zones, are potential traps for Cu, Au, and Ag mineralization. The McGregor Road Breccia zone (see Bennett, this volume) gave significant values of Ag, and is mineralized with pyrite and minor chalcopyrite. This type of breccia zone is similar to the breccia developed at the Massey Mine, a past producer of Cu. Diatreme-like breccia bodies occur north and south of Lake Wanapitei (Aylmer, Rathbun, Scadding, and Falconbridge Townships) along the Wanapitei River Fault. Soda metasomatism and quartz-carbonate veining (fenitization) is associated with the breccias which are known to carry significant Au and Cu values. The gold deposit reported by P. Maclean (Northern Miner, February, 1979 is probably of this type. During the course of this study, three new breccia zones of similar type were found in the area north and south of Lake Wanapitei.

Skarn deposits, developed mainly in calcareous rocks of the Espanola Fm. which have been thermally metamorphosed by Nippissing Diabase intrusions, occur throughout the study area. These skarns which carry Fe-Cu-Zn-Pb-W and Mo mineralization are similar to descriptions of W-Cu (Zn, Mo) skarns of the Yukon (Dawson and Dick 1978). Rocks of the Espanola Formation, should be explored for economic W-Cu and other base-metal mineralization.

Metal characterization studies carried out as part of this project have shown the presence of significant values of platinoid group metals associated with the Ni-Cu sulphide deposits in Nipissing intrusives in the Ni-Cu-Pt Zone (Figure 1). While several of these deposit types have been explored for Ni and Cu, the platinoid association has not been adequately considered.

To the northeast and west of the Ni-Cu-Pt Zone (Figure 1), a major function of the diabase intrusive activity has been to reconcentrate pre-existing crustal mineralization. This process was the basis for the development of the major Cobalt Mining Camp, economic Cu vein deposits of the Bruce Mines area and some of the Au producers of the Lake Wanapitei area. Beyond their metallogenetic implications, the economic potential of this type of mineralization should not be neglected.

Summary

1. Archean type volcanogenetic base metal deposits.

In the Ag-Co Zone (Figure 1) and to a lesser extent in the Cu-Pb-Zn-Ag Zones (Figure 1).

2. Paleo-placer type deposits in Huronian Sedimentary rocks

a) Lake Wanapitei Area (Alymer, Scadding, Street; Falconbridge, Turner, and Demorest Townships) for Au, U.

b) Agnew Lake Area (Vernon, Porter, Hyman Townships) for Au, U.

c) Espanola Area (Mongowin, Curtin, Truman, Roosevelt, and Dieppe Townships) for Au, Cu.

d) Desbarats–Bruce Mines Area (Tarbutt Township) for Au.

3. Sedimentary-type deposits.

a) Desbarats area (Johnson and Tarbutt Townships) for Cu and Hematite.

b) Flack Lake Area for Cu.

c) Cobalt, Elk Lake, and Gowganda Areas for Cu, Pb, Zn, Ag, Co.

4. Breccia Associated Deposits.

a) Lake Wanapitei Area (Aylmer, Rathbun, Scadding, Street, and Falconbridge Townships) for Au-Cu.

b) Bruce Mines – Massey Area for Cu (Ag,Au).

c) Temagami Area for Mo, Cu (Colvine and Sutherland, this volume).

5. Skarn-type deposits (Cu, Mo, W, Pb, Zn, Au, Ag, Fe) associated mainly with rocks of the Espanola Formation where they are intruded by Nipissing Diabase.

6. Magmatic-type deposits: mainly in the Ni-Cu-Pt Zone on Figure 1 for large tonnage - low grade Ni-Cu-Pt deposits.

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No. 32 Uranium Mineralization and Its Controls in the Immediate Bancroft Area

S. Masson[1] and J.B. Gordon[2]

Introduction

During the 1979 field season, parts of Dungannon and Faraday Townships (Location Map) were remapped, with emphasis placed on stratigraphy and structure, and their relationships to uranium mineralization. The new mapping encloses an area of approximately 115 km^2.

In addition, a portion of the stratigraphic unit in the area mapped during the 1978 field season (Gordon and Masson 1978) were sampled for major and trace elements. Samples included the main lithologies, as well as younger granitic intrusive rocks. The purpose of the sampling was to test background values of uranium in the Bancroft area against lithologic, stratigraphic and structural controls. In as much as the results are not yet available and petrographic studies have yet to be completed, the following observations and conclusions are tentative only.

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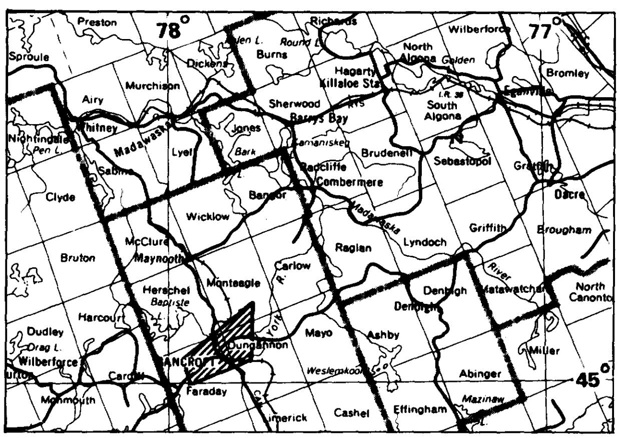

LOCATION MAP

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

Discussion

Mapping indicates that with few exceptions, stratigraphy places only a broad geochemical control on uranium mineralization,and that structure and lithology are much more important controls. In numerous instances, however, structural deformation has taken place along particular stratigraphic horizons. Areas with a more intense deformation history, typified by numerous zones of mylonitization, shearing, slickensiding and/or flowage, and with approximately co-eval felsic intrusions, are areas of important uranium mineralization. Such an area, lying north of the Madawaska and Greyhawk Mines, stretches eastward to include the Eagles Nest Property. The major deformation zones occur along east-west and east-northeast-west-southwest directions, roughly parallel to stratigraphy.

Pegmatites which have intruded these tectonic zones are also deformed, but to a lesser extent. These "deformed" pegmatites have been subjected to later hydrothermal alteration expressed by one or more of silicification, hematization, biotization and peristerization.

Desilicification may also occur along the contact area, and may be due to hydrothermal alteration and wall rock reaction along the incompetent interface of the host and pegmatite. Undeformed, coarse ($>$2 cm) pegmatites are rarely well mineralized, whereas fine grained pegmatites deformed either during or soon after crystallization, tend to be well mineralized. This is also true but less common in younger granites.

In some occurrences, such as the Henderson Property in Raglan Township, secondary enrichment is due to much later deformation, usually faulting, and hydrothermal events. Mineralization of this type is characterized by cross cutting fractures or shear zones and silicification. Both biotite and chlorite may occur, suggesting upper greenschist facies metamorphic conditions, possibly in the waning stages of the last major metamorphic event.

The writers envisage a progressive redistribution in a hypogene environment, with enrichment of the pegmatite in uranium taking place during the early stage of the deformation-hydrothermal event along deformation zones within the crystallized or recrystallizing pegmatite. Textural evidence suggests that in some instances deformation occurred before crystallization was complete. Such deformation is likely related to the waning stages of tectonic activity which formed the deformation zones or fractures into which the pegmatite had been emplaced. This hydrothermal, uranium enrichment process occurred along deformation zones within the pegmatite or along its contact area.

In the more complex deposits, more than one episode of enrichment and deformation has occurred. The Faraday Gabbro at the Madawaska Mine is host to important ore-bearing "deformed" (fractured or rehealed fractures) enriched pegmatites. This brittle mafic body would shear and fracture relative to adjacent rocks, which would have a tendency to flow and fold under conditions of stress and elevated temperature. The fractures provided openings for the pegmatitic melts. Continuing tectonic activity would further deform the crystallized or crystallizing pegmatite, creating openings for enriching hydrothermal solutions. The immediate source of the U and Th in this enrichment process is the pegmatite, involving mass transfer of U and Th upward from presumably now deficient areas at depth. The primary source, however, may be from older Middle Precambrian granites or possibly from the syenites. Whatever the origin, there is some evidence indicating that uranium mineralization in the Bancroft area is not a single stage event but rather a multistage process of upgrading. Mineralized pegmatites are one end product.

One exception to structurally controlled deposits is a marble sequence in which the South State occurrence and the Eagles Nest property are found. Uranium mineralization occurring within the marble unit appears to be unrelated to granite pegmatites. These marble or calc-silicate deposits warrant further study, as their origin, extent and economic importance have yet to be established.

Uranium mineralization related to carbonate veins, especially a variety termed pyroxene veins, is found throughout the area. The pyroxene veins are made up dominantly of pyroxene (aegerine-augite or sodic hedenbergite, (S. Lumbers, Royal Ontario Museum, personal communication)) although calcite, biotite, amphibole and scapolite may also be present in abundance. Apatite, fluorite and minor sulphides, including molybdenite may also occur. These veins increase in abundance near marble units, or where marble or calc-silicate rocks have been intruded by granites and/or syenites. They also show a spatial relationship to syenites and/or syenitic rocks.

The pyroxene veins are late, as none have been deformed; other types of calcareous veins, dominantly of carbonate, may be either deformed or underformed, suggesting at least two ages of emplacement. The veins are mineralized only where they cut granitic rocks, especially pegmatites or young granites and syenites. They have marked fenitization boundaries, often 3 to 5 times as wide as the vein. Quartz and plagioclase are replaced by sodic pyroxenes. It is during this replacement of the wall rocks by the fenitizing fluids and gases that uranium is mobilized and redeposited in the central portion of the vein as reddish uranothorite, generally associated with clusters of biotite. Mineralization of these veins shows a direct relationship to the uranium content of the rocks they intrude. The veins are not of economic importance currently, but their presence is indicative of areas hosting other possible important types of uranium occurrences.

The veins often contain significant amounts of apatite, fluorite and calcite, whose components, fluorine, phosphorous and CO_2, greatly aid in the transfer of uranium. Coupled with the fenitization effect of liberating uranium from granitic rocks, this suggests one important mechanism of mobilizing uranium. The association of these veins with syenites high in calcite, fluorite and apatite suggests a broad stratigraphic-geochemical control at work, as to where important uranium mineralization may occur. The majority of the uranium deposits of the Bancroft area occur within or adjacent to areas dominated by syenitic rocks. Where granites or granite pegmatites have intruded that portion of the stratigraphy containing syenites, the geochemistry of these country rocks aids in the mobilization and redistribution of uranium into mineralized zones. Some of the uranium-rich syenitic pegmatite phases found in some complex deposits may result from a mixing of fenitizing fluids derived from the country rocks with the pegmatitic melt. The high fluorite content in the ore of the Bicroft Mine is to be expected, as the country rocks are dominantly syenites. Structural and chemical evidence exists to indicate that CO_2 complexes, mobilized from the marble units within the map-area, may also aid in the mobilization and movement of uranium from the granitic and syenitic country rocks.

A favourable stratigraphic and geochemical environment is not in itself enough to host uranium deposits. For example not all areas, where pyroxene veins occur, contain significant uranium mineralization, suggesting that other controls such as structure, and in some cases lithology, are also necessary and important conditions.

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No.33 Geological and Geochemical Guide to Gold Mineralization of the Porcupine Camp, Timmins Area

J.A. Fyon[1] and J.H. Crocket[2]

Introduction

Field work on carbonatized rocks, gold deposits, and porphyries in the Porcupine camp was sponsored by the Mineral Deposits Section (Fyon and Karvinen 1978). Laboratory work was undertaken at McMaster University and by the Ontario Geological Survey. Some interpretations of field and lithogeochemical data acquired by the author are summarized below.

Detailed volcanic stratigraphy within the Upper Supergroup (Pyke 1978) was established in area A (see location map) containing only gold prospects (Beaumont, Kinch, Davidson-Tisdale, Dobell, Armstrong-McGibbon and Crown Chartered) and in a control area, area B, (see location map) where economic gold deposits were mined (the Aunor, Buffalo-Ankerite and Delnite mines).

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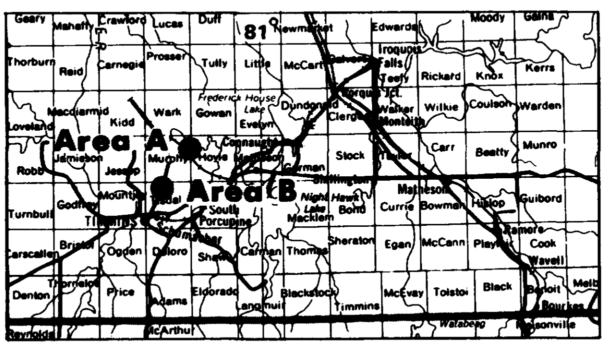

LOCATION MAP

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

Carbonate Alteration

Throughout the Upper Supergroup, volcanic rocks have been altered to spatially and genetically related hydrous and carbonate-rich assemblages (Fyon and Karvinen 1978), referred to as carbonatized or altered rock. The following observations regarding the distribution, timing, and origin of the carbonate alteration are considered significant in developing a genetic model:

a) Carbonatized komatiitic, magnesium- and iron-tholeiitic and calc-alkalic volcanic rocks occur throughout the Upper Supergroup (Fyon and Karvinen 1978) indicating many more than two carbonate-rich horizons;

b) Carbonate alteration occurs as both discordant and stratabound zones (Fyon and Karvinen 1978);

c) Carbonatized volcanic rock clasts occur in the turbiditic sequences of the Porcupine Group.

In area A, discordant alteration zones are developed partly in thick (30-60m) massive flows. This relationship has not been observed in area B. In some of the stratabound carbonatized zones, the brecciated top of the flow and the base of the overlying flow have been altered, implying lateral movement of the alteration generating fluids along the permeable flow top breccia.

These observations, and data reported elsewhere (Karvinen 1976,1978; Fyon and Karvinen 1978, Fyon *et al.* 1978) support a synvolcanic-synsedimentary carbonatization process related to seawater-rock interaction. Although some alteration took place at the seafloor-seawater interface, most of the alteration developed within the evolving volcanic pile beneath the seafloor. Permeable zones such as flowtop breccias, cooling joint sets, and synvolcanic fissures or flow feeder zones acted as significant solution conduits; however, not all permeable zones are carbonatized. The importance of porosity has also been recognized at Kirkland Lake (M. Downes, this volume).

Geological Environment of Gold Mineralization

The spatial association of many gold deposits with carbonate rich rocks in the Porcupine Camp (Burrows 1925; Carlson 1967; Ferguson *et al.* 1968; Pyke 1975; Karvinen 1976,1978) implies a genetic relationship. The presence of carbonatized rock not associated with gold mineralization indicates that carbonate alteration is only one of several parameters which collectively define the optimum environment for gold deposition, dominated by the waning stages of a volcanic episode. Within area B (see location map), auriferous chemogenetic and clastic sediments accumulated during local pauses in volcanism, while nearby, felsic volcanic domes (porphyries) were forming. These domes are not envisioned by the author as the source of the gold as proposed by Karvinen (1978) but rather, represent typical terminal products of an evolved early Precambrian volcanic sequence. The time during which the ocean crust was exposed to circulating brines was the critical factor in development of auriferous chert-carbonate-tourmaline sediments.

Figure 1 shows the absolute variation of gold content as a function of alteration intensity, in a flow exposed on the Davidson-Tisdale property in area A. The absolute gold abundances were calculated assuming a constant volume reaction (Gresens 1967). It is apparent that virtually all the gold (93 percent) is leached from the most intensely altered samples.

Geochemical Aids for Gold Exploration

Due to the extensive overburden cover in Canadian Precambrian terrains, geological parameters which define optimum gold deposit target areas would likely not be recognized in the field. Carbonate alteration phenomenon, one of the most obvious gold deposit associations, however, affects a relatively large volume of rock and there-

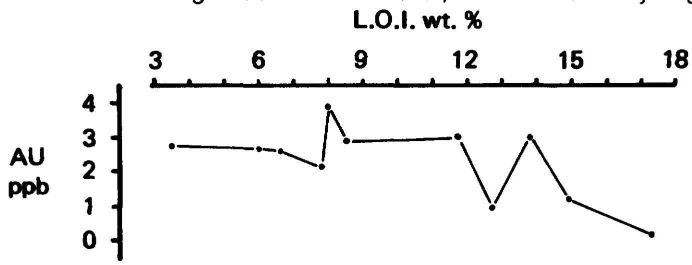

Figure 1—Absolute gold distribution as a function of alteration.

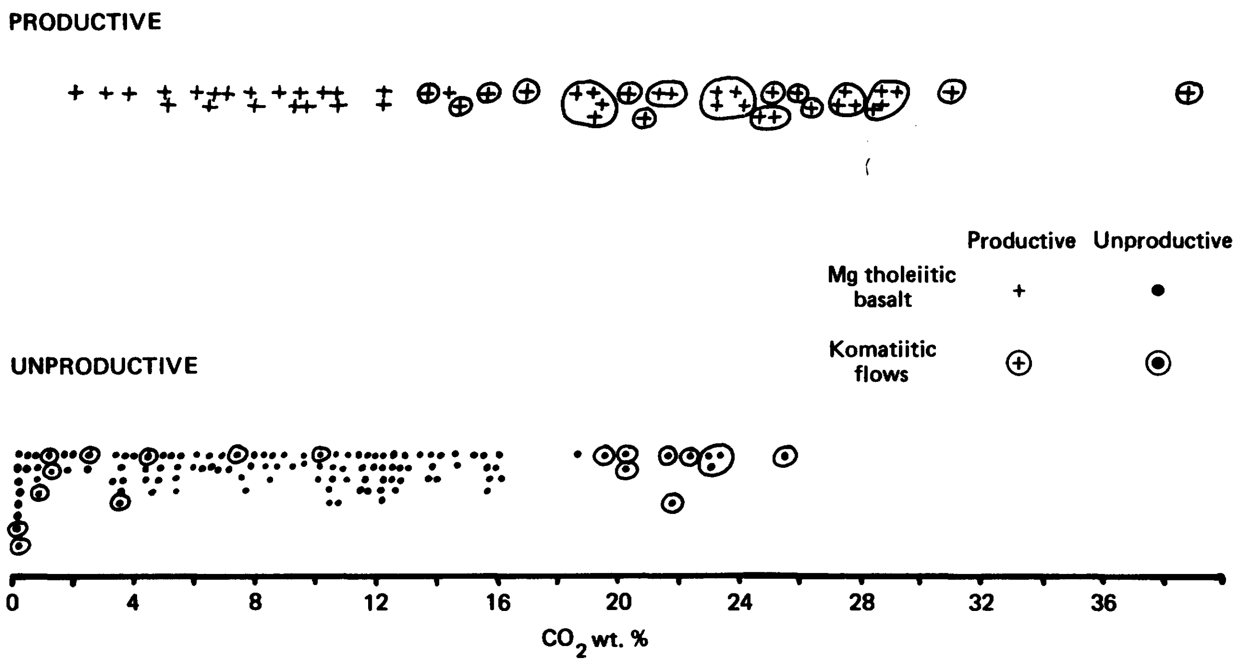

Figure 2.

fore is most likely to be exposed. In this study, altered samples (4 wt. % L.O.I.) have been classified into "productive" and "unproductive" groups based on the spatial proximity of a sample to a known ore deposit. "Productive" group samples were collected in both areas A and B from the numerous alteration zones not associated with gold mineralization. Trace element data has been plotted on binary plots as a function of alteration intensity, expressed as CO_2 content. This procedure minimizes elemental variation attributed to differences in rock type, flow facies and degree of alteration. Table 1 summarizes recommended element thresholds and the percent effectiveness of the group discrimination.

TABLE 1 | SINGLE ELEMENT SCREENS.

Element	Threshold	Percent of Group which Exceed Threshold Value: Productive	Unproductive
Au	4.5 ppb	83	9
S	0.025 Wt. percent	69	28
	0.045 Wt. percent (T)	74	20
As	70 ppm	82	11
Li	(T)	85	6
Sb	0.35 ppm (T)	84	10
B	30 ppm	80	2
Ba	–	–	–
Zn	–	–	–
Cu	70 ppm (T)	11	89
K_2O	–	–	–
Bi	–	–	–

– no discriminatory ability
T threshold suitable for mg-tholeiitic basalts only

CO_2

No group discrimination is possible using CO_2 content, except perhaps for the altered komatiitic volcanic rocks (Figure 2).

Au

Background values range up to 5 ppb. A threshold of 4.5 ppb is recommended (Figure 3), regardless of rock type.

S

Discrimination between productive and unproductive groups is less efficient because pyrite is an ubiquitous phase in all rocks. Better discrimination is achieved by using only data for the magnesium tholeiitic basalts (Figure 4).

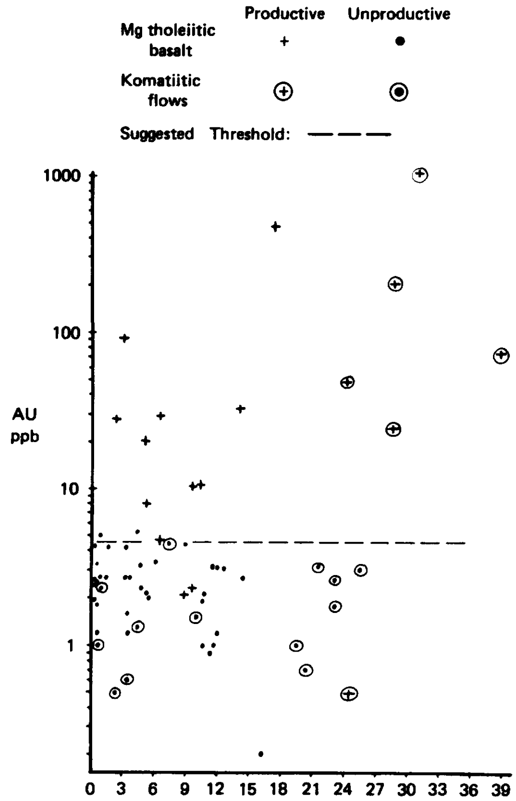

Figure 3—Variation of gold with alteration intensity (loss on ignition).

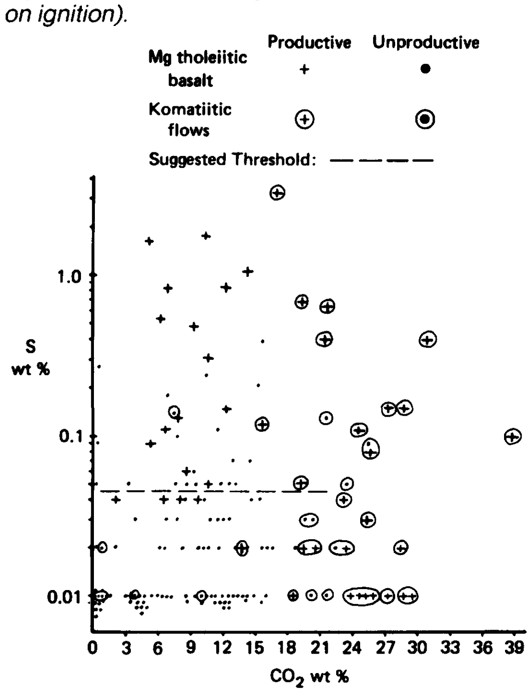

Figure 4—Variation of sulphur with alteration intensity (loss on ignition).

As

Arsenic content of altered tholeiitic volcanic rocks effectively discriminates between "productive" and "unproductive" groups. A threshold of 70 ppm is recommended (Figure 5). Insufficient data is available to evaluate the discriminatory ability of arsenic for altered komatiitic rocks.

