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DEPARTMENT OF ENERGY AND MINES

MINERAL RESOURCES DIVISION

ECONOMIC GEOLOGY REPORT

ER79-2

STRATIGRAPHIC SETTING OF SELECTED ULTRAMAFIC BODIES IN THE SUPERIOR AND CHURCHILL PROVINCES AND CERTAIN ASPECTS OF NICKEL COPPER DEPOSITS IN THE THOMPSON NICKEL BELT

by

P. THEYER

1980

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MANITOBA

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ABSTRACT

Evidence is presented showing that a majority of ultramafic lenses occur at a particular stratigraphic horizon (the contact between a mainly volcanic group and a sedimentary group) identifiable in most greenstone belts of the Superior Province. The author, identifies them as komatiitic ultramafic rocks, extrusive at least in part, based on the occurence of spinifex textures in an ultramafic lense in the Island Lake Greenstone Belt, its chemistry and the chemistry of other ultramafic lenses located along this horizon. Conformable, strata controlled ultramafic lenses in other greenstone belts of the Superior Province are similarly interpreted as flows or shallow intrusives. Volcanic and subvolcanic flows are known to have a good potential to host nickel deposits. Recognition of strata-bound ultramafic flows and the possibility of identifying hitherto unknown ultramafic lenses using stratigraphy and aeromagnetic anomalies may have a large impact on the recognition, classification of economic potential, and exploration of ultramafic hosted nickel sulphides in the Superior Province.

Strata controlled ultramafic bodies may also occur at least in parts of the Churchill Province and in the Thompson Nickel Belt. However, this proposal requires further verification through additional field investigations.

I. INTRODUCTION

Introductory Statement

This report presents the results of the Evaluation of Nickel Environments Project (NM 7504) completed under the Canada-Manitoba Non-Renewable Resources Evaluation Program.*

Objectives

The objectives of this project were to provide:

1) an evaluation of the known nickel reserves in Manitoba with estimates of possible extensions to known deposits;
2) an assessment of the potential for additional undiscovered nickel resources in the Thompson belt, Superior Province and Churchill Province;
3) a data base to study nickel occurrences and associations that would be of aid to companies in formulating exploration programs, and to the government in the planning of mineral policies and long term resource development.

Contents

In this report, the results of the program are presented and an attempt will be made to demonstrate that:

1) many of the known ultramafic occurrences are flows or shallow intrusions;
2) the stratigraphic succession in which these volcanic ultramafic lenses occur is defineable and the stratigraphic position of the lenses are similar in most greenstone belts of the Superior Province in Manitoba and in some greenstone belts in Ontario;
3) the association of aeromagnetic anomalies and stratigraphy can be utilized to infer the presence of hitherto unidentified ultramafic bodies.

In addition, a chapter is devoted to the geology of the Manitoba Nickel Belt and to the results of a Rb/Sr isotope dating program of selected rock samples of the Belt. A separate chapter is devoted to ultramafic occurrences in the Churchill Province — concentrating on the occurrences in the Lynn Lake Greenstone Belt — that are believed to show notable stratigraphic parallels with the stratabound ultramafic bodies of certain greenstone belts of the Superior Province.

Differentiated mafic occurrences that may also include ultramafic lenses such as the intrusion hosting the Lynn Lake orebody are treated in a separate report of this series by R. Pinsent. (Economic Geology Report ER 79-3).

Ultramafic occurrences in the Fox River Sill and dyke swarms of the Western Superior Province have recently been studied in depth and are reported elsewhere. (Scoates and Macek, 1978, and Scoates, in prep.).

The Geological Map of Manitoba, Map 79-2 presents a complete, updated general reference to location and type of ultramafic rocks in the Province.

Scope and Limitations

Work on the Evaluation of Nickel Environments project started in March, 1976. Included in this project were studies dealing with ultramafic or predominantly ultramafic bodies. Only part of the initial objectives of the project were realized. However, close cooperation with personnel of INCO Ltd., resulted in the completion of a Rb/Sr isotope age-dating study of selected samples from the Thompson Nickel Belt. A chemical analysis program of an ultramafic occurrence within the Thompson Nickel Belt using drill core obtained through courtesy of Falconbridge Nickel Mines Limited, was also completed as part of this program.

Field studies in the Churchill Province were limited to a total of approximately three weeks. In this time, emphasis was given to the study of possibly stratabound ultramafic rocks in the Lynn Lake Greenstone Belt. The author also visited several ultramafic outcrops in the Flin Flon — Snow Lake belt such as the Rice Island occurrence in Wekusko Lake.

Following the discovery of a stratigraphically controlled volcanic ultramafic occurrence in the Island Lake Greenstone Belt, emphasis was placed on problems related to the nature and possible stratigraphic control of the ultramafic bodies in the Superior Province of Manitoba. The type and stratigraphic position of ultramafic occurrences in the Superior Province were examined in the field and, in part, mapped in the Island Lake, Bigstone — Knight Lake, and Bird River belts. Data for other ultramafic occurrences were compiled from available literature.

Acknowledgements

The author gratefully acknowledges the supervision and guidance received from Dr. F. J. Elbers of the Manitoba Mineral Resources Division; and Dr. O. R. Eckstrand of the Department of Energy, Mines and Resources of the Geological Survey of Canada.

Field and office assistance was provided by G. Josse, D. Young, J. Hart, R. Haskins, and W. J. McLean. The data compilations prepared by G. Josse and D. Young were used, with only minor modifications, in this report; their contribution deserves special mention.

Maps and figures accompanying this report were drafted by D. Bagwell, D. McShane and E. Truman under the direction of R. Sales.

D. Navitka typed several drafts of this report; the first of these was edited by J. Bamburak.

Last but not least innumerable discussions with my colleagues, D. Baldwin, G. Gale and R. Pinsent helped to orient this program.

*NREP March 1975 to March 1979

II. NICKEL DEPOSIT TYPES

Nickel is almost exclusively associated with mafic and ultramafic rocks that may have been derived from the earth's mantle. It occurs significantly concentrated in three different geologic environments.

a) the world's largest presently known nickel resources occur in laterites that are residual soils formed by the weathering of rocks in a warm humid climate. Laterites enriched in nickel are formed by the weathering of ultramafic rocks. This deposit type occurs predominantly in tropical or subtropical countries such as Cuba, Dominican Republic, Colombia, Phillipines and New Caledonia. Laterites are not known to occur in Canada.

b) vast nickel resources occur in nickel bearing manganese nodules found widespread on deep ocean floors. Many aspects of this resource, such as the technology to be employed in mining and transporting the nodules to the surface are still in an experimental state.

c) deposits of sulphidic nickel are generally encountered in intrusive or extrusive mafic to ultramafic bodies. This deposit type is of prime importance to Canada, since Canadian nickel deposits are almost exclusively of this type.

Low temperature, hydrothermal nickel deposits in which nickel and cobalt occurs as Ni-Co arsenides occasionally containing minor amounts of bismuth and silver, are generally of small tonnage and economically not viable. Deposits of this type may contain large quantities of uranium and hydrothermal Ni minerals such as millerite, gersdorffite and bravoite. One of these deposits — Key Lake (Saskatchewan) is presently under development for its uranium content.

The processes that generate ultramafic magmas are not clearly understood, but there is now fairly general acceptance of the concept that ultramafic magmas are products of partial melting of the mantle, although details such as the degree of melting are still contentious. (Arndt, 1977; Naldrett and Turner, 1977; Nesbitt et al., 1979). The processes that trigger the melting and ascent of the magma are largely unknown. Sialic rifting appears to be associated with these ultramafic eruptions in Rhodesia (Bickle et al., 1975), Western Australia (Naldrett and Turner, 1977) and Northern Quebec, (Cape Smith — Wakeham Bay Belt) (Schwarz and Fujiwara, 1977).

The recognition of extrusive ultramafic rocks acquired special significance, when it was realized that the recently discovered nickel deposits of Western Australia (Agnew, Kambalda) were hosted in such rocks. (Woodall and Travis, 1969; Ewers and Hudson, 1972).

In the Superior Geological Province of Canada, ultramafic flows have been reported in the Abitibi belt (Naldrett and Mason, 1968; Naldrett and Gasparrini, 1971; Pyke et al., 1973; Fleet and McRae, 1975) the North Spirit Lake area, (Wood, 1975, 1976, 1977b) and the Oxford Lake area, (Hubregtse, 1973b). Nickel deposits associated with ultramafic flows in the Superior Province including the Hart, (Muir, 1975), the Texmont (Naldrett and Gasparrini, 1971; Nesbitt, 1971) the Langmuir (Pyke et al., 1973) and Dundonald (Muir and Comba, 1979) deposits in the Timmins area of Ontario. In Manitoba, the Linklater deposit in northwestern Island Lake appears to have similar characteristics (Theyer, 1977, 1978).

The economic importance of the association of nickel deposits with ultramafic flows may be significantly heightened, if it can be proven that at least some of the ultramafic rocks associated with nickel deposits of the Thompson Nickel Belt are ultramafic komatiitic flows as suggested by Peredery (1979).

NICKEL SULPHIDE DEPOSITS IN VOLCANIC ULTRAMAFIC ROCKS

INTRODUCTION

Nickel sulphides are associated with ultramafic bodies that have been classified according to several different schemes, such as chemical composition, size and form (Wyllie, 1967) or whether the body crystallized in situ or was emplaced as a solid or as a partially solid body (Thayer, 1971) or more recently, the tectonic environment of emplacement (Naldrett, 1973).

During the early seventies the concept that MgO rich picritic or ultrabasic liquids reach the earth's surface as volcanic rocks became accepted.

This type of rock was first described from the lower formations of the Onverwacht Group in the Barberton Greenstone Belt of South Africa and was interpreted to be extruded in a submarine environment. (Viljoen and Viljoen, 1969a and b). The major element chemistry of these rocks is characterized by a high MgO (>10%) low TiO_2 (<1%) contents and a high (>1) CaO/Al_2O_3 ratio relative to other volcanic rocks.

They occur as flows carrying sporadic pillows, and may contain in some instances distinctive textures caused mainly by parallel grouping of skeletal olivine or pyroxene crystals referred to as "spinifex" textures (Nesbitt, 1971).

The chemistry, textures and submarine flow characteristics led to the proposal that these rocks constitute a unique class of rocks called "komatiites" (Viljoen and Viljoen, 1969a and b). Subsequently, komatiites have been recognized in other Archean greenstone belts of the world (Rhodesia, Australia, Canada) and described by a number of workers (e.g. Nesbitt, 1971; Eckstrand, 1972 and 1973, Williams, 1972; Brooks and Hart, 1972; Pyke et al., 1973; Arndt, 1975; Green, 1975).

CLASSES OF ULTRAMAFIC VOLCANIC ROCKS

Ultramafic volcanism was the subject of a controversy that persisted well into the second half of this century. The argument was centered on the apparent discrepancy between field observations that suggested the presence of ultrabasic liquids that would crystallize into ultramafic rocks and laboratory observations that called for extremely high liquidus temperatures for a magma of ultrabasic composition. The history of this discussion was summarized by Wyllie (1967). The discovery and description of volcanic ultramafic rocks in South Africa, (Viljoen and Viljoen, 1969a and b) appeared to resolve this controversy. These authors proposed four new volcanic mafic ultramafic rock types based on the apparently distinctive chemistry of the rocks and the occurrence of "spinifex" textures which are interpreted to have resulted from the crystallization of a supercooled liquid of mafic to ultramafic composition. This new class of rocks was called "Komatiite". The term "Komatiite" has since evolved from the original chemical parameters that called for a high CaO/Al_2O_3 ratio, not encountered in similar rocks of other areas. (Nesbitt et al., 1979). The definition of the term "komatiite" is presently under review (Arndt et al., 1979), however, a common practice is to divide volcanic mafic to ultramafic rocks into two groups:

1) *Komatiites*, characterized physically by the common presence of spinifex and chemically by a low FeO/(FeO + MgO) *vs* Al_2O_3 ratio, a low (< 1%) TiO_2 content and a relatively high MgO content.
2) *Tholeiites*, characterized by lack of spinifex texture and by a high FeO/(FeO + MgO) *vs* Al_2O_3 ratio and high (> 1% TiO_2) content.

Komatiites are considered to host the majority of the volcanic nickel deposits, although both volcanic groups contain this type of deposit (Naldrett and Arndt, 1975; Naldrett and Cabri, 1976).

GENETIC MODELS OF NICKEL SULPHIDE DEPOSITS IN ULTRAMAFIC VOLCANIC ROCKS

Various genetic models were developed during the last decade to explain nickel sulphide deposits associated with ultramafic lenses in Archean greenstone belts. Some of the principal concepts include:

a) Sulphurization model (Naldrett, 1966).

b) Gravity induced segregation of immiscible sulphide droplets from magmas of ultramafic to mafic composition. (Ewers and Hudson, 1972; Naldrett, 1973; Naldrett and Cabri, 1976).

c) Early segregation and emplacement of an immiscible sulphide phase, separated from an ascending ultramafic carrier-magma due to viscosity differences between the sulphide and silicate phase (Ross and Hopkins, 1975).

d) Volcanic exhalative model (Lusk, 1976).

e) Ores concentrated by metamorphism of pre-existing disseminated Ni-sulphides (Barrett et al., 1977).

a) A model invoking the sulphurization of ultramafic and mafic rocks and the scavenging of nickel from ultramafic silicates was presented by Naldrett (1966), to explain the ores at the Alexo Mine in Ontario. He thought that the ultramafic intrusion heated the underlying volcanic rocks, which released sulphur that permeated the ultramafic body and scavenged the silica-bound nickel. These Ni-Fe sulphides would then migrate to the margins of the solidifying crystal mush.

A similar model was used by Karup-Møller and Brummer (1971) to explain the formation of the nickel ore of the Dumbarton Mine, which is located in andesite and iron formation that underlies a mafic to ultramafic sill (Bird River Sill). The sulphurization model as a nickel ore forming process, later fell into disfavour as more workers recognized the persistent association of nickel deposits with ultramafic flows and the common occurrence of sulphides at the bottom of these flows. Another problem of the sulphurization theory was the lack of a convincing collection mechanism for the Ni and Fe sulphide molecules that were supposedly created within the sulphidized ultramafic rock. (Hudson, 1972).

The sulphurization model was abandoned by Naldrett in 1973 and is presently only used to explain local metal redistribution phenomena (Groves and Keays, 1979) or to explain compositional variations from theoretically expected values in nickel sulphides (Naldrett et al., 1979).

b) The sulphurization model was replaced by the "immiscible sulphides separation model" — a model that was originally proposed by Vogt (1921 and 1923) and then adapted and presented in schematical outlines by Nesbitt (1971), Hancock et al., (1971), Hudson (1972) and Ewers and Hudson (1972). It was inspired by the discovery of several volcanic sulphide Ni-Cu deposits in Western Australia and was formally presented by Naldrett (1973) who proposed that the magmatic sulphides were carried by a sulphur-saturated ascending magma in the form of immiscible sulphide droplets that segregated out of the magmatic crystal mush during periods of slow magmatic movement or quiescence; i.e. they segregated due to their high molecular weight as soon as the magma was extruded or intruded into its final position. Naldrett (1973) explained the occurrence of three different ore types (massive, net, disseminated) by the "billard ball immersion" model that shows the interaction of the three magmatic components of differing molecular weight. Massive sulphides, being the heaviest component, would coalesce at the bottom of the flow displacing to a certain degree the olivine phenocrysts and the interstitial (pyroxenitic) liquid. Net textured ore would form as soon as the weight of the overlying crystal mush became greater than the weight of the sulphide layer. This ore type is generally overlain by disseminated ore, resulting when sulphide droplets do not coalesce but remain interstitially trapped in the solidifying magma.

c) Certain features of the Kambalda deposits in Western Australia were not explainable by the immiscible sulphides model, (Naldrett, 1973). This led Ross and Hopkins (1975) to propose the "early immiscible sulphides separation model". These authors also envisaged a sulphur-saturated magma that is the carrier of immiscible sulphides. The sulphide droplets are believed to have separated from the ascending melt due to viscosity differences between the sulphides and the silicate liquid and mush. The separation resulted in pure sulphidic flows followed by olivine rich flows.

This model would, according to Ross and Hopkins (1975), explain the following observations made on the Lunnon shoot of the Kambalda deposits.

i) The lack of a chilled ultramafic selvage between the basal volcanic flow and the massive sulphide layer. Such a selvage should be recognized if sulphides segregated in situ out of a silicate mush.

ii) The presence of chromite at the base of a disseminated sulphide zone overlying a massive sulphide layer. Because of the high density of chromite, it is unlikely that chromite would have formed and remained suspended over a molten layer of massive sulphide, without penetrating it or percolating through it.

iii) The differences in the spatial distribution of contact (high grade) sulphides and overlying disseminated zones. Ross and Hopkins (1975) argued that the ratio between disseminated and massive ore within an orebody should not vary, as is the case in the Lunnon Shoot if the sulphides separated from the melt.

iv) The occurrence of sedimentary layers within the ultramafic body, and the anomalous occurrence of zinc on certain ore horizons. Ross and Hopkins (1975) concluded that these observations could be explained by the emplacement of massive and disseminated sulphides and ultramafic magma in a sequence of consecutive extrusive events into a sub-aqueous zinc rich sedimentary environment.

d) A "volcanic exhalative" genetic model was presented by Lusk (1976) who suggested that there are similarities between exhalative volcanic Cu-Zn and Ni-Cu deposits. He proposed that the generation of Ni-Cu deposits by a volcanic exhalative process would explain; i) the pyrite content and occurrence of pyrite banding in the massive sulphide portion of some nickel deposits; ii) the intimate association of some nickel deposits with iron formations and chert; and iii) the occurrence of bleached zones interpreted as hydrothermally altered rocks in the footwall of the Scotia deposit (W. Australia). The existence of igneous textures in nickel sulphide ore was explained by outpourings of hot ultramafic lavas across the surface of these deposits that partially melted the substratum and generated these textures.

Lusk's (1976) model gained little acceptance, since most of his observations were explained by other authors as being artifacts of post depositional metamorphism and sulphide oxidation (Groves et al., 1976). Despite this, Lusk's (1976) model should not be discounted since certain characteristics in nickel deposits are not easily accounted for without resorting to volcanic exhalative processes. The occurrence of anomalous zinc values in nickel deposits is intriguing and obviously requires some explanation, as for example in the Dumbarton deposit (Karup — Møller and Brummer, 1971) the Windarra deposit (Watmuff, 1974) and the Kambalda deposits of Western Australia (Ross and Hopkins, 1975). An alternate explanation, to volcanic exhalative processes could be an early contamination of the magma with zinc bearing sediments, or the extrusion of sulphides into zinc rich sediment layers (Ross and Hopkins, 1975).

Another intriguing feature is the occurrence of Ni sulphide zones offset from ultramafic bodies. A well-known example is the Thompson deposit (Zurbrigg, 1963), commonly explained by tectonic dislocations causing large scale sulphide displacement. A similar situation is encountered in the Dumbarton Mine (Karup — Møller and Brummer, 1971) and in the lenses of the Sherlock Bay deposits of Western Australia (Miller and Smith, 1975). However, in the Sherlock Bay deposits a structural displacement interpretation seems unlikely, since the mineralized lenses appear interconnected and are locally but not everywhere in contact with a gabbroic lense.

e) A nickel sulphide ore formation model that relies on the concentrating effect of metamorphism on disseminated sulphides, without concerning itself with the origin of these sulphides was presented by Barrett et al., (1977).

The ore forming models of Naldrett (1973) and Ross and Hopkins (1975) are presently accepted as most valid. However it is recognized that metamorphic upgrading of disseminated sulphides as proposed by Barrett et al., (1977) may be an important process in certain highly deformed terranes.

III. STRATABOUND ULTRAMAFIC OCCURRENCES OF THE SUPERIOR GEOLOGICAL PROVINCE OF MANITOBA (NORTHERN SEGMENT)

INTRODUCTION

Ultramafic occurrences in the Superior Province have received the attention of many mining companies (Inco, Falconbridge, Cominco, Canico, Amax and others) in their search for nickel deposits. Exploration was most intense in the middle to late nineteen fifties, but achieved little success and only a few subeconomic deposits were found in the Island Lake and Carrot River areas. Mining companies then shifted their interest to the "Manitoba Nickel Belt" after the discoveries of the Moak Lake deposit (1953) and the Thompson orebody (1956).

PREVIOUS WORK

Comprehensive studies of ultramafic occurrences in Manitoba are few in number. Ultramafic rocks of the Manitoba Nickel Belt were described by Coats (1966). An inventory and classification of ultramafic occurrences in Manitoba including those in the Superior Province and an overview of their mineral potential has been presented by Scoates (1969a), (Scoates, 1971b and c). He has also provided a series of descriptions of individual ultramafic bodies that were published in several reports of field activities (Scoates, 1968, 1969b, 1971a; Scoates et al., 1972).

Ultramafic bodies have been frequently mentioned in descriptions of geological map areas, but detailed observations were generally scanty. The stratigraphic position of the ultramafic bodies and their contact relationships with the surrounding rocks were generally not described in detail, because it was assumed that all such occurrences were intrusive in nature.

GENERALIZED STRATIGRAPHY OF THE GREENSTONE BELTS IN THE SUPERIOR PROVINCE OF MANITOBA

Archean greenstone belts of the Superior Geological Province show similarities in their stratigraphic developments. The first author who mentioned these similarities was Wright when he described the Island Lake Greenstone Belt and the Oxford-Knee Lake Greenstone Belt (Wright, 1932a). This concept was accepted and applied by Horwood (1934) to the Cross Lake Greenstone Belt, by Barry (1959, 1960, 1962) to the Oxford, Knee and Munro Lake area, and by Godard (1963a and 1963b) to the Island Lake Greenstone Belt.

a) Hayes River Group

The oldest rocks recognized in the greenstone belts of the Superior Province belong to the Hayes River Group. This name was originally proposed by Wright (1928) for a group of mainly volcanic rocks that are the basal members of the Island Lake Greenstone Belt.

A comparison of the stratigraphy of the Hayes River Group between different belts is possible only in general terms, since the stratigraphic bottom of this group has been in most cases obliterated by tonalitic intrusions or younger intrusives. This group is mainly (70%) composed of basalts. Hubregtse (1978) described other related volcanogenic rocks of an effusive, pyroclastic, hypabyssal and epiclastic nature, ranging in chemistry from rare ultramafics through common basalts to rare felsic rocks. The remainder of this group (~ 30%) are of sedimentary origin, and comprise layers of greywackes, subgreywacke, argillite, slate and derived schists, iron formation and chert.

b) Oxford Lake Group (=Island Lake "Series*"; = Cross Lake Group?)

A group of predominantly clastic sediments overlies and is separated from the Hayes River Group by either a disconformity or an angular unconformity. Wright (1928) was the first to describe this mainly sedimentary rock group in the Island Lake Greeenstone Belt, and called it the "Island Lake Series". Subsequently, he described a similar sedimentary sequence from the Oxford-Knee Lake Greenstone Belt and called them "Oxford Lake Group" (Wright, 1932a). Horwood (1934) recognized the stratigraphic similarity of the Oxford Lake Group and a group of sediments overlying the Hayes River Group in the Cross Lake Greenstone Belt, however, he called these for geographic reasons — "Cross Lake Series". The following description is a condensed version of Wright's (1932a) description of the Oxford Lake Group. It also applies to the Island Lake "Series" and to the Cross Lake Group although minor discrepancies were observed in the field, especially in the sequence in which the different members occur. These sequences, are peculiar to each greenstone belt and are described in the section of the text dealing with the general geology of each belt. The basal member of this, chiefly clastic sedimentary group of rocks, is a conglomerâte layer ranging from less than 1 metre to a kilometre in thickness. The conglomerate may contain subangular clasts from the underlying Hayes River Group. These clasts and local erosional channels found in the Hayes River Group at the contact with the clastic sedimentary group indicate that the Hayes River Group was locally eroded at the time of the deposition of the clastic group. The basal layers of the Oxford Group contain mainly felsic clasts imbedded in a chloritic matrix. However, the majority of the clasts in stratigraphically higher levels are of allochthonous tonalitic or granitic origin and the matrix shows a gradual enrichment in quartz. These conglomerates grade abruptly into layers of quartzite, protoquartzite, arkose, argillite and banded slate. Hubregtse (1978) described shoshonitic volcanism in the Oxford Lake Group and added that this type of volcanism is typical of a stable consolidated crust environment.

ISLAND LAKE GREENSTONE BELT (MAP ER 79-2-5) (NTS 53E 9, 10, 14, 15, 16 AND 63F 12, 13)

PREVIOUS WORK

Wright (1928) proposed a stratigraphy of the Island Lake Greenstone Belt (Table I) in which he distinguished:

(a) "Hayes River Group", a stratigraphically lower group of volcanic flows and tuffs with some interbanded sediments;

(b) "Island Lake Series", a stratigraphically higher, exclusively sedimentary group of rocks deposited on the Hayes River Group and separated from it by an erosional surface.

Wright (1928) inferred a discordance between the Hayes River Group and the Island Lake "Series" because they have markedly different dips in the Sinclair and Savage Island area. (Map ER 79-2-5) He concluded that the Island Lake "Series" was deposited "on an eroded surface of the volcanics (the Hayes River Group) and possible within a broad shallow depression". Wright (1928, p. 72).

*The Island Lake "Series" is not a true "series" in the sense of being "a clearly designated stratigraphic interval in a type area", but rather a "group" of rocks and thus "series" in the context, will be written with quotation marks.

TABLE I
SUMMARY OF STRATIGRAPHIC CORRELATIONS IN THE GODS, OXFORD AND ISLAND LAKE AREAS
(after Harrison, 1951 with modifications)

Wright (1928) Island Lake Area	Wright (1932) Oxford Lake Area	Wright (1932) Gods-Island-Oxford	Horwood (1935) Cross Lake Area	McMurchy (1944) Island Lake Area	Godard (1963) Island Lake Area	Theyer (this paper) Island Lake Area	Hubregtse (in prep.) Oxford-Knee Lake Area
Diabase Intrusive Contact Granite Granite Porphyry Basic Intrusions	Diabase Intrusive Contact Granite Intrusive Contact Basic Intrusions	Diabase Intrusive Contact Granite Quartz & Feldspar Porphyry Basic Intrusions	Diabase Intrusive Contact Granite Basic Intrusions	Diabase Intrusive Contact Granite Intrusive Contact Basic Intrusions	Diabase, Lamprophyre, Gabbro, Pegmatite, Aplite, Quartz Porphyry, Granite, Granodiorite, Tonalite, Granitic Gneiss Complex Peridotite, Pyroxenite	Diabase, Gabbro Granodiorite	Diabase, Gabbro Granodiorite
Intrusive Contact	Intrusive Contact	Intrusive Contact Island Lake Series: Grit, Congl; Quartzite (Proterozoic) Unconformity	Intrusive Contact	Intrusive Contact	Intrusive Contact	Intrusive Contact	Intrusive Contact
Island Lake "Series" Grit, Congl; Quartzite Linklater Ultramafic Suite	Oxford Sediments Slate, Greywacke, Qtzite., Ark., Congl.	Oxford Sediments Slate, Greywacke, Qtzite., Ark., Congl.	Cross Lake Series Arkose, Qtzite., Conglomerate	Island Lake Series Grit, Arkose, Greywacke, Qtzite., Slate, Conglomerate	Island Lake Series Arkose, Greywacke, Argillite, Qtzite., Conglomerate	Island Lake "group" Arkose, Greywacke, Argillite, Qtzite., Linklater Ultramafics-Extrusives and Intrusives Conglomerate, Slate	Oxford Lake Group Greywacke, Arkosic wacke Granite, Argillite, minor Iron formation, Conglomerate, Volcanogenic Sediment, Porphyritic volcanic rocks, Flows and Pyroclastics
Unconformity	Unconformity "Qtz-Eye" Granite? Intrusive Contact?	Unconformity	Unconformity	Unconformity	Unconformity	Unconformity and local disconformities	Unconformity Bayly Lake Group Tonalite, Granodiorite, Granite, Quartz wacke and Conglomerate, Intermediate and Felsic Pyroclastics Intrusive Contact
Hayes River Group Lavas & Sed. Rocks	Hayes River Group Lavas & Sed. Rocks	Hayes River Group Lavas & Sed. Rocks	Hayes River Group Lavas & Sed. Rocks Unconformity? Tonalite	Hayes River Group Lavas & Sed. Rocks	Hayes River Group Lavas & Sed. Rocks	Hayes River Group Lavas & Sed. Rocks	Hayes River Group Lavas & Sed. Rocks Peridotite and Gabbro Sills and rare Flows

Quinn and Meinert (1959) concluded that the break between the Island Lake "Series" and the Hayes River Group in eastern Island Lake is a disconformity, rather than an angular unconformity as proposed by Wright (1928).

Godard (1963a and 1963b) agreed with Wright's stratigraphic interpretation but noted that it was difficult to distinguish with certainty between the sediments of the Hayes River Group and the Island Lake "Series", due to their similar structures and lithologies.

HAYES RIVER GROUP — ISLAND LAKE "SERIES"

Although all authors who have worked in the Island Lake Greenstone Belt agree that the distinction between the two superimposed groups of rocks (Hayes River Group and Island Lake "Series") is valid in this belt within the Island Lake area, a controversy still exists as to the exact distribution of each throughout the entire greenstone belt since both groups, as defined, contain sediments (Wright, 1928; McMurchy, 1944; Quinn and Meinert, 1959; Godard, 1963a and 1963b). However, it became important to define the boundary between the two groups after it was realized that the ultramafics might have a stratigraphically consistent and diagnostic setting in this general stratigraphic position. (Theyer, 1977, 1978, 1979). As noted earlier in this report, some ultramafic bodies can be interpreted as having been emplaced as volcanic or subvolcanic eruptives at a specific stratigraphic horizon and may thus be of special economic significance (See also Chapter II).

LOCATION AND NATURE OF THE HAYES RIVER GROUP — ISLAND LAKE "SERIES" INTERFACE

The author examined most localities where the contact between the Hayes River Group and Island Lake "Series" is exposed. An angular disconformity between the rock groups was not observed. However, local erosion channels in the Hayes River Group were seen in the Loonfoot Island area together with incorporation of mafic pebbles and cobbles of the Hayes River Group into the basal units of the Island Lake "Series".

In the Stevenson Island area (Map ER79-2-5) there is a gradual and concordant progression along a 200 m south-north section from massive flows through well layered mafic tuff interbanded with argillite, to a section containing argillite with small quartz pebbles that grades into coarse polymictic conglomerates, typical of the Island Lake "Series". This vertical sequence marks a progression from a dominantly volcanic regime (massive mafic flow) through a quiet sedimentary environment (argillite bands) into a clastic sedimentary regime that grades rapidly from a few quartz pebble beds to thick polymictic conglomerate beds that are the product of rapid erosion and tubulent deposition. Similar transitional relationships were also observed in the Loonfoot Island area.

On the basis of these observations, it is tentatively concluded that the boundary between the Hayes River and Island Lake rocks is in general a narrow (up to 100 m wide) transitional zone in which volcanic rocks are gradually superceded by a sedimentary section that grades rapidly from argillites to conglomerate. Angular disconformities are rare and restricted to narrow erosional channels. It is proposed as a working model that the base of the Island Lake "Series" can be considered as the interface of the sediments with the underlying volcanic rocks. Sediments are thus considered to belong to the Island Lake "Series" only if they are part of an uninterrupted stratigraphic succession with polymictic conglomerates of the type exposed on the Sinclair Islands, the type locality of the Island Lake "Series" (Wright, 1928). This model avoids the ambiguities arising out of the presence of sedimentary layers in the Hayes River Group previously described by Godard (1963a and 1963b).

ULTRAMAFIC OCCURRENCES IN THE ISLAND LAKE GREENSTONE BELT

All ultramafic occurrences recorded on the maps accompanying this report are numbered in a sequence that follows the NTS system within each NTS Block. Appendix "A" contains tables in which additional detailed information on ultramafic localities and characteristics are given.

LINKLATER ULTRAMAFIC SUITE

A large number of ultramafic occurrences in the immediate Island Lake area of the Island Lake Greenstone Belt occur near or at the interface of the Island Lake "Series" with the Hayes River Group. On the basis of spinifex textures found in one of these occurrences, their position in the belt and their chemistry, it will be suggested that these rocks have a possible volcanic or subvolcanic origin and that their position is stratigraphically controlled. It is proposed that these ultramafic occurrences, of which the most important ones are described below, are members of an ultramafic suite to be called "Linklater Ultramafic Suite", a unit of the Island Lake "Series".

LINKLATER ISLAND, OCCURRENCE NO. 11 (MAP ER 79-2-5)

Spinifex textures were observed in a small exposure of one of the ultramafic bodies of the "Linklater Ultramafic Suite" located in northwestern Island Lake, adjacent to Linklater Island. (Theyer, 1978) (Fig. 1). Thin sections prepared from drill core of this outcrop show laths and needles of hornblende and magnetite in so-called "sargent stripes" patterns, confirming the presence of spinifex textures within the outcrop (Fig. 2).

The portion of the outcrop with spinifex textures, faintly visible on the surface, measures approximately 1m by 2m. The rock is massive and homogeneous in this portion of the outcrop. However, immediately to the west of this massive layer an inhomogeneous zone is visible over an approximate distance of 5 m measured between the spinifex layer and the edge of the water. The inhomogeneities consist of sharply defined ovoidal lenses measuring up to 1.5 m along their long axis by 1 m along the shorter axis with massive cores and thin black aphanitic selvages. These lenses are tentatively interpreted as pillows.

The existence of spinifex textures and incipient pillowing in the immediate vicinity are interpreted as evidence that the rock crystallized from an ultramafic liquid.

Chemistry

Chemical data for several ultramafic rock occurrences of the Island Lake Greenstone Belt, of the Oxford Lake Greenstone Belt and, for comparison purposes, of the Barberton area (South Africa) are assembled in Table II. These analyses indicate that all samples are of komatiitic chemistry in the sense of Arndt et al., (1976). Figures 3A and 3B (Al_2O_3 *vs* Fe/FeO + MgO) and (TiO_2 *vs* MgO) show that all samples plot in the komatite field. A ternary diagram of the Al_2O_3 *vs* (FeO + Fe_2O_3 + TiO_2) *vs* MgO (Jensen diagram) in Figure 4 shows a similar result, i.e. all points plotted fall into the komatiitic field of the diagram.

Stratigraphic Position

The ultramafic lense is in a possibly faulted contact with Island Lake type conglomerate that outcrops on the southeast of the island (see inset on the Island Lake compilation map ER 79-5). This conglomerate is composed of about 80% rounded and 20% subrounded pebbles imbedded in a fine grained, slightly chloritic arkosic groundmass. The majority of the pebbles are biotite hornblende granite with subordinate pebbles of fine grained volcanic and sedimentary rocks. A fine grained grey to black cherty argillite containing specks of pyrite and pyrrhotite is exposed on the western shore of this island.

FIGURE 1: Spinifex texture in an outcrop of ultramafic rocks in the Island Lake Greenstone Belt east of Linklater Island.

FIGURE 2: Photomicrograph of drill core from the outcrop shown in Figure 1. (Note spinifex texture.)

TABLE II: Chemical Analysis of Ultramafic Rocks from the Island and Oxford Lake Greenstone Belts and the Barberton Area (South Africa).(1)

Column	1	2	3	4	5	6	7
Samples Number	**51-8-0-5**	**51-8-19**	**51-7-108**	**51-7-95**	**34-3-1026**	**331-79**	**331-80**
SiO_2	46.19	43.51	41.67	41.16	44.65	47.22	48.56
Al_2O_3	4.72	1.87	4.14	3.33	2.85	4.10	4.78
FeO^*	9.74	8.80	13.2	9.46	12.25	12.04	10.88
CaO	6.27	0.25	1.21	1.32	2.49	6.44	7.88
MgO	32.25	42.92	34.2	37.08	35.3	27.37	24.78
Na_2O	0.02	0.01	tr	tr	0.22	0.69	0.85
K_2O	0.03	0.02	tr	tr	0.02	0.07	0.11
TiO_2	0.28	0.08	0.16	0.18	0.24	0.38	0.45
P_2O_5	0.09	0.02	0.03	0.03	0.06	0.03	0.04
MnO	0.17	0.11	0.2	0.21	0.18	0.21	0.23
NiO	—	—	0.77	0.08	0.25	—	—
Cr_2O_3	—	—	—	—	0.01	—	—
S	—	0.0	1.08	1.1	0.08	—	—

(1)All analyses recalculated less H_2O and CO_2.

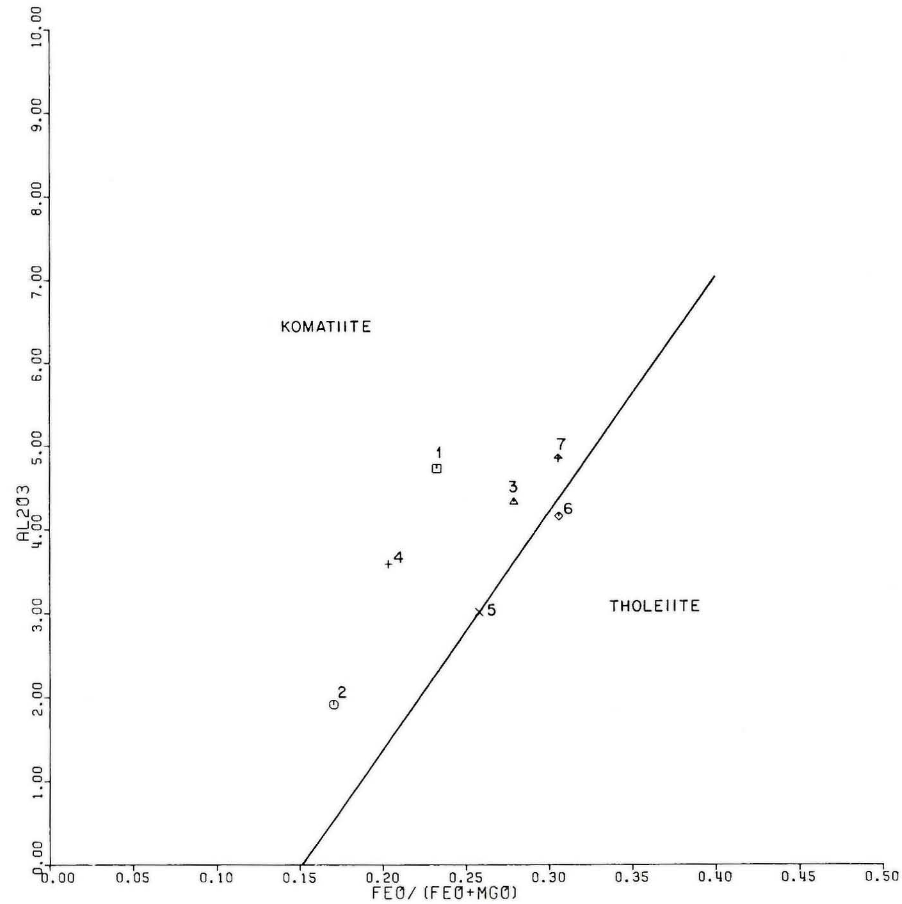
*Iron calculated as total iron and expressed as FeO.

— Analyses in Column 1 to Column 5 inclusive, by the Analytical Laboratory of the Manitoba Mineral Resources Division.

— Analyses in Columns 6 and 7 out of Nesbitt et. al., 1979, Table 1, Columns 2 and 3.

Specimen Locations and Descriptions

51-8-0-5	Spinifex textured peridotite, east of Linklater Island, Island Lake Greenstone Belt.
51-8-19	Serpentinized peridotite northeastern Linklater Island area, Island Lake Greenstone Belt.
51-7-108	Serpentinized peridotite Loonfoot Island area, Island Lake Greenstone Belt.
51-7-95	Serpentinized peridotite west of Linklater Island, Island Lake Greenstone Belt.
34-3-1026	Spinifex textured peridotite "High Rock Island" Oxford Lake Greenstone Belt. (Data supplied courtesy J.J.M.W. Hubregtse).
331-79, 331-80	Spinifex textured peridotitic komatiites, Barberton area, South Africa.



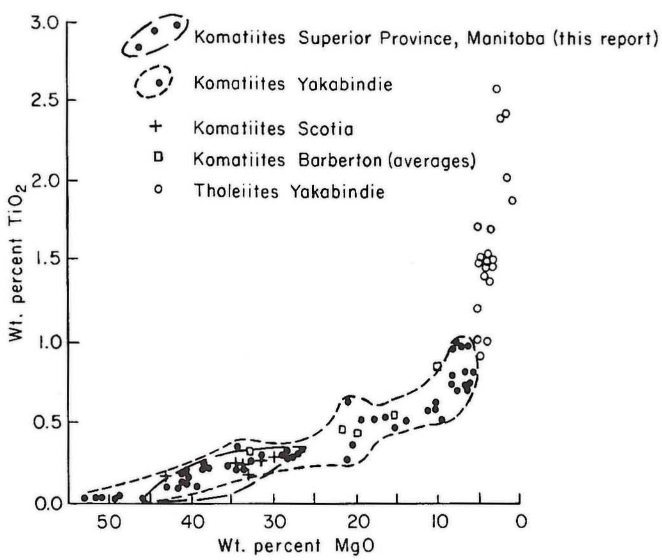


FIGURE 3: A) Weight percent Al_2O_3 vs. FeO/(FeO + MgO) diagram for ultramafic rocks of the Island Lake — Oxford Lake Greenstone Belts, and the Barberton area, (South Africa).

B) Weight percent TiO_2 vs. weight percent MgO from selected areas in South Africa, Western Australia and the Superior Province in Manitoba. (After Naldrett and Cabri, 1976.) (Analytical data assembled on Table II.)

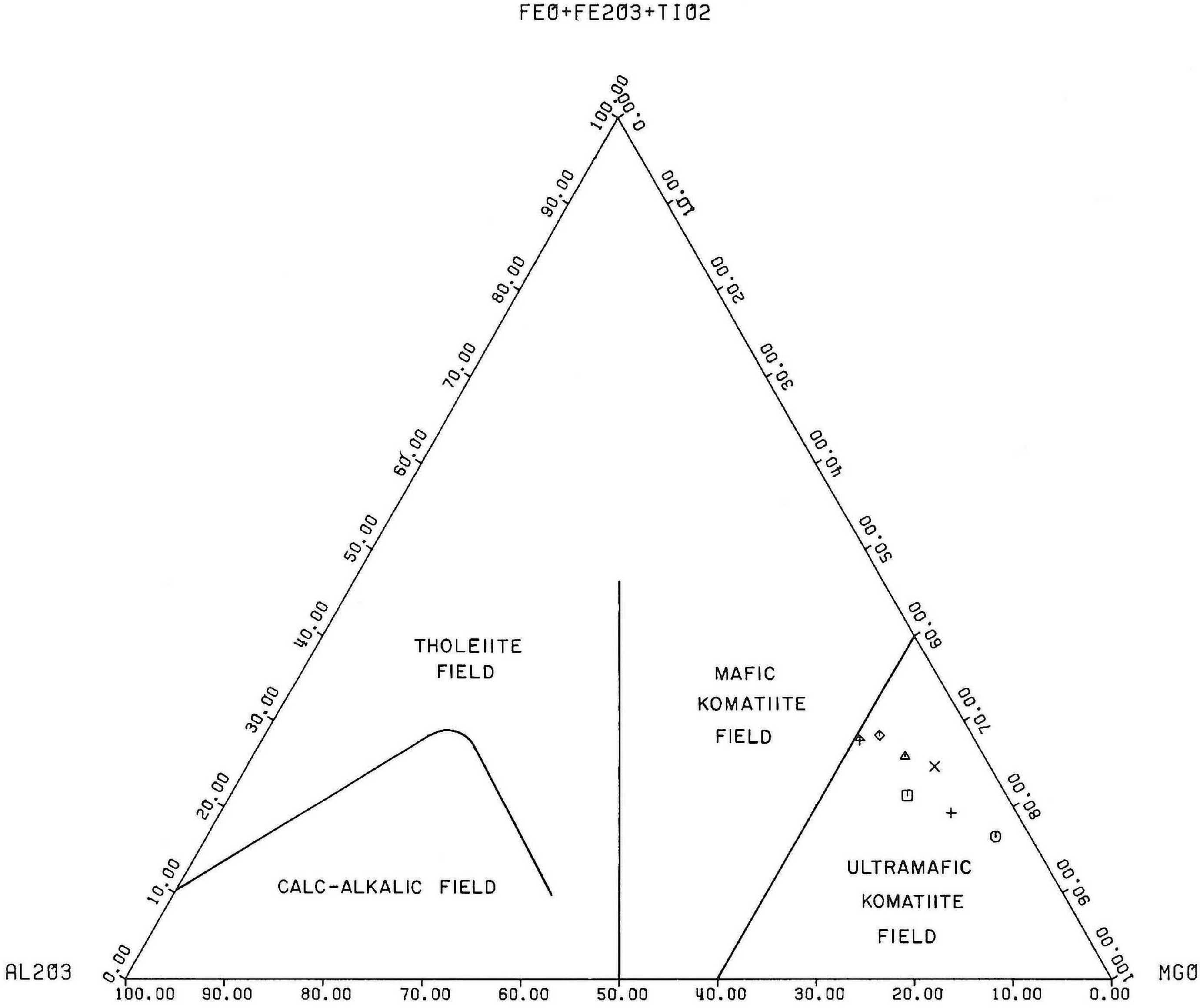


FIGURE 4: Cation diagram, Al_2O_3 vs ($FeO + Fe_2O_3 + TiO_2$) vs MgO showing compositions of ultramafic rocks of the Island Lake — Oxford Lake Greenstone Belts and the Barberton area (South Africa)

(Key to symbols on Figure 3A, analytical data on Table II)

Thick overburden conceals the relationships of the conglomerate, argillite and ultramafic rocks. However, an escarpment of the ultramafic against the conglomerate may indicate a faulted contact between these two rock types. No indication of a fault is seen in the area where argillites and ultramafics should be in contact. Thus the author infers an undisturbed direct contact between argillites and ultramafic.

A sharp contact between this ultramafic unit and overlying protoquartzite and quartz pebble conglomerate is exposed on an island located east of the island on which the quenched ultramafic occurs. A 5 mm thick layer of acicular hornblende needles in the ultramafic is attributed to metamorphic interactions between the ultramafic and protoquartzite that was deposited on the ultramafic.

Several other islands located east of the island on which this contact is exposed, are underlain by polymictic conglomerates of the type that outcrops on the Sinclair Islands, described by Wright (1928) as typical of the Island Lake "Series".

Based on the observation of spinifex textures, possible pillows, chemical composition and stratigraphic position of this occurrence, it is tentatively concluded that ultramafic body No. 11 on Map ER 79-2-5 is a "komatiitic" ultramafic flow extruded onto argillites occurring at the base of the Island Lake "Series" (see stratigraphic column, Fig. 5).

"LINKEX" AREA, OCCURRENCE NO. 7 (MAP ER 79-2-5)

The "Linkex" area explored by Canadian Occidental Petroleum Ltd. in 1974 lies northwest of the Linklater Island ultramafic zone. The area contains two ultramafic bodies of which only the northern has an aeromagnetic expression. The southern lense is in contact to the north with a sedimentary series that includes very fine grained laminated cherts, cherty argillite, and conglomerate. The conglomerate has rounded clasts (up to 10 cm in diameter) of granite, dacite, andesite and rhyolite, in a sandy chloritic matrix. This sedimentary series is interpreted as part of the Island Lake "Series". The stratigraphic relationships between the sediments and the ultramafic are unclear due to extensive overburden coverage. The northern ultramafic lense outcrops on two isolated islands.

Gabbro is exposed to the west of the southern ultramafic body whereas dacitic tuffs and pillowed lavas outcrop to the south of this lense.

Stratigraphic Position

Exposures in the "Linkex area" are not as widespread as at the Linklater Island occurrence, nevertheless, based on the available evidence it appears that the position of the "Linkex" ultramafic zone occurs near the interface of the sediments of the Island Lake "Series", and the volcanic rocks of the Hayes River Group. Thus, this occurrence is by definition most likely a member of the Linklater ultramafic suite.