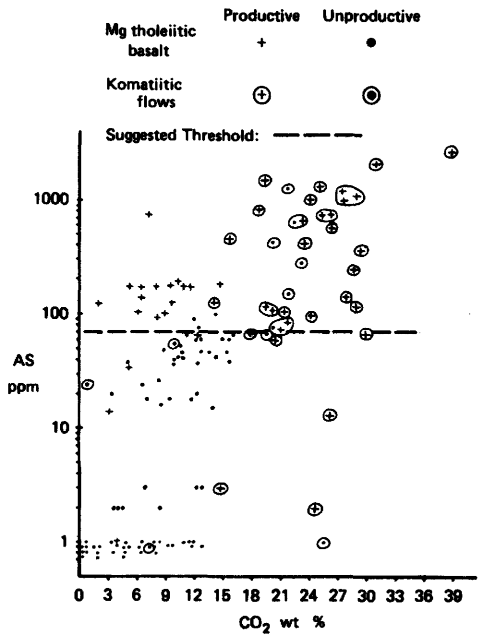

Figure 5—Variation of arsenic with alteration intensity (loss on ignition).

Li

Group discrimination is maximized using only tholeiitic data. No discrimination exists for altered komatiitic rocks (Figure 6).

Sb

A threshold of 0.35 ppm effectively screens tholeiitic data. No discrimination exists for the komatiitic rocks (Figure 7).

B

Data for boron is incomplete; however, the two groups are distinguished using a threshold of 30 ppm (Figure 8).

Cu

Copper depletion characterizes the productive tholeiites, using a threshold of 70 ppm. No discrimination exists for the komatiitic rocks (Figure 9).

Geochemical Summary

For the data reported, As, Li, Sb, and Cu are effective gold pathfinder elements only for altered magnesium tholeiitic basalts. To use these screens, the rock type must be iden-

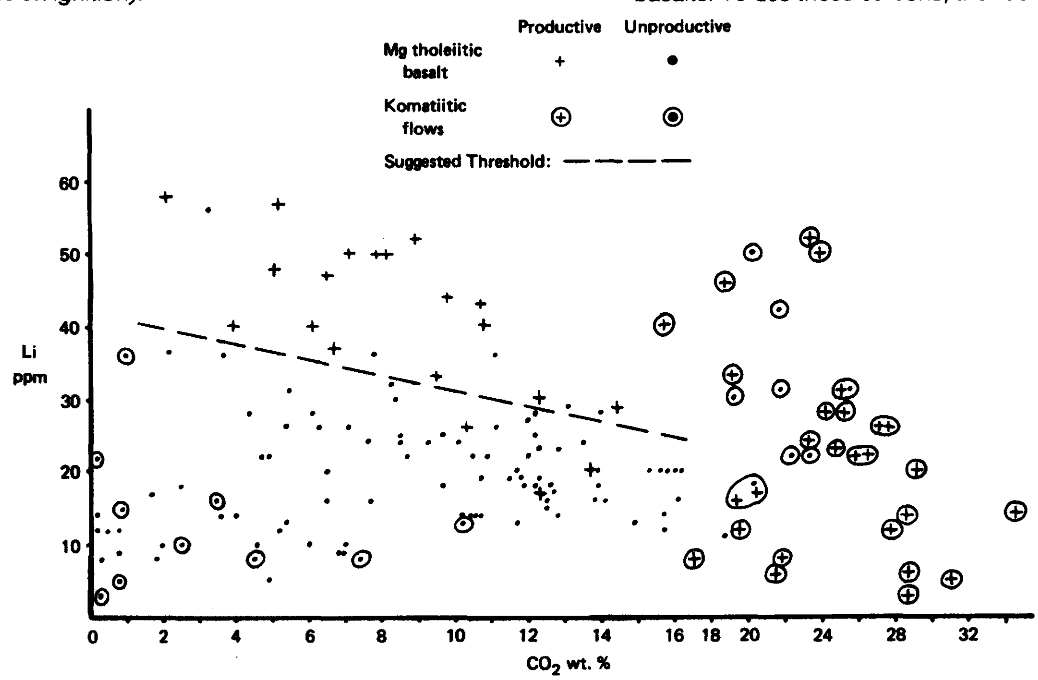

Figure 6—Variation of lithium with alteration intensity (loss on ignition).

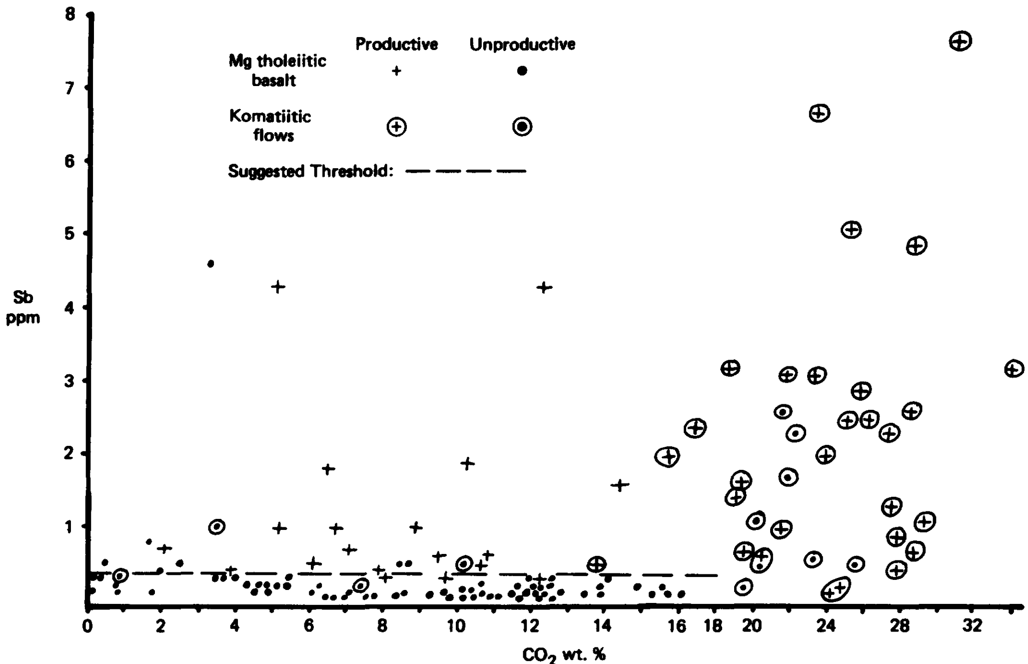

Figure 7—Variation of antimony with alteration intensity (loss on ignition).

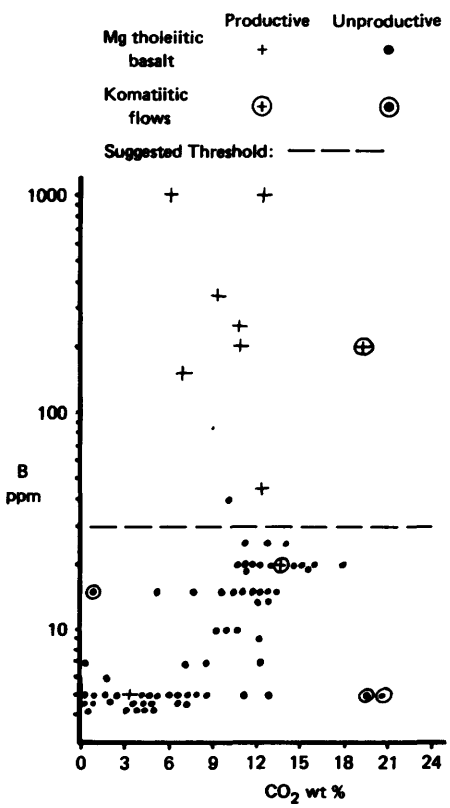

Figure 8—Variation of boron with alteration intensity (loss on ignition).

tified using field and/or petrochemical criteria. Of more general application are Au and B, whose use is not rock type dependant.

To avoid the possibility of geochemical "fliers", it is recommended that binary elemental screens (Figure 10) be used routinely.

Conclusions

In the Porcupine camp, auriferous chert-carbonate-tourmaline sediments (Fryer and Hutchinson 1976; Karvinen 1976; 1978; Fryer *et al.* 1979) were precipitated during pauses in tholeiitic-komatiitic volcanism. They are spatially associated with stratabound bodies of quartz-feldspar porphyry, and are genetically linked to intense, pervasive carbonatization of the footwall rocks. Gold is effectively leached from the most intensely carbonatized zones. This gold remains in solution and is mobile until fixed in an arseno-sulfide sedimentary phase, or in a structural trap.

Single or binary element plots using Au, As, Li, Sb, Cu, or B effectively discriminate between carbonate alteration zones not associated with exhalative gold, and those generated in an ore-bearing environment.

Detailed magnetic and induced polarization surveys indicate the presence of carbonatized and pyritized rock respectively.

Gold exploration programs which integrate geological, geochemical, and geophysical techniques will be the most effective.

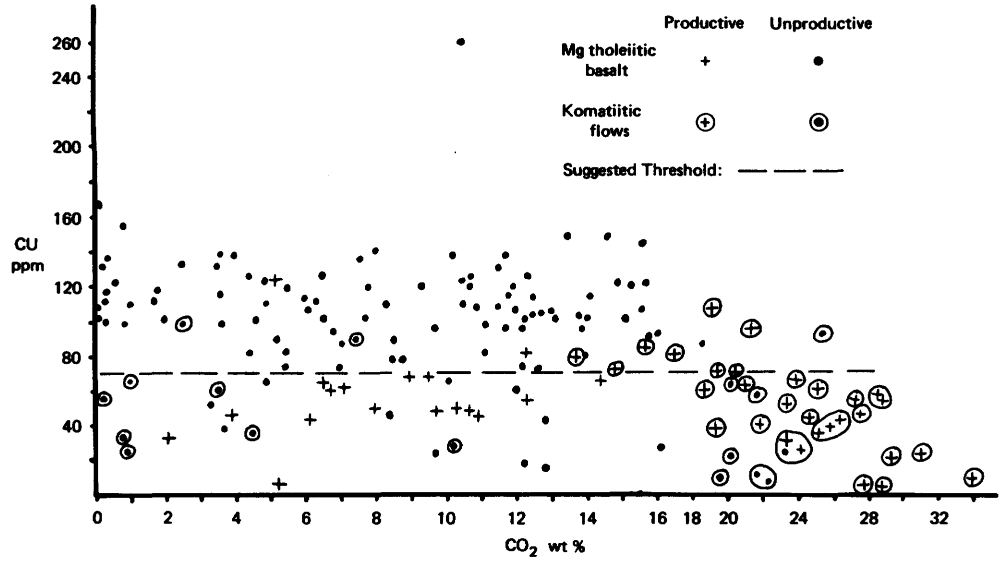

Figure 9—Variation of copper with alteration intensity (loss on ignition).

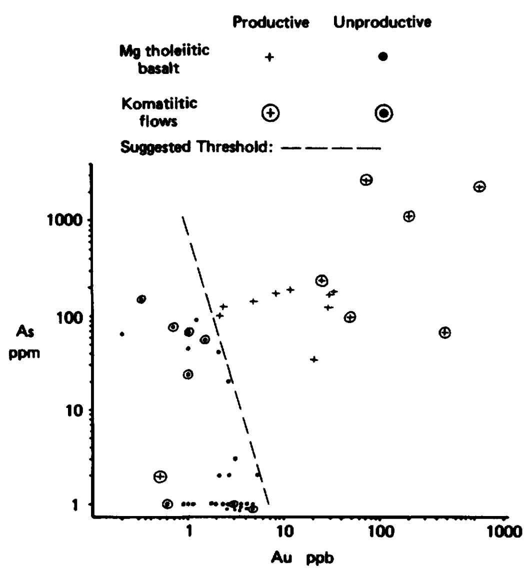

Figure 10.

Acknowledgments

The author wishes to thank Pamour Porcupine Mines Limited for access provided to active mining areas. Communication with industry and government geologists has been stimulative and fruitful.

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No. 34 The Geology and Preliminary Metallogenetic Classification of Metallic Mineral Deposits of the Grenville Province of Southeastern Ontario

T.R. Carter[1] and A.C. Colvine[2]

Introduction

This year's field studies are an extension of mineral deposit studies carried out by the authors in the Pembroke-Renfrew area in 1977 and 1978 (Colvine *et al.* 1977; Carter and Colvine 1978; Carter *et al.* 1979). The purpose of the work is to determine the geological setting of minerali-

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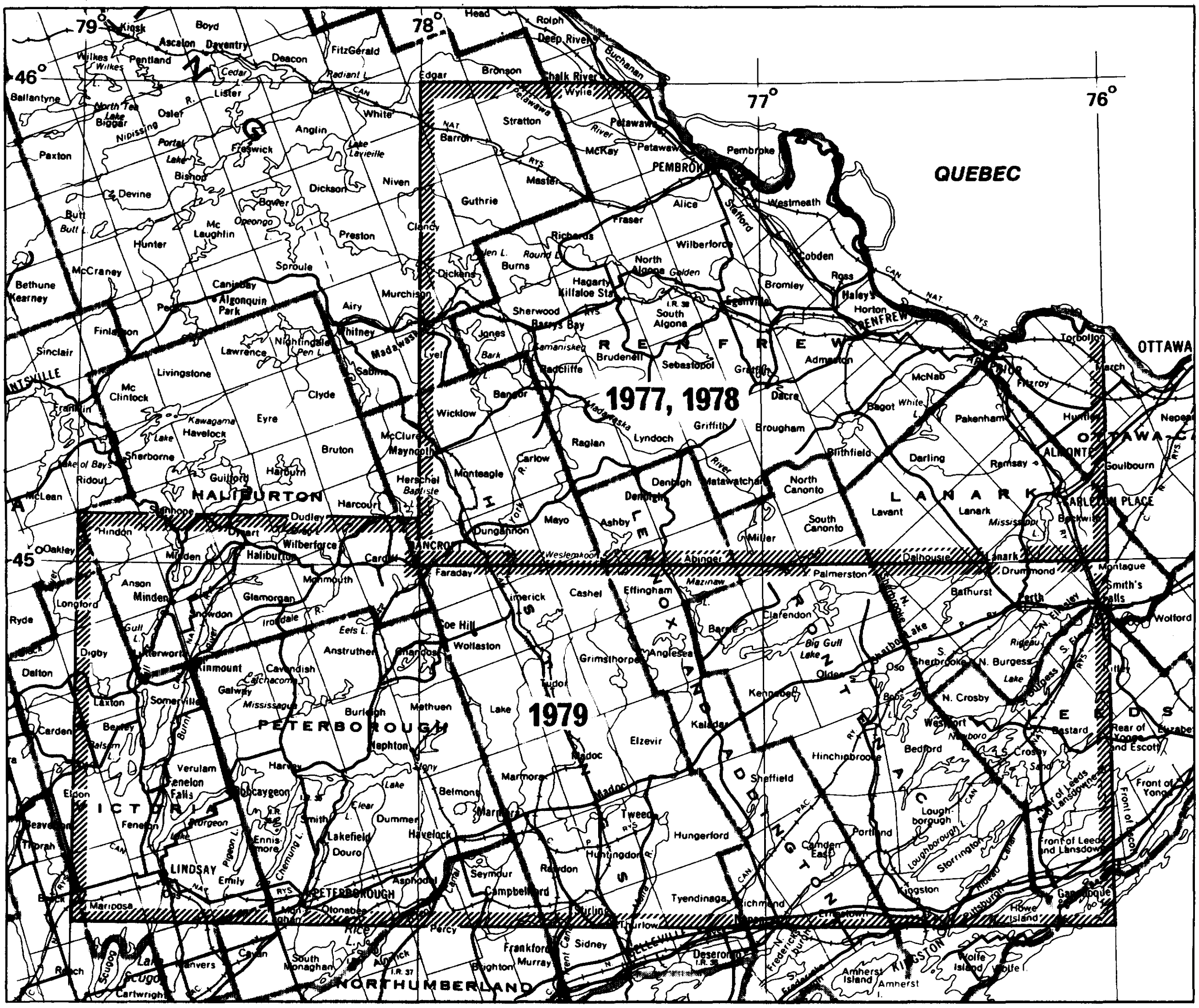

LOCATION MAP

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

zation in the Grenville Supergroup of Southeastern Ontario, and hence establish metallogenetic relationships in order to help delineate areas of greatest economic interest.

During 1979, approximately five weeks were spent on a reconnaissance examination of mineral deposits and their related geology in the southern portion of the Grenville Supergroup. The deposits examined are described briefly and classified according to metal content and geological association (Table 1). In addition, a brief description is included of similar mineralization in other parts of the Grenville Province, examined by the authors in co-operation with geologists working in these areas.

The final portion of this report summarizes the geological relationships of the mineralization of the Grenville Supergroup of Southeastern Ontario, based on work completed to date. In addition to a preliminary metallogenetic classification, an attempt is made to diagrammatically represent the lithologic and possible stratigraphic relationships of mineralization. A brief discussion is also included, of those deposit types which the authors consider to be of greatest economic interest.

Description of Deposits

The 26 deposits examined during 1979 are listed and classified in Table 1.

Pyrite: These deposits occur in the Madoc area as stratiform, massive-sulphide lenses within felsic and intermediate metavolcanics at the top of a thick succession of mafic metavolcanics. Mineralization consists of disseminated to massive pyrite intergrown with minor quartz. Disseminated to massive sphalerite and arsenopyrite are associated with the Blakely Deposit. An inclined diamond drill hole, completed by Freeport Canadian Exploration Company in 1973, intersected 2.1 m of massive base-metal sulphides containing 0.32 percent Cu, 5.12 percent Zn, 3.70 percent Pb, 2.32 ounces of Ag, and 0.01 ounce

TABLE 1 | MINERAL DEPOSITS EXAMINED, 1979.

IRON DEPOSITS	
Stratiform, volcanic hosted, massive pyrite	
Bannockburn	Madoc Tp.
Blakely	Madoc Tp.
Canadian Sulphur Ore Co.	Madoc Tp.
Stratabound, skarn hosted, magnetite	
Dufferin	Madoc Tp.
Marmoraton	Marmora Tp.
COPPER - LEAD - ZINC DEPOSITS	
Stratiform, carbonate hosted, Zn	
Slave Lake	Sheffield Tp.
Spry	Kaladar Tp.
Stratabound, carbonate hosted, Zn-Cu-Pb	
Stead	Barrie Tp.
GOLD AND POLYMETALLIC DEPOSITS	
Unconformable-to-conformable, quartz-ankerite vein hosted, Au	
Big Dipper	Barrie Tp.
Cook	Marmora Tp.
Cordova	Belmont Tp.
Deloro	Marmora Tp.
Golden Fleece	Kaladar Tp.
Helena	Barrie Tp.
Ore Chimney	Marmora Tp.
Sovereign	Barrie Tp.
Star	Barrie Tp.
Stratabound, quartz-dolomite vein hosted, Au-Cu-Zn-Pb-Sb	
Barrie Syndicate	Barrie Tp.
Gough	Barrie Tp.
Mazinaw Base Metals	Barrie Tp.
CALCITE - FLUORITE - BARITE - CELESTITE - GALENA	
Unconformable, calcite vein hosted, Pb	
Hollandia	Madoc Tp.
Robinson	Bedford Tp.
Unconformable, calcite vein hosted, fluorite	
Bailey	Madoc Tp.
Blakely	Huntingdon Tp.
Johnston	Huntingdon Tp.
Perry	Huntingdon Tp.

of Au. Numerous other drill holes in the vicinity failed to intersect significant base-metal mineralization.

Magnetite: Both deposits consist of stratabound lenses of disseminated to massive magnetite contained in skarn zones along the contacts between granitic intrusive rocks and marbles, similar to some of the iron deposits in the Pembroke–Renfrew area. These are probably contact metasomatic in origin.

Zinc: Both zinc deposits have similarities to those in the Pembroke–Renfrew area (Carter *et al.* 1979). They occur as stratiform layers of disseminated to massive sphalerite and pyrite in dolomitic marbles within a sequence of interbedded carbonate and clastic metasediments. The Slave Deposit is hosted by a calcitic marble unit which forms a xenolithic layer within a large gneissic, granitic intrusion.

Zinc, Copper, Lead: The Stead is the only known deposit of this type in the area and has no counterpart in the Pembroke–Renfrew area. Brecciated dolomitic marble within a sequence of interbedded dolomitic and calcitic marbles and minor mafic volcanics hosts the mineralization. Disseminated to massive sphalerite, chalcopyrite, galena, and pyrite occur in the matrix of the brecciated marble.

Gold: The nine Au deposits have variable characteristics, but in all cases, the deposits are hosted by quartz or quartz-ankerite veins in areas of relatively low metamorphic grade. The veins occupy cross-cutting shear zones in gabbroic (Cordova) and granitic intrusions (Cook, Deloro, Sovereign), form concordant lenses along major lithological contacts (Golden Fleece, Ore Chimney), or occupy fractures in dolomitic marbles (Big Dipper, Helena, Star). Mineralization consists of varying proportions of pyrite and arsenopyrite with minor chalcopyrite and gold. Significant gold production is recorded from several of the deposits (Table 2).

Reserves remaining at the Cordova Deposit are reported to average 0.12 ounce of Au per ton with 46 000 tons proven, 50 000 tons probable, and 100 000 tons possible ore outlined (Company Files, Cominco).

Gold, Copper, Zinc, Lead, Antimony: The three deposits are very similar to a group of Cu-Sb-Au-Ag deposits studied in the Pembroke–Renfrew area (Carter *et al.* 1979). The deposits are hosted by networks of narrow quartz-dolomite veins occupying fractures in dolomitic marbles. Mineralization consists of variable amounts of disseminated sphalerite, jamesonite, boulangerite, pyrite, arsenopyrite, and minor galena and chalcopyrite.

Lead, Fluorite: The two lead and four fluorite deposits are similar to the late, epigenetic vein deposits examined in the Pembroke–Renfrew area. They are hosted by calcite veins occupying tension fractures and faults associated with the Ottawa-Bonnechere Fault System. The two lead-bearing deposits are contained in Late Precambrian marbles (Robinson) and metaclastics (Hollandia). Mineralization consists of scattered, very coarse grained galena. The fluorite-bearing veins are part of a large group of deposits contained in, or associated with, the Moira Lake Fault near Madoc. Most cut Black River limestones of Ordovician age (Hewitt 1968). Mineralization consists of disseminated to massive fluorite and barite, and variable amounts of celestite, quartz, marcasite, pyrite, and sphalerite (Guillet 1964). Sphalerite is abundant at the Blakely Deposit. Production of fluorite from veins in the Madoc

TABLE 2 | PRODUCTION STATISTICS OF GOLD MINES IN S.E. ONTARIO*.

Mine	Year	Tonnage Milled	Au(oz)	Ag(oz)	Recovered Grade (Au oz/ton)
Big Dipper	1907, 1909	52	17	–	0.33
Cook	1901, 1902, 1904	1 483	389	–	0.26
Cordova	1892-93, 1898-1903 1912-1915, 1917, 1939-40	120 670	22 774	687	0.19
Craig	1905, 1906	1 850	248	–	0.13
Dean and Williams	1870	1 000	500	–	0.5
Deloro	1897-1902	39 143	10 360	–	0.26
Gatling Five Acre	1900, 1902-03	6 114	2 353	–	0.38
Gilmour	1909-1910	550	172	–	0.31
Golden Fleece	1919, 1922	–	65	26	–
Ledyard	1893-94	55	13	–	0.24
Pearce	1893, 1908	239	302	60	1.26
Sophia	1940-1941	1 800	110	7	0.06
Sovereign	1891-92, 1900	1 962	370	–	0.19
Star	1905, 1907	976	134	–	0.14

*Data summarized from Gordon *et al.* 1979.

area ceased in 1961 and amounted to 121 919 tons (Guillet 1964, p.59).

Other Areas: Five areas of mineralization outside the study area were examined during 1979. These are: (Haliburton and Peterborough Counties– uranium, Bancroft area– uranium; Parry Sound area– copper and copper-zinc; Mont Laurier area, Quebec– zinc; and Balmat-Edwards mining district, New York– zinc). These visits helped with the interpretation of the mineralization within the study area, particularly in relation to the basal Grenville Supergroup stratigraphy and the stratigraphic association of carbonate hosted zinc mineralization; the more significant points are included in the discussion of deposit types below.

Metallogenetic Classification and Discussion

Previous classification by the authors (Carter *et al.* 1979) was based on contained metals and geological association, and applied only to the Pembroke–Renfrew area. This additional work covering a larger area has resulted in the development of a preliminary metallogenetic classification scheme (Table 3) modified after Sangster (1970).

The implied genetic relationships of the observed lithologic association of mineralization lead to the generalized diagrammatic representation of the overall associations of mineralization shown in Figure 1. While the overall stratigraphy of the Grenville Supergroup has not been defined, several publications (Lumbers, 1967; Moore and Thompson 1972; Wynne-Edwards 1972; and Bright 1977) allow a tentative interpretation of the approximate stratigraphic relationship of the major lithologic types, and hence the stratigraphic relationships of mineralization (Table 4); the interpretive nature of this table must be stressed.

The reader is referred to Carter *et al.* (1979) for discussion of the deposit groups (Table 3) not covered below, for which recent work has not provided significant new information.

1.A. Syngenetic Stratiform Sedimentary Zinc

Numerous marble hosted deposits occur in the Grenville rocks of Ontario, Quebec, and New York State. Over 20 million pounds Zn was produced from the Long Lake Deposit between March 1973 and December 1975. The Balmat–Edwards district, New York is currently one of the largest Zn producers in the United States and has maintained continuous production since 1915; between 1915 and 1964, 17 432 184 tons ore containing 10.11 percent Zn and minor Pb were produced.

In Ontario similar deposits occur within a major carbonate belt (Mayo Group?) generally remote from and stratigraphically above the major metavolcanic succession. They fall within a broad zone trending south-southwest from the Quebec deposits and have two forms: 1) extensive layered zones of disseminated sphalerite with

TABLE 3 METALLOGENETIC CLASSIFICATION OF MINERAL DEPOSITS IN THE GRENVILLE SUPERGROUP OF SOUTHEASTERN ONTARIO (EXCLUSIVE OF URANIUM).

1. Syngenetic volcanic and sedimentary (Base & precious metal sulphide)
   - A. Stratiform sedimentary Zn.
   - B. Stratiform volcanic Cu,Pb,Zn,Au,Ag.
   - C. Stratiform sedimentary Cu,Sb,Ag,Hg.
2. Early Epigenetic vein
   - A. Stratabound, quartz-dolomite, base & precious metal.
   - B. Discordant, quartz-ankerite, Au,Ag,As
   - C. Stratabound Zn,Cu,Pb.
3. Syngenetic, volcanic & sedimentary (Iron)
   - A. Stratiform sedimentary quartz-magnetite ironstone.
   - B. Stratiform volcanic massive pyrite.
   - C. Stratiform sedimentary pyritic schist.
4. Syngenetic Magmatic
   - A. Copper-nickel.
   - B. Iron-Titanium.
5. Contact Metasomatic (Iron)
6. Metamorphic-Metasomatic (Molybdenum)
   - A. Stratabound, skarn hosted.
   - B. Stratabound, pegmatite hosted.
   - C. Stratiform, paragneiss hosted.
7. Late Epigenetic vein
   - A. Discordant calcite, barite, fluorite, celestite, galena, sphalerite.
   - B. Supergene hematite.

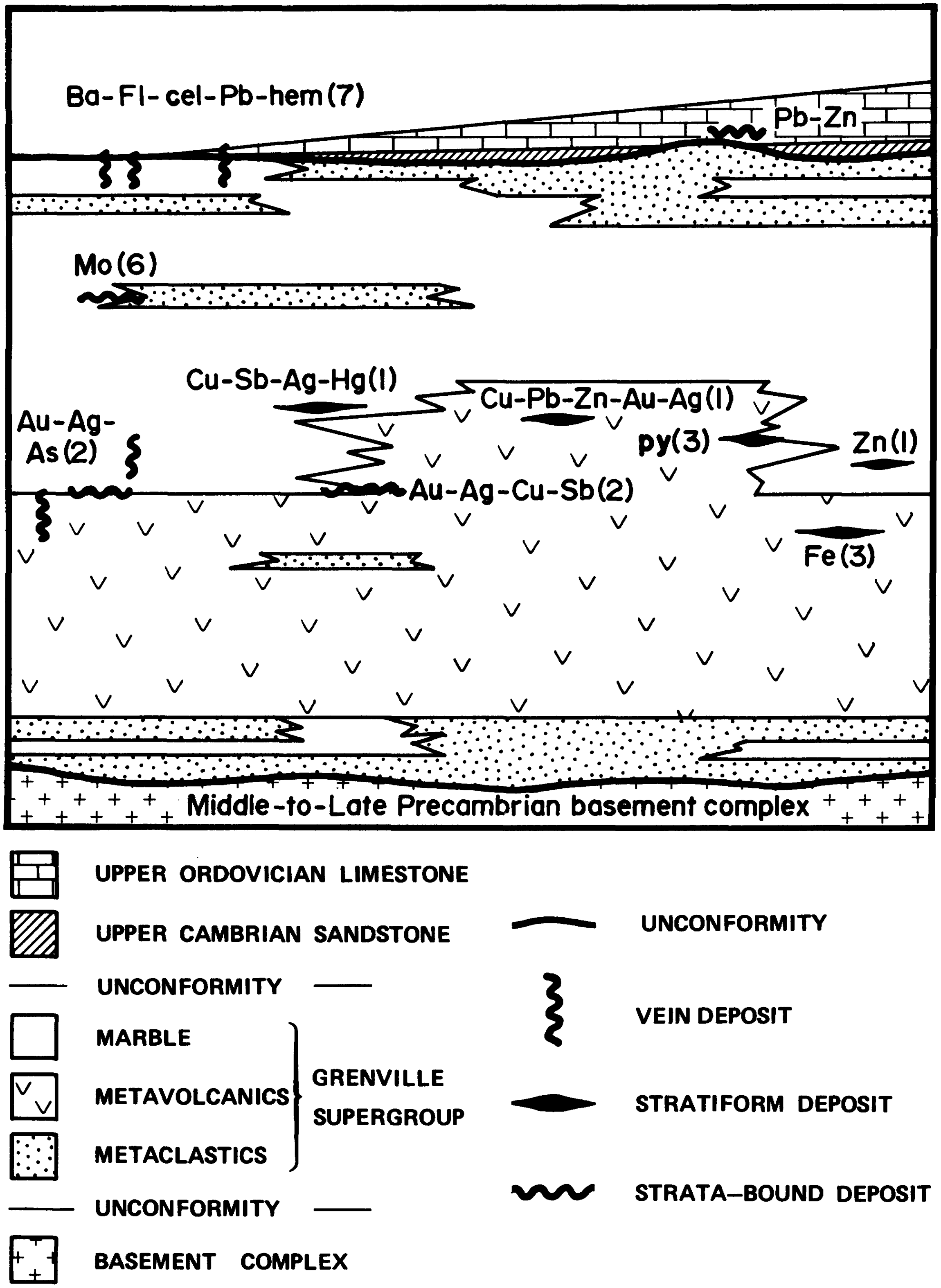

Figure 1—Diagrammatic representation of the lithologic associations of stratabound and stratiform metallic mineral deposits in S.E. Ontario.

TABLE 4 | **LITHOLOGIC & INTERPRETED STRATIGRAPHIC ASSOCIATIONS OF METALLIC MINERAL DEPOSITS IN SOUTHEASTERN ONTARIO (SEE FIGURE 2).**

INTERPRETED GROUP	LITHOLOGY	MINERAL DEPOSITS
Upper Ordovician	Limestone. Minor dolostone, shale, sandstone.	Late fluorite, barite celestite, calcite, sphalerite veins. Possible mississippi valley type lead-zinc.
Upper Cambrian	Quartzite, sandstone. Basal conglomerate Minor Limestone, Dolostone.	
	unconformity	
Westport Area (Stratigraphic relationship uncertain)	Marbles, Quartzites Feldspathic sandstone Siltstone.	Late calcite, galena barite veins (Post-Ordovician age). Pyrite schist, some stratabound vein base & previous metals.
Flinton Group	Quartzite, conglomerate Marble, calcareous and non-calcareous feldspathic pelites.	Gold in quartz veins along basal unconformity.
	unconformity	
Mayo Group	Marble Subordinate calcareous & non-calcareous feldspathic sandstone and siltstone Minor mafic volcanics quartzite.	Late calcite, galena, barite celestite veins in marble. Stratiform Cu,Sb,Ag,Hg in intercalated marbles & clastics. Stratabound Zn Cu Pb in dolomitic marbles. Stratiform synsedimentary sphalerite in dolomitic marbles (near base?). Minor stratiform magnetite-carbonate ironstone (near base?). Base & precious metals in stratabound veins in dolomitic marbles (at base). Metamorphic metasomatic Mo in skarn, pegmatite & amphibolite in intercalated marble & metaclastics (upper Hermon, lower Mayo).
Hermon Group	Mafic metavolcanics Subordinate intermediate and felsic volcanics. Feldspathic sandstones and siltstones, marble, calcareous clastics minor conglomerate.	Au Ag As; minor base metal in quartz & quartz-ankerite veins in fractures & shear zones in mafic volcanics & intrusives (upper). Massive stratiform pyrite in volcanics (upper). Stratiform polymetallic base metal sulphide in volcanics (upper). Minor stratiform quartz-magnetite ironstone. No significant mineralization (excluding uranium).
Anstruther Lake Group	Feldspathic sandstones and siltstone. Minor calcareous mudstone	
	unconformity	
Middle to Late Precambrian Basement Gneiss Complex		

(*From Lumbers 1967; Moore & Thompson 1971; Wynn-Edwards 1972; Bright 1977).

minor pyrite and galena in siliceous dolomitic marble; and 2) lenses and layers of disseminated to massive sphalerite, pyrite, and minor galena in calcitic marble remnants within igneous intrusive rocks.

The third mode of occurrence, exhibited by many Quebec and New York deposits, consist of layers of massive sphalerite, pyrite, variable pyrrhotite, and minor galena in siliceous dolomitic marble along or immediately adjacent to its contact with intercalated metaclastics. The Balmat deposits are associated with a major bedded anhydrite unit. Folding is common, and reconcentration of mineralization in fold noses is evident.

While these deposits are similar in mineralogy and geological setting to Mississippi Valley Type Pb-Zn deposits, their concordant stratiform nature and absence of open space fracture or breccia filling features indicates a different mode of formation. The evidence for their syngenetic formation during sedimentation has been discussed previously (Lea and Dill 1968; Gauthier and Brown 1979; Carter *et al.* 1979). Detailed mapping work in the Mount Laurier and Balmat areas in particular in particular demonstrate clearly the stratabound and stratiform nature of much of the mineralization.

With the exception of the Slave Lake and Long Lake Deposits, all are associated with dolomitic marbles, indicating a possible relationship of mineralization with dolomitization (Lumbers 1977; Carter *et al.* 1979). The spacial relationship with volcanic rocks suggests that metals, (Mg,Fe, and Zn), could have been introduced into the carbonate depositional environment by a distal source of volcanogenic exhalative actively resulting in both dolomitization and deposition of zinc mineralization. Alternatively, a purely chemical sedimentary source of metals is also considered feasible.

While most known deposits in Ontario occur within the broad zone in the eastern part of the area, referred to above, the authors consider all carbonate sequences (of the Mayo Group?) as favourable for zinc mineralization. The transitional contacts of siliceous dolomitic marbles with intercalated clastic sediments appears to be the most favourable target particularly where deformed. Conversely, thick sequences of calcitic marbles do not appear to host this type of mineralization. Exploration around known showings in the Balmat–Edwards and Mont Laurier areas in particular resulted in the discovery of additional deposits. Any zinc showings indicate the presence of a favourable environment, and the surrounding area therefore, is of highest potential for further exploration.

Soil geochemistry and glacial boulder train tracing have proven successful prospecting techniques. The use of "zinc zap" (3 percent potassium ferricyanide, 3 percent oxalic acid, and 0.5 percent diethyaniline) is essential in areas of overburden and weathered surface outcrops in which sphalerite may have been leached. Due to the non-conductive nature of sphalerite and the presence of conductive pyritic, pyrrhotitic, and graphitic sedimentary rocks throughout the area, geophysical exploration techniques are generally not applicable.

1B,3B: Volcanogenic Massive Sulphides

Two significant base-metal deposits (1B) of this type occur in Ontario and Quebec. At the Simon Deposit (Carter *et al.* 1979, p.94) 253 000 tons averaging 1.09 percent Cu and minor Zn have been outlined to 350 feet. Production of approximately 3.5 million tons of Zn, Pb, and Ag ore recorded from the New Calumet Mine, Quebec between 1943 and 1969 (Sangster 1970). In addition, while their stratigraphic relationships are not known, production has been achieved from several Cu-Zn-Pb-Ag-Au deposits in the Montaban–Les Mines area of Quebec (Gauthier and Brown 1979). Some production has also been achieved from Cu-Zn deposits in the Parry Sound area. One significant intersection of base-metal mineralization has been obtained from the massive pyrite deposits (3B) of the Madoc area mentioned above.

Base-metal mineralization occurs within the major belt of volcanic rocks (Hermon Group?) as stratiform layers or lenses of massive to disseminated chalcopyrite, pyrrhotite, sphalerite, and galena in intermediate to mafic volcanic rocks and narrow intercalated carbonate to calcsilicate horizons. The pyritic deposits occur at the transitional contact between volcanic rocks and carbonates (Hermon and Mayo Groups?) as stratiform lenses of massive to disseminated pyrite with pyrrhotite and chalcopyrite, intergrown with quartz and exhibiting layering in places. Host rocks include felsic and mafic volcanic rocks, mudstones and marbles.

A volcanogenic, exhalative origin is indicated for these deposits analagous to those of Early Precambrian "greenstone" sequences. These polymetallic deposits are formed proximal to volcanic activity whereas the carbonate-hosted zinc-rich deposits (1A) have a possible distal deposition. Areas of intermediate to felsic volcanic rocks within mafic volcanic rocks, particularly towards the top of the volcanic succession would appear to be promising exploration targets. The association of base metals with pyritic deposits should be further investigated. In addition to geological mapping, geophysical and geochemical exploration techniques could be applied.

2A. Early Epigenetic Base and Precious Metal Vein Deposits

Continuing study of these deposits (T.R. Carter, M.Sc. Thesis in progress, University of Toronto) has shown that mineralization, which may be related to the intercalated volcanics, was introduced into the carbonate sequence during sedimentation possible related to the intercalated volcanics and subsequently locally remobilized into quartz and dolomite vein networks during regional metamorphism. Primary metal introduction is considered analagous to the 1C deposit type in which the one known deposit contains an estimated 60,000 tons averaging 0.67 percent Cu, 0.37 percent Sb, 0.03 percent Hg, and 1.23 ounces of Ag (Carter *et al.* 1979). Significant assays of up to 0.8 ounce of Au and 3 ounces of Ag have been obtained from the Lavant and Darling Township deposits. While massive sulphides are rare, these assays have been obtained from samples with relatively low sulphide content. This area has not been adequately investigated for its precious metal potential. The relatively low grade of metamorphism, upper greenschist to lower amphibolite facies, appears to be important in the retention of precious metals.

Similar mineralization occurs in dolomitic marbles within a sequence of intercalated dolomitic and calcitic marbles, greywacke and minor quartzite in Barrie Township. These rocks have been assigned to the Flinton Group (Moore and Thompson 1972).

Discordant Quartz Ankerite Au-Ag-As Veins

Numerous deposits of this type are found in an area of relatively low grade metamorphic rocks centred on Madoc Township. The deposit type was not recognised in the Pembroke–Renfrew area. Production statistics (Table 2) demonstrate their economic importance. They occur within mafic volcanic rocks, carbonates and granitic and gabbroic intrusives, and mostly near major mafic volcanic units. Veins occur in shear zones, fractures, and along major lithologic contacts. Gold and minor silver occur with the sulphide mineral assemblage, principally with pyrite and arsenopyrite.

The epigenitic origin of the mineralization is demonstrated by their structural and metamorphic control and occurrence with different lithologies. Derivation of the mineralizing fluid by dehydration during metamorphism of deeper level rocks would account for the metamorphic control. Alternately, the fluid may have been derived during igneous intrusive activity, acting as a heat or metal source.

Shear zones and major lithologic contacts in lower grade metamorphic areas are the most favourable exploration targets. Re-evaluation of known deposits is also warranted. Arsenic may be a useful geochemical indicator due to the presence of arsenopyrite.

Summary and Conclusions

Several metallogenetic processes have resulted in the development of mineralization in and around rocks of the Grenville Supergroup in Southeastern Ontario:

Syndepositional processes related to formation of Grenville supracrustal rocks;

Epigenetic metasomatic processes related to regional metamorphism;

Magmatic processes related to igneous intrusion;

Contact metasomatic processes related to igneous intrusion;

Low temperature metasomatic processes related to diagenesis of Paleozoic rocks;

Supergene enrichment subsequent to uplift and stabilization;

Syngenetic activity during formation of volcanic and sedimentary rocks appears to have been particularly important in introduction and concentration of mineralization.

The highest potential deposit types discussed above are:

Carbonate hosted zinc;
Volcanic hosted polymetallic sulphide;
Carbonate-hosted base and precious metal;
Quartz ankerite precious metal veins;
The economic potential of other deposit types (Table 3) is inadequately assessed. These are:
Polymetallic carbonate breccia fillings (2C);
Graphitic schist zones (3C) as stratigraphic indicators and as graphite or base-metal sources;
The widespread distribution of small high grade molybdenum deposits (6);

The mineralogical and genetic similarity of late veins (7A) to Mississippi Valley-type deposits. More extensive mineralization of this type may occur within Ordovician age carbonates around traps such reefal structures or basement highs.

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No. S18 Gold Mineralization of the Atikokan Area

S. Wilkinson[1]

Introduction

A study of the Atikokan area mineral deposits was initiated by the Ontario Geological Survey in 1978 (MacRae 1978), with the examination of ten gold deposits and visits to other precious-metal and base-metal occurrences.

During 1979, the writer investigated eleven additional gold deposits and under took further mapping of four gold deposits examined by MacRae.

For each deposit, a preliminary search of available data was followed by field examination, and if warranted, by detailed mapping and sampling.

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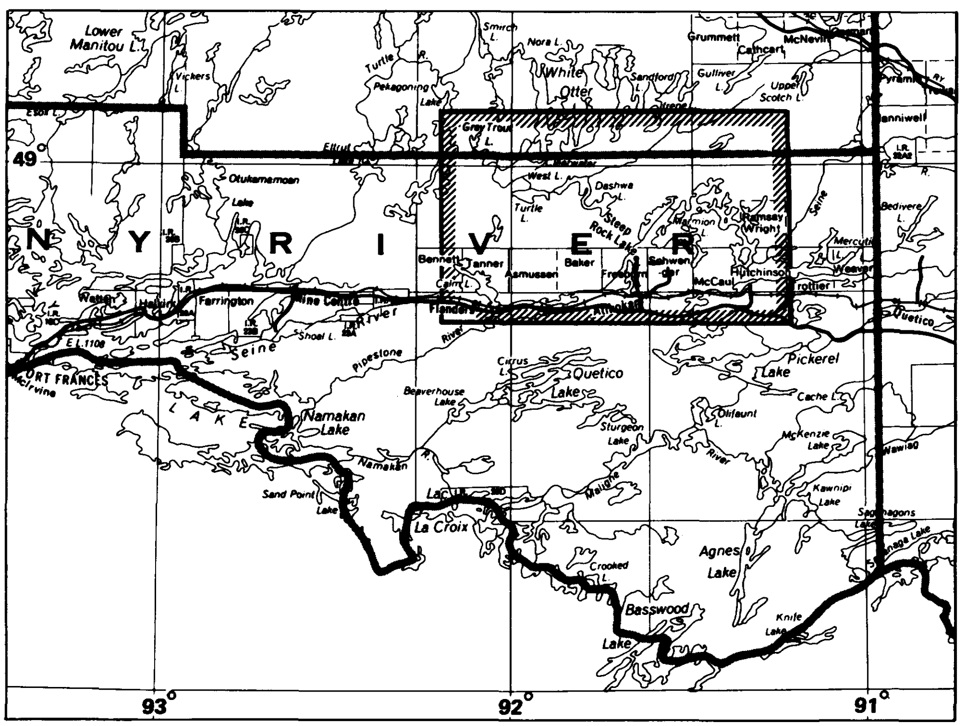
Location and Access

The Atikokan area is located approximately 200 km west of Thunder Bay (Figure 1). The Trans-Canada Highway 11 crosses the southern part of the area. Numerous logging roads and fire access roads afford good vehicular access to the central and northern parts. The Seine River and Marmion and Finlayson Lakes provide limited access by boat to much of the remaining area.

Previous Work

Most of the study area was mapped by Hawley (1929) and Moore (1939) whose reports contain extensive references to earlier work. Later mapping was undertaken by Woolverton (1960), Young (1960), Shklanka (1972), Fenwick (1976), and Fumerton (this volume).



LOCATION MAP

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

General Geology

Rocks of the Atikokan area are early Precambrian in age. The major structure is the Quetico Fault which forms the boundary between the predominantly metavolcanic belts of the Wabigoon Subprovince to the north, and the metasedimentary belts of the Quetico Subprovince to the south (Pirie 1978).

The sedimentary rocks of the Quetico Subprovince have been described by Pirie (1978).

The Wabigoon Subprovince consists primarily of mafic to intermediate volcanic rocks, intercalated with felsic volcanic rocks and interflow sedimentary rocks. The mafic to intermediate volcanic rocks consist predominantly of fine- to medium-grained massive flows and pillowed flows. Less common varieties include variolitic flows and pyroclastic rocks.

Felsic flows occur throughout the metavolcanic belt and include aphanitic quartz-feldspar porphyry flows, tuffs and tuff-breccias, intruded by felsic sills and plugs.

Thin metasedimentary units are commonly found between the flows and are composed mainly of material derived locally from the associated volcanic rocks. Fenwick (1976) listed the sedimentary rocks present as, "feldspathic greywacke, arkosic grit, argillite, slate, impure quartzite, pebble conglomerate and schists derived from these rocks."

Two felsic batholithic complexes, the Marmion Lake Batholith and the Dashwa Lake Batholith, occur in the eastern and central parts of the area, respectively. The relative age of these batholiths is not certain.

The Marmion Lake Batholith is described by Pirie (1978) as a complex of gneissic to massive trondhjemitic rocks, ranging from amphibolite to leucotrondhjemite. MacRae (1978) considered this batholith to be a principle host for gold mineralization.

Fenwick (1976) described the granitic rocks of the Dashwa Lake Batholith as massive to foliated, medium to coarse grained, and mostly pink. Trondhjemite and granodiorite occur within the batholith as lensoid bodies up to a few hundred metres across. These bodies are most commonly found along the batholith-metavolcanic belt contacts.

Gold Mineralization

Three types of gold mineralization occur in the Atikokan area:

1) Veins of quartz (±carbonate) within shear zones in the Marmion Lake Batholith.

2) Veins of quartz and carbonate located at or near the contact of batholiths and metavolcanic belts.

3) Stratabound quartz (chert) or carbonate lenses hosted by volcanic rocks.

Type 1, gold mineralization (Table 1) is found within shear zones, up to 300 m wide, in the Marmion Lake Batholith. These zones are associated with major regional lineaments, trending northeast from the Quetico Fault.