Chemistry

Chemical data for a sample of the "Linkex" occurrence is given in Table II, Column 4, and is plotted on the binary and ternary diagrams (Figs. 3A + B and 4). The data suggests that this rock is of generally similar chemical composition to the Linklater ultramafic, although of significantly lower SiO_2 and higher MgO contents. The diagrams indicate that the sample has a chemistry characteristic of komatiitic ultramafic rocks.

"SOAPSTONE QUARRY", OCCURRENCE NO. 19 (MAP ER 79-2-5)

This ultramafic lense which is also interpreted as a part of the Linklater ultramafic suite, outcrops along the northern shore of an island located west-southwest of Stevenson Island. It is in fault contact with a fine grained faintly layered gabbro which closely resembles other gabbroic bodies in the Hayes River Group. In this study the gabbros are thought to be products of intensive feldspar metasomatism of mafic volcanics, often observed in the Hayes River Group that outcrops on Henderson Island and Jubilee Island.

This ultramafic occurrence is separated from the northern mainland by a stretch of lake approximately 100 m wide. The mainland's shore is underlain by intensely folded, fine grained, dark, cherty argillite containing quartz pebbles and clastic fragments of igneous rock. This unit is in contact to the north with polymictic pebble conglomerates in a coarse sandy matrix.

Stratigraphic Position

This ultramafic occurrence may be part of a differentiated mafic-ultramafic sill if the rock outcropping to the south of the peridotite is a true gabbro. However, the author interprets this rock to be derived from metasomatized mafic volcanic rocks of the Hayes River Group and the sediment outcropping on the northern mainland as parts of the Island Lake "Series", thus effectively locating the ultramafic zone between these two groups.

HENDERSON ISLAND AREA, OCCURRENCES NO. 24 and 25 (MAP ER 79-2-5)

Of these two occurrences only the eastern lense (#25) is definitely known to be an ultramafic rock. The western occurrence (#24) is inferred to be an ultramafic lense from its apparent stratigraphic position and aeromagnetic signature (Theyer, 1979).

Three drill holes intersected a rock described on drill logs as being a "peridotite" in the eastern occurrence (for details see Appendix B, Island Lake Area, Borehole data from Cancelled Assessment Files). The peridotite is enclosed by hornblende schist.

The inferred ultramafic lense appears to underlie an approximately 100 metre wide graben structure that trends east (Map ER 79-2-5). Steep outcrops rise above both sides of the trench. On the southern side are highly metamorphosed hornblende gneiss and hornblende schist derived from tuffs of the Hayes River Group. The northern wall is deformed conglomerate. Deformation is intense, and has reduced the pebbles and the fine grained arkosic matrix to an ultramylonite with a peculiar, knotty looking surface caused by the relict pebbles. The true conglomeratic nature of this rock is only recognizable in a less deformed outcrop a few metres north of the trench. The conglomerate here carries quartz pebbles of uniform size and rounding, imbedded in an arkosic matrix. This type of conglomerate is part of the Island Lake "Series" and has been recognized elsewhere in various localities. The author believes that this inferred ultramafic lense (#24), and the proven ultramafic lense (#25), on strike to the east, are both stratigraphically controlled by the interface of the Hayes River Group and the Island Lake "Series" and thus includes them into the Linklater ultramafic suite.

LOONFOOT ISLAND AREA, OCCURRENCES NO. 29 AND 30 (MAP ER 79-2-5)

Occurrence No. 29* is located in a channel between Loonfoot Island in the south and Whiteway Island to the north. It outcrops as a small isolated reef of peridotite containing disseminated pyrrhotite and pyrite. A sample from this outcrop was reported to contain 0.72% nickel and 0.02% cobalt. (Quinn, 1960).

Occurrence No. 30 is completely covered by water and is located approximately 1.5 km northeast of Occurrence No. 29. The north shore of a small island immediately south of this occurrence is composed of polymictic conglomerate containing lensoid pebbles of coarse grained biotite hornblende granite and minor felsic porphyritic volcanic rock embedded in an arkosic matrix. The first two metres of conglomerate contain numerous cobbles and pebbles of mafic volcanic composition derived from the underlying Hayes

*Outline and drillhole patterns — Published with permission of Cominco Ltd., 1979.

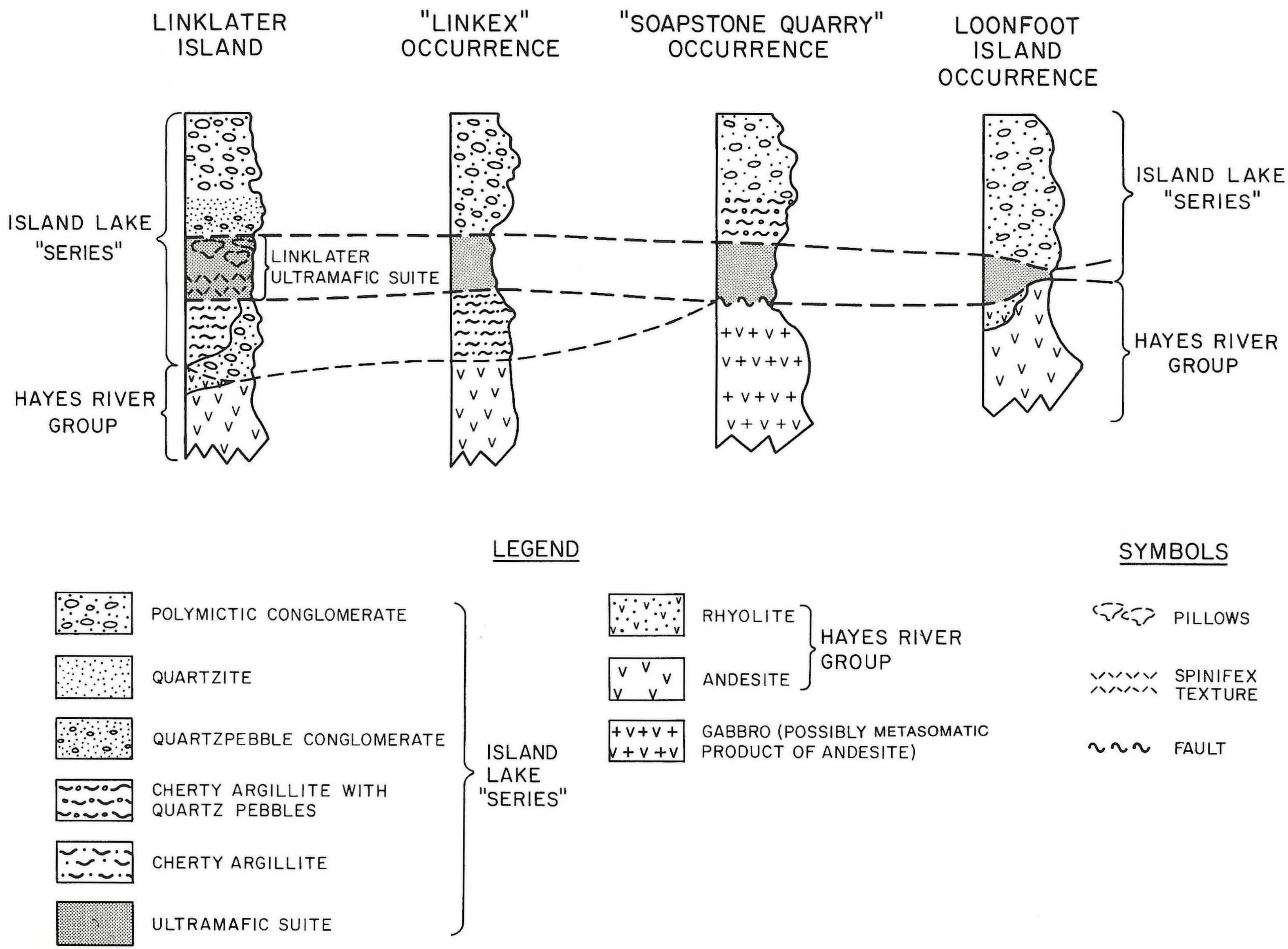


FIGURE 5: Schematic stratigraphic columns of selected areas of the Island Lake Greenstone Belt.

River Group. The conglomerate was deposited disconformably on mafic volcanic rocks of the Hayes River Group. A schematic stratigraphic column (Fig. 5) shows the inferred position of this lense. It is concluded that this lense is also probably stratigraphically controlled and lies in a stratigraphic position similar to the ultramafic lense of Linklater Island.

Occurrence #28 outcrops on a shoal in southeastern Island Lake. It is a mineralized body of serpentinized peridotite in contact on the south with felsic volcanic rocks. These felsic volcanics are thought to be part of the Hayes River Group. Outcropping approximately 30 metres to the north, are polymictic conglomerates typical of the Island Lake conglomerates.

The eastern end of Occurrence #34 outcrops on a small reef and is massive pyroxenitic peridotite. On the adjacent island approximately 50 metres to the north are vertically dipping sedimentary rocks comprising sandstone, quartz pebble conglomerate and slate, which closely resemble the sediments enclosing the quenched ultramafic of Linklater Island.

WAPUS BAY, OCCURRENCE NO. 1 (MAP ER 79-2-1)

Quinn (1960) tentatively interpreted the Wapus Bay Greenstone Belt as being the eastern extension of the Bigstone-Knight Lake Greenstone Belt. Located in the southwestern part of Island Lake, it is separated from the Island Lake Greenstone Belt by a granitic terrane. Ames (1975) reported ultramafic rocks south of and at the entrance to Wapus Bay in contact with amphibolite and gabbro, and cross cut by granite.

Field examinations by the author in 1979 in the area south of Wapus Bay and south of Highway Bay were not successful in locating the reported ultramafic rocks in this area due to lack of exposures. Nevertheless, their presence is suggested by an aeromagnetic anomaly that straddles the southern shore of Wapus Bay and extends to the south of Highway Bay. The anomaly shows a very steep gradient and a maximum intensity of up to 2500 gamma above background (Federal-Provincial aeromagnetic map #7274G, 53/E).

DISCUSSION

Ultramafic lenses were apparently emplaced on a specific stratigraphic horizon in the lower part of the Island Lake "Series" that can be traced in the Island Lake Greenstone Belt for a minimum strike length of 60 km. (Fig. 5) Spinifex textures and possible pillows, found in one of the lenses on this horizon suggest a volcanic origin for the ultramafic. All the previously described ultramafic lenses of the Island Lake Greenstone Belt are located in or at least in the immediate vicinity of sediments that may be fine grained in some cases, but invariably grade into or are in connection with coarse polymictic conglomerates. The co-existence of sediments including coarse conglomerates and stratabound ultramafic rocks interpreted to be flows appears to be best explained by a genetic model proposed by Naldrett and Turner (1977) for the emplacement of ultramafic flows in the Yakabindie area of Western Australia. They described the occurrence of ultramafic and mafic lavas, acid volcanics and sediments including polymictic conglomerates and explained this stratigraphy "in terms of incipient rifting, similar to the Red Sea, which never reached the proportions of an ocean basin". (Naldrett and Turner, 1977, p. 90). They interpreted the sediments to be partially derived from volcanics and partially from the walls of a graben. The author proposes that the ultramafic lenses of the Linklater ultramafic suite of the Island Lake Greenstone Belt are genetically related and were deposited in a similar way as that proposed by Naldrett and Turner (1977).

OTHER ULTRAMAFIC BODIES OF THE ISLAND LAKE GREENSTONE BELT

Data on ultramafic bodies that have not been studied in detail can be found tabulated in Appendix "B".

PICKET LAKE AREA, (MAP ER 79-2-1, NTS 63E/11)

Picket Lake is located at the eastern extremity of the Bigstone — Knight Lake Greenstone Belt. Quinn (1960) notes felsic and mafic volcanic rocks of the Hayes River Group in this area. R. Herd (pers. comm., 1979) stated that ultramafic sills interlayered with gabbro occur to the south and southwest of Picket Lake. He also reported polymictic conglomerates but could not remember evidence of a stratigraphic association of the ultramafic bodies with the conglomerates.

A visit to the area south of Picket Lake during the 1979 field season disclosed a dominantly mafic volcanic domain including finely banded lavas, massive flows and gabbroic intrusives. Neither polymictic conglomerates nor ultramafic rocks were observed. However, a magnetic high (up to 2 000 gammas above background), Occurrence No. 2, with a steep gradient located west and southwest of Picket Lake (see Federal-Provincial aeromagnetic map series 7274 53/E) tends to suggest the existence of an ultramafic body.

PONASK LAKE — PONASK RIVER BELT (MAP ER 79-2-4F, NTS 63H 15, 16)

LOCATION AND PREVIOUS WORK

This greenstone belt, can be traced for a distance of approximately 65 km from Stevenson Lake to a point 20 km southwest of Ponask Lake. It is generally narrow (500 metres wide) but may be up to 6 km wide at some localities.

Previous geological work in the area was carried out by Ermanovics (1973). Map ER 79-2-4F is based on his work.

GENERAL GEOLOGY

Ermanovics (1973) divided the belt into a northern, dominantly sedimentary domain and a southern, dominantly volcanic domain. The northern fringe of the belt appears to be intruded by diorite, whereas the southern edge lies at a faulted contact with quartz-diorite. All rocks of the belt are intensely deformed.

Epidote-chlorite schists and epidotized andesite were inferred by F.J. Elbers (pers. comm., 1979) to have been derived from basic to intermediate volcanic rocks. Elbers suggested that thin black aphanitic layers were pillow selvages. Greywacke with arenaceous and argillaceous beds occur to the north of the volcanic suite. The arenaceous beds contain minor pebble layers and feldspar fragments.

ULTRAMAFIC OCCURRENCES

Ermanovics (1973) described the ultramafic occurrences on Ponask Lake as lenses and plugs of medium-to fine-grained amphibolite which he believed to have been orthopyroxene cumulates containing interstitial clinopyroxene. On a small scale map (1:250 000) prepared by Ermanovics (1973) the ultramafic rocks appear to be concentrated on or near the northern edge of the volcanic group, i.e. at or near the contact between the volcanic and sedimentary rocks. Ermanovics (pers. comm., 1979) also stated that an ultramafic lense at the southwest end of Ponask Lake occurs at the interface of volcanic and sedimentary rocks. Detailed mapping of the lenses and surrounding rocks is required before definitive statements can be made.

BIGSTONE-KNIGHT LAKE GREENSTONE BELT (MAP ER 79-2-5D, NTS 53E 11, 12, 13)

PREVIOUS WORK

McIntosh (1938) separated the rocks in the belt into a sequence of volcanic rocks (andesite with subordinate dacite and rhyolite) and a sequence of fine grained clastic sediments (arkose, greywacke, sandstone). He considered that the sediments occupied the trough of a synclinal structure in the volcanic sequence and tentatively correlated the volcanic sequence with Wright's (1928) Hayes River Group and the sediments with Wright's (1928) Island Lake "Series" of the Island Lake Greenstone Belt.

Quinn (1960) did not change McIntosh's interpretation and tentatively connected the Bigstone-Knight Lake Greenstone Belt with the Wapus Bay Greenstone Belt of southern Island Lake.

Ermanovics et al, (1975) and Herd and Ermanovics (1976) mapped the Island Lake, Stevenson Lake and Bigstone — Knight Lake Belts and concluded that these were formerly one continuous volcanic belt. They recognized two rock sequences in the Bigstone Lake area, a stratigraphically lower mainly volcanic sequence the "Lower Series", overlain by the "Upper Series" consisting of a lower, predominantly clastic sedimentary portion, succeeded by an upper, predominantly volcanic portion.

These authors conformed to McIntosh's (1938) interpretations by correlating the "Lower Series" with the Hayes River Group, and the "Upper Series" with the Island Lake "Series". They recognized that the volcanic portion of the "Upper Series" is not entirely correlatable with the Island Lake "Series", which by Wright's definition is devoid of volcanic rocks; Herd and Ermanovics (1976) stated: "the occurrence of volcanic rocks above the clastic sequence in the Bigstone Lake and Stevenson Lake Belt as reported in Ermanovics et al. (1975) is an unresolved problem." (Herd and Ermanovics, 1976, p. 394).

ULTRAMAFIC OCCURRENCES

Three ultramafic occurrences were reported by Park and Ermanovics (1978) in their final report for this area. A fourth occurrence was recorded on a map published in a previous report (Ermanovics et al., 1975), however, this occurrence was not included on their final map. Of the four occurrences, the present author has concluded that one (Occurrence No. 3) is a serpentinized ultramafic. The other three occurrences are hornblendites and may have been derived from mafic volcanic rocks.

Occurrence No. 3 is a serpentinized ultramafic lense which outcrops on islands near the eastern shore of Bigstone Lake (Map ER 79-2-4D). It is stratigraphically underlain by a massive fine grained dark grey gabbro which is in turn underlain by mafic volcanic rocks. The serpentinite is overlain by a very fine grained banded sitty sandstone, which is a member of the sedimentary "Upper Series" of Ermanovics et al., (1975). These sediments outcrop on several islands adjacent to the eastern shore of the lake. Approximately 30 metres to the north, on strike with the outcrop of ultramafic rocks but at the tip of the peninsula is a 3 metre thick layer of monomictic siliceous breccia that contains slightly rounded fragments ranging in size from 1 to 25 cm in a fine grained arkosic matrix. The fragments comprise 85% to 90% of the rock. This unit is probably a slump breccia indicating a steep slope and rugged topography at the time of its formation (Theyer, 1979).

DISCUSSION

Although a total of four ultramafic lenses were previously reported, (Ermanovics et al., 1975; Park and Ermanovics, 1978) only one appears to be a genuine ultramafic in the context of this study. Conclusions regarding the mode of emplacement of this ultramafic occurrence and its stratigraphic position relative to the extrusive "Linklater Ultramafic Suite" will only be possible after proving that the "Lower" and "Upper Series" of Ermanovics et al., (1975) are correlatable with the Hayes River Group and the Island Lake "Series" respectively, of the Island Lake Greenstone Belt.

BEAVER HILL — GOOSE LAKE AREA (MAP ER 79-2-4I, NTS 53L/6, 7)

PREVIOUS WORK

Geological reports and maps of the area have been published by (Wright, Quinn and Currie, 1961; Elbers, 1972; Macek and Trueman, 1972; Elbers and Marten, 1973; and Elbers, in prep.).

GENERAL GEOLOGY

The greenstone belt consists of a series of volcanic and sedimentary rocks metamorphosed to amphibolite grade and surrounded by large granite plutons. In the eastern part of this area (Map ER 79-2-4 I) near Goose Lake, the belt is divided into a predominantly volcanic portion that underlies the shore and the area south of Goose Lake, and a predominantly sedimentary sequence underlying the northern portion of the belt.

VOLCANIC AND VOLCANOGENIC ROCKS

This group of rocks comprises pillowed basalts, mafic tuffs, mafic agglomerate and layers of slaty argillite and greywackes. Pillows are rarely recognizable, however, an abundance of quartz filled vesicles is interpreted to show the presence of mafic tuffs. (Elbers, in prep.). Minor felsic volcanic tuffs were metamorphosed to mica-quartz schists. Volcanic flows are often intimately mixed with volcanogenic sediments and greywacke.

SEDIMENTARY ROCKS

Clastic sediments including feldspathic wacke, quartz wacke, arkose, and protoquartzite comprise this rock group. Elbers (in prep.) mentions conglomerate underlying the northern portion of Goose Lake. Clasts are described as spheroidal, ellipsoidal, and well rounded and include the following rock types: granodiorite (55%), aplite (20%), felsite, (10%), and slate (5%). Elbers (in prep.) speculates that the source of this conglomerate lies in a granodiorite terrane cut by numerous granitic aplites.

ULTRAMAFIC OCCURRENCES

Four ultramafic bodies outcrop in the Goose Lake Greenstone Belt. One of these underlies part of northern Beaver Hill Lake. The others outcrop on islands and peninsulas in Goose Lake.

Goose Lake

The ultramafic bodies of Goose Lake as described by Elbers (in prep) are serpentinized and carbonatized bodies. Lenses No. 1, 2 and 3 are reflected by a steep magnetic anomaly that shows two separate peaks suggesting that the ultramafic body exposed at outcrop No. 1 has an extension to the west and that outcrops No. 2 and 3 are the two extremes of a single body.

These ultramafic lenses are located at the interface between volcanic and sedimentary sequences, a position that is stratigraphically similar to that of ultramafic lenses in other greenstone belts of the Superior Province. However, the stratigraphic sequence of the Goose Lake Greenstone Belt is currently a matter of controversy, and this comparison may thus be invalid. Elbers (in prep.) interprets top directions from graded bedding, ripple marks and other sedimentary criteria which indicate that the sedimentary group underlies the volcanic rocks. Other workers (J.J.M.W. Hubregtse, W. Weber, pers. comm., 1979) maintain that top directions determined from sedimentary rocks indicate that the sedimentary group overlies the volcanic group.

Beaver Hill Lake

This body appears to be a broadly folded ultramafic to mafic layered complex. It is composed of peridotite, clinopyroxenite and gabbro. It appears that the complex is discordant to the country rocks (Scoates, Trueman and Macek, 1972).

INFERRED ULTRAMAFIC OCCURRENCES OF THE PONASK LAKE AREA (MAP ER 79-2-4F)

Two aeromagnetic anomalies (I and II) are indicated on the compilation map (ER 79-2-4F) and on the corresponding aeromagnetic insert. They are shown as Anomalies I and II. Both occur at a volcanic sedimentary contact.

Anomaly I is relatively broad and weak, (250 gamma above background) and may possibly be attributable to a deeply buried ultramafic lense (Hosain, pers. comm., 1979). Anomaly II however, located on the same stratigraphic interface to the west of Anomaly I, has features thought to be typical of aeromagnetic anomalies caused by ultramafic lenses. These are elongate, lensoid shapes and steep magnetic gradients.

MUNRO LAKE AREA (MAP ER 79-2-4C, NTS 63L/11)

PREVIOUS WORK

The Munro Lake area was mapped by Wright (1932b), Wright, Quinn and Currie (1961) and Barry (1962). Additional geological information, particularly for the western part of the Munro Lake Belt, can be found in Elbers and Marten (1973) and is also contained in Elbers (in prep.).

GENERAL GEOLOGY

The Munro Lake area is underlain by an east-west trending greenstone belt approximately 6 km wide that is flanked to the north and south by migmatitic gneisses. The western end of the belt is truncated by a granodiorite pluton. Towards the east the belt narrows to a width of less than 1 km in the Southern Gods Lake extension.

The rocks in the belt comprise basalt, andesite, tuff, metasediments, derived schists and mafic intrusions and are believed to be typical of the Hayes River Group (Barry, 1962). Thin bands of tuffs and tuffaceous sediments occur, interbedded with flows throughout the greenstone belt. Three predominantly volcanic domains (northern, central, and southern) are separated by two sedimentary domains. The widest of these two sedimentary domains is 1 800 m in width north of Reekie Lake. (Barry, 1962, Map 61-1). The rock sequence comprises hornblende-biotite schist, slate and fine grained greywacke. These fine grained sediments include a prominent conglomerate unit that is approximately 30 metres wide and outcrops for a distance of approximately 10 km along strike. The conglomerate is poorly sorted and contains fragments of greenstone and gabbro as well as felsite. It is strongly drag folded and at the west shore of Lake "X" appears to be steeply dipping and overturned.

ULTRAMAFIC OCCURRENCES

Of the five known ultramafic occurrences in the Munro Lake area, two occur in volcanic rocks (occurrences #7 and #9) and three in sedimentary rocks (#8, #10 and #11).

The following descriptions refer to the ultramafic occurrences that are considered to be of special interest in this study. All additional data for these and other ultramafic occurrences are tabulated in Appendix "A".

Rifle Lake Occurrence No. 8 (Map ER 79-2-4C)

Ultramafic rocks are exposed on small reefs near greywacke on the south shore of Rifle Lake. The ultramafic zone was drilled by Falconbridge Nickel Mines Limited in 1968. The holes reportedly intersected ultramafic rocks, argillite, quartzite and tuff. No further information on these occurrences is available.

Reekie Lake Occurrence No. 10 (Map ER 79-2-4C)

Two holes drilled by Falconbridge Nickel Mines Limited intersected an ultramafic lense flanked by "tuff" to the south and "quartzite" to the north.

INFERRED ULTRAMAFIC OCCURRENCES

Two aeromagnetic anomalies are highlighted on the map insert (ER 79-2-4C). The one centered over Rifle Lake is thought to be caused by the previously mentioned ultramafic body.

A second narrow and elongated (19 km long x 1 km wide) anomaly stretches from Western Colen Lake to Reekie Lake to a small unnamed lake east of Reekie Lake. This anomaly is composed of several smaller anomalies which vary in intensity from 250 to 300 gammas above background (see aeromagnetic insert on map ER 79-2-4C). Most of the smaller magnetic peaks are caused by known ultramafic bodies, with the exception of the two that are grouped under IV to the east of anomaly No. 7, and III, located on the north shore of an unnamed lake east-southeast of Reekie Lake. Because their location is on strike with known possibly stratabound ultramafic lenses and because of their magnetic characteristics, these anomalies may also be caused by ultramafic lenses.

DISCUSSION

In the Munro Lake — Rifle Lake area, ultramafic occurrences No. 8, 9 and No. 10 appear to lie near the interface of volcanic rocks (tuffs) and sedimentary rocks (quartzites); however, the author has not visited the area and is therefore unable to comment further on the precise stratigraphic position of the ultramafic rocks. The occurrence of a polymictic conglomerate band within a sedimentary sequence of considerable width (Barry, 1962, p. 8 and 9) leads the author to concur with Elbers' contention (Elbers, in prep.) that this sequence is not correlatable with the Hayes River Group as proposed by Barry (1962). Following Elbers (in prep.) it is thus proposed that only the volcanic portion of the greenstone belt may be correlatable with the Hayes River Group and that the sedimentary portion is equivalent to the Island Lake "Series" or the Oxford Lake Group.

CARROT RIVER AREA (MAP ER 79-2-4E, NTS 63I/10, 15, 16)

GENERAL GEOLOGY

The Carrot River area is underlain by a narrow, discontinuous belt of mainly volcanic rocks believed to be part of the Hayes River Group (Barry, 1960; Hubregtse, in prep.). The belt is divided into an eastern and western part by tonalitic intrusions.

Hubregtse (in prep.) postulates that the Hayes River Group of the Carrot River Belt comprises the eastern extension of the southern limb of the Hayes River Group exposed at Oxford Lake. He bases this interpretation on similarities in stratigraphy, widths, and facing directions in the two areas.

The volcanic rocks of the Carrot River area are predominantly basalts, although rhyolitic and dacitic flows are present, especially in the eastern part of the belt. Sedimentary rocks are rare, occurring mainly as iron formation and conglomerate beds in the western part of the Carrot River area. The conglomerates consist of cherty pebbles and fragments of tuff, andesite, dacite and diorite. Barry (1960) noted that granitic components common in conglomerates of the Oxford Group were not found in the Carrot River conglomerate bands.

In bore holes drilled by Canex Placer Limited (Assessment File number in Appendix "A") greywacke, quartzite and siltstone are reported to occur in contact with serpentinized peridotite.

ULTRAMAFIC OCCURRENCES

Six separate bodies of ultramafic rocks are known in the Carrot

River Area. (Map ER 79-2-4E).

Hubregtse (in prep.) briefly describes these bodies. Details on the petrography and mineralization of the "Peridotite Island" sill are contained in an unpublished thesis by Davidson (1974).

The ultramafic sill at "Peridotite Island" is partially exposed along the south shore, approximately 250 m thick and its eastern extension is in a brecciated contact with a granitic pluton, which is in turn crosscut by a gabbroic intrusion (Davidson, 1974). The western extension of the sill is a thin, brecciated carbonate-rich serpentinite layer. Davidson (1974) described this sill as being differentiated into olivine peridotite, pyroxenite and metagabbro and proposed that the sill was generated by emplacement of a partially crystallized "supermafic" melt. Nickel-copper sulphides in uneconomic concentrations are present within the intrusion. Davidson (1974) accounted for the sulphide concentrations by a process of sulphurization of the hot intrusive by sulphur derived from adjoining volcanic and metasedimentary rocks or from a granitic intrusion.

He concluded that nickel sulphides were scarce or non-existent in the intruding melt and were only generated by post-emplacement sulphidization of silicate bound nickel. If true, this deposit may have little potential, as the formation of economic concentrations of nickel sulphides by such a process seem unlikely. As discussed earlier in the report (p. 9) the "sulphurization" model of Naldrett (1966) is not currently considered valid for the explanation of ultramafic associated economic nickel deposits; however there may be alternative interpretations to explain the "Peridotite Island" mineralization.

CROSS LAKE, ECHIMAMISH RIVER, MAX LAKE (MAP ER 79-2-4G and ER 79-2-3A, NTS 53L/12, 63I/5, 6, 7, 8, 9, 12, 13, 14)

PREVIOUS WORK

The first geological work in this area was presented by Horwood (1934). He divided the rocks of this belt into two groups: the predominantly volcanic Hayes River "Series" overlain with angular disconformity by the predominantly sedimentary Cross Lake "Series". Horwood noted that mafic volcanic pebbles, which he thought were derived from the underlying volcanic rocks occur in the basal layers of the sedimentary group.

Bell (1962) mapped and compiled the geological information available for the Cross Lake Greenstone Belt. He noted that sediments occur interbedded with volcanic rocks and that sporadic tight synclinal folding makes subdivision of the two groups difficult. Moreover, he remarked that he was unable to corroborate the existence of Horwood's reported angular unconformity between the two rock groups and stated that final clarification might be expected only from detailed mapping in the Cross Lake Area.

Rousell (1965) disagreed with Horwood's (1934) geological subdivision, stating that he was unable to find the angular unconformity and that he was unable to observe a succession of basalt pebbles followed by tonalitic pebbles in the overlying sediments. He proposed abandonment of Horwood's subdivision and inclusion of both volcanic and sedimentary rocks in a "Cross Lake Group".

The Max Lake area was studied by Hubregtse (1974) who described a central metasedimentary unit flanked by metabasalt. He found two ultramafic layers at the southern interface of metasediments and basalts.

GENERAL GEOLOGY

Mafic to intermediate volcanic rocks comprise the bulk of the Hayes River Group. These include andesite, biotite-hornblende-plagioclase schist and chlorite schist. Locally, intercalated bands of silica-rich sediments or tuffs give the rocks a well layered appearance.

Sediments can occur interbedded with the volcanic rocks of the Hayes River Group in bands of varying widths. They can also occur as a thick sedimentary succession capping the underlying volcanic rocks and were separated into a new stratigraphic group, the Cross Lake Group (Horwood, 1934, 1936).

Bell (1962) believed that intravolcanic sedimentary layers may be members of an intermittent sedimentary series of which the younger members were included in the Cross Lake Group. The Cross Lake Group includes slate, sericite schist, greywacke, quartzite, sandstone and conglomerate. The conglomerates occur in bands and lenses or as massive units up to 30 metres thick. They consist of pebbles and cobbles of granodiorite and tonalite gneiss, quartz, chert, quartzite and basalt.

Conglomerates have been described from various locations of the Cross Lake Greenstone Belt (see Map ER 79-2-3A and Map ER 79-2-4G). They unconformably overlie biotite granodiorite gneiss to the north of Cross Lake. Most of the boulders are biotite granodiorite gneiss that are identical to the underlying gneiss (Rousell, 1965). Rousell (1965) also described conglomerates that contain granodiorite boulders up to 1.2 metres by 2 metres occurring at the east end of Pipestone Lake.

Pebbles of quartz and quartzite are abundant in conglomerates at the west end of Cross Lake. In addition, conglomerate lenses with a variable content of igneous, volcanic and sedimentary components were reported from islands between Cross Lake and Pipestone Lake (Rousell, 1965).

A narrow elongated band of sediments roughly 30 km long including quartzite, conglomerate, dacite and greywacke was reported to strike east from south of Butterfly Lake to Painted Stone Portage on the Echimamish River (Bell, 1962).

Conglomerate apparently also underlies volcanic rocks. A conglomerate band, approximately 10 km in length, is reported to occur north of Robinson Lake. Its width varies from 100 to 250 m. The majority of the components were reported to be tonalite and granodiorite gneiss with minor leuco-granite and quartz.

ULTRAMAFIC OCCURRENCES

Occurrence No. 3

Peridotite and serpentinite within the volcanic sequence near the west end of Pipestone Lake, were reported by Bell (1962). Sediments including quartzite, arkose, greywacke, argillite and minor pebble conglomerate outcrop a few hundred metres northeast of the ultramafic lense. Rousell (1965) mapped garnet diopside schist in this location and a metasedimentary sequence including greywacke, siltstone and minor conglomerate on the northeastern shore of the Nelson River. Combining the data from both maps leads to the interpretation that an ultramafic lense occurs at the interface of the Hayes River Group and the Cross Lake Group. This interpretation is shown on Map ER 79-2-3A.

Occurrence No. 4

According to information from a drilling program conducted by Noranda Mines Limited*, an ultramafic lense lies beneath the water of Sandy Bay in Cross Lake. The eastern shore of Sandy Bay is underlain mainly by granodiorite gneiss that is overlain discordantly by polymictic conglomerate containing pebbles derived from the underlying gneiss. The western shore of the bay is underlain by basalt. Based on this information, the Sandy Bay ultramafic appears to lie between conglomerate and basalt. Assuming that the western shore basalts represent a part of the Hayes River Group, and that the

*Results contained in Assessment Report #91262, Geoscience Data Section, Manitoba Mineral Resources Division.

(overlying?) conglomerates are correlatable with the Cross Lake Group, the Sandy Bay ultramafic may be interpreted as lying close to the interface between the two groups, in a stratigraphically similar relationship as other Superior ultramafics discussed appear to have with the Hayes River — Island Lake "Series" interface.

INFERRED ULTRAMAFIC OCCURRENCES

A total of nine aeromagnetic anomalies are highlighted on Map ER 79-2-3A. They are grouped arbitrarily into a southern group #VII and a northern group #IX. Brief descriptions are tabulated in Appendix "A".

These anomalies are thought to be caused by narrow elongated highly magnetic ultramafic bodies located on a stratigraphically defineable horizon, because they are all located on and on strike with the interface of the Hayes River Group and the Cross Lake Group. The longer axes of the anomalies are oriented parallel to the strike of the belt's fabric and they show steep gradients and intensities up to 1 000 gamma above background.

OXFORD — KNEE LAKE GREENSTONE BELT (MAP ER 79-2-3B, NTS 53L/13, 14, 15)

LOCATION AND GENERAL GEOLOGY

This greenstone belt ranges in width from 3 to 16 km and extends from Carrot River to Gods Lake, a distance of over 100 km. The generalized geology of the area between Lynx Bay and northern Knee Lake is shown on Map ER 79-2-3B.

Wright (1932a) subdivided the belt into the volcanic Hayes River Group and the stratigraphically overlying sedimentary Oxford Lake Group. The two groups are separated by an angular unconformity, and basal conglomerates of the Oxford Lake Group appear to be derived from erosion of the Hayes River Group. This stratigraphic subdivision has been adopted by Barry (1959, 1960, 1963); Gilbert and Elbers (1972b); Elbers (1973); and Hubregtse (1978) all who have subsequently mapped in the area.

An U-Pb age of 2.7 Ga was determined on zircons in dacites of the Hayes River Group (Catanzaro, unpubl.). A minimum Rb/Sr wholerock age of 2 455 ± 35 Ma has been established for part of the Oxford Lake Group from a granite-granodiorite that intrudes the Oxford Lake Group (Cheung, 1978).

ULTRAMAFIC OCCURRENCES OF THE OXFORD LAKE AREA

All the known ultramafic bodies in this belt occur within volcanic rocks of the Hayes River Group. This situation appears to be unusual considering that the majority of the other known occurrences within greenstone belts of the Superior Province in Manitoba seem to be controlled by the interface of the Hayes River Group with overlying sedimentary sequences. Ultramafic occurrences No. 19 and No. 21 are described below, No. 20 and No. 22 are tabulated in Appendix "A".

Occurrence No. 19

This ultramafic body is located on a peninsula on "Bleak Island" in Carghill Channel, Oxford Lake. It is a peridotite sill that cuts an intravolcanic gabbroic sill. The gabbroic sill is overlain by an oligomictic conglomerate layer in which the clasts are largely derived from the gabbro and to a minor extent from an adjacent rhyolitic stock. The relationship between this erosional surface and the emplacement of the ultramafic lense is not resolved since ultramafic components have not been found in the conglomerate (Hubregtse, pers. comm.). The evidence suggests that a ultramafic intrusive or extrusive (?) episode occurred after emplacement of the gabbro and possibly after the weathering of the latter intrusion.

Occurrence No. 21

This ultramafic outcrop is located on a small island east of "High Rock Island". Hubregtse (1973b, and in prep.) reports that the exposure is part of a differentiated layered ultramafic that is concordant with an underlying iron formation and an overlying variolitic pillow lava. It has been traced along strike for a distance of approximately 3 km and is up to 150 metres wide.

Spinifex textures and partial assimilation of the underlying iron formation, forming local accumulations of hornblendites occur in the ultramafic. In this sections the spinifex textures in the ultramafic are displayed by elongate chlorite and amphibolite aggregates.

An analysis of this ultramafic (High Rock Island) is presented in Table 1, Column 4, (p. 7).

A plot of the Al_2O_3 *vs* $FeO/(FeO + MgO)$, (Fig. 3) and a plot of the Al_2O_3 *vs* $Fe_2O_3 + FeO + TiO_2$ *vs* MgO (Jensen diagram, Fig. 4) show that this ultramafic is of tholeiitic affinity but very close to a komatiitic composition as defined by Arndt et al., (1977).

ULTRAMAFIC OCCURRENCES OF THE KNEE LAKE AREA

Six outcrops of ultramafic rocks occur in Knee Lake Area. Each of these outcrops represents a discrete lense that is emplaced in intermediate to felsic volcanic rocks of the Hayes River Group.

Gilbert and Elbers (1972b) described the ultramafic bodies that are referred to as No. 15, 16, 17 and 18 on Map ER 79-2-3 accompanying this report. They noted that each ultramafic body is adjacent to a gabbroic body and that they are emplaced in intermediate to felsic volcanic rocks in the upper unit of the second cycle of volcanism in the Hayes River Group. Two of these occurrences were explored by mining companies but the results were not encouraging. For further details and information on Occurrences No. 13 and No. 14, see Appendix "A".

INFERRED ULTRAMAFIC OCCURRENCES (GROUP V, MAP ER 79-2-3D)

A total of eleven aeromagnetic anomalies are highlighted on the aeromagnetic map insert of Map 79-2-3D.

These anomalies are inferred to be caused by ultramafic occurrences because

1) their stratigraphic association with the contact between the Hayes River Group and the Oxford Lake Group of rocks is similar to the setting of numerous other known ultramafic lenses; and
2) their characteristic shape and intensity, is consistent with narrow, elongated, highly magnetic rock bodies. The magnetic intensity ranges between 800 and 2 000 gammas above background.

DISCUSSION

Known ultramafic occurrences in the Oxford — Knee Lake area occur within the Hayes River Group. One of these occurrences contains spinifex textures and its chemistry is very close to that of a komatiitic ultramafic. This ultramafic sill is thus interpreted to have been extruded as a flow. At present the data that are available for the other ultramafic occurrences are too restricted to allow further conclusions. The inferred ultramafic lenses occur, unlike their known counterparts, at the interface of the Hayes River Group and the Oxford Lake Group of rocks. Their relation to the described ultramafic lenses is unknown.

IV. ULTRAMAFIC OCCURRENCES OF THE SUPERIOR GEOLOGICAL PROVINCE OF MANITOBA (SOUTHERN SEGMENT)

RICE LAKE GREENSTONE BELT (MAP ER 79-2-2 AND ER 79-2-4, NTS 52M and 62P)

LOCATION AND GENERAL GEOLOGY

The Rice Lake Greenstone Belt extends east-southeast from Pipestone Rock in Lake Winnipeg to Wingiskus Lake, located east of the Manitoba-Ontario border (Map ER 79-2-2). Two outlying greenstone belts at English Lake and at Wallace Lake are separated from the main belt by a linear fault that has a 16 km apparent dextral displacement (McRitchie, 1969).

Several regional and detailed investigations have been carried out in the area. Most pertinent to this report are the studies by Wright (1932c), Russell (1938 and 1949), Davies (1939 and 1951), Ermanovics (1970), McRitchie (1971) and Scoates (1971d).

The Rice Lake Greenstone Belt consists of felsic to intermediate volcanic rocks, interlayered sediments and felsic to intermediate intrusions that are unconformably overlain by proto-quartzite and minor conglomerate. Further details on the geology of this belt may be found in McRitchie and Weber (1971).

ULTRAMAFIC OCCURRENCES

Three different types of ultramafic occurrences were distinguished by Scoates (1971d) in the Rice Lake area:

1) discontinuous series of "discrete" ultramafic bodies that extend from Saxton Lake to Clangula Lake;
2) a cortlandite dyke located southeast of Dove Lake;
3) a slightly differentiated, layered ultramafic body located on Garner Lake.

In addition, a series of pyroxenites were described by Russell (1949) and Karup-Møller (1969) in the English Brook area. (Appendix "A", Table 52M and 62P).

The "discrete" ultramafic bodies are located along a linear zone that cuts the quartz-diorite of the Wanipigow River complex. They were described as serpentinities of which one specimen indicated the original peridotite composition. Sulphide mineralization was described as very rare (Scoates, 1971d). One of these lenses (No. 10 on Map ER 79-2-4H) located east of Clangula Lake was quarried for use as decorative stone on the early thirties (Wright, 1932c).

Some of the ultramafic bodies in the English River — English Lake area were described as pyroxenite intrusions in which steatized and tremolitized rock alternates with fresh material. Sulphides occur as fracture fillings and are interpreted to have resulted from post-depositional sulphurization of the pyroxenites. Karup-Møller (1969) attributed the concentration of up to 4.5% Ni to this mechanism.

Both the Wallace Lake (No. 1) and the Beresford Lake (No. 4) occurrence were described as serpentinite, whereas the Garner Lake occurrence (No. 12) has igneous layering (Scoates, 1971d). These three occurrences occupy similar positions along the contact of the Rice Lake Greenstone Belt and the Wanipigow River plutonic complex.

DISCUSSION

The described ultramafic bodies do not appear to be stratigraphically controlled and show no volcanic features. They appear to be discrete fault controlled intrusive lenses. Thus their Ni-sulphide potential is judged to be low.

ULTRAMAFIC OCCURRENCES ON THE EASTERN SHORE OF LAKE WINNIPEG (MAP ER 79-2-4H, NTS 62P/1)

GENERAL GEOLOGY

These ultramafic occurrences are located in the Rice Lake Greenstone Belt and may be related to the "discrete" ultramafic bodies extending from Saxton to Clangula Lake. Nevertheless they will be described separately because of the possibility that they could be stratigraphically controlled bodies.

The geology of the eastern shore of Lake Winnipeg between Rice River and the Wanipigow Indian Reserve was mapped by Brown (1973). He described a sequence of volcanic rocks whose lower members to the west are covered by Paleozoic sediments. The higher members of the sequence are felsic and include dacitic and rhyolitic flows and fragmental rocks that are superceded by greenstone tuffs. This sequence of volcanic rocks is overlain by arkosic quartzites that are overlain by ultramafic rocks.

ULTRAMAFIC OCCURRENCES

A series of isolated ultramafic outcrops, straddling the eastern shore of Lake Winnipeg between Clement Point and a point north of the Wanipigow Indian Reserve, were mapped by Brown (1973). He described the ultramafic as a "mapping unit made up of spinifex textured ultramafic rocks, sericitic cherts, iron formation and talc schist". Ermanovics (pers. comm., 1979) stated that the "spinifex textured ultramafic" was an unconfirmed field diagnosis which could not be followed up since the original sample containing the alleged spinifex textures has been misplaced.

DISCUSSION

The Lake Winnipeg spinifex textured ultramafic may, if confirmed, be in addition to the Linklater Island occurrence, the only known spinifex textured ultramafic present in conglomerate and quartz sandstone that unconformably overlie a volcanic rock sequence within the Superior Province in Manitoba. A third occurrence located in Ontario will be described later. Because the alleged Lake Winnipeg spinifex rock find has not been corroborated, it is not possible to speculate further on the significance of the occurrence.

BIRD RIVER SILL (MAP ER 79-2-6, NTS 52L 5, 6)

GENERAL GEOLOGY

The Bird River Sill is a composite mafic to ultramafic intrusion with an average thickness of 1000 m. It crops out along both of the near vertical limbs of an eastward plunging anticline developed in an east-trending belt of volcanic and sedimentary strata of the Precambrian Rice Lake Group. On the northern limb (Euclid Lake — Cat Lake Belt) the sill can be followed for 11 km and on the southern limb (Bird River Belt) for approximately 30 km. Block faulting and younger intrusions divide the sill into many individual sectors.

Type sections through the sill, in the Bird River Belt have been presented by Osborne (1949) and by Trueman (1971). Trueman distinguished 45 discrete layers; 19 of serpentinized peridotite; 18 of interbanded chromitite and serpentinized peridotite, 1 of pyroxenite, and 7 of undivided gabbro, anorthositic gabbro and anorthosite.

Map ER 79-2-6 compiled from various publications, and data on open file in the Manitoba Mineral Resources Division, shows the location of sulphide deposits that contain either one of the following two sulphide assemblages: 1) Fe-Ni-Cu-Zn sulphides; 2) Fe-Ni-Cu sulphides.

The first type, Fe-Ni-Cu-Zn sulphides is hosted by volcanic and sedimentary rocks of the Rice Lake Group. The most important of these occurrences is the Dumbarton Mine (Map ER 79-2-6, location 1). Other examples of this type, each accompanied by its location number are; Cup Anderson (3), Beaver (4), Wento (5), a part of the Ore Fault (6) and Pay Ore (8).

The second type consists of Fe-Ni-Cu sulphides located in mafic to ultramafic rocks. The best known example of this type is the Maskwa West Pit (location 2). Other occurrences of this type are a part of the Ore Fault (6), Coppermine Bay (7), Mayville (19) and New Manitoba (20).

THE DUMBARTON MINE

Diamond drilling in 1949-1965 delineated 1,213,000 tonnes of Ni-Cu sulphide averaging 1.23% Ni and 0.73% Cu to a depth of about 150 m (Karup-Møller and Brummer, 1971). Production of about 635 tonnes/day of ore was attained in September 1969, and ceased in December, 1974. 1 539 290 tonnes of ore grading 0.81% Ni were mined during this period (Coats, et al., 1979).

The ore of the Dumbarton Mine occurs in amphibolite thought to have been derived from andesite of the Rice Lake Group. The major sulphide is pyrrhotite, with exsolved pentlandite as lamellae and grains along the pyrrhotite boundaries. Other sulphides are chalcopyrite, violarite and marcasite. Major oxides are magnetite and ilmenite (Karup-Møller and Brummer, 1971). Sulphides are generally disseminated in amphibolite, but massive sulphide beds are also present. Light grey, fine grained cherty beds that were presumed to be tuffaceous horizons can contain concentrations of sulphides carrying up to 0.02% Zn. Karup-Møller and Brummer, (1971) also found that in the tuffaceous horizons the sulphide ratio varies considerably between the cherty layers and noted that on the average the chalcopyrite content is much higher and the nickel content much lower than in the mineralized amphibolite.

Another characteristic of this deposit is the variation in the Ni-Cu ratio within the entire orebody and within discrete zones in the orebody. A variety of hypotheses have been advanced to explain the co-existence of Cu, Zn and Ni sulphides, but the most likely explanation seems to be that Zn sulphides occurred in sedimentary layers within the volcanic group. The reader may find a compilation of these theories in Theyer (1977).

SULPHUR ISOTOPE DISTRIBUTION IN THE BIRD RIVER SILL

Samples from both the Fe-Ni-Cn-Zn and Fe-Ni-Cu sulphide assemblages in the Bird River Sill were analyzed in an attempt to distinguish between the two groups on the basis of their $^{34}S/^{32}S$ ratios.

Theoretically, contrasting modes of origin might be reflected in different $\delta^{34}S$ values but since both assemblages were presumably derived from magmatic parents any such differences would tend to be subtle and perhaps undetectable.

Analytical data are given in Table 3 and $^{34}S/^{32}S$ values are plotted on Figure 6. The results are inconclusive.

THE MASKWA WEST NICKEL DEPOSIT

This Ni-Cu deposit is located 1.2 km southwest of the Dumbarton Mine. It produced 265 730 tonnes of ore with an average tenor of 1.16% Ni and 0.20% Cu during the period from August 1969 to June 1976.