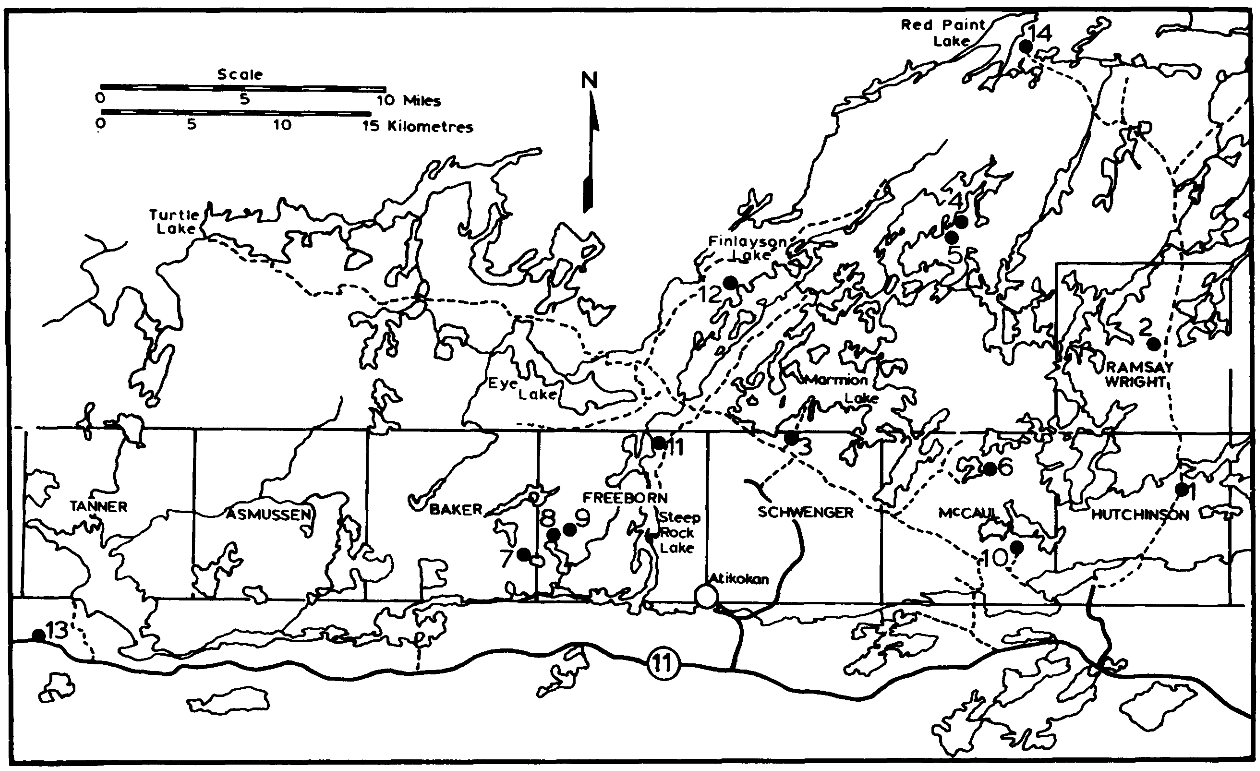


Figure 1—Investigated occurrences of the Atikokan Area. Key to occurrences in Tables 1, 2, and 3.

TABLE 1 | GOLD OCCURRENCES CONTAINED WITHIN THE MARMION LAKE BATHOLITH.

Map Key(1)	Name of Occurrence	Status(2)	Accessory(3) Minerals	Average Grade(4) ppb (Au)	Remarks
1	Minto Mine	p	ank, py, asp, cp, Au	ND	Two quartz veins; -south vein 103 m long with max. width 4 m. Shaft sunk to approx. 20 m in 1903-5. One fleck visible gold found in mine dump, (Hawley 1929) -North vein 135 m long, 3.5 m wide, located 404 m northeast of shaft.
2	Pettigrew Mine	p	ank, py, asp, cp, gn	ND	Series of small veins exposed over strike length of 85 m. Largest vein 16 m by 1.4 m. Shaft no. 1 (7 m) and shaft no. 2 (31 m) sunk during 1890's (Hawley 1929).
3	Snow Lake	o	ank, py, cp, sp, gn	ND	Quartz vein 47 m by 1.7 m. Locally vein up to 20 percent sulphide minerals.
4	Sawbill Bay Mine	pp	ank, py, asp, cp	7 190	Main quartz vein approx. 600 m by 1.8 m on surface. Shaft sunk to depth of 75 m during 1899. Levels at depths of 6 m, 36 m and 73 m, (Bow 1899 *in* Fenwick 1976).
5	Hammond Reef Mine	pp	ank, py, cp, asp, sp	5 940	Located 840 m southwest of Sawbill Bay Mine on possibly extension of same mineralization. Several Quartz veins, largest measures 120 m by 1.2 m, (Fenwick 1976).
6	Jack Lake Mine	p	ank, py, asp, cp, sp, gn	14 060	Quartz vein exposed irregularly over strike length of 110 m, width 0.3 m. In 1890's shaft sunk to approx. 60 m with drifts at 3 m and 30 m, (Hawley 1929).

(1) Map Key: Occurrences located by number in Figure 1.
(2) Status: o = undeveloped occurrence; p = partially developed or prospected occurrence; pp = past producer
(3) Accessory Minerals: ank = ankerite; py = pyrite; asp = arsenopyrite; cp = chalcopyrite; sp = sphalerite; gn = galena; mo = molybdenite; shee = scheelite; and, Au = visible gold
(4) Average Grade: from data available in Assessment Files, Regional Geologist's Office, Thunder Bay

Fenwick (1976) and Pirie (1978) described the rocks associated with the mineralization as variably sheared, albite-rich leucocratic trondhjemites. These rocks are sporadically distributed and are elongated parallel to regional lineaments. The trondhjemites grade laterally into gneissic, more mafic phases.

Deformation of the trondhjemites intensifies towards the cores of the shear zones:

a) Fracturing and jointing are subparallel to, and *en echelon* with, the direction of shearing. Calcite and accessory pyrite occur as fracture fillings. Biotite, when present, is the only mafic mineral. Feldspar is pale green.

b) Weak foliation is due to alignment of sericite (or muscovite) and chlorite. No mafic minerals are present. Trace to accessory amounts of calcite, epidote, pyrite, and chalcopyrite are disseminated throughout. Feldspar is either greenish or milky in colour.

c) Distinct schistosity is due to subparallel orientation of medium- grained chlorite and muscovite with numerous inclusions of fine-grained apple-green epidote. Calcite, pyrite, and chalcopyrite are also present.

d) Intense schistosity, essentially chlorite, muscovite, and quartz, with accessory pyrite, ankerite, and trace chalcopyrite are present.

Gold-bearing quartz veins occur most commonly in zones (c) and (d) above. The veins are boudin-like, irregularly spaced and consist of quartz, ankerite, chlorite, pyrite, and chalcopyrite. Arsenopyrite, sphalerite and galena are common and scheelite is rare. Visible gold was found in only one instance, but is reportedly common in veins of this type (Hawley 1929).

Type 2, gold mineralization (Table 2) is associated with the contacts between batholiths and metavolcanic belts. The contacts are seldom simple or sharp, but consist of zones of complex interdigitations. The batholithic rocks are medium-grained, weakly foliated leucrocratic trondhjemite, composed mainly of alkalic feldspar and quartz, with varied amounts of sericite, chlorite, and epidote. The predominantly mafic volcanic rocks are chloritic, schistose to slaty rocks and occur as variably-sized lensoid bodies. The lenses are oriented subparallel with the trend of the contact zones.

Rocks occurring adjacent to gold-bearing veins are locally intensely sheared and contain abundant ankerite and pyrite, with trace amounts of chalcopyrite. Zonation of shearing in the rocks hosting the veins has not been observed.

The veins are composed primarily of quartz, either milky and coarse-grained, or grey and sugary textured. Other constiutents rarely exceed 5 percent by volume of the vein and are, in order of decreasing abundance, ankerite, pyrite, chlorite, chalcopyrite, sphalerite, scheelite,

TABLE 2 GOLD OCCURRENCES LOCATED AT OR NEAR THE CONTACTS OF METAVOLCANIC BELT AND BATHOLITHS.

Map Key(1)	Name of Occurrence	Status(2)	Accessory(3) Minerals	Average Grade(4) ppb (Au)	Remarks
7	Harold Lake Mine	pp	py, ank, asp, cp, sp, gn	14,700	Two main veins; open stope mining removed most of principle vein (35 m by 1.0 m). Second vein with shaft, 12 m deep, now submerged in lake. Operated during 1895-6, (Moore 1939). 17 subsidary veins on property.
8	Elizabeth Mine	pp	py, ank, cp, gn	12,500	Main vein mined with average width 0.5 m for 23 m along strike and to depth of 81 m. Second shaft sunk to depth of 33 m with 35 m lateral work, circa 1912, (Moore 1939).
9	Rebair Mine	p	ank, py, cp, asp	ND	Two quartz veins measured 13 m by 0.3 m. Tested with pits and trenches during 1930's, (Moore 1939).
10	Atiko (Sapawe) Mine	pp	ank, py, cp, asp	4,375	One shaft worked to depth of 305 m over period of 1960-6. Levels at 15 m, 97 m, 156 m, 216 m and 276 m. Mineralization (not exposed at surface) consisted of five quartz veins in sheared zone, (Assessment Files, Regional Geologist's Office, Thunder Bay).
11	Black Fly Mine	p	ank, py, cp, asp	1,800	Mineralization in series of small quartz veins over 270 m strike length. Shaft, 14 m deep, sunk during 1930s, (Fenwick 1976).
12	Golden Twins	p	py, ank, cp, mo	ND	One quartz vein 300 m by 9.8 m (max.). Two shafts, 19.2 m and 4.9 m, sunk prior to 1899, (Fenwick 1976).

(1) Map Key: Occurrences located by number in Figure 1.
(2) Status: o = undeveloped occurrence; p = partially developed or prospected occurrence; pp = past producer
(3) Accessory Minerals: ank = ankerite; py = pyrite; asp = arsenopyrite; cp = chalcopyrite; sp = sphalerite; gn = galena; mo = molybdenite; shee = scheelite; and, Au = visible gold
(4) Average Grade: from data available in Assessment Files, Regional Geologist's Office, Thunder Bay

galena, sericite, tourmaline, and green mica. Fenwick (1976) reported the gold to be sporadically distributed within the quartz veins. Gold occurs in the free state, but is more concentrated in veins containing abundant pyrite.

Type 3, gold mineralization (Table 3) occurs within metavolcanic belts. In the two areas examined, the host rocks are mainly mafic metavolcanic flows with minor intercalated felsic pyroclastic rocks and quartz-feldspar porphyry. The mineralization is confined to one stratigraphic horizon, marked by a thin but persistent pyrite-rich unit hosted within a zone of rusty micaceous schist. The pyrite-rich unit varies from 0.7 m to 3.0 m thick. Near Red Paint Lake, this unit can be traced along strike for several kilometres. It is composed of discrete fine-grained pyrite crystals and microcrystalline aggregates of pyrite in a matrix of quartz, feldspar, chlorite, and sericite. The rusty micaceous schist, most commonly 9 m to 22 m thick is composed of fine-grained chlorite, sericite, carbonate, and pyrite. Chalcopyrite is a common accessory. The schist, overlying the pyrite-rich unit, is occasionally enriched in carbonate and grades into lenses of carbonate or chert. The lenses, up to 2 m thick and 5 m long are composed of aphanitic, alternating, millimetre-thick layers of grey and buff carbonate or chert. The gold occurrences near Red Paint Lake, are hosted by carbonate lenses; at the Mayflower Mine, the mineralization is associated with cherty units (see Figure 1). Pyrite, arsenopyrite, sericite, green mica, and chlorite are disseminated in the lenses. Quartz-carbonate stringers and veins, containing up to 3 percent disseminated pyrite, and chalcopyrite, occur throughout the lenses and the accompanying schist.

Summary

Three types of gold mineralization are recognized in the Atikokan area. Some key features of each type may prove useful for the exploration of similar deposits:-

Type (1) is localized within regional lineaments in the Marmion Lake Batholith and is associated with shear zones and diagnostic mineral suites.

Type (2) occurs sporadically in narrow and laterally continuous shears in contact zones between batholiths and metavolcanic belts.

Type (3) is hosted within sulphide-rich rocks of laterally continuous stratigraphic horizon.

TABLE 3 | STRATABOUND CARBONATE/CHERT TYPE GOLD MINERALIZATION.

Map Key(1)	Name of Occurrence	Status(2)	Accessory(3) Minerals	Average Grade(4) ppb (Au)	Remarks
13	Mayflower Mine	p	py, ank, cp, sp, gn, shee	ND	Mineralization in banded chert and quartz veins. Shaft sunk to 30 m with levels at 15 m and 30 m, prior to 1900. Reported gold content from trace to 18 625 ppb. (Assessment Files, Regional Geologist's Office, Thunder Bay).
14	Sawdo Claims	p	py, cp, sp, shee	ND	Several carbonate lenses and quartz-carbonate veins over strike length of 1.4 km. One sample reported 43 125 ppb over 1.4 m, (Woolverton 1960).

(1) Map Key: Occurrences located by number in Figure 1.
(2) Status: o = undeveloped occurrence; p = partially developed or prospected occurrence; pp = past producer
(3) Accessory Minerals: ank = ankerite; py = pyrite; asp = arsenopyrite; cp = chalcopyrite; sp = sphalerite; gn = galena; mo = molybdenite; shee = scheelite; and, Au = visible gold
(4) Average Grade: from data available in Assessment Files, Regional Geologist's Office, Thunder Bay

Future Work

Follow up work will continue in 1980. The research will include:

(i) Detailed petrographic studies;
(ii) Chemical analyses;
(iii) Aerial photograph study of the region.

The report will consist of descriptions of each investigated deposit and discussion of possible genetic models.

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No S19 Styles of Chromite Mineralization in Ontario

P.J. Whittaker[1]

Introduction

The program to investigate chromite deposits in Ontario initiated in 1978 by the Mineral Deposits Section of the Ontario Geological Survey (Whittaker 1978) was continued during 1979.

Chromite is associated mainly with the ultramafic-mafic suite of rocks; this association was studied during the 1979 field season. Attention was paid to the type and distribution of ultramafic-mafic suite rocks in order to distinguish different environments of chromite occurrence.

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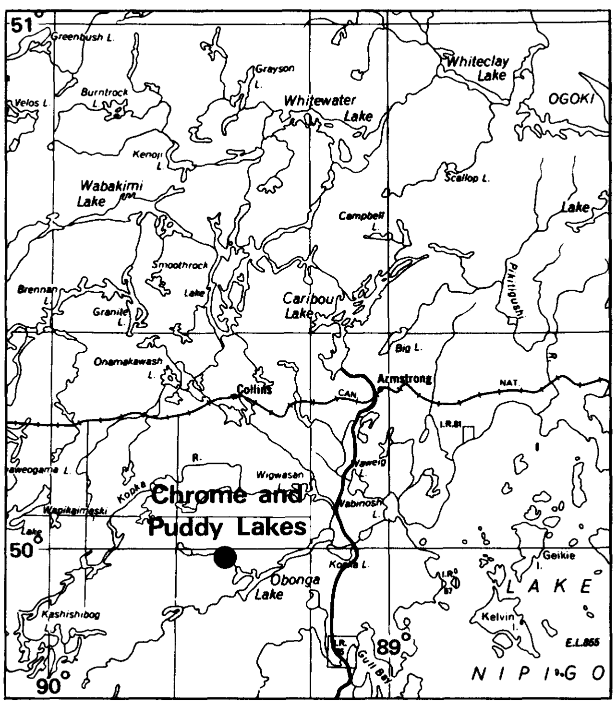

LOCATION MAP

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

Chromite in Ontario

Chromite in Ontario occurs in ultramafic and mafic suite rocks which represent three distinct crystallization environments: extrusive, hypabyssal, and plutonic.

Komatiitic suite rocks represent the extrusive ultramafic environment, where trace amounts of chromite (up to 1 modal percent) occur. Very fine-grained euhedral chrome spinel is described by Arndt (1977) in the Munro Township komatiites. This environment offers no potential for economic concentrations of chromite.

Hypabyssal rocks of ultramafic and mafic affinity contain variable amounts of chromite in both disseminated and thinly layered form. Chromite has been recognized in the lower portions of peridotitic-gabbroic sills in the Abitibi area (MacRae 1969), and in the Dundonald intrusion (Naldrett and Mason 1968). In both occurrences chromite is present in amounts varying from trace to a maximum of 5 modal percent.

Another example of this environment is found at the Shebandowan Nickel Deposit where chromite in disseminated form occurs throughout most of the "Mine Ultramafic". Poorly defined chromite layers, 1 to 2 cm thick, with 30 to 40 modal percent chromite, occur at the base of the ultramafic body in a zone approximately 0.5 m wide (Morton 1979).

Chromite is also developed in the Crystal Lake gabbro, a fractionated olivine gabbro to anorthositic gabbro (Geul 1970). Chromite layers developed within the anorthositic gabbro are diffuse and contain 15 to 20 modal percent very fine grained chromite. The layers are 1 to 2 cm thick and are widely separated (2 to 3 m) by anorthositic gabbro containing 5 to 10 modal percent very fine grained disseminated and euhedral chromite. The disseminated chromite grains appear as fine black specks, both within and interstitial to, plagioclase phenocrysts. Disseminated chromite in irregular patches is also found from the lower portion of the anorthositic gabbro to the lower contact of the olivine gabbro with the underlying Rove Formation shales.

Gabbroic-anorthositic suite rocks such as those described by Hudec (1964) at Big Trout Lake may represent a similar environment for chromite. This hypabyssal environment for gabbroic anorthositic suite rocks is similar to that of the Bushveld Complex in South Africa (Hunter 1978) and the Stillwater Complex in Montana (Hess 1960) where economic deposits of chromite and associated platinum group metals occur.

The past producing chromite deposits at Puddy-Chrome Lakes (see location map and Figure 1) represent

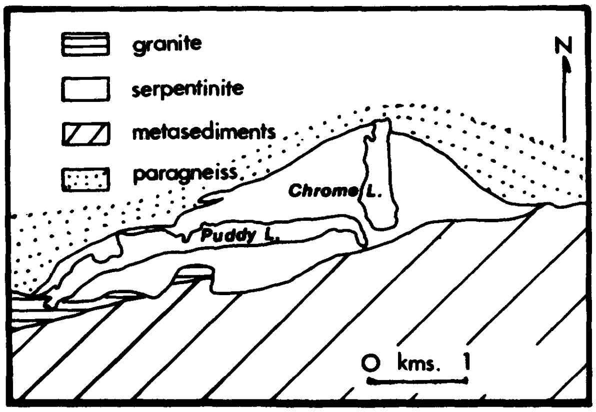

Figure 1—Puddy–Chrome Lakes serpentinite.

the only known deposits of chromite in a plutonic environment in Ontario. The petrochemistry of chromite from these deposits is currently being studied (Watkinson and Mainwaring 1979).

Investigations by the writer are summarized below.

General Geology

Early mapping in the Puddy-Chrome Lakes area was carried out by Graham (1930), Hurst (1931), and Kidd (1933). The serpentinized ultramafic intrusion at Puddy and Chrome Lakes (Figure 1) is exposed for 6 km along strike and is approximately 1 km in width. The ultramafic intrusion is emplaced at the contact between Archean paragneiss and Archean volcanogenic metasediments. Country rock xenoliths occur close to the contacts of the ultramafic body. North-south striking Keweenawan diabase dikes cut the serpentinite and enclosing country-rocks. The centre of the intrusion exhibits a weak foliation which becomes intensified towards its northern and southern contacts. Scattered occurrences of relict olivine-pyroxene cumulate textures, together with petrography, indicate primary dunitic and peridotitic compositions.

Chromite Deposits

Chromite occurs at the eastern end of the serpentinite along the northern contact between the north end of Chrome Lake and the eastern terminus of the intrusion, 1.6 km to the east, as illustrated in Figure 2.

Chromite in these deposits is developed in both dis-

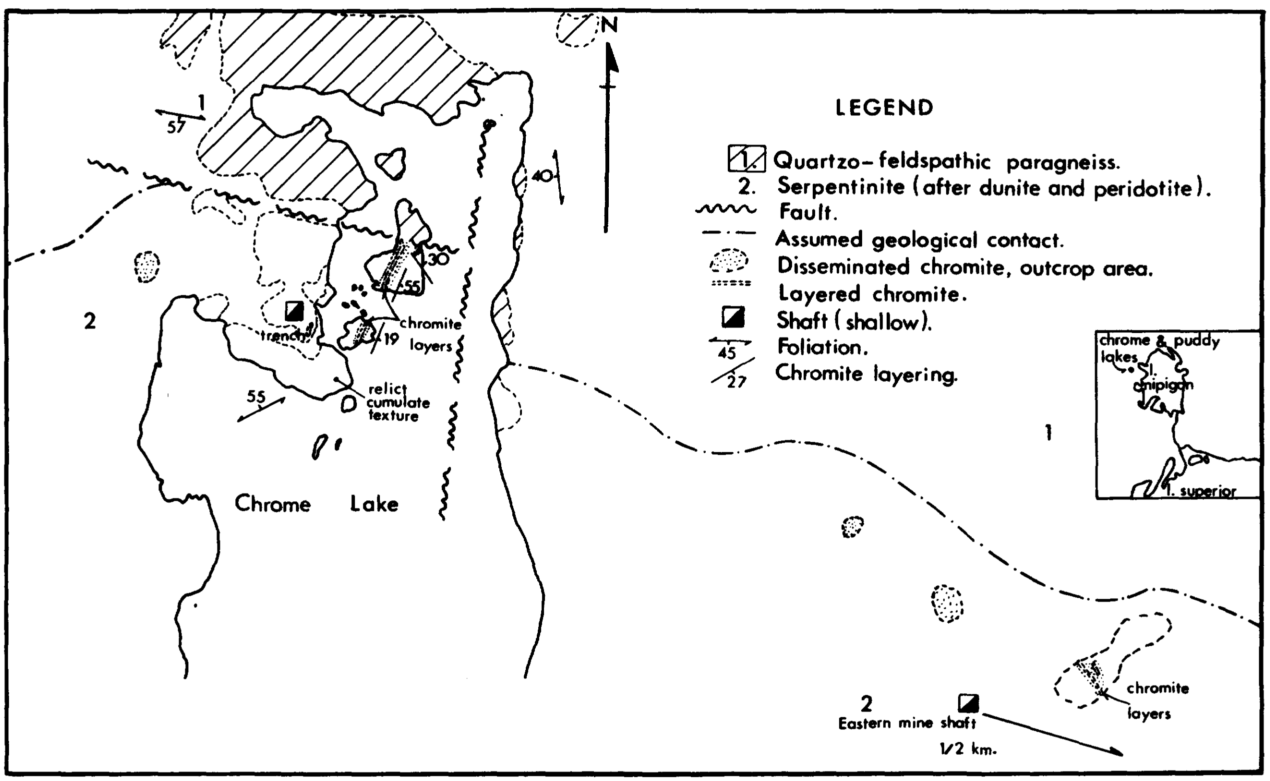

Figure 2—Disseminated and layered chromite occurrences at Chrome Lake.

seminated and layered form. Disseminated chromite is very fine grained and forms 5 to 15 modal percent of the serpentinite. The distribution of disseminated chromite within individual outcrops is patchy and chromite-bearing outcrops are scattered (Figure 2). Chromite in disseminated form is also developed between, and on either side of chromite layers.

Layered chromite is best exposed at the north end of Chrome Lake where the layered zone is approximately 0.5 m thick, strikes north and dips easterly. The layers are deflected to a north-westerly strike as the paragneiss contact is approached. The layers vary from 1 cm to 6 cm thick and are cumulate concentrations of medium-grained subhedral chromite. A representative sequence is described by Whittaker (1978). Deformation has sheared the thinner (1 cm) layers into stretched fragments 1 cm to 3 cm in length. Most of the chromite grains within the chromite layers have been fractured as a result of shearing. In thin section, large (1 to 2 mm) chromite grains are fractured with angular, smaller (0.1 mm) fragments in the shadow of the parent grain. Chromite layers formed of massive chromite were mined at the eastern end of the intrusion. The significant percentage of Fe in chromite (Sample 4, Table 1), typifies a drawback to chromite from Ontario localities studied to date. High Fe in chromite causes costly problems in the Cr recovery process (Raicevic 1976).