The ore consists of disseminated sulphides including marcasite, pyrrhotite, pyrite, violarite, chalcopyrite and pentlandite in a matrix of altered serpentinized ultramafic that forms part of the basal section of the Bird River Sill (Coats et al., 1979). These authors proposed that the sulphidic ore formed by primary magmatic segregation of immiscible sulphides in an ultramafic magma. They believed that they had located the magma's feeder pipe in a satellite ultramafic body located in the volcanic footwall of the pit, and that the amount of immiscible sulphides in the magma was small. They attributed the differences in the spatial distribution of sulphides, on both sides of the alleged feeder pipe, to a change in the direction of flow during the initial volcanic event.

DISCUSSION

It appears evident from the foregoing discussions that the source of nickel sulphides in the Bird River Sill area is found within the mafic and ultramafic rocks of the Bird River Sill. Thus if the Ni-Cu mineralization is synvolcanic and magmatic, as suggested for the Maskwa deposit by Coats et al., (1979), then sulphides would be expected to occur at and/or close to the base of the sill especially in depressions in or at the sill's base.

Deposits of the type represented by the Dumbarton Mine, will be found in the rocks underlying the sill but close to the stratigraphic bottom of the sill. It is thus considered important to trace the exact outline of the ultramafic sill by mapping, and geophysical methods.

Areas along the Bird River Sill that are close to and include the stratigraphic bottom of the Bird River Sill, and considered to be prime exploration targets for nickel deposits are shaded on Map ER 79-2-6.

TABLE III Sulphur isotope data from ore sample of the Dumbarton Mine.

Sample	Mineral	$\delta^{34}S$,
51-6-6	(Pyrite	- 5.1
	(Pentlandite	- 6.2
	(Pyrrhotite	
51-7-90	(Pyrrhotite	- 3.3
	(Chalcopyrite	4.2
51-7-92	(Pyrite	- 3.5
	(Pentlandite	- 4.0
	(Pyrrhotite	- 3.7
	(Chalcopyrite	- 3.7

$\delta^{34}S$ values with respect to Canyon Diablo Troilite.

Analyses by C.E. Rees (1978), McMasters University.

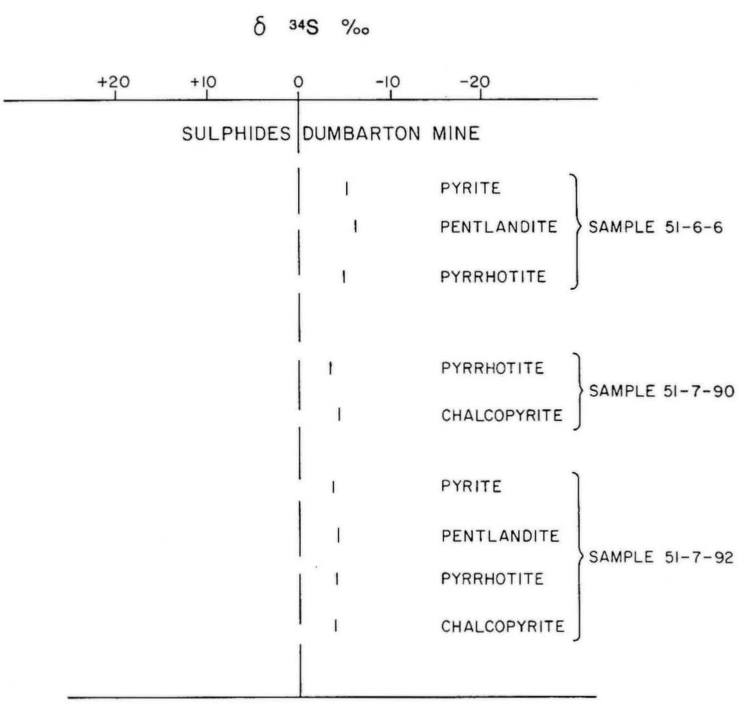


FIGURE 6: $\delta^{34}S$ values of ore samples from the Dumbarton Mine. Analyses by C.E. Rees (1978), McMaster University.

V. A SELECTED ULTRAMAFIC OCCURRENCE OF THE SUPERIOR PROVINCE OF ONTARIO

INTRODUCTION

Because there are a number of well-documented spinifex ultramafic associated nickel deposits in Archean greenstone belts of the Ontario Superior Province, it is of interest to examine an Ontario occurrence for purposes of comparison with similar geological environments in the Superior terrane of Manitoba.

NORTH SPIRIT LAKE — OPWAGAN LAKE AREA

LOCATION

This area is located roughly 185 km north-northeast of Red Lake in Ontario at the northern end of the North Spirit Lake — MacDowell Greenstone Belt (Fig. 7).

GENERAL GEOLOGY

The geological data are based on two reports and geological maps by Wood (1977a and b). The greenstone belt is composed of metamorphosed volcanic rocks that are overlain by metamorphosed sedimentary rocks. The belt is bounded by batholithic granitic intrusions. The volcanic rocks comprise mafic to felsic flows and tuffs, whereas the sedimentary rocks include conglomerates, sandstones, mudstones, carbonates and chert. The rocks were isoclinally folded and subsequently faulted.

POSITION OF ULTRAMAFIC ROCKS

Wood (1977a) mapped ultramafic rocks occurring stratigraphically between volcanic and sedimentary rocks. He assumed that the contact between sediments and ultramafic rocks was possibly intrusive in the North Spirit Lake area. Wood (1977b) also described ultramafic flows south of Wapisipi Lake with spinifex textures that are on strike with the ultramafic rocks of North Spirit Lake.

Figure 7 shows a location sketch and a schematic geological column of the Opwagan-South Bay area of North Spirit Lake after Wood (1977a).

DISCUSSION

Ultramafic rocks that are volcanic in origin, occur in immediate contact with conglomerates over an extensive area in the North Spirit Lake — Opwagan Lake region. It thus seems that the ultramafics have a comparable stratigraphic position to those Manitoba environments that have been discussed, in particular the Island Lake Greenstone Belt.

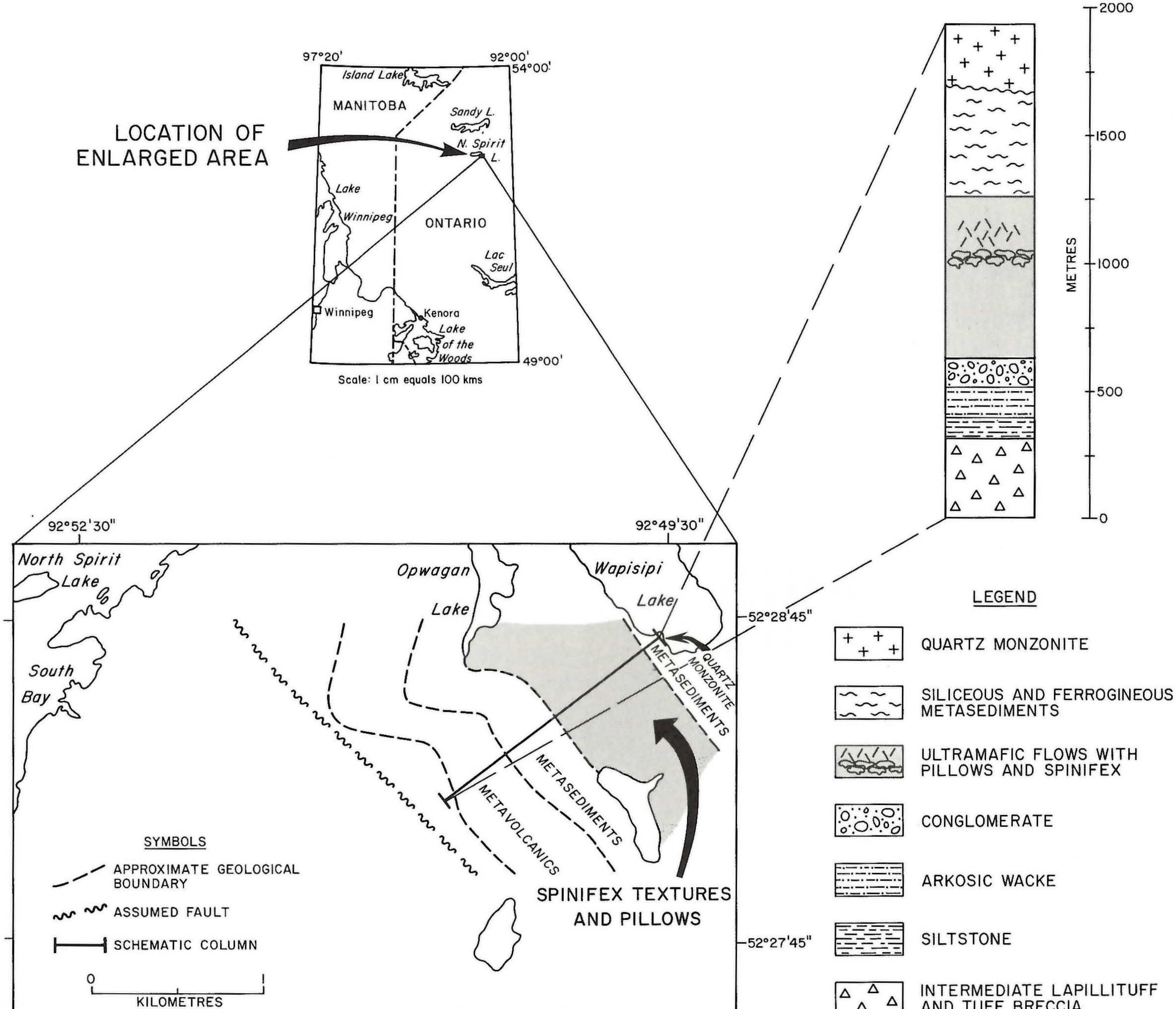


FIGURE 7: Location, geology and schematic column showing rock sequences in part of the Opwagan — South Bay area of the North Spirit Lake — MacDowell Greenstone Belt. (Modified after Wood and Hunter, 1974 and Wood, 1977a.)

VI. THOMPSON NICKEL BELT
(MAPS ER 79-2-8 to ER 79-2-12)

INTRODUCTION

The Thompson Nickel Belt is the major nickel producing region in Manitoba and next to Sudbury, Ontario, the largest in the country. In the period of maximum production from the belt (1971), six mines; Thompson, Birchtree, Pipe, Soab North, Soab South, Manibridge were active. Of these six, only the Manibridge deposit was mined until exhaustion of ore reserves in April, 1977. The Birchtree and the Soab mines are presently held on a standby basis, ready to go into production when markets for nickel improve. Additionally, a large number of nickel prospects are in diverse states of exploration or development, however, most are presently dormant. The best known, major prospects are: Moak Lake, Mystery Lake, Ospwagan Lake, Hambone, Bowden Lake, Bucko Lake and the Nose deposit (Maps ER 79-2-7 to ER 79-2-12 inclusive).

Two nickel mines are producing at present, the Pipe 2 and the Thompson Mine, both operated by Inco Ltd. The nickel content of all the ore mined in Manitoba in 1975 was approximately 62 854 tonnes (Spoerry, 1976). Of this total, which is the latest published figure, about 4 000 tonnes are from ores mined at Lynn Lake (Farley Mine) and from the Maskwa pit and Dumbarton Mine of the Bird River Sill. The balance of about 58 500 tonnes was from mines of the Thompson Nickel Belt. This figure compares with a total Canadian production of 179 095 tonnes of nickel in 1975 almost entirely from the Sudbury district of Ontario. A small part of this total (exact amount unpublished) should be subtracted since it originated at the Shebandowan Mine near Thunder Bay, a 1 800 tonnes/day mine operated by Inco Ltd.

The Thompson Nickel Belt contains the largest known concentrations of nickel sulphides in the Province and is also expected to have the greatest potential to contain additional undiscovered nickel sulphides. The Belt's geology has been studied by many investigators and is currently the theme of ongoing geological studies by geologists of mining companies, government and the University of Manitoba.

PREVIOUS WORK

The development of geological thoughts on the Churchill-Superior boundary was summarized by Bell (1971a). Bell (1971b) proposed that granulite facies gneisses in the northwest corner of the Superior Province represented the basement to the Superior Archean greenstone belts, and constituted a separate geological entity which he called "Pikwitonei Province". In the immediately adjacent area to the west Bell (1971b) described gneisses of the "Pikwitonei Province", overlain by sedimentary and volcanic rocks all intruded by felsic mafic and ultramafic rocks and metamorphosed to amphibolite facies. He called this complex "Thompson Belt rocks" and assigned to it the status of a geological subprovince, the "Wabowden Subprovince" which he tentatively considered to be part of the Churchill Province.

Weber (1976) and Scoates et al., (1977) proposed that Bell's (1971b) "Wabowden Subprovince" may be a retrogressively metamorphosed part of the Superior Province. Scoates et al., (1977) renamed the gneisses of the Thompson Nickel Belt "Moak Lake Gneisses", and proposed the name "Ospwagan Group" for the weakly deformed and metamorphosed volcanic, sedimentary and intrusive rocks that host the serpentinized ultramafic bodies which are carriers of most of the Ni-Cu deposits in the Belt. Weber and Scoates (1978) reiterated their prior finding of a metamorphic transition zone between the gneisses of the Thompson Nickel Belt and Superior Province. They relegated Bell's (1971b) "Pikwitonei Province" to the status of a geological region, calling it the "Pikwitonei Region".

Cranstone and Turek (1976) reported a Rb/Sr age of 2 820 ± 135 Ma for migmatitic gneisses of the Wabowden area. A Rb/Sr age of 1 720 Ma from two other gneiss samples of the same area was interpreted to reflect updating by the Hudsonian orogeny. K Ar biotite ages in gneiss of the Thompson Nickel Belt range from 1700 to 1800 Ma and northeast trending, steeply plunging regional folding and foliation in the Belt were attributed to effects of the Hudsonian orogeny (Bell 1971b). However, evidence of earlier shallowly northeast and southwest plunging linear structures indicate the existence of a pre-or at least early Hudsonian deformation. It appears therefore that some of the gneissic rocks of the Thompson Nickel Belt may be of Archean age (Hubregtse, 1980).

The age of the Ospwagan Group is highly contentious. Weber and Scoates (1978) tentatively proposed three options, the choice depending on the importance one attributes to lithological similarities between the Fox River Sill and the Ospwagan Group and to dissimilarities in the degree of metamorphism and deformation between these rock groups. A radiometric dating program on samples of the Thompson Nickel Belt that was undertaken as part of the NREP Nickel Project, will be discussed in the following section.

NREP RADIOMETRIC DATING PROGRAM

INTRODUCTION

A Rb-Sr radiometric dating program on rocks of the Thompson Nickel Belt was undertaken with the cooperation of Inco Ltd. Radiometric dating and the writing of two unpublished internal reports, on which this condensed account is based, was carried out by C. Brooks at the Université de Montréal.

OBJECTIVES

This program was designed to determine:

a) The age of formation of major rock units of the Thompson Nickel Belt.
b) Ages of metamorphic events affecting these rock units.
c) Geochronological information to aid in interpreting the origin of the rock units associated with nickel mineralization and the relationship of this mineralization to geological events in the nickel belt.

SAMPLES

The following samples were taken (most locations shown on Fig. 8):

1) Samples from the "Undifferentiated" gneisses and metasediments, i.e. "Moak Lake gneisses" (Scoates et al., 1977) (Borehole 55711, Sample A-40-74).
2) Paragneiss from the vicinity of Soab Lake (Sample T-75-1649).
3) Core samples from a borehole (BH 45966) that intersected paragneiss in the vicinity of Soab Lake.
4) a) Ten core samples from borehole (BH55798) of the vicinity of the Thompson Mine that intersected Thompson-type sediments.
   b) Ten additional core samples from borehole (BH48037) also drilled in Thompson type sediments.
5) a) Ten core samples from borehole (BH 55716) drilled in the vicinity of the Pipe 2 Mine which intersected Pipe type sediments.
   b) Ten core samples from borehole (BH 56038) drilled in the vicinity of the Pipe 2 Mine intersecting Pipe type sediments.

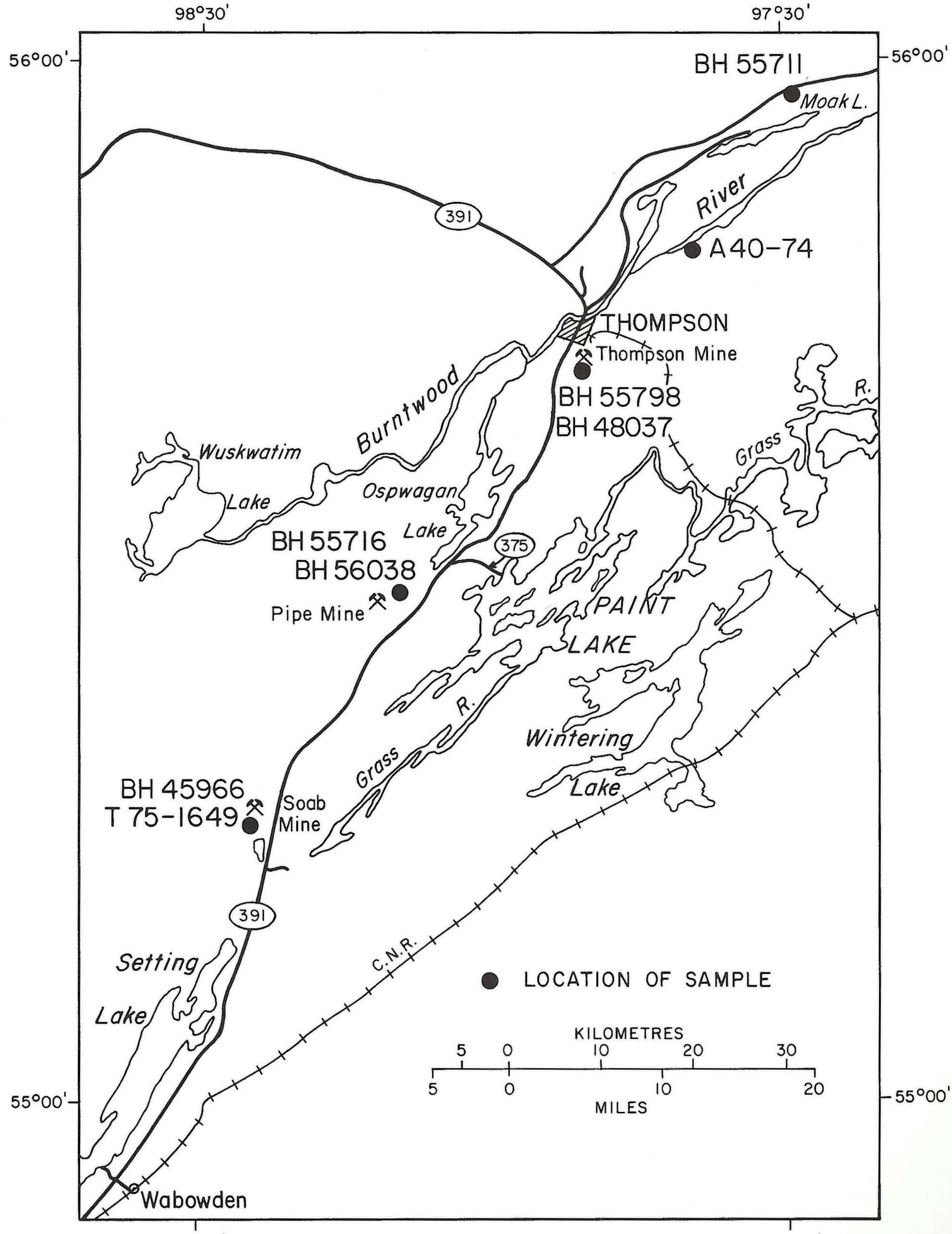


FIGURE 8: Sample location map. Thompson Nickel Belt, NREP Radiometric Dating Program.

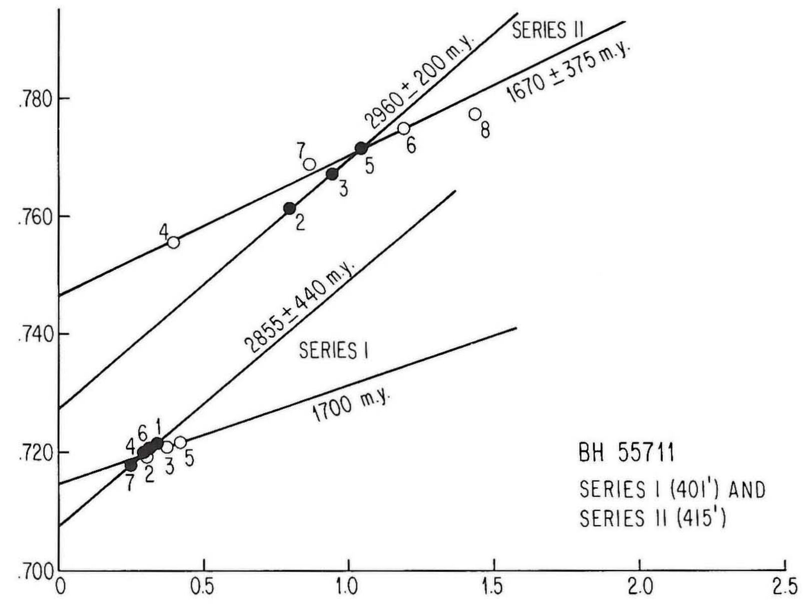


FIGURE 9: Isochron diagram for gneisses east of Moak Lake (BH55711).

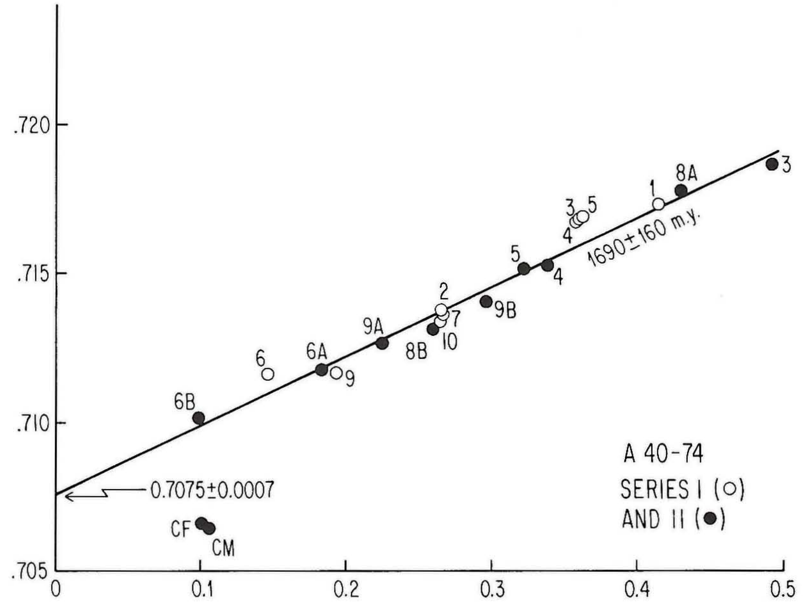


FIGURE 10: Isochron diagram for gneisses from Apussigamasi Lake (A40-74).

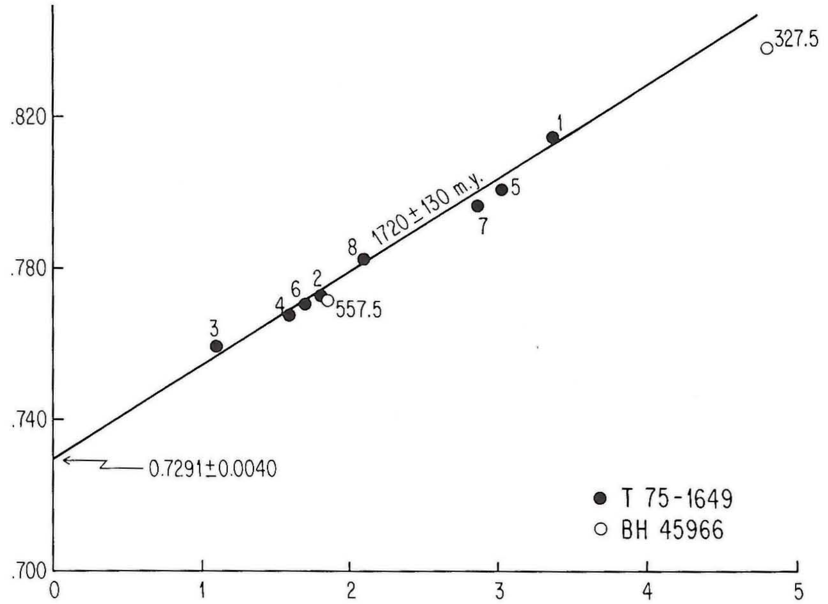


FIGURE 11: Isochron diagram for gneisses north of Soab Lake (T75-1649) and (BH45966).

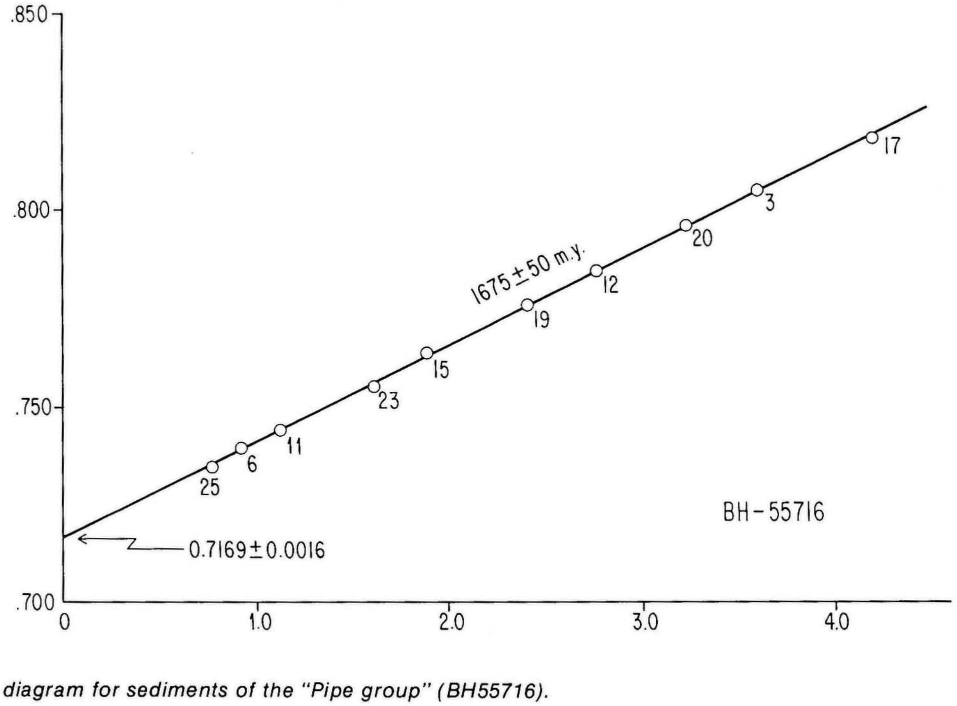


FIGURE 12: Isochron diagram for sediments of the "Pipe group" (BH55716).

RESULTS

Gneissic Series

a) Isochron plots (Fig. 9) of the gneisses east of Moak Lake (BH 55711) show Archean ages in sample series I and II (2 855 ± 440 Ma and 2 960 ± 200 Ma respectively) and superimposed Hudsonian ages (1 700 Ma and 1 670 ± 375 Ma) (series I and II). Sample series I and II were taken from core of borehole 55711 to a depth of 122 m and 126 m respectively. The results seem to indicate that the gneisses are of Archean age but were partially reset by the effects of the Hudsonian orogenesis. Sample A-40-74 (Fig. 10) shows an age of 1 690 ± 160 Ma only. It was interpreted to be a "new addition to the crust at or about 1 700 Ma age" (C. Brooks, unpubl. report, 1979).

b) Soab Lake Paragneiss (Fig. 11) (Samples T75 - 1649 and BH 45966). These samples show an age of 1 720 ± 130 Ma with a high initial $^{87}Sr/^{86}Sr$ ratio (0.7291) possibly representing erosion of Archean sediments and redeposition during the Hudsonian orogenesis. (C. Brooks, unpubl. report, 1979).

SEDIMENTARY SERIES

a) Thompson type sediments yielded erratic results with a high degree of scatter. Ten core samples of borehole BH 55798 defined an errorchron of 1 575 ± 260 Ma. This age should "be treated with extreme caution" (C. Brooks, unpubl. report 1980). Ten additional core samples of borehole (BH 48037) also intersecting Thompson type sediments defined an errorchron of 1660 ± 200 Ma.

b) Pipe type sediments represented by borehole BH 56038 define an errorchron of 1 880 ± 90 Ma with an initial Sr ratio of 0.7107 ± 0.0030. An additional ten core samples of borehole BH 55716 also intersecting Pipe type sediments were analyzed to confirm the age obtained from the previously quoted samples of borehole BH 56038. The samples from borehole BH 55716 define an isochron of age 1 675 ± 50 Ma (Fig. 12) of considerably lower scatter than that of borehole BH 56038.

DISCUSSION

Preliminary results for metasediments of the Thompson mine area yield errorchrons with a high scatter of points and high initial $^{87}Sr/^{86}Sr$ ratio that define ages near 1600 Ma.

The Thompson Mine sediments were presumably deposited on Archean basement that yields ages between 2 850 and 2 950 Ma but is in part reset to give typical Hudsonian ages. In contrast sediments of the Pipe Mine area show ages of 1 880 ± 90 Ma and 1 675 ± 50 Ma. It should be noted, however, that the former is based on an "errorchron" interpretation, whereas the latter is based on an isochron with a very high degree of reliability.

NICKEL DEPOSITS IN THE THOMPSON NICKEL BELT

GENERAL GEOLOGY

The nickel deposits of the Thompson Nickel Belt occur in or closely associated with ultramafic rocks that predominantly underlie the western edge of the belt. Most of the ultramafic rocks are associated with bands of low grade metamorphosed volcanic and sedimentary rocks called the "Ospwagan Group" (Scoates et al., 1977). These sedimentary piles include layers of siliceous, calcareous, pelitic and ferruginous rocks (Peredery, 1978 and 1981). Several of these bands have been mapped in the Thompson Belt, but two contain most of the larger nickel deposits. The "Pipe group" is a sedimentary pile associated with metavolcanic rocks that extend from the Pipe mines through Ospwagan Lake and Mystery Lake to Moak Lake (Map ER 79-2-8 and ER 79-2-9). The "Thompson group", containing only sediments, extends parallel to the "Pipe group" from a point approximately 4 km south of Thompson through to Apussigamasi Lake (Map ER 79-2-9). In addition to its association with volcanic rocks, the "Pipe group" can also be distinguished from the "Thompson group" by a lesser degree of metamorphism, and by stratigraphic differences. The metavolcanic rocks of the "Pipe group" include metapicrites and massive and pillowed metabasalts in the Ospwagan Lake area (Stephenson, 1974; Peredery, 1978). These metabasalts and metapicrites, by virtue of their chemistry and the observation of quench textures within magnesian metabasalts are classified as komatiites by Peredery (1979). Spatial association and chemical continuity amongst metabasalts, metapicrites and serpentinized ultramafics, suggest a common magmatic source of the rocks, which may have been extruded as flows or emplaced as hypabyssal intrusions. (Peredery, 1979).

The ultramafic rocks which are associated with the nickel sulphide deposits of the belt are mainly serpentinized peridotites, described separately in the individual deposit descriptions. In addition to these there are amphibole rich ultramafic rocks which Peredery (1979) has called "ultramafic amphibolites" and has suggested they may be equivalent to Zurbrigg's (1963) "metaperidotite" in the Thompson Mine.

ORE MINERALOGY

The ore mineralogy of the nickel deposits in the Thompson Belt is simple, consisting of pyrrhotite, pentlandite, chalcopyrite and rare marcasite and traces of nickel arsenides. Sulphide alternation products including pyrite and violarite are rare. Minor amounts of sphalerite and nickel arsenides were found locally (Zurbrigg, 1963; Coats et al., 1972; Peredery, 1978). Platinum group minerals occur in trace amounts only (Naldrett et al., 1979).

ORE TYPES

Sulphide ores can occur as disseminated sulphides in serpentinized ultramafic, sulphide networks, sulphide veins, sulphide breccia and massive sulphides.

Cu-Ni RATIOS

Cu-Ni and Ni/(Ni + Cu) ratios shown in Table 4, although quite variable from stope to stope within a single deposit, appear to have generally similar ranges throughout most of the deposits of the Thompson Nickel Belt.

Table 4: Cu-Ni and Ni/(Ni + Cu) ratios of selected ore deposits of the Thompson Nickel Belt; from Peredery, 1978.

	Cu/Ni	Ni/(Ni + Cu)
Thompson Mine	1/15	0.9375
Pipe II MIne	1/12	0.923
Manibridge	1/15.4	0.939
Thompson Belt (average)	1/14.5	0.935

DESCRIPTIONS OF SELECTED DEPOSITS OF THE THOMPSON NICKEL BELT

Moak Deposit (Map ER 79-2-9)

The Moak deposit is located some 27 km northeast of Thompson in the "Pipe group". The nickel sulphide mineralization is associated with a deformed serpentinite body that takes the form of a syncline approximately concordant with the enveloping sediments. The nickel sulphide content is extremely variable and mineralization ranges from disseminated zones to massive sulphide veins (Coats et al., 1972). Development of this deposit was halted after the discovery of the Thompson deposit dictated new company priorities. Work had been completed on the sinking of a shaft and the establishment of several levels.

MYSTERY DEPOSITS (MAP ER 79-2-9)

These deposits are located some 12 km northeast of Thompson in the "Pipe group". The sulphide mineralization is disseminated within two separate ultramafic bodies (a northern and southern). The southern body was exposed in an outcrop on the southwest shore of Mystery Lake containing serpentinized peridotite with spinifex textures and sulphides which Patterson (1963) identified as pyrrhotite and pentlandite. This outcrop is now permanently flooded due to water level regulations by Manitoba Hydro. Exploration of these deposits was restricted to surface based drilling. Reserve figures for the southern deposit are conflicting; in 1975 it was reported as containing approximately 45 000 000 tonnes grading 0.5% Ni (Northern Miner's editor; written communication to the Manitoba Mineral Resource Division, 1975).

THOMPSON MINE (MAP ER 79-2-9)

The ore zone of this deposit is a highly deformed sulphide layer within a sedimentary sequence ("Thompson group") that stretches over 12 km in a northeasterly direction and is up to 2 km wide. The sulphide ore is confined to the pelitic portion of the "Thompson group" that also includes siliceous, calcareous, and ferruginous rocks. The metasediments are folded into a steeply plunging anticlinal structure surrounded by gneiss.

Figure 13 is a section through the Thompson Mine showing the typical succession in the sediments of the "Thompson group". The following descriptions are after Coats et al., 1972.

a) quartzite in the core of the fold is coarse grained and massive, containing microcline, plagioclase, biotite, muscovite, zircon, apatite and sphene in variable amounts;
b) skarn is a light green, medium to coarse grained, carbonate rich assemblage containing calcite, diopside, carbonate-phlogopite-diopside, diopside-clinozoisite and carbonate-diopside-tremolite-microcline;
c) iron formation is usually banded; with darker bands containing garnet, amphibole, carbonate, biotite, pyrrhotite and magnetite and lighter bands consisting mainly of crystalline quartz;
d) biotite schist — hosts the ore and is composed of biotite, quartz, plagioclase, orthoclase, chlorite, muscovite, garnet and sillimanite;
e) biotite gneiss is a light to dark grey rock containing quartz, plagioclase, biotite with or without microcline, muscovite and sillimanite;
f) granite gneiss is virtually similar to the biotite gneiss and is distinguished from the latter by its pink colour and foliation.

The quartzites in the core of the anticline are interpreted as the oldest rocks with the youngest rock being the surrounding gneisses. These age relations are, however, incompatible with the observation that the Ospwagan Group — to which the rocks of the "Thompson group" belong — is younger than the gneisses. Drag folding of the sulphide zone has concentrated sulphides in fold noses relative to fold limbs. Ultramafic rocks are restricted to small lenses and blocks adjacent to, or within the sulphide zone. The small amount of ultramafic material present in the ore zone clearly indicates that it could not have been the source of the large masses of sulphides concentrated in the ores.

The sulphide mineralogy of the Thompson Mine is simple, consisting mainly of pyrrhotite, pentlandite and chalcopyrite. The ore can be of massive, stringer or disseminated type.

The nickel concentration in the ore may be related to the width of the ore zone. In a study of samples of the Thompson mine it was found that the Ni content of pyrrhotite may be higher than 0.6% in the widest part of the ore zone if the width is greater than 3 m. Conversely for parts of the ore zone less than 3 m in width, the Ni content of pyrrhotite is usually less than 0.6% Ni, (J.D. Scott, unpubl. report 1977). A similar rough correlation between the grain sizes of pentlandite crystals and the widths of the ore from which the sample was taken, was also tentatively established during this study. (Scott, 1977).

Exact ore reserve figures for the Thompson deposit have not been published, but from sources such as Inco Annual Reports, Zurbrigg (1963) and Coats et al., (1972) an estimate is that in the early 1970's the deposit contained about 22 700 000 tonnes of ore at a tenor of 2.97% nickel and copper combined.

The Thompson Mine is producing ore at a rate of approximately 7 250 tonnes/day hoisted out of two shafts (T1 and T3). A third shaft (T2) is used for ventilation.

BIRCHTREE MINE (MAP ER 79-2-9)

This mine is located some 5 km southwest of the community of Thompson within the "Pipe group". Sulphides occur in massive, stringer and disseminated form in serpentinized ultramafics and as massive and stringer ore in biotite schist. The deposit has a tabular shape and is approximately 1 450 m long and 1 200 m wide by 3 m thick, and strikes north to northeast, dips steeply to the west and plunges 80° in direction north. The orebody is located at the contact of ultramafic rocks with metasediments. The sulphides are partially separated from the ultramafic rocks and concentrated in lenses and pods in metasediments presumably due to tectonic dislocation. These observations may be of special significance to the understanding of the Thompson deposit which is interpreted by Peredery as being a sulphide body that was separated completely from an original ultramafic host rock due to tectonic stress.

The Birchtree Mine commenced operations in 1969 and reached a peak ore production of approximately 3 600 tonnes/day. This was reduced to approximately 2 540 tonnes/day in 1976 and mining was suspended in 1977. The mine is presently maintained on a standby basis.

PIPE 2 MINE (MAP ER 79-2-9)

Sulphides of the Pipe 2 ore are contained in serpentinized ultramafic rocks. The serpentinite body has a tabular shape and is located between intensely folded gneisses and metasediments. Figure 14 shows the position of the Pipe open pit, located at the nose of a tight fold in which the ultramafic rocks occur.

A cross section in the pit area (Fig. 15) shows the rock succession in the "Pipe group". These are, in a direction from the gneisses to the core of the fold; quartzitic rocks; carbonaceous rocks with diopsidic skarn; pelitic phyllites containing the mineralized serpentinite, iron formation and quartzite. The contrasting mineralogy between the east side of the pit (altered pyroxenite) and its west side (serpentinized peridotite) has prompted Peredery (1978) to tentatively interpret the ultramafic body as being originally a layered sill that was subsequently folded with the surrounding gneisses and metasediments. Since the folding is attributable to the Hudsonian orogenesis, it follows that the intrusion of the Pipe ultramafic sill was a pre-Hudsonian or at least early Hudsonian event.

Peredery (1978) stated that the degree of metamorphism in the sediments of the Pipe area reached a maximum of amphibolite rank and then was followed by extensive retrogressive metamorphism. He interpreted the younging direction in the Pipe sediments to be from carbonaceous rocks toward iron formation thus concluding that the gneisses are stratigraphically below the metasediments.

The sulphide mineralogy of the Pipe 2 deposit includes pyrrhotite, pentlandite, chalcopyrite and cubanite. Peredery (1978) distinguished between three sulphidic ore types in this deposit. They are:

a) Sulphide matrix ore, in which sulphides occur as a matrix to brecciated serpentinite and is made up mainly of subparallel pentlandite stringers
b) Vein ore
c) Disseminated sulphides

The Pipe 2 deposit is presently mined as an open pit but is scheduled to be operated as an underground mine in the future.

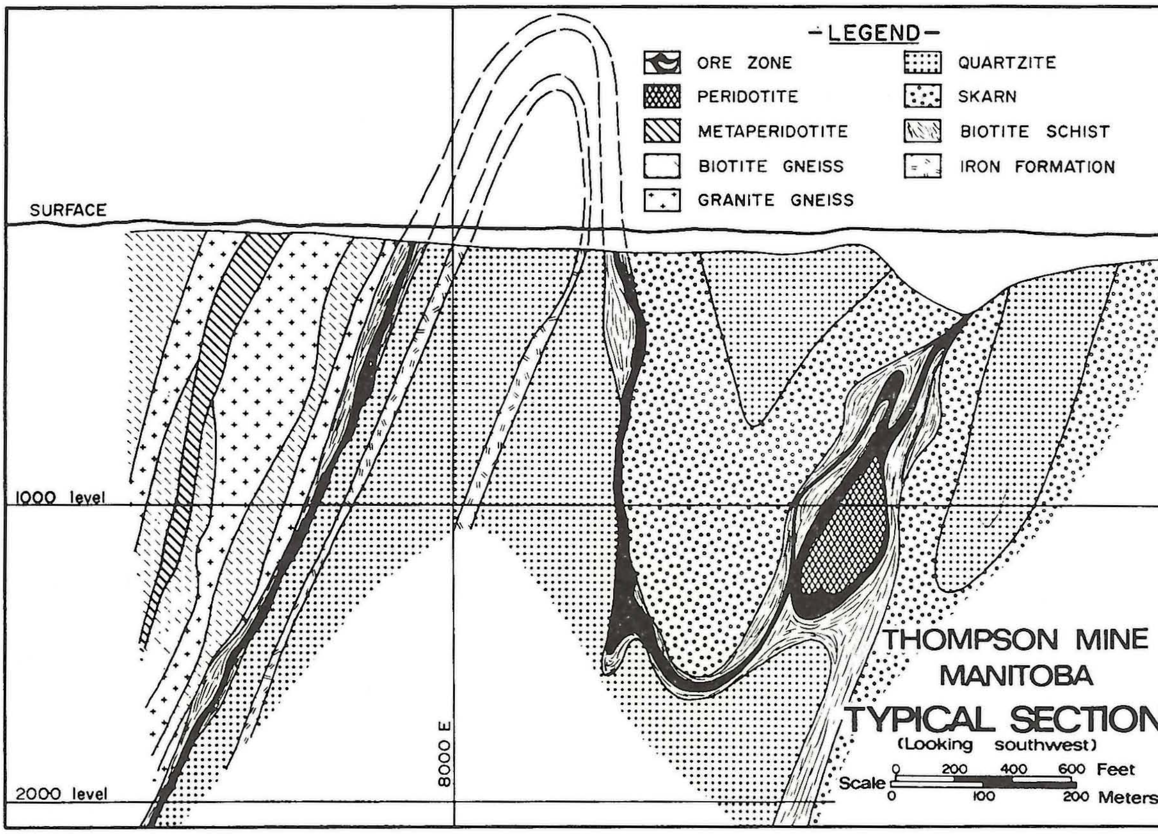


FIGURE 13: Typical section through the Thompson Mine. (From Coats et al., 1972).

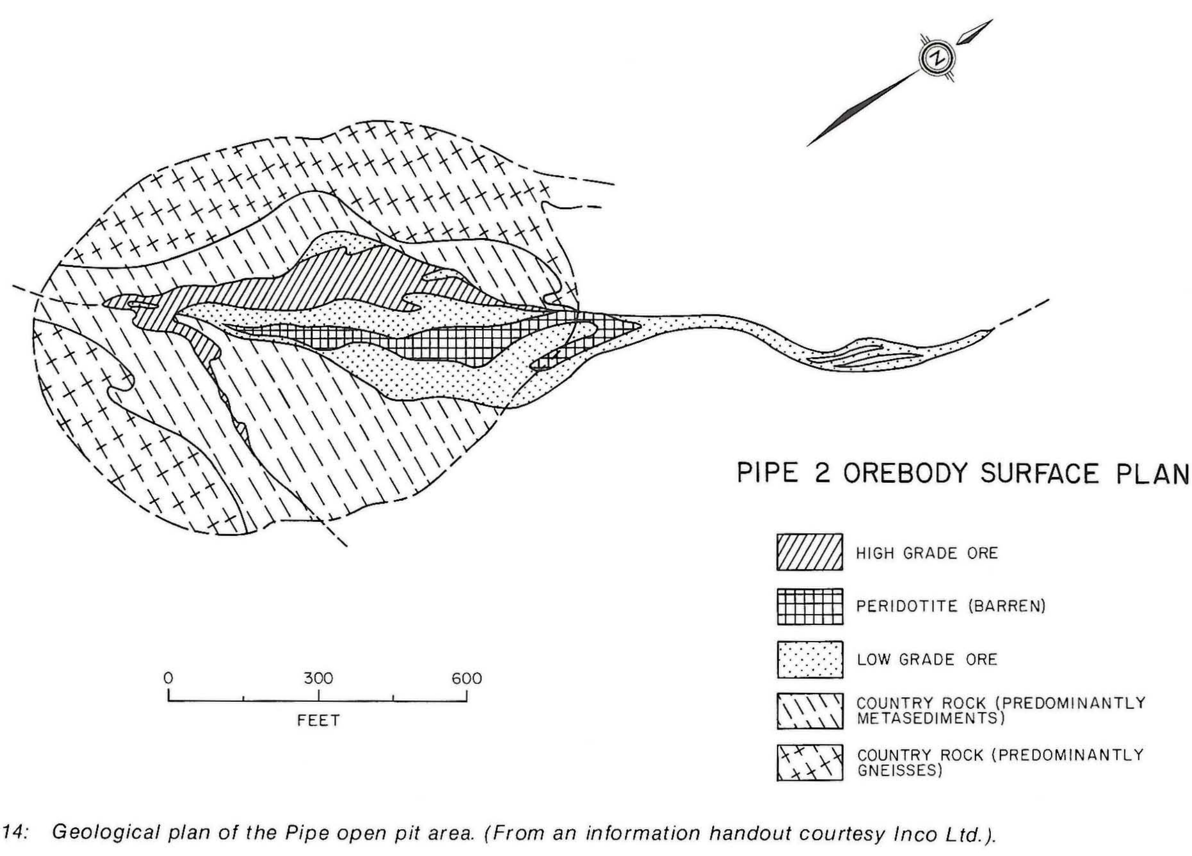


FIGURE 14: Geological plan of the Pipe open pit area. (From an information handout courtesy Inco Ltd.).