Chromite mineralization in the Puddy–Chrome Lakes serpentinite is similar to that of ophiolitic chromite deposits, where layered and podiform chromite is also irregular and discontinuous. The Trodoos Ophiolite Complex in Cyprus (Panayiotou 1978) has a small but economic deposit, and in Canada the Thetford Mines area, Quebec, has produced chromite from ophiolitic rocks. The Puddy–Chrome Lakes serpentinite offers limited potential, due mainly to the small size of the intrusion, and the high Fe ratio. However, exploration for chromite in ultramafic plutonic rocks of similar type should not be neglected.

Table 1 lists the whole rock analyses, trace element, and normative compositions of dunite and peridotite samples. Figure 3 is an AFM diagram of selected ultramafic samples and accentuates the high MgO and low alkali contents of these rocks.

Discussion

The Puddy–Chrome Lakes deposits of chromite are irregular and discontinuous layered zones with minor disseminated chromite. The irregular nature of the chromite distribution was,in part, responsible for the cessation of mining in 1937 and must be considered in exploration and development of other deposits of this type.

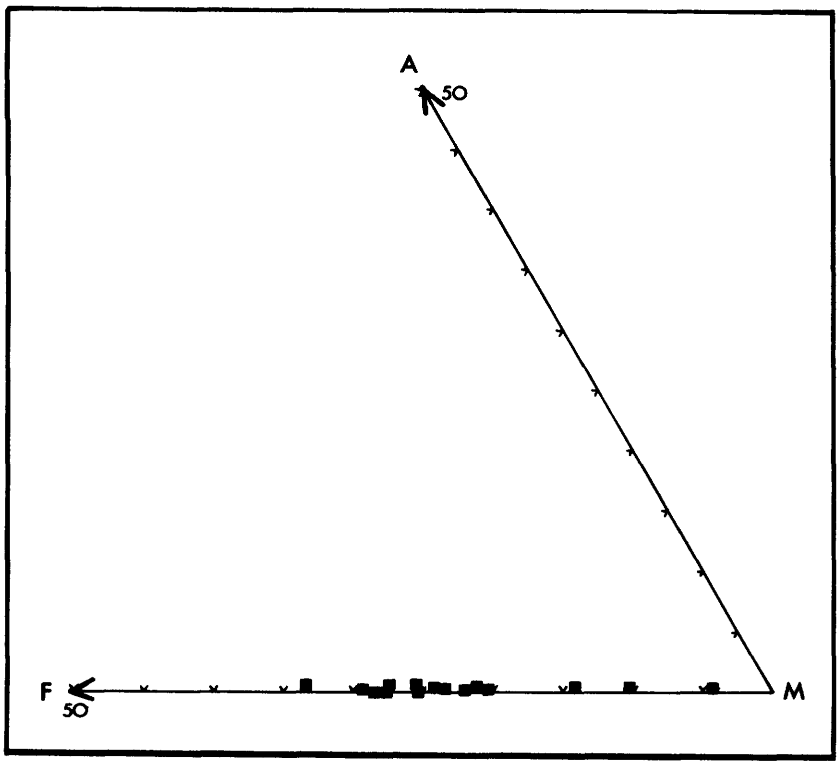

Figure 3—AFM plot of Chrome and Puddy Lakes serpentinite analyses.

TABLE 1 ANALYSES OF SERPENTINITE FROM CHROME AND PUDDY LAKES

	1	2	3	4	5	6	7
SiO_2	35.50	34.90	37.80	8.80	31.40	37.90	46.70
$A1_2O_3$	1.09	1.14	3.31	11.60	2.50	2.22	13.40
Fe_2O_3	8.51	10.50	13.20	23.50	16.00	10.50	14.30
FeO	3.86	3.94	'	'	'	'	'
MgO	37.00	36.10	34.50	13.20	31.00	37.40	9.25
CaO	0.05	0.21	0.51	0.18	0.10	0.70	10.20
Na_2O	0.00	0.00	0.00	0.00	0.00	0.00	1.67
K_2O	0.00	0.00	0.00	0.00	0.00	0.00	0.82
TiO_2	0.03	0.03	0.17	0.50	0.07	0.09	1.02
P_2O_5	0.00	0.00	0.04	0.03	0.03	0.03	0.10
S	0.02	0.02	0.03	0.01	0.01	0.01	0.03
MnO	0.04	0.04	0.16	0.77	0.18	0.14	0.23
CO_2	1.44	1.70	0.56	0.21	0.13	0.86	0.07
H_2O^+	10.30	10.50	10.60	2.20	10.40	11.60	2.20
H_2O^-	2.43	1.79	0.00	0.00	0.00	0.00	0.00
TOTAL	100.30	100.80	100.30	61.00	91.82	100.60	99.90
L.O.I.	13.30	12.50	10.60	2.20	10.40	11.60	2.20
Ba	20	20	20	20	20	20	140
Co	61	65	101	15	42	152	48
Cr	850	990	5240		75 100	2 000	109
Cu	5	5	10	5	6	7	290
Li	3	3	3	3	8	3	79
Ni	2350	2360	1060	140	920	920	64
Pb	10	10	10		10	10	17
Zn	15	15	26	10	20	26	122
Ap	0.022	0.022	0.087	'	'	0.064	0.219
Po	0.074	0.074	0.108	'	'	0.036	0.109
Il	0.044	0.044	0.246	'	'	0.129	1.484
Or	0.063	0.063	0.061	'	'	0.061	5.066
Ab	0.095	0.095	0.093	'	'	0.092	15.662
An	0.194	1.038	2.356	'	'	3.364	27.839
C	1.154	0.876	2.779	'	'	1.112	0.00
Mt	9.441	9.652	1.813	'	'	1.707	2.752
Hm	0.00	1.342	0.00	'	'	0.00	0.00
Wo	0.00	0.00	0.00	'	'	0.00	0.00
En	30.482	29.454	23.354	'	'	18.671	10.757
Fs	0.00	0.00	3.634	'	'	2.056	5.687
Q	0.00	0.00	0.00	'	'	0.00	0.00
Di	0.00	0.00	0.00	'	'	0.00	12.742
Fo	58.431	57.339	56.655	'	'	65.495	7.160
Fa	0.00	0.00	8.815	'	'	7.214	3.786

Notes:

A. Major oxides expressed as weight percent.
B. Trace elements expressed in ppm.

1. Serpentinized peridotite, Puddy L.
2. Serpentinized peridotite, Chrome L.
3. Serpentinized peridotite, mine dump.
4. Chromitite, main mine shaft dump.
5. Chromitiferous serpentinite, main mine shaft dump.
6. Serpentinized peridotite, Chrome L.
7. Serpentinized gabbro, Puddy L.

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No. S20 Uranium Deposits of the Cobalt Embayment

H.D. Meyn[1]

During the 1979 field season, the author commenced a two year examination of the uranium deposits in the Southern Province northwest of Lake Wanapitei, and the southern portion of the Cobalt Embayment (see Location Map). Figure 1 is a sketch map of part of the study area showing the geology north of Lake Wanapitei. Areas of uranium mineralization are generally hosted by the Mississagi Formation. Deposits in areas 1,2,3,4,5,6,7,8,9, and 10 were examined during the field season.

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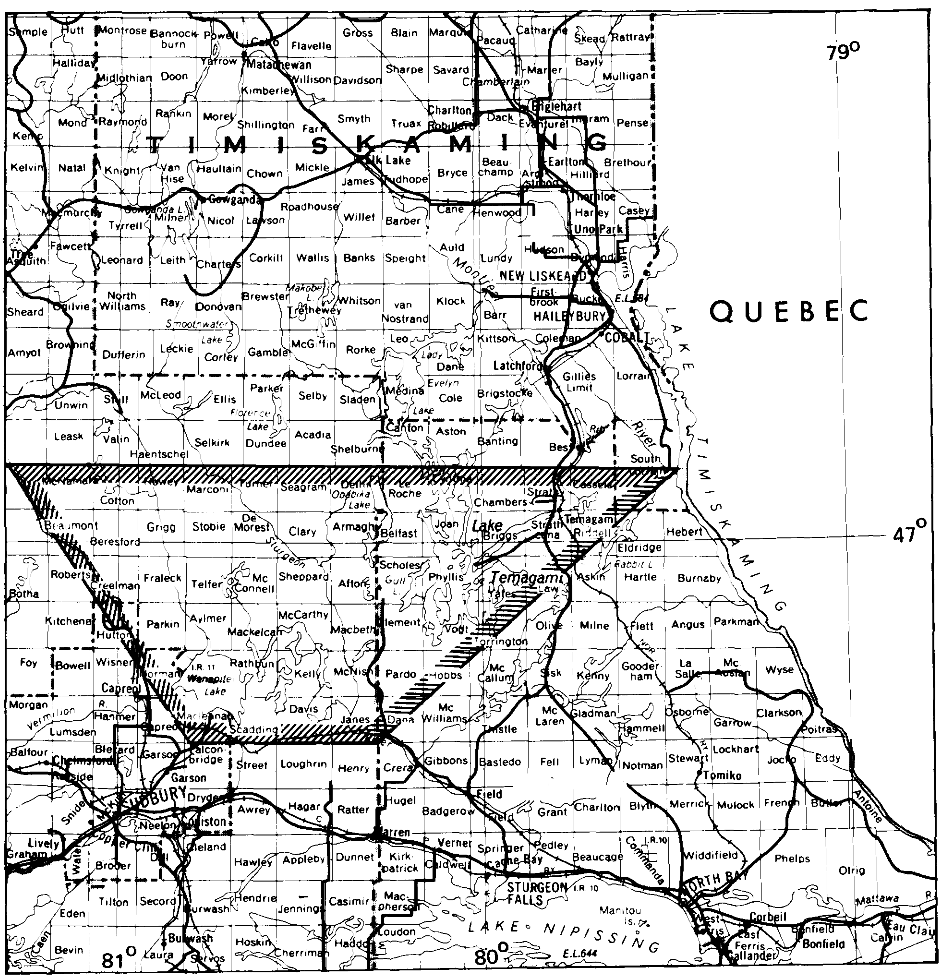
A description of many of the uranium deposits of the area is found in Thomson (1960). Subsequently, this author mapped many of the townships with rocks favourable for uranium mineralization at a scale of 1 inch to ¼ mile (1:15 840) published at 1 inch to ½ mile (1:31 680) (Meyn 1970, 1971, 1972, 1973).

North of Lake Wanapitei only one formation of the sedimentary rocks is present between the Archean basement and the Bruce Formation. It is at or near the base of this formation that most of the uranium deposits of the area are found. Applying the nomenclature of Robertson, Card, and Frarey (1969) and Robertson, Frarey, and Card (1969), the author has called it the Mississagi Formation.



LOCATION MAP

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

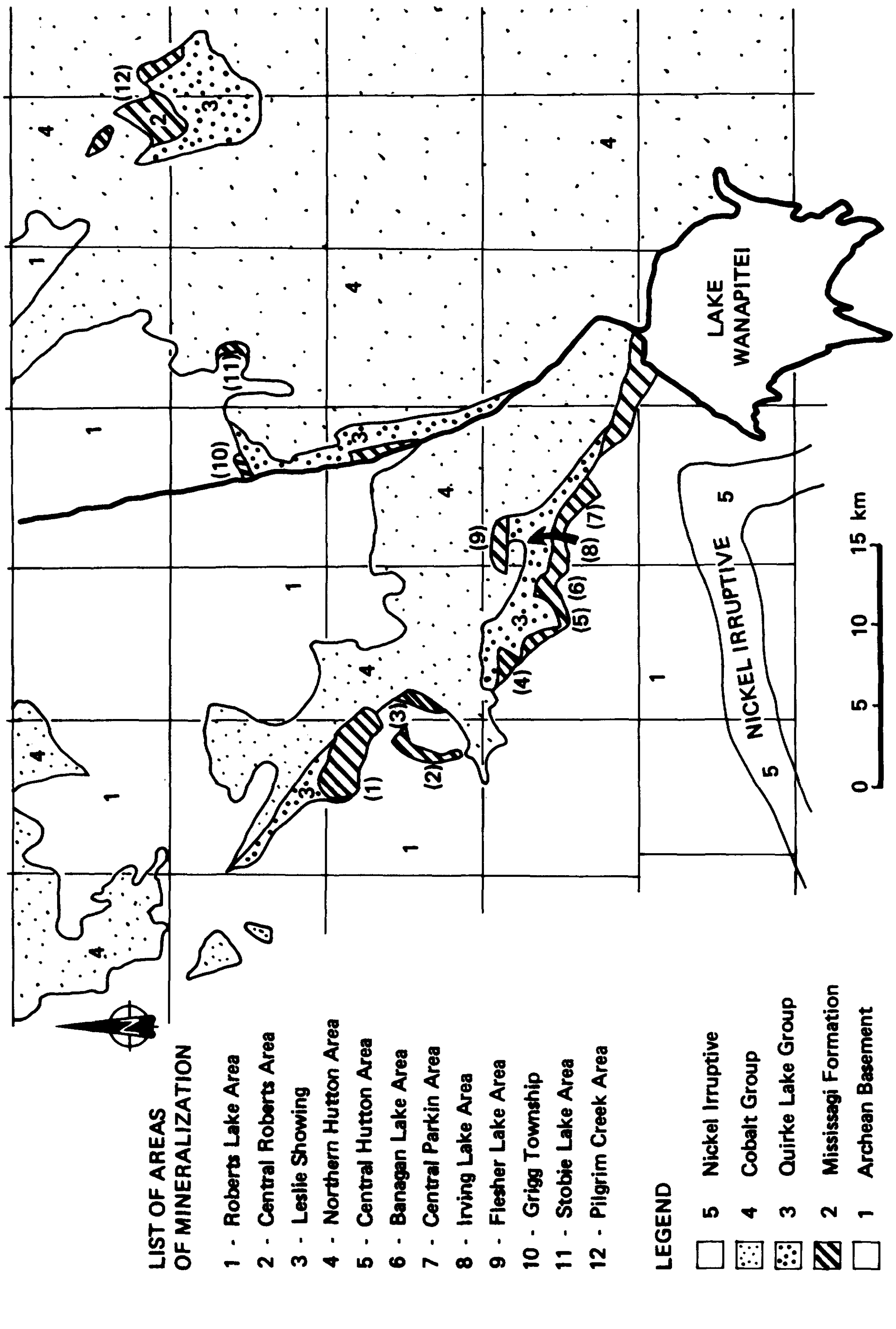


Figure 1–Sketch map of the Proterozoic rocks north of Lake Wanapitei.

The Matinenda and McKim Formations of the Elliot Lake Group and the Ramsay Lake and Pecors Formation of the Hough Lake Group are reported to be present in Falconbridge and/or Street Townships (D.G. Innes, Geologist, Ontario Geological Survey, personal communication 1979). However, a subdivision resembling these formations within the sedimentary sequence, called Mississagi Formation by the author, has not been possible. Long (1976,p.52) stated: "The presence of uraniferous quartz-pebble conglomerates near the base of the sequence may indicate that the lower part of the sequence is equivalent to the Matinenda Formation in the Quirke Lake area. As the Ramsay Lake conglomerate has not been positively identified north of Wanapitei Lake, such a correlation can only be considered tentative". Also, based on Peters (1969), Long (1976,p.53) speculated: "The thinly bedded argillaceous sequence may tentatively be correlated with the Pecors Formation, and the overlying sandstones, which are locally in contact with the basement may be correlated with the Mississagi Formation, in the sense of Roscoe (1957) and Robertson, Card, and Frarey (1969). Units below this thinly bedded unit may be correlated in part with the Elliot Lake Group, and possibly with the Ramsay Lake Formation. The absence of conglomerates identifiable as Ramsay Lake Formation may be due to a facies change, or non-deposition of this formation." The greatest obstacle to a successful correlation attempt is the extreme faulting in the area west of the Wanapitei River, with the largest block no longer than about 1 km making tracing of favourable mineralized beds from one fault block to the next very difficult, and frequently impossible.

In order to obtain a better understanding of the type of uranium mineralization present, its mode of occurrence, and consequently its origin, more than 200 samples have been submitted for autoluxographs and chemical analyses, with follow-up by optical microscope, x-ray diffraction, and possibly microprobe.

Some generalizations can be made as a result of this summer's field work. Uranium mineralization is present in conglomerate, sandstone, siltstone, and argillite. In any one deposit it may be present in one or more rock types, but usually it occurs predominantly in one rock type. The highest grades (0.31 percent U_3O_8, Thomson 1960, p.31) are attained locally in black to brown mudstones and siltstones such as at the Leslie showing (Number 3, Figure 1). Pyrite is normally closely associated with uranium mineralization, but the reverse is not true. Uranium mineralization seems to be very local, that is, local concentration may be a bed or part of a bed to 30 cm thick (locally to 1 m) and extending along strike from 50 cm to as much as 30 m, but generally not much more. The extent of mineralization in the third dimension is not known, but is probably of the same order of magnitude.

The uranium-bearing conglomerates resemble those in the Elliot Lake area, but there is a difference. The conglomerates north of Lake Wanapitei are generally polymictic frequently reflecting the under-lying basement with clasts of diabase, volcanic rocks, iron-formation, and felsic intrusive rocks. The quartz clasts are generally a mixture of vein quartz and quartzite rather than being predominantly vein quartz. The matrix of the conglomerates ranges from fine-grained, chloritic, black-green mudstone to light grey, medium-grained sandstone.

If the Mississagi Formation was deposited in a braided stream environment (Long 1976). Paleocurrent information would be helpful in tracing uranium mineralization, however, paleocurrent directions have been difficult to obtain in the rocks stratigraphically near the mineralization. In stratigraphically higher rocks, crossbedding is most clearly developed and paleocurrent determinations can be made more easily, but these may not accurately apply to the lower rocks.

To assess the uranium potential of the area, laboratory work in progress will help, but further detailed mapping, with special attention to paleocurrent information and structural deformation must be undertaken. Information on the third dimension can only be obtained by drilling. The author feels that, with the lensoid mineralization currently indicated, successful exploitation of the resources north of Lake Wanapitei will require large tonnage, low average grade mining or leaching operations.

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No.S21 Metallogenetic Relationships of Base-Metal Occurrences in the Cobalt Area.

G.C. Patterson[1]

Introduction

The nature, geological association, and distribution of base-metal mineralization in early Precambrian Keewatin type, metavolcanics and metasediments of the Cobalt area is documented. In addition, results of a preliminary field investigation of mineralization associated with the Middle Precambrian Huronian sedimentary rocks are included. The objective of this study is to gain a better understanding not only of the processes involved in formation of this type of mineralization, but also its relationship with the economically important cobalt-silver (Co-Ag) vein deposits of the area. This study is an integral part of a broader metallogenetic program in the eastern part of the Southern Province (Innes and Colvine, this volume).

The Cobalt area has been described by Miller (1904, 1906, 1908, 1911, 1913), Knight (1924), Thomson (1960a,b,c; 1961a,b,c,d,e; 1962; 1964a,b,c) and Berry (1971). Due to changes in property names and ownership, the names of properties used in this summary are the same as those in Sergiades (1968).

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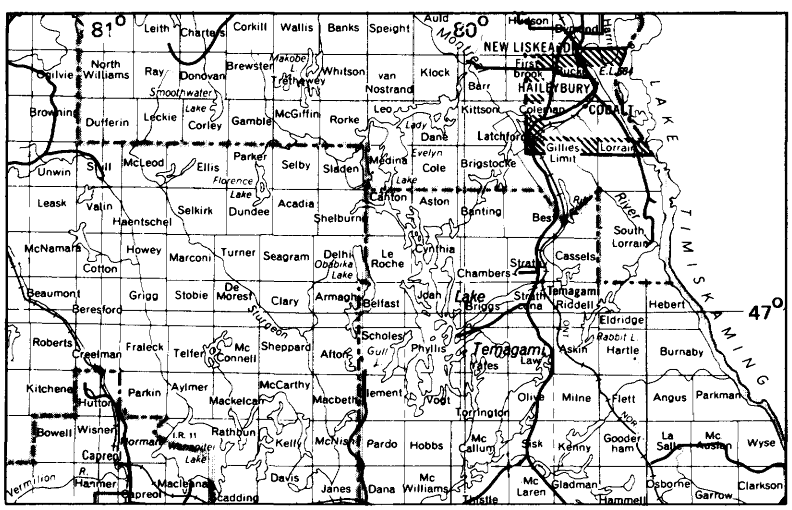
Keewatin

Approximately 25 percent of the Cobalt area is underlain by Keewatin metavolcanics and metasediments. The predominant volcanic rock type (approximately 80 percent) consists of pillowed mafic volcanic rocks with discontinuous layers of hyaloclastite marking flow tops. Individual flows average 15 to 30 m in thickness. Pillows are often indistinct and rounded, with chloritic selvages. Massive sill-like bodies up to 150 m thick are locally present within the flow sequence. These represent either thick flow units or co-magmatic synvolcanic intrusions. Some dike-like intrusions with distinct flowage textures occur on the Chambers–Ferland property. Initial whole rock analyses indicate the pillowed mafic volcanic rocks have a spillite affinity.

Felsic tuffs and rhyolites occur associated with feldspar-quartz porphyry, northeast of Cross Lake and on the Montreal River south of Cassidy Lake. The porphyry consists of up to 30 percent bladed feldspar phenocrysts, 3 to 6 mm in size, with minor rounded quartz eyes in a grey fine-grained matrix. The rhyolites are dark in colour with quartz eyes in a fine-grained matrix. The siliceous tuffs are fine-grained and well layered such that some were previously mapped as volcanic sedimentary rocks.

Altered andesites and andesite breccia occur around Sasaginaga Lake. The breccia consists of partially to com-



LOCATION MAP **Scale: 1: 1 584 000 or 1 inch to 25 miles**

pletely altered andesite fragments up to 20 cm in diameter. Some breccias contain tuffaceous fragments with distinct layering. Commonly, the breccia has a dark graphitic matrix with pyrite rich sulphides.

A possible volcanic cycle at Whitney Lake 24 km south of Cobalt starts with komatiitic rocks and continues through a series of predominantly mafic volcanic rocks to the felsic volcanic rocks near Cross Lake (Lovell 1978). The Timiskaming sedimentary rocks appear to conformably overlie the cycle. A possible subcycle consists of the felsic volcanic rocks at the Montreal River upwards through mafic volcanic rocks to a series of felsic centres (at Cross Lake, Kerr Lake under the Huronian cover, and Sasaginaga Lake) that are associated with sulphide mineralization. Approximately 200 rock samples were collected for chemical analyses to test this hypothesis.

Sedimentary rocks consisting of graphite schist, wackes, argillites, and cherts, occur as units up to 200 m thick between volcanic flows. At the New Bailey Mine, an interflow sediment can be seen dropping into the pillowed top of a flow unit. These sedimentary rocks commonly occur as discontinuous lens along the flow tops. In thicker units individual wacke beds are graded and soft sediment deformation features are common.

Sulphide Mineralization

Sulphide mineralization occurs with Keewatin graphitic schists, cherts, tuffs, and pyroclastic breccias and within pillow selvages of mafic volcanic rocks. Sulphides associated with graphitic schists consist of pyrite-rich layers and are commonly boudinaged. Some pyrite concretions within the graphitic schist exhibit radial concentric structures. Chalcopyrite forms distinct layers within the schist, both conformable to and cross cutting the foliation. Cherts commonly contain disseminated pyrite as porphoblasts up to 2 mm; chalcopyrite and galena occur as fine disseminations. Several tuffs contain layered sulphide mineralization rich in sphalerite and/or chalcopyrite. Sulphides associated with pyroclastic breccias consist of fragments of volcanic material often showing alteration textures in a matrix rich in pyrrhotite, pyrite, chalcopyrite, sphalerite, and galena. Sulphides in pillow selvages and pillow breccias are usually pyrrhotite rich with minor amounts of chalcopyrite.

Extent of Base Metal Mineralization

Table I lists the present and past producers in which base-metal mineralization in Keewatin rocks has been observed by the author on mine dumps or was reported by Thomson (1960 to 1962 inclusive). Of the 77 mines in the area, 68 contain base metals, three did not enter Keewatin rocks, and six reported no sulphides. In addition, 37 of the 73 prospects with silver-cobalt mineralization in Keewatin rocks also report base-metal mineralization. Many of the silver-cobalt mines produced significant amounts of copper (Table 2). The statistics are incomplete and the relative production of copper from the carbonate vein and the sulphide rich wall rocks is not known. Many of the mines made no attempt to concentrate copper. The total production reported by Sergiades (1968) is approximately 2.2 million pounds of copper of which a significant proportion came from Keewatin rocks. Not included in these figures is production from the LaRose Mine which is reported to contain 30 000 tons at 1.75 percent Cu, (Thomson 1961b). In addition, a deposit estimated at 300 000 tons at 3 percent Zn, 1.5 percent Pb, 0.5 percent Cu, and 0.75 oz/ton Ag was drilled off at the Foster Mine (Thompson 1961d).

Few assays or tonnage estimates for the base metals have been published. Approximately 75 samples were collected in an effort to determine metal content. Visually, the estimated ratio of Cu:Zn:Pb is 1:1:0.5; these are copper and lead rich in comparison to other early Precambrian volcanogenic massive sulphides.

Continuing work will include a detailed petrographic study of these samples.

Huronian Supergroup

Mineralization in Sedimentary Rocks

The Coleman Formation in the Cobalt area consists of conglomerate, sandstone, and argillite. The conglomerate can be divided into three groups; a basal breccia, developed locally on the early Precambrian unconformity, interpreted as a paleosoil horizon; basal conglomerate made up of subangular to subrounded clasts of local derivation, interpreted as talus material; and the widespread polymictic paraconglomerate with a wide variety of well-rounded clast types in a matrix of quartz and lithic fragments, interpreted as a reworked glacial till.

Sulphide mineralization occurs as detrital clasts in the basal conglomerate and paraconglomerate; syngenetic sulphides occur in argillite; vein related sulphides occur in all rock types, but most commonly in sandstone. Whether the sulphides are of vein or sedimentary origin is not clear in many cases.

Detrital-Type Sulphides

Clasts of sulphide rich, Keewatin rocks, up to 75 cm in size occur in the basal conglomerate and paraconglomerate. The sulphide clasts contain pyrrhotite, chalcopyrite, sphalerite, and galena in varying proportions. Many of the clasts show textures that suggest remobilization; for example, halos of disseminated sulphide around sulphide clasts, chalcopyrite clasts rimmed by galena, and fractures rich in sulphide. Most of the basal Coleman conglomerate, for example at the Drummond and Silverfield Mines, contain both mineralized clasts and finely disseminated sulphide in the matrix of the conglomerate.

TABLE 1 SULPHIDE MINERALIZATION IN KEEWATIN ROCKS, COBALT.

	DEPOSIT	In Pillow Selvages	Graphitic Schist	Argillites	Tuffs	Cherts	Pyroclastic Breccia	Massive	SULPHIDES	COMMENTS
COLEMAN TP.										
1.	Hudson Bay		x			x	x		cp, po, gn, sp	Dump removed
2.	Trethwey		x						py, cp, sp	
3.	Conigas		x						py, cp, sp, gn	Cu mine 1923-1924
4.	Buffalo	x	x				x	x	po, py, cp, gn	
5.	City of Cobalt		x						py	"iron formation"
6.	Nancy Helen Ltd.								Not reported	Part of Buffalo in 1911
7.	Nipissing R.L. 400	x	x						mar, cp, gn sp, po	
8.	Nipissing R.L. 401				x		x		cp, gn, sp, py	Up to 12% Sulphide
9.	Chambers Ferland R.L. 402				x	x		x	cp, pn, sp, py	In trench
10.	Right of Way Mine (North)			x					po, cp	
11.	LaRose Mine		x			x	x	x	po, py, cp, gn	Mined for Cu.
12.	Chambers Fer land R.L. 401		x			x			cp, sp	
13.	Nipissing R.L. 402									Not in Keewatin
14.	O'Brien Mine	x	x			x	x	x	po, py, cp, gn	
15.	Violet Mine Co.			x				x	po, py, cp, sp, gn	
16.	Colonial Mining Co.					x			cp, sp, gn	
17.	Nerlip Mines					x			minor py	Dominately Diabase
18.	Silver Cliff	x	x			x		x	po, cp, gn, sp	
19.	Cobalt Silver Queen		x		x				po, pg, cp, gn	
20.	Princess				x			x	po, py, cp	Reported
21.	Cobalt Townsite	x	x		x	x			po, cp, gn, sp	
22.	Little Nipissing	x	x						py, po	Reported
23.	McKinley-Darragh		x						po, cp	
24.	Right of Way Mine (South)		x	x					po, py, cp, sp gn	
25.	Cobalt Lake Mining	x							py, po, cp	
26.	Nipissing R.L. 404		x						py, po, gn, cp sp,	
27.	Nipissing R.L. 406	x		x						Reported

TABLE 1 continued

DEPOSIT		In Pillow Selvages	Graphitic Schist	Argillites	Tuffs	Cherts	Pyroclastic Breccia	Massive	SULPHIDES	COMMENTS
28.	Cart Lake Prop.	x							po	
29.	Agnico Mines R.L. 407									In Coleman
30.	Nipissing R.L. 408									In Coleman
31.	Nipissing R.L. 405									Explored from 34
32.	Peterson Lake					x			py, po, cp, sp	
33.	Victoria Silver Cobalt									In Diabase
34.	Nova Scotia	x	x			x				
35.	Juno Metals Corp.									In Diabase
36.	Juno Metals Reliance						x x			Reported
37.	Morgan Silver Cross					x			cp, py, sp, gn	
38.	King Edward M. Co.		x						py, po	
39.	Reinhardt Cross Lake									As O'Brien
40.	Cross Lake O'Brien	x	x			x	x	x	po, py, cp, gn sp	
41.	Smith Cobalt		x						py, po, cp, sp	
42.	Red Jacket Group	x					x		py, po, cp	
43.	Salvage Mine						x		py, cp, po	Reported
44.	Mensilvo					x			py, cp, sp, gn	
45.	Silverfield Mine	x				x			po, cp, py	
46.	New Bailey Mine	x		x		x			cp, sp, gn, py, po	
47.	University Mine			x					py, gn, cp	Reported
48.	Penn Canadian Mine									Not Reported
49.	Foster Cobalt Mines		x		x	x		x	py, cp, sp, gn	300,000 tons @ 5%
50.	Silver Leaf Mining Co.	x						x	cp, po	
51.	Lawson Mine		x			x		x	po, py, cp, sp gn	
52.	Consil Mine Ltd.	x	x			x			py, po, gn, cp sp	
53.	Crown Reserve Mining		x			x	x		py, cp, sp	

TABLE 1 continued

DEPOSIT		In Pillow Selvages	Graphitic Schist	Argillites	Tuffs	Cherts	Pyroclastic Breccia	Massive	SULPHIDES	COMMENTS
54.	Kerr Lake					x			gn, sp, cp	
55.	Hargrave Silver Mines	x	x			x			po, cp, sp	
56.	Drummond M Mines Ltd.		x			x			po, py, cp, sp	
57.	Cobalt Badger	x							po, cp	
58.	Silver-Miller		x			x			po, py, cp, gn	
59.	Christopher Silver Mines		x						gn, cp, sp	
60.	Cobalt Lode	x	x			x			py, po, cp, sp gn	
61.	Coballoy Mines		x						py, cp	
62.	Beaver	x							po	
63.	Temiskaming		x			x			po, py, cp, sp	Drill Hole
64.	Cochrane Cobalt Mining Mines						x		cp, py, sp	
65.	Ophir Mine			x					mag, cp, py, po	
66.	Mayfair Mine Ltd.			x					mag, po, cpy	
BUCKE TP.										
1.	Agaunico Group	x				x	x	x	cp, py, gn, sp	
2.	Hunter-Cobalt					x			cp, gn, sp, py	
3.	Cobalt Contact Mine					x			py, po, cp, gn	
4.	Green-Meehan					x			py, cpy, sp	
5.	Harrison-Hibbert				x	x		x	po, py, cp, gn, sp	
GILLES LIMIT										
1.	Provincial Mine		x						py, cp	Reported
2.	Waldman Silver Mine		x						po, py	
3.	Wyandoh Silver Mine		x						po, py	
4.	Cleopatra Mining		x	x					po, py, cp	
5.	Cobalt A53 Mining Co.	x							po	
6.	Claim A.3	x				x			po, cp	

TABLE 2 | COPPER PRODUCTION FROM COBALT-SILVER MINES.

MINE	PERIOD	PRODUCTION	ROCK TYPE
COLEMAN TP.			
3. Coniagas Mines Ltd.	1922-1924	47,470 lb.	Keewatin + Vein
14. O'Brien Mine R.L. 403	1923-1940	695,450 lb.	Keewatin + Vein, R.L.
18. Silver Cliff Mining Co.	1951	6,387 lb.	Keewatin + Vein
23. McKinley-Darraugh	1904-1954	51,751 lb.	Keewatin + Vein
38. King-Edward Mining Co.	1962-1964	3,466 lb.	Keewatin + Vein
40. Deer Horn Mines Ltd.	1960-1965	158,467 lb.	Keewatin + Vein
43. Savage Mines of Cobalt	1922-1924, 1927	51,751 lb.	Keewatin + Vein
44. Silver Summit (Mensilvo)	1953, 1963-1964	21,834 lb.	Keewatin + Vein
45. Silverfields	1964-1967	238,893 lb.	Coleman, Keewatin, Vein
46. New Bailey Mines	1962	3,661 lb.	Keewatin + Vein
47. University Mines Ltd.	1945	1,205 lb.	Keewatin + Vein
49. Foster Cobalt Mining Co.	1905-1954	24,121 lb.	Keewatin + Vein
54. Kerr Lake Mining	1947-1948	1,792 lb.	Keewatin + Vein
58. Silver Miller Mines	1951	11,320 lb.	Keewatin + Vein
60. Cobalt Lode Silver Mines	1967	459,078 lb.	Keewatin + Vein
63. Temiskaming Mines Co.	1945	1,205 lb.	Keewatin + Vein
BUCKE			
1. Agaunico Mines	1905-1961	216,767 lb.	Keewatin + Vein
4. Green-Mehan Mines	1905-1963	6,700 lb.	Keewatin + Vein
5. Harrison-Hibbert Mines	1907-1965	69,458 lb.	Keewatin + Vein
CASEY			
Casey-Cobalt Langis	1956-1966	88,437 lb.	Keewatin + Vein
TOTAL		2,164,581 lb.	

Sedimentary-Type Sulphides

At the Silverfield Mine, an argillite unit contains thin layers, rich in very finely disseminated chalcopyrite, galena, or sphalerite. The individual layers commonly contain sphalerite, galena, or chalcopyrite in distinct laminae. Lovell (1978) suggested that zinc and lead were precipitated in lakes in a seasonal cycle.

Vein-Related Sulphide Mineralization

Carbonate veins often carry significant amounts of sulphides. The disseminations such as those in sandstone units appear to be related to the veins. The sulphides are usually chalcopyrite rich, occurring as pods and lenses or are interstitial to the sand grains. At the Little Silver vein, several samples show distinct zoning, over 5 cm wide, about fine Ag veinlets. Galena and chalcopyrite occur next to the vein, and chalcopyrite occurs 2 cm from the veins. Sulphides also commonly occur, and in at least one instance, silver was noted at the core of chloritic spots. At several locations near carbonate veins, felsic clasts within the conglomerate appear to have been selectively impregnated with chalcopyrite and galena.

Extent of Mineralization

Table 3 shows mineralization associated with Huronian rocks that were noted on mine dumps, many of the prospects in the area also have mineralized Huronian rocks. There are no estimates of the grade or extent of these occurrences. Many of the deposits, such as the Drummond Mine and Silverfield Mine, appear to be controlled by paleovalleys in the Keewatin. An attempt will be made from available information to contour the Huronian-Keewatin unconformity in order to estimate their extent and possible sources of clastic material. Approximately 50 samples have been collected to give an indication of their grade. Visual estimates indicate less than 1 percent combined metals (Pb, Zn, Cu, Co, Ni, Ag), but there is the potential for large tonnage.

Metallogenetic Relationships

It has previously been suggested (Boyle *in* Berry, L.G. (1971), Hutchinson *et al.* (1971)) that mineralization in the Keewatin volcanic and sedimentary rocks was the source of metals for the Co-Ag vein systems. Subsequent reconcentration into the vein was achieved through hydrothermal activity initiated by diabase intrusion. This project documented numerous features of mineralization in this area which not only substantiate this hypothesis, but also go beyond it to a more complete understanding of the overall mineralizing processes.

The features are as follows:

a. The numerous and widespread occurrence of base-metal mineralization in the Keewatin volcanic rocks.

b. The nature of this mineralization shows it to be volcanogenic in origin; intense alteration of the volcanic rocks is commonly associated.

c. Much of the base metal mineralization in the Huronian rocks was derived by weathering from pre-existing Keewatin volcanogenic mineralization.

d. In virtually every instance, Keewatin base-metal mineralization was observed associated with Co-Ag vein deposits.

e. In some instances, the ore distribution in the carbonate veins was clearly controlled by Keewatin mineralization. Veins crossing the interflow sediments at right angles form pipe-like deposits, while those that are parallel form long ore shoots with the rake determined by the angle of intersection (L.G. Berry, personal communication, 1976).

f. Joints and fractures are often coated by a film of sulphide, particularly near interflow units.

g. The diabase has been observed in contact with interflow sulphides with little direct evidence for remobilization. The controlling factor may be the presence of water (D. Watkinson, personal communication 1979).

h. The presence of water in the mineralizing system is indicated by the close association of mineralized Keewatin rocks, Huronian sediments and diabase. The Huronian sediments could supply water. The presence of chlorite spotting and the development of epidote layers in the volcanics indicates that the volcanics were affected by hydrothermal activity.

The above points provide clear evidence for development of early Precambrian mineralization, redistribution by Huronian sedimentary activity and subsequent re-concentration by the Nipissing diabase intrusive activity. The repetition of these processes through the eastern Southern Province is the basis of the development of much of the mineralization of this area (Innes and Colvine, this volume).

TABLE 3 BASE METAL MINERALIZATION IN COLEMAN SEDIMENTARY ROCK, COBALT, ONTARIO.

DEPOSIT	BASAL CONG.	CONG.	SANDSTONE	ARGILLITE	DISSEMINATE	CLASTS	SULPHIDES
COLEMAN TP.							
1. Hudson Bay		X			X		po, cp, gn
4. Buffalo		X			X		po, cp
10. Right of Way		X	X		X		po, cp
11. LaRose Mine		X			X		po, cp
12. Nipissing Co. Ltd.		X			X		po, cp, sp
14. O'Brien		X					po, cp
15. Violet Mining Co.		X					po, cp
20. Princess Claim JB3		X			X	X	py, cp, gn, sp
22. Right of Way Mines Ltd.		X			X		py, cp, sp, gn
21. Cobalt Townsite Mining Co.		X			X		po, cp
23. Cobalt Lake Mining Co. Ltd.		X			X		po, cp
24. Nipissing R.L. 404		X	X				po, cp, sp, gn
27. Nipissing R.L. 406		X					po, cp, sp, gn
28. Cart Lake Prop.		X			X	X	po, cp, sp
29. Nipissing R. L. 407		X			X	X	cp, po
32. Peterson Lake Silver		X			X		po, py, cp, gn
41. Smith Cobalt Mines Ltd.		X	X				sp, cp, gn
42. Red Jacket Group		X	X		X		po, sp, cp
43. Mensilvo	X	X			X	X	po, sp, gn, cp
45. Silverfields	X	X		X	X	X	po, sp, gn, cp
49. Foster Cobalt Mining Co.		X	X		X	X	po, py, cp, sp, gn
53. Crown Reserve Mining Co.	X				X		po, cp, sp, gn
56. Drummond Mines Ltd.	X				X	X	po, cp, sp, gn
BUCKE TP.							
1. Agaunico Mines		X	X		X	X	py, cp, sp, gn
GILLIES LIMIT							
5. Cobalt A-53 Silver Mining Co.		X			X		po, cp

Recommendations for Exploration

1. Since much of the sulphide mineralization in the Cobalt area is related to volcanogenic activity within a volcanic cycle, geochemical characterization of the volcanic rocks could indicate favourable horizons in the cycle to the west of the main Cobalt camp. These units contain sufficient sulphides and magnetite and pyrrhotite to respond to electromagnetic and magnetic surveys.
2. The occurrence of base metals in basal Coleman conglomerate is associated with valleys in the Keewatin basement. Delineation of these valleys, possibly by seismic surveys, would outline potential base metal targets.
3. Since there appears to be a relationship between base-metal occurrences and the silver-cobalt vein system, any area with base-metal potential and located within approximately 200 m of the Nipissing Diabase would also be a potential silver-cobalt target area.
4. The favourable area for both base metals and silver-cobalt mineralization continues westward under the Firstbrook Formation cover rocks in Barr, Firstbrook, Cassels, Riddell, and West Coleman Townships.

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1964c: Cobalt Silver Area, Southeastern Sheet, Timiskaming District, Ontario; Ontario Department of Mines, Map 2052, scale 1 inch to 1000 feet.

No. S22 Early Precambrian Porphyry Deposits

A.C. Colvine[1], and I.G. Sutherland[2]

Introduction

Three additional mineralized stock-like bodies were mapped during the third field season of this project to investigate possible porphyry-type deposits in the Superior Province of Ontario. The purpose of the project is not to establish that early Precambrian porphyry-type deposits do exist, but to document fully the nature and extent of mineralization in and around these bodies, its relationship with stock and wallrocks, and to determine its possible economic potential; many of these deposits, although not formed by a porphyry-style hydrothermal system are economically interesting.

Kirkham (1972) outlined features of several bodies in the Canadian Shield of Manitoba, Ontario, and Quebec which he considered analagous to more recent Cordilleran porphyry coppers. Many of these have since been investigated more fully, particularly through university theses studies (Chibougamau, Quebec, J. Cimon (1970); Setting Net Lake, Ontario, L.D. Ayres *et al.* (1973); Canoe Lake,Ontario, S.W. Campbell (1973); Beidelman Bay, Ontario, P. Friske (1974); Missi Island, Saskatchewan, L.D. Ayres and D.J. Findlay (1976); High Lake, Ontario, J.M. Pedora (1976); Lang Lake, Ontario, D.J. Findlay, and L.D. Ayres (1977); McIntyre Mine, Ontario, J.F. Davies and L.E. Luhta (1978); Matachewan, Ontario, W.D. Sinclair (1979) of which several substantiated the porphyry hypothesis. The detailed work in the Setting Net Lake area of Ontario in particular (Ayres and Findlay, 1976) described many of the features expected in a porphyry system. In addition, epizonal intrusive activity is thought to have played a significant role in formation or reconcentration of mineralization in many of the major gold producing areas. At a special session held at the GAC Annual Meeting in 1979, several examples of Precambrian porphyries were described leading to a concensus that processes analagous, although not identical to those of more recent porphyry systems, were operative during the Precambrian; examples of producing deposits were, however, limited.

This study has demonstrated clearly that pre-supposition of a particular genetic process does not significantly aid valid assessment of the economic potential of intermediate to felsic stock-like bodies. Each of the six bodies investigated to date is sufficiently unique in its geological association and style of mineralization that interpretation of their formation by a single genetic process is not warranted. A brief summary of each deposit studied is presented below. This demonstrates the uniqueness of each deposit, hence the necessity to continue a detailed study of each. This work will enable more generalized conclusions to be made about mineralization expected in various situations.

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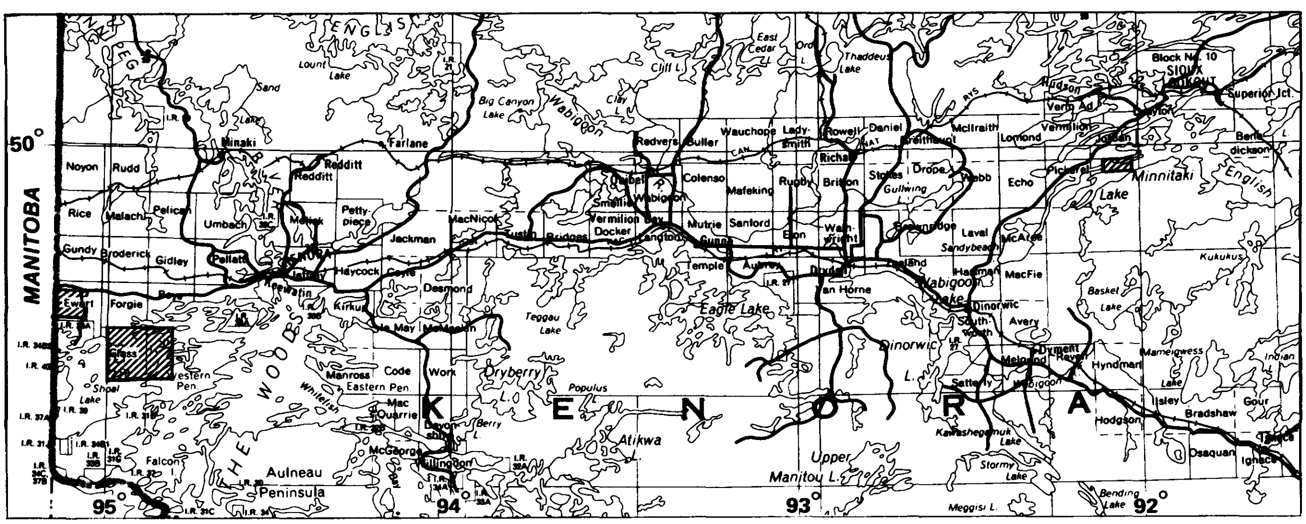

LOCATION MAP

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

1. The Lateral Lake Stock (Colvine and McCarter 1977) appears to have been emplaced at a mezozonal level. Mineralized aplite and quartz pegmatite veins, a late stage of the intrusion, have been contained around its margin and are associated with the alteration of the stock. Pegmatites are common in the area surrounding the stock (Page, this volume) and may be related to potassic magmatic activity and crusted partial melting in this area of relatively high metamorphic grade, adjacent to the boundary of the English River Gneiss Belt. These pegmatites contain rare molybdenite and may be analagous to the late stage potassic magmatic fluids which were more concentrated in a structural-stratigraphic trap.

2. Molybdenum mineralization in the Bamaji Lake Area (Sutherland 1978) also appears to have been introduced at a mesozonal depth and is related to the late-stage potassic magmatic activity of the Bamaji-Blackstone Pluton to the south. Mineralization is widespread, but appears to have lacked a suitable site for concentration.

3. In contrast, the Gutcher Lake Stock (Studemeister and Colvine 1978) constitutes part of a volcanic plutonic complex, emplaced at a shallow subsurface level during volcanism and is probably co-magmatic with felsic volcanism. Mineralization consists of volcanogenic exhalative sulphide horizons in the volcanic-sedimentary wallrock, stockwork mineralization in the stock and wallrocks, and remobilized vein mineralization adjacent to the stock contact. While the stock has played a role in focussing, concentrating, and possibly introducing mineralization, the environment is volcanic.

4. Similarly the Pickerel Arm Body (Sutherland and Colvine, this volume) previously considered to be intrusive, was demonstrated to be largely of extrusive pyroclastic origin. The body probably forms part of a felsic intrusive-extrusive domal centre. The widespread mineralization and associated alteration in the felsic body is similar to that expected in a porphyry system, but volcanogenic sulphide horizons are also present. The mineralization within the body may therefore be more akin to the feeder pipes of an exhalative system.