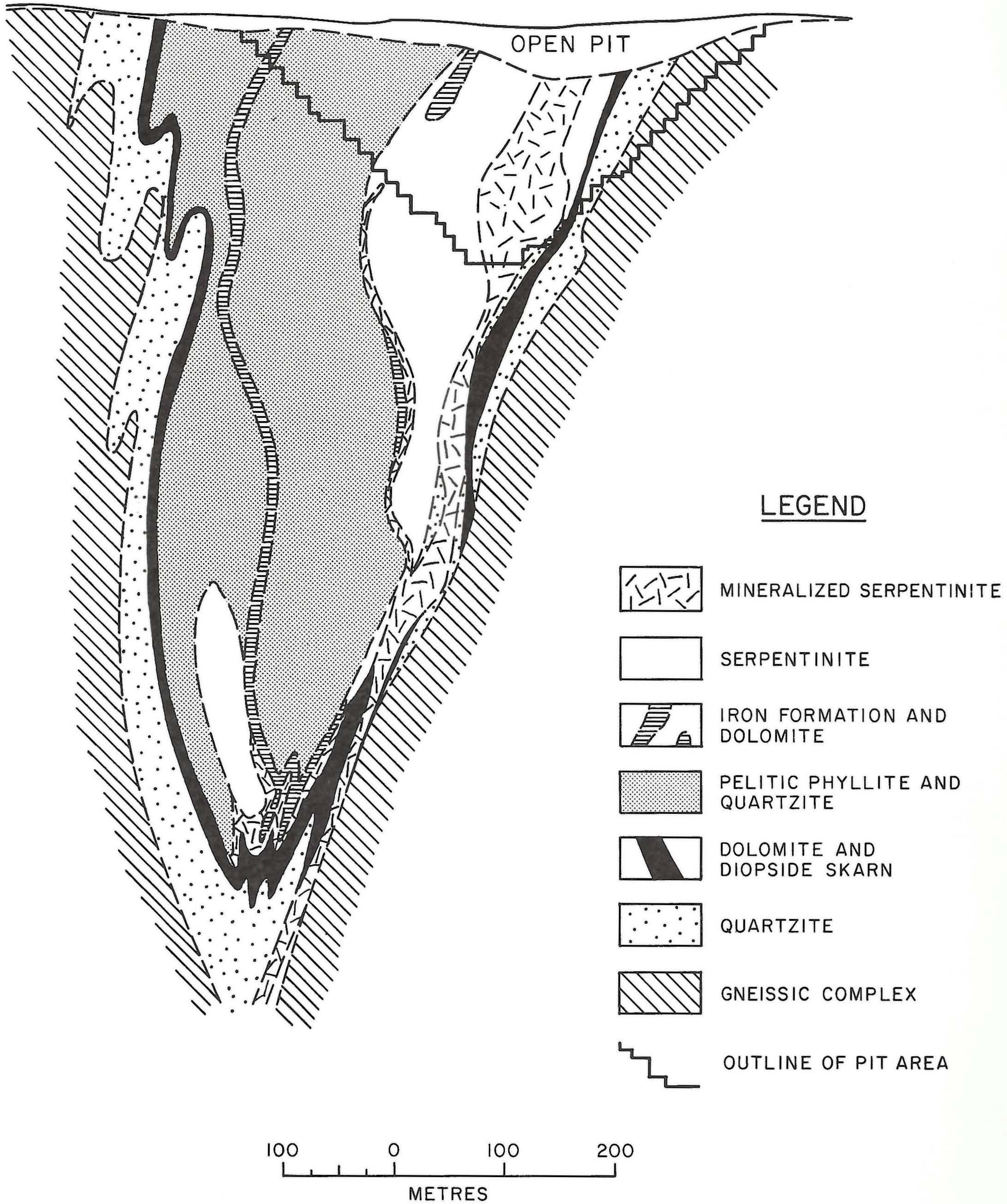


FIGURE 15: Geological section of the Pipe 2 mine. (After Peredery, 1978, with modifications)

Sketchily available data on production and ore reserves are the following:

a) ore production from the pit was scheduled to reach 5440 tonnes/day as of September, 1973;
b) overall ore grade in the pit was reported to be less than 1% nickel (Northern Miner, October 8, 1970);
c) ore from the Pipe open pit shipped to Thompson for concentration is reported (Inco Ltd. geological staff) to have a tenor between 0.8% and 0.9% nickel.

BOWDEN DEPOSIT (MAP ER 79-2-11)

The Bowden deposit is located near the town of Wabowden and in part, underlies Bowden Lake. It contains disseminated sulphides in a series of ultramafic layers that lie concordantly within steeply dipping paragneiss (Kilburn et al., 1969). The deposit was estimated to contain approximately 72 500 000 tonnes of rock grading 0.6% nickel to the 305 m level. (Northern Miner; August 6, 1970). A shaft was sunk to a depth of approximately 195 m, but further development was suspended in 1971.

BUCKO DEPOSIT (MAP ER 79-2-11)

This deposit partially underlies Bucko Lake. It contains disseminated to massive sulphides in serpentinized peridotite enclosed by migmatic gneisses. The ultramafic body has a width of approximately 150 m at a depth of approximately 330 m. High grade concentrations of nickel sulphides are arranged in an *en echelon* pattern within the ultramafic body. Remobilized sulphide veins were reported to occur in faults within the country rock (Northern Miner, November 23, 1972).

Estimates of grade and tonnage for the Bucko Lake deposit range from approximately 26 300 000 tonnes at 0.8% Ni to 27 200 000 tonnes grading 0.81% Ni (Northern Miner, April 23, 1970; November 6, 1975). The development of the deposit was halted after sinking of a shaft beyond approximately 305 m of depth and extensive underground drilling.

MANIBRIDGE MINE (MAP ER 79-2-11)

The Manibridge Mine (Map ER 79-2-11) is located 32 km southwest of Wabowden. The deposit was mined from 1971 until April, 1977 during which time 937 912 tonnes of ore with an average grade of 1.81% Ni and 0.14% Cu were produced. The ore zone is in the southern, widest part of an ultramafic lense that measures approximately 3.2 km in length and ranges between 30 m and 150 m in width. The ultramafic body is composed of serpentinized peridotite and minor amounts of amphibole bearing olivine pyroxenite (Coats et al., 1972). The surrounding rocks are migmatized gneisses that include on the east side of the ultramafic zone amphibole-granodiorite gneiss, amphibole gneiss and intercalated bands of amphibolite (Fig. 16).

The rocks on the west side of the ultramafic zone are similar, with exception that they exhibit effects of an increase in the degree of cataclastic deformation (Coats, 1978). Pegmatite injections are ubiquitous, they can comprise up to 70% of the gneiss unit. They also occur commonly in the ultramafic rocks and are estimated to locally comprise up to 30% of the volume of the ultramafic zone (Coats, 1978).

The sulphide minerals present in the Manibridge deposit are in order of abundance; pyrrhotite, pentlandite, pyrite and chalcopyrite.

The ore includes massive, net textured, and disseminated types. Coats et al., (1976) described sulphide mobilization and migration that had occurred over a maximum distance of a few metres. The constant S/Ni ratios in sulphides considered as primary, as well as in sulphides considered to be mobilized, along with the apparently restricted migration distance induced him to advocate "subsolidus diffusion at elevated temperatures to explain the distribution of sulphides in the deposit".

Coats (1978) interpreted the Manibridge ultramafic zone as an inhomogeneous composite of several ultramafic layers that had been deformed to a steeply plunging fold with its closure at the southern end of the ultramafic zone

Whole rock analysis and CIPW norms calculated from core samples of borehole W50-92A* collared approximately 600 m northeast of the Manibridge Mine headframe are given in Figure 17. This borehole intersected a layer of serpentinized ultramafic that is the northeastern extension of the serpentinite that hosts the Manibridge orebody.

The most interesting feature of Figure 17 is the Ni sulphide curve which shows two peaks (Sample #3, 0.56% Ni and Sample #8, 0.8% Ni) over a background which fluctuates between 0.2% and 0.3% Ni. Additional evidence of lithological inhomogeneity is found in a ternary diagram of the olivine (Ol), clinopyroxene (Cpx) and orthopyroxene (Opx) distribution. (Figure 18).

As Figure 18 shows, evidence of two differentiation cycles consisting of a progressive enrichment in Ol and Opx at the expense of Cpx from sample #1 to sample #4. The composition of samples #5, #6 and #7 fluctuates slightly, however, their composition is similar as sample #3. Sample #8 shows a marked decrease in the 01 contents combined with the appearance of sulphur bound nickel as shown in Figure 12. Sample #9 shows a decrease in Cpx and a slight decrease in Ol contents. Sample #10 shows again a dramatic increase in Ol followed by a decline in Ol and Cpx, in samples #11 and #12, a differentiation pattern very similar to that seen between samples #7 and #8.

The author tentatively interpreted that this differentiation was due to magmatic pulses followed by quiescence, crystallization of mafic minerals and the formation of ultramafic cumulates. A similar mineralogical trend was found in the main Manibridge ultramafic body, but was interpreted to be due to repetitions of thin sills or flows (Coats, 1978).

NOSE DEPOSITS (MAP ER 79-2-11)

This deposit is located between the Minago River and the William River about 2-1/2 km west of Highway No. 6. Disseminated nickel sulphides are hosted by a serpentinized ultramafic body. Indicated tonnages were quoted as "7 300 000 tons grading 0.33% Ni to a depth of 1 200 feet" (Roth, 1975). This deposit has not been developed.

DISCUSSION

Most of the nickel deposits of the Thompson Nickel Belt occur along the western side of a highly deformed gneissic belt located between the Churchill and Superior Provinces. The intensity and style of deformation along with the degree of metamorphism suggests that this belt may be a remobilized and metamorphosed (partly retrograde) portion of the Superior Province. Enclosed in the gneisses are serpentinized ultramafic rocks, "ultramafic amphibolites" (Peredery, 1978), migmatized remnants of sedimentary and volcanic inliers and bands of sedimentary and volcano-sedimentary assemblages that contain serpentinized ultramafic bodies. Nickel sulphide deposits occur in some bands of serpentinized ultramafic bodies in both the gneissic and metasedimentary environments.

Peredery (1979) distinguished amphibole rich ultramafic rocks from the serpentinized ultramafic rocks and called them "ultramafic amphibolites" suggesting that they may be equivalent to Zurbrigg's (1963) "metaperidotite" of the Thompson Mine. He also described them as occurring on the fringes of other serpentinized ultramafic rocks, especially in Ospwagan Lake where they are in contact with

*(Samples and permission to publish this data are courtesy of Falconbridge Nickel Mines Ltd.)

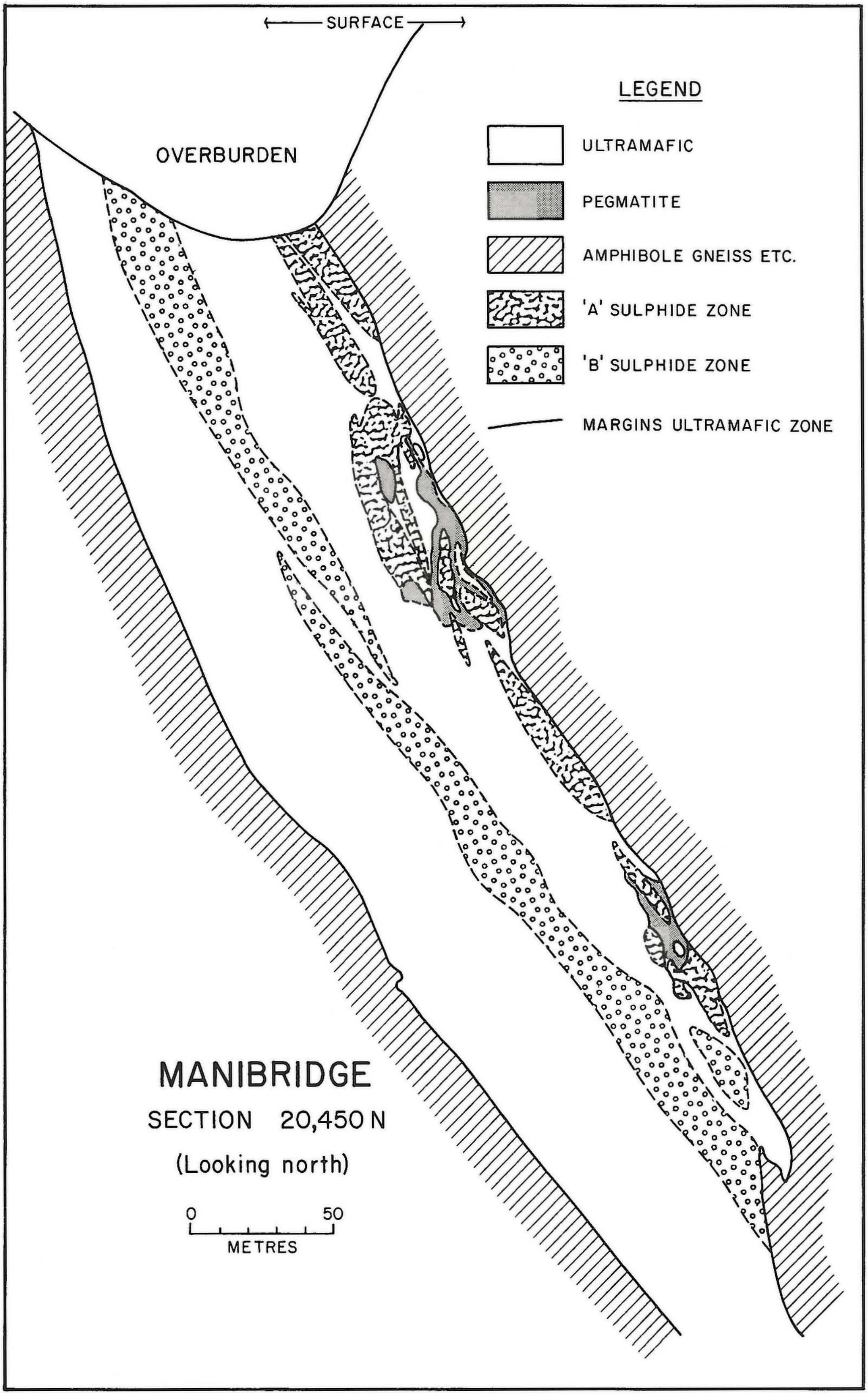
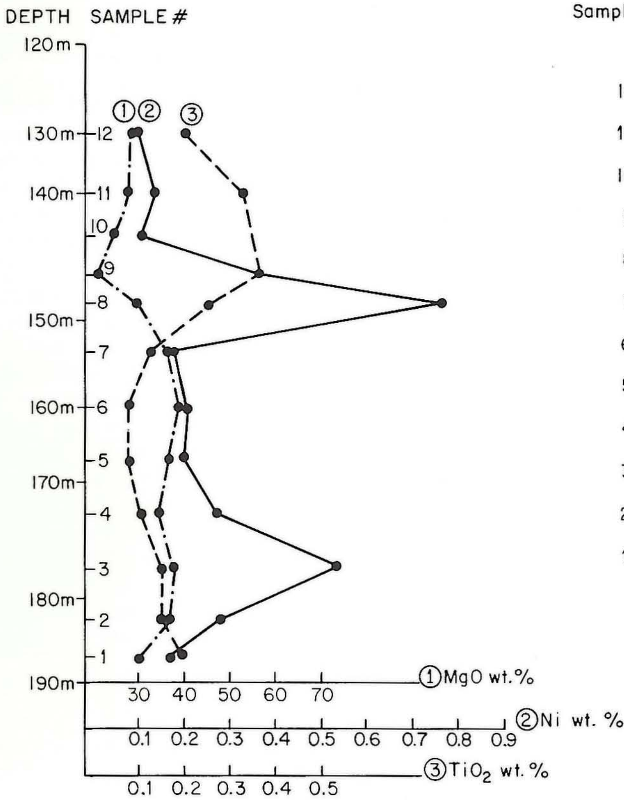


FIGURE 16: Geological section through the Manibridge Mine. (From Coats et al., 1976).



Sample#	Ol	Opx	Cpx	Plag	Normative rock name	
	wt. percentages					
12	43.3	30.8	7.6	12.7	Olivine mela norite	CYCLE B
11	50.0	20.0	9.3	12.9	Olivine mela norite	
10	51.1	11.4	11.8	16.5	Olivine mela gabbro	
9	23.3	35.1	14.9	16.3	Olivine mela norite	
8	33.2	46.3	0.0	11.5	Olivine mela norite	
7	68.6	17.8	1.1	6.3	Plagioclase bearing harzburgite	CYCLE A
6	70.6	16.7	0.0	4.6	Plagioclase bearing harzburgite	
5	64.0	22.2	0.1	6.2	Plagioclase bearing harzburgite	
4	77.5	5.3	0.0	9.3	Plagioclase bearing harzburgite	
3	71.7	14.7	0.0	6.7	Plagioclase bearing harzburgite	
2	75.9	6.4	5.2	9.1	Plagioclase bearing harzburgite	
1	51.3	11.0	10.5	11.4	Olivine mela norite	

FIGURE 17: Sample data and CIPW data of samples from borehole W50-92A from the northern prolongation of the Manibridge ultramafic zone.

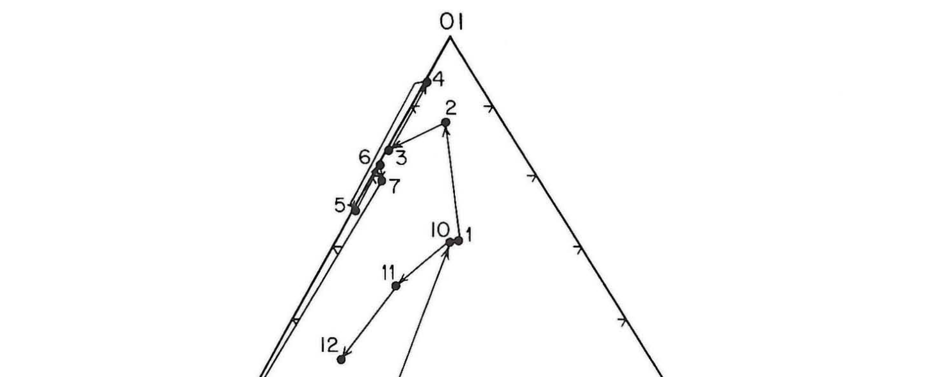


FIGURE 18: Ternary diagram; Ol vs. Cpx vs. Opx of samples from borehole W50-92A from the northern prolongation of the Manibridge ultramafic zone.

pillowed Mg-rich basalt carrying spinifex textures. Based on the similar komatiitic chemistry shown by the ultramafic amphibolite, the serpentinized peridotite of the Thompson, Soab South, and Pipe-Ospwagan zones and the magnesian basalts of Ospwagan and Mystery Lakes, Peredery concluded that all these rocks may have a close genetic relationship. (Peredery, 1979)

Evidence of two major superimposed deformation events is found in the gneisses of the Thompson Nickel Belt. Rb-Sr radiometric dating of gneisses of the belt gave an Archean age of 2 820 ± 135 Ma (Cranstone and Turek, 1976). On the other hand the sediments and volcano-sedimentary bands hosting the majority of the ore bearing ultramafic rocks show evidence of Hudsonian orogenesis only. Most of the ultramafic bodies appear to be concordant with their host rocks and at least one of these bodies appears to have intruded its metasedimentary host in the form of a sill (Pipe 2). Evidence of differentiation in the Pipe 2 ultramafic indicates that facing in the sill coincides with the direction of the stratigraphic top of the hosting sedimentary pile.

These ultramafic bodies, some of them carrying economic quantities of nickel sulphides, were subjected to intense deformation during the Hudsonian orogeny, which led to varying degrees of sulphide remobilization. Coats et al., (1966) reported evidence of minor sulphide remobilization in the Manibridge orebody. The Bucko deposit has been subjected to intense *en echelon* disruption of the orebody and mobilization of sulphides into fault controlled veins in the country rock (Northern Miner, November 23, 1972). Indications of minor sulphide remobilization concurrent with the formation of breccia ore were observed in the Pipe 2 deposit. Intense large scale deformation and separation of sulphide ore from the ultramafic host rocks has occurred in the Birchtree Mine. W. Peredery (pers. comm., 1978) invoked complete separation of the Thompson deposit sulphides from ultramafic rock as a model to explain the almost total absence of the latter in the ore zone. The absence of ultramafic rocks, coupled with the large tonnages and high grade of ores, sets the Thompson deposit apart from most of the other sulphide deposits of the Belt.

A variety of other models have been advanced to explain the genesis of the stratabound Thompson nickel deposit. They all rely fundamentally on a volcanogenic interpretation with the following variations: sulphide flows in the sense of Ross and Hopkins (1975); volcanogenic immiscible sulphide deposits in the sense of Naldrett (1973); exhalative nickel deposits in the sense of Lusk (1976); and hydrothermal nickel mineralization. All these models are at least in part acceptable and are difficult to dispute, however, no evidence of volcanic activity nor alteration zones have been found in the vicinity of the Thompson Mine. Bearing in mind that all other nickel deposits in the Belt are associated with ultramafic rocks and that evidence of sulphide remobilization in varying degrees is evident in these deposits, Peredery's model of magmatic sulphides tectonically separated from a presently unidentified ultramafic body appears to be the most acceptable genetic model.

VII. STRATABOUND ULTRAMAFIC OCCURRENCES OF THE CHURCHILL GEOLOGICAL PROVINCE OF MANITOBA (MAP ER 79-2-13)

INTRODUCTION

Ultramafic rocks occur in the Churchill Province in a variety of geologic environments*. However, a particular type of ultramafic rock appears to occur consistently at a similar stratigraphic position over long distances. This stratigraphic level is characterized by the presence of an amphibolitic layer which also contains iron formation and quartzo-feldspathic and carbonaceous rocks. The layer is overlain by a sedimentary suite that locally contains polymictic conglomerates. The area within which this stratigraphic layer is identified extends along the Lynn Lake Greenstone Belt, from the Manitoba-Saskatchewan border toward Lynn Lake and thence in a southeasterly direction toward the Thompson-Odei River region. Toward the north it was also identified in the Southern Indian Lake—Partridge Breast Lake areas. (See Map ER 79-2-13). Occurrences of komatiitic ultramafic within a similar association have also been identified along strike to the west in Saskatchewan (Fox and Johnston pers. comm.).

GENERAL GEOLOGY

Three main rock groups are distinguished in the Lynn Lake Greenstone Belt, these are:

a) Sickle Group
b) Wasekwan Group
c) Burntwood Metamorphic Suite

a) Sickle Group: This group comprises a gneissic sequence with arkoses, conglomerates and potassium feldspar bearing paragneiss derived from sediments. The Sickle Group overlies the Wasekwan Group unconformably but appears to have a conformable relationship with the Burntwood Metamorphic Suite.

b) Wasekwan Group: Rocks of volcanic and sedimentary origin compose this group. The volcanic suite includes basic, intermediate and acid tuffs and flows. The sediments comprise greywackes, sandstones and rare intraformational conglomerates. The Wasekwan Group is interpreted to be age equivalent with, and to represent the proximal, volcanic facies of the distal, sedimentary Burntwood Metamorphic Suite.

c) Burntwood Metamorphic Suite: The main components of this suite are muscovite, garnet, biotite, cordierite and sillimanite-bearing metagreywackes, metamudstones and metasiltstones and their migmatitic derivatives. Layered amphibolites, sulphide iron formation, laminated quartzofeldspathic rocks and carbonaceous rocks occur near the stratigraphic top of this suite, but are regionally restricted to the flanks of the main Kisseynew Sedimentary Gneiss Belt.

STRATABOUND ULTRAMAFIC OCCURRENCES

Numerous occurrences of ultramafic rocks were reported to occur in close association with an "amphibolite" horizon that was variously described as "marker" amphibolite (Campbell, 1969, p. 15), or "contact" amphibolite. This amphibolite bands shows a wide compositional range and includes rocks of quartzitic, carbonaceous and feldspathic sediments, iron formation with or without sulphides and mafic volcanic rocks. Although generally highly metamorphosed, so that all traces of the original fabric are obliterated (McRitchie, 1975) instances were reported in which the amphibolite layer is locally better preserved and appears to be, at least in part, pillowed basic volcanic rocks (Lenton and Cameron, 1976). Zwanzig (1976, p. 90) reported that in the Laurie Lake area, mafic tuff breccias, rhyolitic tuff and ultramafic units including one differentiated ultramafic sill "were apparently deposited at the same time."

STRATIGRAPHIC COLUMNS

Fig. 19 shows a series of stratigraphic columns that illustrate the stratigraphic position of ultramafic rocks in several areas of the Churchill Province. The location of each stratigraphic column is shown on Map ER 79-2-13.

a) Russell Lake (Column 1)

Nineteen ultramafic lenses were reported to occur in association with the "contact" amphibolite, i.e. an amphibolite layer occurring between the greywacke and arkosic groups (McRitchie, 1975). Lenton and Cameron (1976) described this amphibolite horizon as consisting normally of a thinly layered para-amphibolite band ranging in thickness between 0 to 50 m, containing thin layers of carbonate, iron formation and quartzite. However, within the Russell Lake structure, occurring at the same stratigraphic level as the para-amphibolite they describe a massive amphibolite. This massive amphibolite horizon, occurring instead of the para-amphibolite, is from 30 to 100 cm thick and on well preserved exposures resembles pillowed basic flows. Lenton and Cameron (1976) interpreted the para-amphibolite and massive amphibolite respectively, as distal and proximal mafic volcanic facies. It is in the massive amphibolite facies that nineteen discontinuous pods and lenses (McRitchie, 1975) of enstatite bearing hornblende peridotite (Fo_{85}) occur, and this suite is overlain by polymictic conglomerates comprising granitic cobbles, quartz pebbles and fine grained mafic and felsic clasts.

b) Tod Lake and Laurie Lake West Area (Column II and Column III)

Zwanzig (1976) observed in the Laurie Lake area a facies transition zone between the Lynn Lake Greenstone Belt terrane and the southern Kisseynew Sedimentary Gneiss Belt. Lithological changes include a thickening of the greywacke succession and a transition of volcanic flows to pillow breccia hyalocastites and mafic volcanic wackes. Ultramafic lenses were found associated with mafic volcanic flows or amphibolites at the top of the Wasekwan Group or Burntwood River Metamorphic Suite. These rocks are conformably overlain by the sedimentary Sickle Group.