5. Three styles of mineralization are present at the High Lake Stock (Sutherland and Colvine, see below): i) disseminated chalcopyrite, pyrite and magnetite localized in one part of the body; ii) quartz veins with molybdenite and chalcopyrite in the sheared contact between two phases of the body; and iii) widespread minor gold-bearing sulphide veins that occur particularly in the wallrocks adjacent to the stock. While the stock intrusion played a role in formation of each, the styles of mineralization do not appear to be genetically directly related. The first style of mineralization probably formed by local assimilation of adjacent pyrite-magnetite ironstone; the second may be related to magmatic fluids of the second phase of the stock; and the third, a thermal effect of the stock remobilizing pre-existing mineralization into veins. Hence, the interpretation of the zonation of mineralization forming by a porphyry system about one phase of the intrusion (Pedora 1976) may not be valid.

6. While the cause of mineralization at the Canoe Lake Stock (Sutherland and Colvine, see below) was not adequately determined, the discovery of one new area of mineralization is an area of "low alteration" (Campbell 1973) casts doubt on the simplistic picture of large areas of porphyry-style alteration associated with mineralization. The erratic nature of mineralization and the widespread occurrence of xenolith inclusions suggests possible assimilation of sulphide-bearing wallrocks. Vein-gold mineralization around the stock margin was probably re-mobilized from the stock wallrocks.

It must be stressed that although each of these areas was specifically selected from preliminary investigation as exhibiting porphyry-type features, closer examination indicates none can be considered true porphyries. This conclusion in itself, however, does not necessarily downgrade their economic potential.

Two areas which may be further investigated in relation to this project, which were examined this summer, are the gold and disseminated chalcopyrite near Atikokan (Wilkinson, this volume) and the molybdenum mineralization at Schreiber (Carter, this volume). In addition, a preliminary investigation of the Net Lake molybdenum mineralization 6 km north of Temagami was carried out. While the main concentration of molybdenite occurs in shear or fracture controlled quartz veins, a broad area of brecciated mafic volcanic rocks, over 150 m square, occurs around the showings. Breccia filling is quartz with minor molybdenite. In places, potassic feldspar rims the fragments. The brecciation and mineralization may be related to the emplacement of the quartz monzonite immediately to the north, which also contains minor molybdenite and scheelite.

Several generalized conclusions can be made on the basis of the work completed to date. The level of intrusion and its age in relation to volcanism and tectonism appears to be important in determining the nature and style of mineralization.

- Synvolcanic epizonal intrusions play an important role in localization and concentration of mineralization. Porphyry-style mineralization in this environment may represent hydrothermal feeder pipes to the higher potential, volcanogenic massive sulphide type deposit.
- Molybdenum mineralization appears to be most common with mesozonal intrusions and its concentration is dependent on local conditions. Areas of pegmatite veining related to potassic magmatism and crustal partial melting may provide the best exploration targets.
- Assimilation of sulphidic supracrustal material may result in formation of disseminated, copper-rich mineralization within the stock.
- The thermal effect of stock intrusion results in reconcentration into quartz veins of pre-xisting mineralization, in the supracrustal wallrocks. Economic gold producers in particular are present around stock margins.
- Porphyry-style hydrothermal activity is associated with some stocks but its potential extent may be more limited than in Cordilleran types. This may be due to the higher geothermal gradient of the Early Precambrian, resulting in more rapid dehydration of metamorphism with depth; the porphyry system may therefore be drier at a sufficient depth for containment of the system.

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The Geology and Mineralization of the Pickerel Arm, Canoe Lake, and High Lake Bodies

I.G. Sutherland[1] and A.C. Colvine[2]

Pickerel Arm Body, Minnitaki Lake

Introduction

The study area is situated near the eastern end of the long peninsula separating Pickerel Arm from Minnitaki Lake, south of Jordan Township, approximately 18 km southwest of Sioux Lookout (Location Map). Access is excellent by short lodge roads off Highway 72 or by a longer boat trip directly from Sioux Lookout.

The Pickerel Arm body has been interpreted from this study to be an intermediate to felsic volcanic pile contained within a thick sequence of predominantly mafic metavolcanics and associated sedimentary rocks. The north-central and eastern part of the felsic pile is extensively mineralized with disseminated and stringer chalcopyrite and pyrite. Exposure is moderate along shorelines, especially the mineralized section of Pickerel Arm, and sparse over most of the peninsula.

Early geological and mineral deposit maps and reports of the Minnitaki Lake area are included in works by R. Bell (1873), A.P. Coleman (1895), W.A. Parks (1898), Jas. A. Bow (1899,1900), Wm. McInnis (1905), M.E. Hurst (1932), F.J. Pettijohn (1934, 1935, 1936, 1937), and H.S. Armstrong (1951). More recent studies of the area have been done by F.J. Johnson (1967), R.G. Walker and F.J. Pettijohn (1971), C.C. Turner and R.G. Walker (1973), N.F. Trowell *et al.* (1977, 1978), R.O. Page (1978 and this volume) and R.O. Page and P.M. Clifford (1977). The main thrust of recent work has been to investigate the structural and stratigraphic complexities of the area.

Geologic mapping and trenching on the property began in 1955 when it was optioned by Rio Canadian Exploration Limited from Don Campbell of Sioux Lookout. Later geophysical surveys and follow-up diamond drilling was carried out by Dome Exploration (Canada) Limited in 1971, 1973, and 1974, clarifying some aspects of the geology and mineralization. Records and assay data from gold exploration work on large quartz veins, particularly within surrounding mafic metavolcanics are poor. Reassessment of the gold potential of the area by Consolidated Mosher Mines Limited in 1964 did not lead to further work (Johnson 1967).

General Geology

The study area is situated along the southern boundary of the Central Volcanic Belt of the Abram–Minnitaki Greenstone Belt (Turner and Walker 1973). The belt consists of mafic to intermediate flows, pyroclastic rocks, and associated sedimentary material. The continuity of the volcanic units of this sequence is locally broken by intermediate to felsic volcanic flows and pyroclastic rocks of limited extent. Sulphide mineralization in the study area is associated with one of these more felsic piles (Figure 1). Johnson (1967) and previous workers considered these rocks as part of a variably sheared and recrystallized quartz and feldspar porphyritic intrusive body. Such porphyritic intrusive rocks may be present within the felsic pile, but distinct intrusive relationships were not observed.

The felsic to intermediate metavolcanics consist of quartz, quartz-feldspar, and feldspar crystal tuff, lithic tuff, and reworked bedded crystal tuff. A wide variation in composition, grain size, sorting, and degree of alteration and mineralization occurs throughout the sequence. Colour variations between shades of red, green, purple, and grey are largely the result of alteration of feldspar in the fragments and matrix. Drill intersections (Dome Exploration (Canada) Limited; Assessment Files Research Office, Ontario Geological Survey, Toronto) of fine-grained, massive rocks, with indistinct quartz and feldspar grains, pink or light green in colour, very hard, and essentially structureless except for localized fracturing and alteration were observed. As these units were not encountered in outcrop, a massive flow or intrusive origin is possible.

The felsic tuffs are quartzo-feldspathic with up to 20 percent micaceous minerals. Crystal and lithic fragments are contained in a fine-grained matrix which constitutes between 10 percent and 90 percent of the rock. Quartz crystal fragments are angular to rounded, disc shaped, or rodded with a maximum size of about 1 to 5 cm; grain boundaries are sharp in hand specimen. Feldspar fragments are very angular to subhedral with generally poor grain definition. The relative quartz and feldspar crystal fragment content is variable with both sharp and gradational changes taking place. Mafic content is generally low but medium grained, wispy fragments of mafic material are present locally. Large, rounded fragments of mafic volcanic rocks are also common in the quartz-feldspar rocks along the south shore of Pickerel Arm just west of

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the main area of mineralization. These were also encountered in drill core. Bedding and sorting are generally indistinct to absent, but where bedding is present, it may be a result of reworking of the tuffs. Distinct, highly stretched lapilli-tuff units up to 30 cm in thickness were encountered in drill core; these contain minor sulphide and chlorite in the matrix. Some brecciated units observed in drill core appear to have been affected by hydrothermal alteration with chlorite and pyrite forming the matrix.

The flanks and northern and southern margins of the felsic pile are intercalated with mafic volcanic rocks and volcanically derived wacke and argillite. In the immediate study area, the mafic volcanic rocks are fine to coarse grained and massive to moderately foliated. Medium-grained, massive diorite units with up to 10 percent disseminated magnetite are quite prevalent in the area, but intrusive relationships were not observed.

Along the north shore of Pickerel Arm, the mafic and felsic volcanic sequences are roughly separated by wacke and argillite with minor interbeds of graphitic mudstone and cherty ironstone. The wackes are massive, poorly bedded, and mostly structureless with variable amounts of interbedded argillite. Good graded bedding was observed only outside the study area; indicators of south facing tops from possible graded beds cut in drill core are reported (Assessment Files Research Office, Ontario Geological Survey, Toronto). Apparent soft-sediment deformation structures in thinly interbedded wacke and argillite on Pickerel Arm may substantiate this interpretation. The argillites range from siltstone to slate and commonly host disseminated pyrite, interbedded with minor fine-grained, black, graphitic mudstone with disseminated or framboidal pyrite. The 2 to 10 mm framboids of 20 to 100 percent fine-grained pyrite are spherical with concentric growth layering and frequently with pyrite tails along the bedding. Similarly thin beds of pyrite-chert or pyrite-magnetite-chert ironstone were seen both in outcrop and in drill core. The chert is recrystallized with bands and disseminations of pyrite and/or magnetite and trace chalcopyrite and sphalerite.

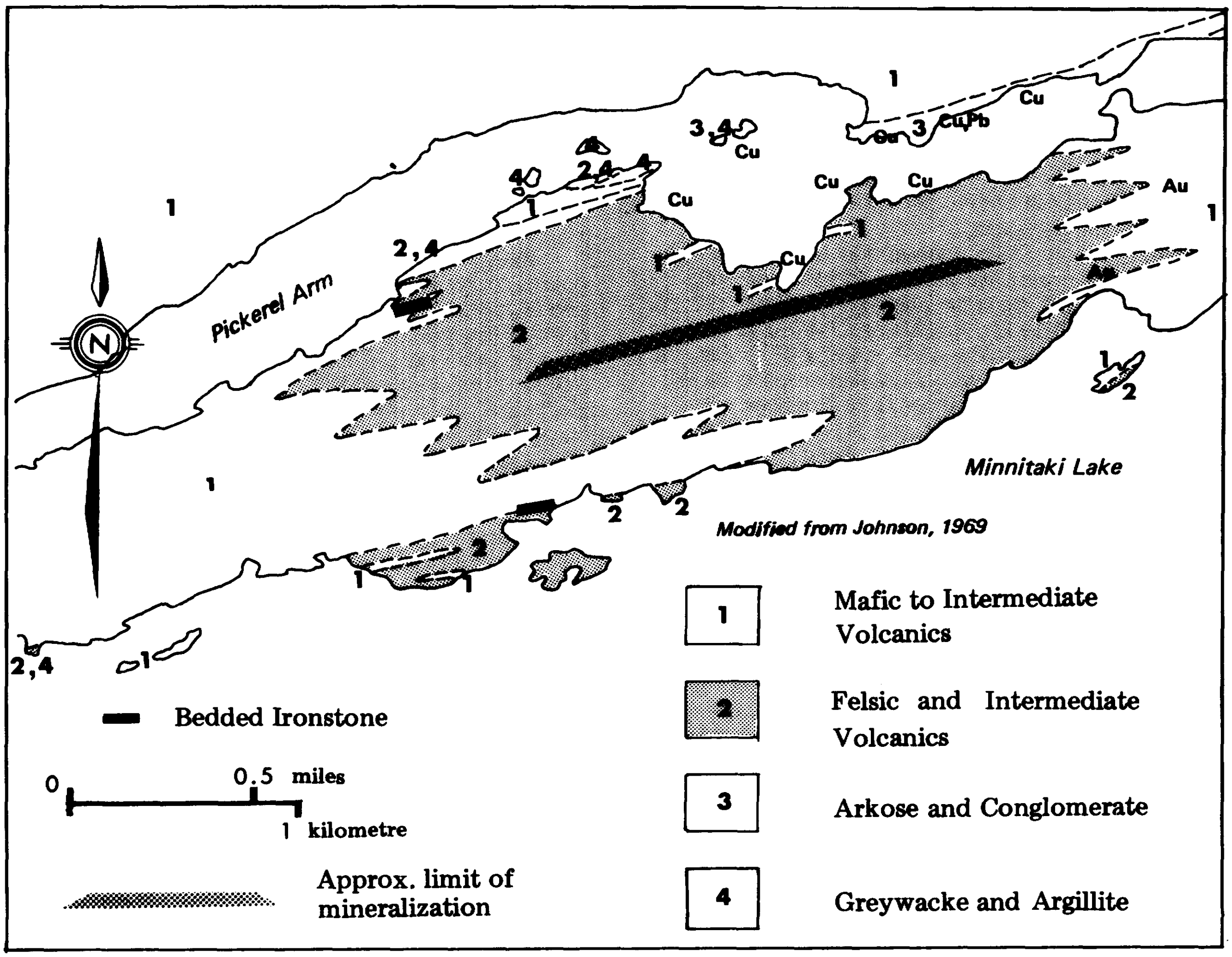

Figure 1—Geology and mineralization of the Pickerel Arm body.

Medium- to coarse-grained, quartz-feldspar crystal tuff with clasts of wacke outcrops along the south shore at the western edge of the study area. An apparent erosional trough infilled with laminated wackes also indicate south facing tops here. Further to the southwest in the Minnitaki Group sedimentary rocks (Turner and Walker 1973) thick wacke sequences with minor, irregular beds of quartz-fedlspar crystal tuffs are present suggesting a combined sedimentary/volcanic environment.

In the northeast corner of the study area along the north shore of Pickerel Arm are outcrops resembling coarser-grained quartz-feldspar crystal tuffs. Thin beds of magnetite ($\leqslant$1 mm) and variably rounded clasts of similar tuffaceous material, mafic volcanics, wackes, and a few angular pebbles of cherty magnetite are present. The bedding and rounded nature of many of the clasts indicates some current reworking and, hence, a sedimentary origin.

Structure

The major stratiform units in the study area strike at 75° and dip 75° to 85°N. Considerable controversy exists over the true degree of folding and deformation of these rocks. Turner and Walker (1973) suggested a fairly simple sequence of rocks that becomes progressively younger to the south with predominantly south facing tops. R.O. Page (Ontario Geological Survey 1979, personal communication) suggests that the local rocks have undergone much more complex folding and faulting than has been previously recognized. Beyond the few tentative top determinations, the limited scope of this study did not resolve this problem.

Johnson (1967) and others suggest that the "quartz-feldspar porphyry" body is locally strongly sheared. The regional shear strain is, however, apparently low to moderate, as evidenced by the only slightly deformed pyrite framboids in very incompetent graphitic mudstones observed in drill core.

Alteration and Mineralization

Extensive sulphide mineralization is restricted essentially to the felsic rocks of the northern half of the peninsula with minor amounts of the other sedimentary and volcanic units. The main showing of chalcopyrite is in the felsic rocks along the southern shore of Pickerel Arm (Figure 1) with the greatest concentrations around the largest bay on the peninsula. In outcrop, the tuffs contain strictly disseminated, fine- to medium-grained pyrite and chalcopyrite rarely in quartz-carbonate veinlets. Weathered outcrops exhibit considerable malachite staining and a light brown, altered carbonate. A few stringers of quartz and dark green chlorite with minor sulphides also cut these rocks. In drill core, however, mineralization predominates consisting of stringer and stringer-controlled, massive to disseminated pyrite and chalcopyrite, which occur with any of quartz, calcite, chlorite, and magnetite, and rare tourmaline, sphalerite, and galena. Also in the core, secondary sulphide and silicate minerals were seen over broad, poorly defined zones of alteration of up to about 0.3 m across with coarser blebs of pyrite, chalcopyrite, and magnetite.

Drill assays of stringer sulphide contained between 0.05 percent and 0.25 percent copper over 3 m; more massive sulphides in broader alteration zones gave assays of up to 0.7 percent copper over 2 m (Assessment Files Research Office, Ontario Geological Survey, Toronto). This type of mineralization is also present locally in the sedimentary rocks and mafic volcanic rocks in this part of Pickerel Arm. Disseminated, intergranular pyrite, chalcopyrite, and magnetite are also seen in the drill core in varying amounts in the felsic volcanic rocks.

At a few localities in the area, there are planar zones, less than 1 m in width, of pyrite, magnetite, and trace chalcopyrite mineralization in vein-like structures and ill-defined zones of quartz, carbonate, and chlorite alteration. Two zones are strongly bleached and recrystallized, with some coarse blebs of galena. These cross-cut local stratigraphy of mafic volcanic rocks, felsic pyroclastic rocks, and "pebbly arkose/tuff" in the northeast part of the study area. These features are consistent with their formation by hydrothermal activity, as possible feeder pipes, related to the surrounding disseminated and vein mineralization. Varying intensities and styles of alteration are present throughout the whole felsic volcanic sequence; this study did not determine the extent to which alteration is related to mineralization. The overall inhomogeneity of the rocks precludes the use of simple chemical techniques to determine the nature and extent of alteration. Additional chemical and petrographic work to investigate this is in progress.

Conclusions

The above features suggest that sulphide mineralization and some associated alteration are related to hydrothermal activity affecting the relatively porous, tuffaceous intermediate to felsic volcanic rocks during volcanism. Most mineralization is restricted to the northern part of the intermediate to felsic crystal tuffs and is most intense at one stratigraphic level striking along the length of the peninsula, south of the large bay.

The very distinctive nature of the large, quartz eye crystal tuff indicates a local derivation, probably forming on the flank of a domal centre of a felsic intrusive-extrusive complex. Re-working on the margin resulted in deposition of the bedded volcanic derived sedimentary rock. In this volcanic environment, the mineralization is more akin to volcanogenic base metal sulphides. The presence of sulphide-bearing graphitic mudstones and cherty ironstone within the northern part of the felsic pile may represent associated, surficially deposited exhalative mineralization. While mineralization encountered is generally low grade, further work to determine the full extent and the nature of mineralization may be warranted.

Canoe Lake Stock

The Canoe Lake Stock is located approximately 35 km southwest of Kenora on the northeast shore of Shoal Lake. The stock and surrounding metavolcanics form a large peninsula separating Shoal Lake from Labyrinth Bay of Lake of the Woods. The intrusion is elongated to the northeast with a length of about 11 km and a width of 8 km. Exposure is excellent especially in the centre of the stock but is very limited towards the contacts. Water access to the area is very good from Clytie Bay on Shoal Lake and from Clearwater Bay on Lake of the Woods. Land access is limited to a bush road as far as Canoe Lake and a continuing foot trail to Love Lake (Figure 2).

Early mapping and gold assessment includes work by Lawson (1885), Parsons (1911), Greer (1931), and Thomson (1937). During the summers of 1968 and 1969, most of the area was mapped by J.C. Davies (1969,1970) at a scale of 1 inch to ¼ mile with primary concentration on the surrounding supracrustal rocks. Photo interpretation was used for much of the central stock area. During the summer of 1972, a detailed study of the stock and its

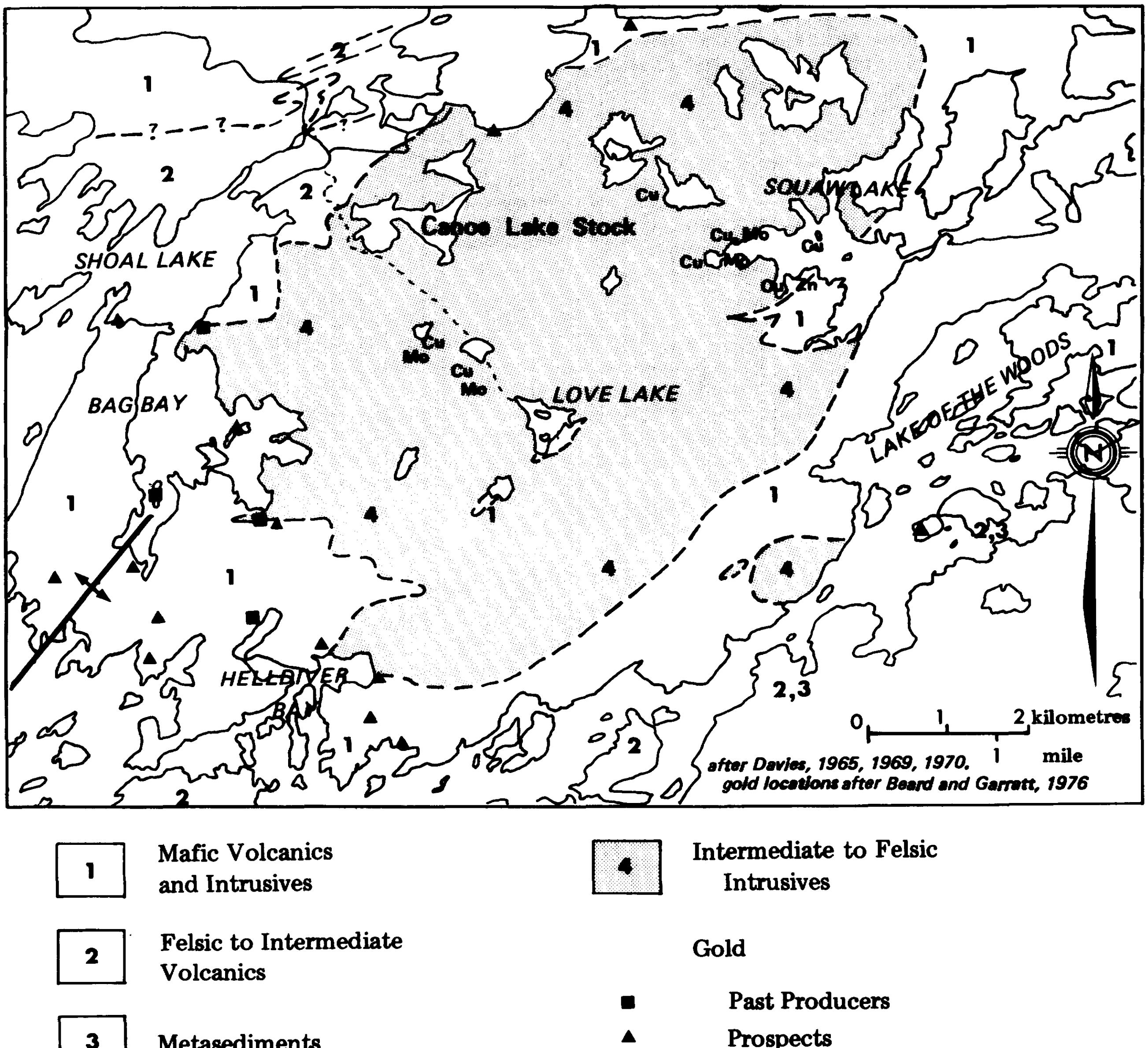

Figure 2—Geology and mineralization of Canoe Lake Stock.

mineralization was carried out by S.W. Campbell (1973). This consisted of extensive chemical and petrographic work, but no new map was produced.

Considerable geological data has been supplied by work associated with gold exploration and development primarily within the metavolcanics on the eastern side of the Canoe Lake Stock. The Lake of the Woods gold rush occurred between 1885 and 1895 and maximum production was reached in 1899. Many mines closed by the end of the following year with only the three largest producers (the Mikado, Cameron Island, and Cornucopia Mines) seeing later activity during the late 1930's and early 1940's.

Minor geophysical and diamond drill exploration was carried out at Squaw Lake by Kerr Addison Mines Limited for copper in 1972. More recent work has concentrated primarily on reassessment of the gold potential of the Shoal Lake area.

General Geology

The oldest rocks of the area are Early Precambrian mafic to felsic metavolcanics of typically calc-alkaline affinity (Goodwin 1970). Mafic metavolcanics and intrusive rocks predominate with lesser, overlying felsic to intermediate metavolcanic pyroclastic rocks and flows.

Sedimentary rocks stratigraphically overlie the volcanic sequences and include volcanic conglomerate and volcanic-derived sedimentary rocks with chert to cherty siltstone and wacke interbeds. These finer grained sedimentary rocks are commonly interbedded with intermediate tuffs. Exposure of sedimentary rocks is limited to an area south of the study area (Davies 1978).

The Canoe Lake Stock which intrudes these units varies in composition from coarse-grained, equigranular quartz diorite to fine- to coarse-grained, porphyritic quartz diorite; fine- to medium-grained sheared and fractured equivalents of these are recognized. Strong colour variations in the quartz diorite, from dark to light red, grey-red, grey and grey-green occur over short distances and do not appear to form regular patterns. The quartz diorite consists of 45 to 70 percent andesine feldspar, 15 to 50 percent quartz and up to 15 percent of both hornblende and biotite, with accessory sphene, rutile, and apatite and trace magnetite and ilmenite (Campbell 1973). Minor hematite occurs in stringers crosscutting grains or at grain boundaries. The authors observed mafic mineral content of equigranular rocks to range between 2 and 15 percent, without a regular pattern.

Davies (1978) recognized a "dividing septum" separating two lobes of the intrusive body, marked by a magnetic anomaly, large blocks of included volcanic rocks through the centre of the body, and a large tongue of mafic volcanic rocks and intrusives trending roughly southwest from Squaw Lake. Large xenoliths of mafic volcanic material are present within the quartz diorite stock along the southeast shore of Love Lake and also southwest of the small lake immediately southwest of Love Lake. A significant number of smaller inclusions (1 cm to 5 m) were observed between Canoe Lake, Love Lake, and Potter Lake, many of which were elongate in a N45°E to N60°E direction. To the northwest of Love Lake there is a concentration of mafic, altered mafic, and felsic volcanic intrusions of variable size and abundance. Reaction rims on the inclusions in all areas indicate some assimilation.

Later dikes of quartz, feldspar, and quartz-feldspar porphyry cut the quartz diorite, but seem to be directly related to the same major intrusive event. The dikes are generally buff coloured to light grey and are composed of fine- to coarse-grained quartz and feldspar phenocrysts in a fine-grained, quartzofeldspathic groundmass; mafic content is minor. They average 10 m in width and are generally quite linear with sharp, planar contacts with the quartz diorite. Dike orientation is not consistent throughout the stock, but locally some subparallellism is evident; contacts are commonly sheared over a narrow width. The dikes are massive with regular, blocky cooling fractures. The characteristic, chloritic, curviplanar shear fractures of the quartz diorite are lacking, suggesting that the dikes were emplaced after an early deformation-alteration event in the quartz diorite rocks. The concentration of dikes varies locally from as much as 50 percent to zero. The size, orientation, and local concentration of the dikes, as well as the type of dominant phenocryst phase present, are highly variable across the stock.

Minor pegmatites and aplites are associated with the intrusion. Pegmatites are most common in the volcanic rocks around the margin of the intrusion and in the included blocks within it. A few 2 cm to 8 cm pegmatite and aplite dikes were observed throughout the stock, but these were minor and can be easily mistaken for alteration along fractures.

More widespread within the intrusion are various types of quartz veins. They occur along fractures and shear zones in the rocks and vary from roughly planar veins to irregular pods and masses. Three main types are observed:-

1) Grey to white glassy quartz occurs with accessory chlorite, carbonate, muscovite, tourmaline, and potassic feldspar. The vein boundaries are sharp where the veins occupy fractures but become diffuse in shear zones. Sulphides are commonly present in these veins; pyrite is most common and is generally less than 5 percent; trace chalcopyrite is present locally. Where more of the accessory minerals are present, veins are very similar to pegmatites. Less vein material is present in the porphyry dikes.

2) White, porcelain-like quartz and light green sericite occurs as irregular veins or networks of vein material. Minor pyrite ± chalcopyrite are also present locally. Veins are very abundant locally and cut quartz diorite and, rarely, the porphyry dikes.

3) White, saccharoidal quartz veins occur mostly as linear features with sharp to indistinct borders. They are generally less than 5 cm wide and host disseminated pyrite with trace chalcopyrite and molybdenite. These veins commonly occur with veins (type 1) in quartz diorite.

Structure

The Canoe Lake Stock is characteristically riddled with irregular, curviplanar and horsetailing, tectonic fractures. The alteration mineralogy along the fractures includes chlorite, epidote, quartz, sericite, and carbonate; chlorite is most abundant and slickensiding is common. The fractures are mainly vertical indicating vertical tectonic movement. Numerous, irregular, and bifurcating, chloritic shear zones are also present, with the foliated material oriented at 30° to 45° to the shear zone orientation, further supporting a vertical shear displacement. The time of deformation to that of intrusion and of mineralization is not certain except in relative terms.

Later linear fractures and shear zones are much more regular than the curviplanar fractures and commonly are filled with quartz veins. A. Hopkins (Assessment Files Research Office, Ontario Geological Survey, Toronto) has delineated four major fault and shear zone trends - N40°E, N60°E, N75°E, and N70°W - for the Bag Bay–Helldiver Bay gold region east of the intrusive. Observed fracture sets in the field match these trends with another set observed striking approximately north-south. Relative ages of the fracture sets could not be determined.

Mineralization

Gold mineralization is hosted by quartz and quartz-carbonate veins which occupy roughly east-west and north-to-northwest trending fractures. This latter trend has proven to be the best mineralized set, responsible for most of the production from the Cornucopia, Mikado, and Olympia mines. The veins are hosted primarily in the volcanic rocks, but a few significantly mineralized ones occur within the Canoe Lake Stock (Campbell 1973; Davies 1978). Accessory vein minerals include pyrite, chalcopyrite, sphalerite, galena, and molybdenite, with minor muscovite and rare mariposite. No visible gold was seen in mine dumps but it has been reported (Beard and Garratt 1976).

Copper and molybdenum mineralization occur at several localities throughout the intrusive. The main copper occurrences are at Squaw Lake in the northeastern part of the body where trenching was done on the south shore of the lake along two east-west, silicified, shear-fracture zones in the quartz diorite. These semi-schistose zones host abundant secondary quartz carbonate and chalcopyrite, pyrite, and traces of sphalerite. Diamond drilling by Kerr Addison Mines Limited in 1972 indicated eight mineralized intersections of generally less than 0.6 m with disseminated pyrite and lesser chalcopyrite in all the rocks (Assessment Files Research Office, Ontario Geological Survey, Toronto). Best assays were 0.06 ounce gold per ton, 2.94 ounces silver per ton, and 2.22 percent copper over 0.2 m; generally the results were 0.2 percent to less than 1 ounce silver per ton. The best mineralization was present primarily along altered fractures in the quartz diorite, in quartz-feldspar porphyry, and in a short section of amphibolite. The quartz diorite varies from fresh and equigranular, to moderately sheared, recrystallized, and fractured.

Elsewhere on Squaw Lake are several small, showings of trace disseminated chalcopyrite in undeformed and equigranular quartz diorite. The immediate extent of this style of mineralization is limited to apparently small pockets. No distinct relation to fractures could be seen suggesting that the mineralization may be a primary magmatic feature.

Small quartz veins with scattered traces of pyrite, chalcopyrite, and molybdenite are present in the Squaw Lake area. Pyrite and chalcopyrite are hosted in many of the quartz veins, but molybdenite seems to be limited to saccharoidal veins. All mineralized veins occupy approximately roughly east-west or north-south trending fractures.

Outside the Squaw Lake mineralized area, the largest concentration of disseminated mineralization was discovered during this study about 600 m northwest of Love Lake. Disseminated chalcopyrite, pyrite, and secondary iron and copper alteration minerals occur in intensely fractured and altered quartz diorite over an area of about 14 400 m^2. The mineralization is not uniform, and is present only in the deformed quartz diorite. Quartz and quartz-feldspar porphyry dikes which cut the rocks locally are not mineralized. Also present are irregular areas of fresh, undeformed, and essentially unmineralized quartz diorite. Due to the highly weathered and altered nature of these rocks, a detailed assessment of the nature and extent of this copper mineralization was difficult to obtain. Assay results from the few fresher mineralized samples are not yet available.

Conclusions

The disseminated base-metal showings appear to be of limited extent and of relatively low grade and are sporadically distributed throughout the intrusion. The cause of their localization has not been adequately determined, and several alternatives are considered feasible: i) Primary magmatic concentration; ii) hydrothermal activity related to stock emplacement; iii) assimilation of sulphide-bearing supracrustal material, evidenced by the large concentrations of xenolithic fragments; and iv) reconcentration during tectonic deformation, which appears to have been the mode of formation of quartz vein mineralization. The hydrothermal "porphyry" origin proposed by Campbell (1973) was based on a sample pattern much too widely spaced to cover the large changes in stock nature and composition which occur erratically over short distances. This present study did, however, discover a new area of mineralization thereby indicating the potential for more mineralization of this type. The depth extension mineralization would be necessary to encourage further work.

The proven gold potential around the margin of the stock should be further investigated. This mineralization appears to be caused by remobilization into quartz veins during stock emplacement. The highest concentration at the western margin may be the result of intrusion into specific, favourable, mafic volcanic rocks.

High Lake Stock

Introduction

High Lake is located in Ewart Township about 48 km west of Kenora and 3 km south of the Trans-Canada Highway (Location Map). Access by four-wheel drive vehicle can be made along a trail from the Shoal Lake road to the east end of High Lake. The Trans-Canada natural gas pipeline passes through the area just to the north of High Lake.

Mafic, intermediate, and felsic metavolcanic country rocks as well as associated metasediments have all been intruded by the High Lake Pluton which is centred on the lake (Figure 3). Three main styles of mineralization occur:

1) Quartz veins and pods generally with traces of some or all of pyrite, pyrrhotite, chalcopyrite, arsenopyrite, molybdenite, sphalerite, galena, gold, and silver,

2) Disseminated pyrite, chalcopyrite, and magnetite in equigranular to porphyritic granodiorite in the northern phase of the High Lake pluton,

3) Shear zones containing molybdenite and chalcopyrite-bearing quartz veins.

The earliest work in this area was done by Parsons (1911). Greer (1931) examined the rocks of the Shoal Lake area, including the southern part of High Lake. More recent detailed mapping by J.C. Davies (1965) of the High Lake–Rush Bay area provided the most complete understanding of local and regional geology. Work in the adja-

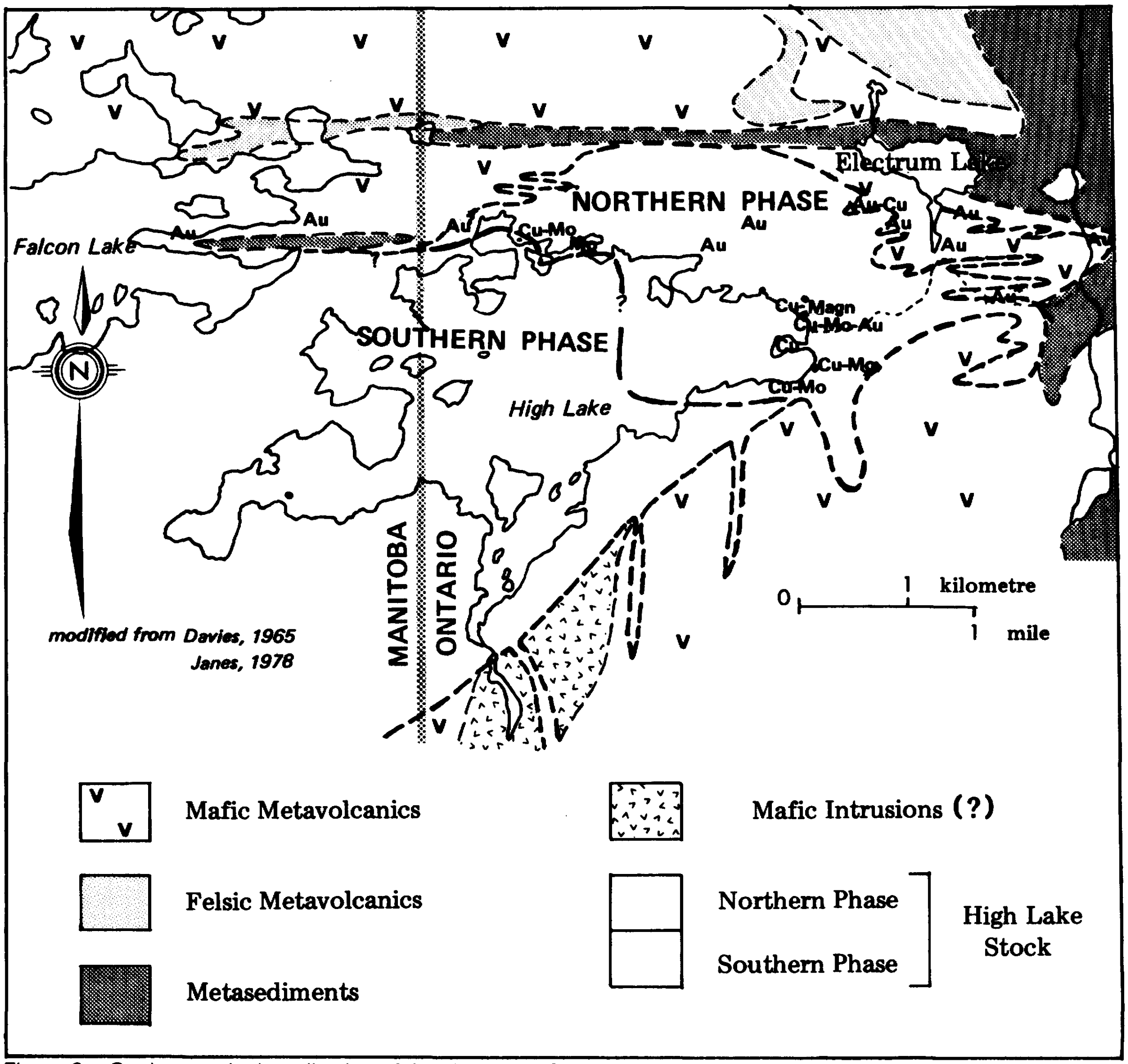

Figure 3—Geology and mineralization of the High Lake Stock.

cent area of Manitoba includes maps by G.D. Springer (1952), J.F. Davies (1954) and D.A. Janes (1978). A detailed study was carried out in 1975 by J.M. Pedora (Pedora 1976) of a few localities of the northern mineralized phase of the intrusive. Comprehensive mapping, geophysical studies, diamond drilling, and trenching throughout the area north of the eastern half of High Lake has been carried out by several mining companies (see Davies 1965, p.31-53).

General Geology

The oldest rocks of the area are Early Precambrian (Archean) basaltic and rhyolitic metavolcanics. Sediments derived primarily from these volcanics include conglomerate, arkose, wacke, and argillite with a predominance of wacke and arkose, in part possibly tuffaceous (Davies 1965). Greer (1931) first recognized a group of sedimentary rocks from the Crowduck Lake area to the southeast which he considered younger than the northern phase of the High Lake intrusive on the basis of clasts of "definitely" porphyritic granodiorite in beds of Crowduck Lake conglomerates; however, the relatively large volume of intermediate and felsic volcanic rocks close to the Crowduck Lake sedimentary rocks could have been the source of these clasts. In the absence of further evidence, the authors treat all the local sedimentary rocks as one group.

Minor gabbroic bodies, some of which may, in part, be extrusive, occur primarily in the mafic volcanic rocks. These rocks were subsequently intruded by the felsic to intermediate High Lake granodioritic stock. The stock was divided by Davies (1965) into a northern granodiorite to trondhjemite phase, with associated dikes in the volcanic rocks, and a southern phase of tonalite, granodiorite, and hybrid rocks. The southern phase was considered the youngest, since it did not possess the supposedly characteristic penetrative cleavage and cataclastic zones of the northern phase (Pedora 1976, p.11).

The central stock zone of the northern phase contains 50 to 70 percent phenocrysts of quartz, plagioclase (An_{24} to An_{32}), microcline and biotite in a fine grained groundmass of similar composition (Pedora 1976). The distinctive large microcline phenocrysts are highly variable in abundance, with crystallographically aligned plagioclase inclusions, indicating a magmatic origin. Dike swarms east and west of the central zone are poorly exposed, but appear compositionally and texturally similar to the central stock, with generally more plagioclase, less microcline phenocrysts, and higher ground mass content.

The southern phase consists of a complex mixture of granodiorite to quartz monzonite with mafic inclusions, or separate mafic intrusive phases, and hybrids of these. The monzonite is light pink to buff in colour with medium-grained, equigranular quartz, feldspar, biotite, and hornblende; microcline phenocrysts are common, but their size and abundance is highly variable. The most common rock type, however, is a hematite-red or grey hybrid granodiorite, with considerably higher mafic content, often as patchy concentrates of amphibole and biotite. Variably digested mafic inclusions are present throughout and assimilative processes appear to account for the full range of compositions and textures observed. This high mafic content could have resulted either from mixing with a co-magmatic mafic liquid or more probably from stoping and mixing of xenolithic blocks of mafic volcanic wallrocks.

More than one pulse of intrusion is indicated by an occurrence of hybrid, inclusion-filled granodiorite, cut by inclusion-free pink granodiorite. Locally, narrow dikes of aplite and pegmatite cut the southern phase.

Structure

The supracrustal rocks of the High Lake area are characterized by a predominant east-west structural trend; Davies (1965) suggested two phases of folding with extensive and intensive overprinting by the second easterly trending event. Most faulting trends east-west (070° to 100°) and is characterized by sharp, narrow breaks, with some accompanying shear zones. The lack of suitable stratigraphic markers makes interpretation difficult. The stock appears massive wherever observed and cuts the vertically foliated supracrustal rocks, which appear to have been deformed prior to intrusion; the stock body, however, is more competent and less likely to show a penetrative deformation; in places elongation of quartz phenocrysts was observed within its margin.

At the east end of the lake, strongly cataclastized granodiorite of the northern phase, at the contact with the southern phase, marks the broadest area of shear deformation; deformation is less intense along the contact westwards. The intensity of shearing and faulting decreases rapidly northwards from the contact. Evidence for tectonic deformation of the southern phase was not observed, indicating two separate pulses of intrusion, with the southern phase intruding and deforming the northern phase. Two distinct intrusive events could have occurred, but due to the similar composition of both phases, they are more probably separate pulses of the same intrusive event.

Mineralization

Numerous gold showings are present in quartz pods or veins that cut metavolcanics, metasediments, quartz porphyry, and in two instances, the central stock near the northeast stock contact. Quartz veins carry accessory carbonate, tourmaline, and potassic feldspar with trace pyrite, pyrrhotite, chalcopyrite, molybdenite and galena. Two drill intersections of semi-massive pyrite and chalcopyrite in quartz veins are reported (Davies 1965). Narrow stringers to massive veins and pods up to 2 m in width are present. Veins are fault, joint or shear zone controlled. Visible gold and electrum are present. Spectacular occurrences are reported (Davies 1965), but distribution appears to be erratic.

An occurrence of graphitic mudstone with massive to disseminated layered arsenopyrite was sampled; assay work is in progress to determine its gold content.

The largest shear zone-controlled quartz vein molybdenite-chalcopyrite occurrence, on the Evenlode Mines

Limited property at the eastern end of High Lake has been explored by trenching and drilling. Three vein sets occupy fractures at 050°, 080° and 125°. The sets pinch and swell considerably with average widths of 30 cm to 1 m. Veins contain accessory carbonate, pyrite, molybdenite and chalcopyrite with minor malachite and azurite. Molybdenite occurs in finely disseminated, discontinuous concentrations giving the veins a steel grey appearance; average concentrations are 0.5 to 2 percent MoS_2. Gold content is generally less than 0.05 oz per ton. Reserves indicated by drilling are 126 000 tons with an estimated 625 000 tons possible ore to a depth of 24.4 m (Davies 1965). Several other similar molybdenite showings are located in sheared rocks westwards from this property.

Other minor quartz-vein hosted sulphide and gold showings occur in sheared or fractured rocks of the northern phase of the stock and in volcanic rocks. Pedora (1976) suggested that the occurrences form a zonal pattern, roughly concentric about the southern phase of the stock, which controlled the nature and distribution of mineralization. On the basis of currently available data and due to the geological complexity of the area, the authors consider that this interpretation is not warranted.

The "porphyry copper showing" occurs north of the east end of High Lake, within the quartz-feldspar porphyry and equigranular granodiorite between the central stock and eastern dike swarm. The showing was first trenched in 1952 and has since been periodically investigated (Regional Geologist's Files, Ontario Ministry of Natural Resources, Kenora). Pyrite, chalcopyrite, and magnetite mineralization occur as fracture-controlled and disseminated, often cuspate blebs in porphyritic granodiorite; mineralization also occurs in net-like structures along with interstitial disseminations, or in wispy concentrations of up to 30 percent magnetite. Similar concentration of biotite ± chalcopyrite characterize much of the host rock. Some fracture controlled stringer sulphide mineralization cuts both phenocrysts and groundmass.

Three of the four long trenches on the property cut disseminated mineralization in the granodiorite; two intersect two narrow discontinuous zones of massive pyrite, magnetite, and chalcopyrite, apparently along fractures; no extensive wallrock alteration around the fracture was observed. The fourth trench intersects the western volcanic intrusive contact between quartz-feldspar porphyry and massive mafic volcanic rocks.

The granodiorite contact parallels the long axis of the known mineralized area. The basaltic volcanic rocks are fine- and medium-grained amphibolites containing finely disseminated magnetite and minor disseminated pyrrhotite and pyrite. Southwestwards from the western trench, the volcanic rocks contain a cherty ironstone horizon 80 cm in width. Saw cut samples display distinct layering of chert, magnetite, pyrite, and minor chalcopyrite. Randomly oriented tourmaline crystals are present in pyrite grains in one sample and soft sediment slump features were observed in several others.

The horizon was traced east-northeast for approximately 50 m in a ground magnetometer survey carried out by Steeprock Iron Mines Limited in 1966 (Regional Geologist's Files, Ontario Ministry of Natural Resources, Kenora). A narrow schistose biotite-rich unit, with minor pyrite and chert beds is also present in the thin volcanic sequence.

Within the western trench, a 3 m wide zone of strongly silicified and hematized granodiorite was observed. Several other narrow, strongly silicified zones or poorly defined quartz veins contain trace pyrite, chalcopyrite, and molybdenite along their borders. Occasional mafic inclusions were observed.

The close spatial association and similar magnetite and sulphide mineralogy of the cherty ironstone and the disseminated mineralization in the stock suggest a genetic link. There is considerable evidence for incorporation of wallrock material in the stock, varying from partially assimilated mafic fragments to wispy biotite and magnetite remnants. This type of mineralization was observed only in this area. Similar assimilation of wallrock material, without disseminated mineralization, was observed elsewhere in the northern phase of the stock, adjacent to the Manitoba border and near Electrum Lake, where no mineralized wallrock is present. This suggests that the mineralization was formed by incorporation and redistribution of a pre-existing sulphide ironstone.

Conclusions

Although generally low grade and erratic, widespread gold mineralization in irregular quartz veins close to the margin of the intrusive has not been adequately investigated. Similarly, the molybdenum and base metal content of these veins is generally low and erratic. The gold content of the arsenopyrite-rich mudstone unit will be reported when available. Assessment file data indicates that molybdenum mineralization associated with the shear zone at the Evenlode Gold Mines Limited property has been drilled to a shallow depth and may warrant further investigation. Only one good gold assay is reported from the property.

The disseminated sulphide-magnetite showing is not fully understood. If the assimilation interpretation is correct, it would be expected to have little potential with depth. The lateral extension of the ironstone horizon may warrant further investigation in relation to its base metal content and its association with the intrusion.

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