Other areas not shown in Figure 20 but identified on Map ER 79-2-13 show similar relationships between the setting of ultramafic lenses and the local stratigraphy. Three examples are, the Kamuchawie Lake area, the Finch Lake area and the Mynarski Lake area.

Kamuchawie Lake area

Zwanzig and Wielezynski (1975) identified three rock groups in the Kamuchawie Lake area. The stratigraphically lowest is a greywacke-migmatite group assigned to the Burntwood Metamorphic Suite. These rocks are conformably overlain by the Amphibolite Group which is a continuous layer of amphibole-diopside and quartz rich rocks with sulphide iron formation, calc silicate rocks and oxide iron formation. Zwanzig (pers. comm., 1979) identified a lense of ultramafic rock in metasedimentary rocks which are laterally associated with amphibolite lying below arkosic gneiss of the Sickle Group.

*Note: Ultramafic occurrences of the Churchill Province are not listed in the appendices. The location of these is given on the Geological map of Manitoba, Map 79-2.

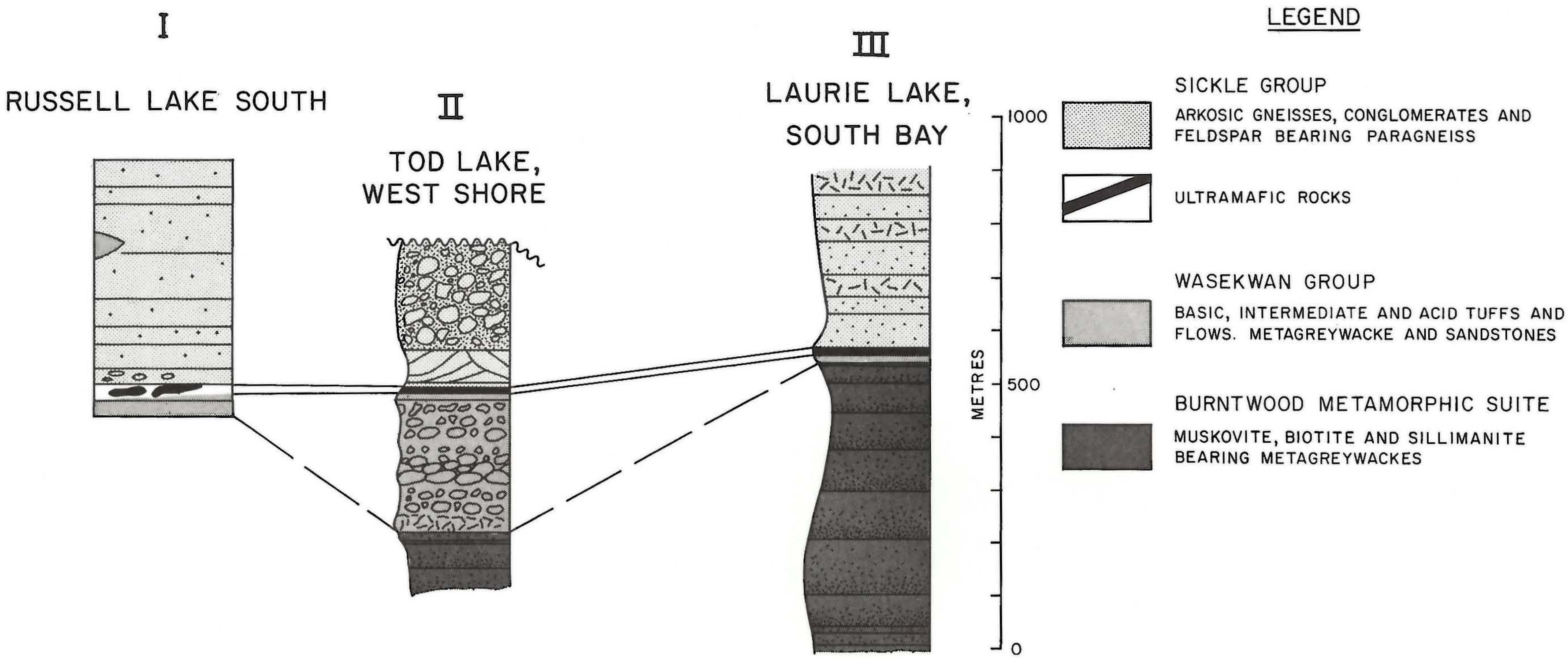


FIGURE 19: Stratigraphic columns through selected areas of the Churchill Province showing the stratigraphic position of ultramafic rocks.
Column I after McRitchie (pers comm.)
Column II and III modified after Zwanzig (1976)

Finch Lake area

Zwanzig (pers. comm., 1979) described a unit which contains biotite and hornblende bearing metagreywackes and mafic volcanics which he correlates with the Wasekwan Group. These rocks are associated with ultramafic lenses in the Finch Lake area. They occur as narrow unaltered "screens" between granitic intrusions.

Mynarski Lake area

Elphick (1972) described a totally recrystallized layered ultramafic sill associated with amphibolite that he considers as a part of the Wasekwan and/or Sickle Group. The ultramafic body is also in contact with biotite-magnetite gneiss of typical "Sickle" affiliation.

DISCUSSION

Ultramafic rocks occur in close association with an amphibolite band which can also contain a variety of marine sediments and mafic volcanic rocks. This band occupies a definite stratigraphic level at the top of a rock group which includes a proximal mainly volcanic facies and a distal mainly sedimentary facies. These rocks are either conformably or unconformably overlain by a sedimentary group of rocks that may, in many instances, start with layers of polymictic conglomerates. There seem to be general parallels between these ultramafic bodies and many of these of the northern Superior Province described in Chapter III and one may speculate that their mode and environment of emplacement must also have been similar. This proposal however, requires further verification through additional field investigations.

VIII. SUMMARY AND RECOMMENDATIONS

SUMMARY

1) Evidence has been presented showing that the majority of ultramafic rocks in greenstone belts of the Superior Province occur at a particular stratigraphic horizon that can be identified in most greenstone belts. Ultramafic bodies in parts of the Churchill Province show a similar tendency.
2) The stratigraphic horizon at which the ultramafic bodies preferentially occur is the contact between a mainly volcanic group and the overlying sedimentary group.
3) The occurrence of spinifex textures in a stratabound ultramafic lense in the Island Lake Greenstone Belt, its chemistry, and the chemistry of other lenses located along this horizon identifies them as komatiitic ultramafic rocks, which are at least in part extrusive in origin.
4) The author infers that many of the known ultramafic occurrences are flows or shallow intrusions based on their similar stratigraphic position, their conformable shapes and the presence of spinifex textures in one of the occurrences.
5) The association of aeromagnetic anomalies and stratigraphy can be used to infer the presence of hitherto unidentified ultramafic bodies.
6) Volcanic and subvolcanic ultramafic rocks in Manitoba, as elsewhere, have good potential as hosts for sulphidic nickel deposits.
7) The stratigraphic control hypothesis may also have useful application in the search for other commodities associated with ultramafic rocks, such as gold.

RECOMMENDATIONS

1) The favourable stratigraphic horizon (i.e., the contact between volcanic and overlying sedimentary groups) in Manitoba's greenstone belts (both Superior and Churchill Provinces) should be explored for as yet unrecognized ultramafic bodies.
2) Comprehensive studies of ultramafic bodies in greenstone belts of the Superior Province should include their stratigraphic position, texture and chemistry. These studies will permit comparison with the ultramafic host rock of known economic nickel deposits and hence permit a tentative evaluation of their nickel potential.
3) Tentative correlation between greenstone belts based on the stratabound ultramafic horizons may be of value both in the Superior and Churchill provinces. Two alternative possibilities are a) time equivalence of the stratabound ultramafic magmatism, or b) similar crustal evolution of greenstone belts, ultramafic volcanism occurring at the transition from a predominantly volcanic period to one of clastic sedimentation.
4) Detailed mapping of portions of this horizon should help to demonstrate whether rock units other than ultramafics are characteristically present.
5) Further studies of the position and possible relationship between the spinifex textured ultramafic occurrence and the other known ultramafic bodies of the Oxford-Knee Lake Greenstone Belt should be undertaken as an aid in interpreting their relation to "hidden" ultramafic zones that are inferred to be present in the belt.
6) The applicability of the stratigraphic control model to ultramafic occurrences in the Manitoba Nickel Belt should be investigated. A useful starting point for this type of study could be the ultramafic lenses adjacent to sedimentary rocks in the Setting Lake and Phillips Lake areas.

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APPENDIX A

Ultramafic Occurrences in the Superior Province of Manitoba (Northern and Southern Segments)

Note: Descriptions of rocks and mineralization are either direct quotes, or attempt to resemble the originals as close as possible.

KNOWN AND INFERRED ULTRAMAFIC OCCURRENCES 53E: ISLAND LAKE — PICKET LAKE — BIGSTONE LAKE (UTM GRID ZONE #15)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
Index	1	53E10 NW/NE	South shore of Wapus Bay — southwestern Island Lake. N: 5953250 E: 386500	outcrop, associated aeromagnetic anomaly	unexplored	amphibolite, granite dykes	Massive ultramafic characterized by asbestos veins and talc schist.	none reported	Ames (1975) Federal-provincial aeromagnetic map series #7274G, Island Lake, Manitoba-Ontario (53E)
Index	2	53E11NE	Picket Lake — southwest shore (R. Herd, pers. comm. 1979). N: 5948500 E: 35500	outcrop, associated aeromagnetic anomaly	unexplored	unknown	Appears near the contact of mafic metavolcanic rocks and clastic sediments at the eastern end of the Bigstone Lake — Knight Lake greenstone belt.	none reported	Federal-provincial aeromagnetic map series #7274G, Island Lake, Manitoba-Ontario (53E) Quinn (1960)
4D	3	53E12NE	Bigstone Lake — small island/reef near the northeast shore. N: 5954250 E: 329000	outcrop, associated aeromagnetic anomaly	unexplored	unknown	Located near the contact of mafic metavolcanic rocks and clastic sediments	none reported	Ermanovics et al., (1975) Federal-provincial aeromagnetic map series #7274G, Island Lake, Manitoba-Ontario (53E) Park and Ermanovics (1978)
4D	4	53E12NE	Bigstone Lake — large island in the northern section. N: 5956750 E: 325000	outcrop	unexplored	mafic metavolcanic rocks	No description given.	none reported	Park and Ermanovics (1978)
4D	5	53E12NE	Bigstone Lake — central portion of the northeast trending body located off the western shore of the lake. N: 5957000 E: 319750	outcrop	unexplored	mafic metavolcanic rocks	No description given.	none reported	Park and Ermanovics (1978)
4D	6	53E12NW	Bigstone Lake — small peninsula near southwestern end of the lake. N: 5948500 E: 313500	outcrop, associated aeromagnetic anomaly	unexplored	gabbro	No description given.	none reported	Ermanovics et al., (1975) Federal-provincial aeromagnetic map series #7274G, Island Lake, Manitoba-Ontario (53E) Park and Ermanovics (1978)
5	7	53E15NW	Island Lake — small islands/reefs 100-200 metres west of Linklater Island, near the mouth to Collins Bay. N: 597850 E: 381000	outcrop, drillcore associated aeromagnetic anomaly	examined	acid to intermediate volcanic rocks, clastic metasedimentary rocks	Two serpentinized peridotite bodies are described. The host rocks are dacite, rhyolite, and andesitic volcanics, with argillite and conglomeratic sediments. Gabbroic masses outcrop at the margins of the ultramafic bodies.	disseminated cp, py, po, minor mag	Ames (1975) Federal-provincial aeromagnetic map series #4041, Island Lake, (53E15) Godard (1963) Man. MRD File #91502; CB6622, CB6623 Lucie 2; Canadian Occidental Petroleum Ltd. Theyer (1978)
5	8	53E15NW	Island Lake — Fleet Point. N: 974500 E: 380000	outcrop	unexplored (?)	mafic metavolcanic rocks	Small outcrop of talc schist (soapstone) along a fault zone between the volcanics.	none reported	Ames (1975)
5	9	53E15NW	Island Lake — small island approximately 2 km north of the west end of Jubilee Island. N: 5971750 E: 381250	drill core, associated aeromagnetic aeromagnetic anomaly	examined	talc schist, metasedimentary rocks; iron formation, slate	Peridotite interlayered with talc schist, iron formation, slate.	Sulphide streaks in sediments.	Federal-provincial aeromagnetic map series #4041, Island Lake (53E15) Man. MRD-File #91152: Asbestos Canico Theyer (1978)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
5	10	53E15NW	Island Lake — inland from the east shore of the central part of Linklater Island. N: 5988850 E: 383000	drill core	examined	greenstone, talc-chlorite schist, limestone	Peridotite interlayered with chlorite-talc schist, limestone, slate, quartzite, tuff, greenstone.	none reported	Godard (1963) Man. MRD-File #99283; Ile 132, 182, 193 Claims; Inco Ltd.
5	11	53E15NW	Island Lake — small islands/reefs in the channel between Linklater Island and Cochrane Island. N: 5977000 E: 384000	outcrop, associated aeromagnetic anomaly	examined	metavolcanic and metasedimentary rocks	Serpentinite and talc schist-highly sheared serpentinized peridotite sill(s) located within highly altered volcanic and sedimentary rocks.	low grade Cu/Ni orebody, with dimensions of 65m x 300m to a depth of 650m. It consists of disseminated millerite, pentlandite, nickeliferous pyrrhotite, pyrite, chalcopyrite, and magnetite in both the peridotite and adjacent volcanics.	Ames (1975) Federal-provincial aeromagnetic map series #4041, Island Lake (53E15) Godard (1963) Quinn (1960) Quinn and Meinert (1959) Theyer (1977) Theyer (1978)
5	12	53E15NW	Island Lake — east central Linklater Island. N: 5979700 E: 381900	drill core	examined	tuff, tuffaceous, metavolcanic rocks, granite	Peridotite.	none reported	Man. MRD Assessment File #99283; Ile No. 132, 182; Inco. Ltd.
5	13	53E15NW	Island Lake — small islands/ reefs immediately south of southern tip of Linklater Island. N: 5973500 E: 384000	outcrop, drill core	examined	talc-chlorite schist, metasedimentary rocks	Partially serpentinized to sheared and serpentinized peridotite cut by veins of asbestos, picrolite and carbonate.	none reported	Ames (1975) Godard (1963) Man. MRD Assessment File #91152; Asbestos, No. 8; Canico Quinn (1960) Theyer (1978)
5	14	53E15NW	Island Lake — immediately south of south tip of Linklater Island. N: 5973200 E: 383800	aeromagnetic anomaly	unexplored	unknown	Elongated aeromagnetic anomaly.		Federal-provincial aeromagnetic map series #4041, Island Lake (53E15)
5	15	53E15NW	Island Lake — small island 1 km north of the west central part of Jubilee Island N: 5969500 E: 384500	drill core	examined	metasedimentary rocks, slate, quartzite	Peridotite.	none reported	Man. MRD Assessment File #91153; Lin. No. 53; Canico
5	16	53E15NE	Island Lake — east end of large island between Wass Island and Linklater Island. N: 5973500 E: 387000	drill core, associated aeromagnetic anomaly	examined	talc-schist, pyroclastic rocks	Peridotite interlayered with talc schist, quartzite, slate, granite.	none reported	Federal-provincial aeromagnetic map series #4041, Island Lake (53E15) Man. MRD Assessment File #99283; Talc #14; Canico
5	17	53E15 SE/NE	Island Lake — two small islands approximately 2 km north of the central part of Jubilee Island. N: 5970500 E: 386500	outcrop drill core associated aeromagnetic anomaly	examined	talc-chlorite schist, mafic metavolcanic rocks	Peridotite interlayered with greenstones, talc-chlorite schist, quartzite, limestone.	none reported	Federal-provincial aeromagnetic map series #4041, Island Lake (53E15) Godard (1963) Man. MRD Assessment File #91152; Asbestos No. 27, 30; Canico Theyer (1978)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
5	18	53E15 NW/NE	Island Lake — approximately 3 km north of Wass Island. N: 5973800 E: 386800	drill core, associated aeromagnetic anomaly	explored	pyroclastics, quartzite	Peridotite.	none reported	Man. MRD Assessment File #99283; Talc #14; Inco Ltd. Federal-provincial aeromagnetic map series #4041, Island Lake (53E15)
5	19	53E15SE	Island Lake — reefs approximately 2.5 km east of Stevenson Island along the north shore of the lake. N: 5967000 E: 394000	outcrop	unexplored	clastic mafic metavolcanic rocks, gabbro	The ultramafic body is on strike with the differentiated sill on Stevenson Island. Adjacent rocks are gabbro and clastic mafic metavolcanic rocks.	none reported	Ames (1975) Godard (1963) Quinn (1960)
5	20	53E15SE	Island Lake — bay approximately 3 km east of Stevenson Island along the north shore of the lake. N: 5966000 E: 394100	outcrop	unexplored	unknown	No description given.	none reported	Petak (pers. comm., 1979)
5 5 5	21, 22, 23.	53E16SW 53E15SE western: eastern: central:	Island Lake — 3 small islands/reefs northeast of Confederation Island along the north shore that occur linearly across 5 km. N: 5964500 E: 396800 N: 5962900 E: 401250 N: 5964400 E: 398200	outcrop, associated aeromagnetic anomaly	unexplored	mafic metavolcanic rocks, clastic metasedimentary rocks	Serpentine layer within mafic metavolcanic rocks.	none reported	Ames (1975) Federal-provincial aeromagnetic map series #4041, Island Lake (53E15) Godard (1963) Quinn (1960) Theyer (1978)
5	24	53E16SW	Island Lake — Henderson Island N: 5958800 E: 400000	aeromagnetic anomaly	unexplored	mafic volcanic rocks, polymictic conglomerates	Inferred ultramafic zone thought to underlie trench situated at the contact of mafic volcanic rocks and polymictic conglomerates		Federal-provincial aeromagnetic map series #4041, Island Lake (53E15) Theyer (1979)
5	25	53E16SW	Island Lake — approximately 1 km west of Henderson Island. N: 5958500 E: 403500	drill core, associated aeromagnetic anomaly	examined	granite gneiss, diorite, hornblende schist	Occurs as a narrow band/lense of altered and serpentinized peridotite.	7% po and py in the amphibolite and hornblende schist sections.	Federal-provincial aeromagnetic map series #4023, York Lake (53E16) Godard (1963) Man. MRD-File #91156; Ni Phelps Dodge Corporation Quinn (1960) Theyer (1979)
5	26	53E16NW	Island Lake — Pickerel Narrows N: 5970250 E: 409500	outcrop, associated aeromagnetic anomaly	examined	mafic metavolcanic rocks (?)	Serpentinized ultramafic occurring as cross-cutting dykes.	none reported	Federal-provincial aeromagnetic map series #4023, York Lake (53E16) Quinn (1960) Sopuck (1972)
5	27	53E16SE	Island Lake — just west of Heart Island. N: 5959500 E: 421250	outcrop, associated aeromagnetic anomaly	unexplored	mafic metavolcanic rocks (?)	No description given.	none reported	Federal-provincial aeromagnetic map series #4023, York Lake (53E16) Quinn (1960)
5	28	53E16SE	Island Lake — north of central Heart Island. N: 5959500 E: 425000	outcrop	examined	mafic acid metavolcanic rocks, clastic metasedimentary rocks	No description given.	none reported	Theyer (1978)

KNOWN AND INFERRED ULTRAMAFIC OCCURRENCES 53E: ISLAND LAKE — PICKET LAKE — BIGSTONE LAKE (UTM GRID ZONE #15) (Cont)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
5	29, 30.	53E16SE western: eastern:	Island Lake — Loonfoot Island — Whiteway Island area. N: 5965250 E: 426750 N: 5960750 E: 428750	outcrop, drill core, associated aeromagnetic anomaly	examined	mafic metavolcanic rocks	Peridotite and serpentinite interlayered with mafic metavolcanic rocks.	minor fine grained disseminated sulphides, 10% (py, po, cp, pn)	Geology of the Pan claim group, Island Lake area, York Lake sheet (53E16) Cominco Federal-provincial aeromagnetic map series #4023, York Lake (53E16) Godard (1963) Man. MRD-File #99285: Pan claims Cominco Quinn (1960) Theyer (1977) Theyer (1978)
5	31, 32, 33, 34. central central	53E16SE western: western: eastern: eastern:	Island Lake — Bluff Island and Sandy Bar Narrows area. N: 5958500 E: 426500 N: 5950000 E: 532250 N: 5956750 E: 432250 N: 5956500 E: 433500	outcrop, drill core, associated aeromagnetic anomaly	examined	mafic metavolcanic rocks, clastic metasedimentary rocks	Consists of serpentinite sections, talc-carbonate veins, and minor asbestos veins linearly arranged along Sandy Bar Narrows, north of Bluff Island.	minor, fine grained, disseminated sulphides (po, py)	Federal-provincial aeromagnetic map series #4023, York Lake (53E26) Godard (1963) Man. MRD-File #99285: Rita claims; Cominco Quinn (1960)

KNOWN ULTRAMAFIC OCCURRENCES 53F: SAGAWITCHEWAN BAY AND N.E. ISLAND LAKE (UTM GRID ZONE #15)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
Index	1	53F12NW	Sagawitchewan Bay, Island Lake — southeastern shore near the mouth of the creek leading to Hayward Lake. N: 5953000 E: 448500	outcrop, drill core	examined	gabbro(?), mafic metavolcanic rocks(?)	No description given.	none reported	Cominco Ltd.: (pers. comm.) Godard (1963)
Index	2	53F12NW	Sagawitchewan Bay, Island Lake — small bay located off the southern shore of the central part of Sagawitchewan Bay. N: 5950250 E: 445500	outcrop, drill core	examined	mafic metavolcanic rocks(?)	No description given.	none reported	Cominco Ltd.: (pers. comm.) Godard (1963)
Index	3	53F12NW	Sagawitchewan Bay, Island Lake — three small islands immediately south of the largest island in the north central portion of the bay area. western: N: 5954500 E: 444750 eastern: N: 5954750 E: 447250	outcrop	examined	mafic metavolcanic rocks(?)	Serpentinite.	none reported	Cominco Ltd.: (pers. comm.) Godard (1963)
Index	4	53F13SW	Island Lake — peninsula in the north-eastern bay, approximately 10 kilometers northeast of Loonfoot Island. N: 5968250 E: 535250	outcrop	examined	unknown	No description given.	none reported	Cominco Ltd.: (pers. comm.)

KNOWN ULTRAMAFIC OCCURRENCES 63H: PONASK LAKE (UTM GRID ZONE #14)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
4F	1	63H15 16	Ponask Lake. N: 5971700 E: 674900	outcrop	unexplored	metavolcanic rocks, metasedi mentary rocks	Generally medium-to coarse-grained amphibolite, pyroxenite, serpentinite.	none reported	Ermanovics (1972)
4F	2	63H15 16	Ponask Lake. N: 5971500 E: 673900	outcrop	unexplored	metavolcanic rocks	Pyroxenite.	none reported	Ermanovics (1972)
4F	3	63H15 16	Ponask Lake. N: 5960900 E: 673600	outcrop	unexplored	metavolcanic rocks	No description given.	none reported	Ermanovics (1972)
4F	4	63H15 16	Ponask Lake. N: 5970650 E: 670800	outcrop	unexplored	metavolcanic rocks	No description given.	none reported	Ermanovics (1972)
4F	5	63H15 16	Ponask Lake. N: 5967250 E: 662300	outcrop	unexplored	metavolcanic rocks, metasedimentary rocks	No description goven.	none reported	Ermanovics (1972)
4F	6	63H15 16	Ponask Lake. N: 5964900 E: 659400	outcrop	unexplored	metavolcanic rocks, metasedimentary rocks	No description given.	none reported	Ermanovics (1972)

KNOWN ULTRAMAFIC OCCURRENCES 53L: KNEE LAKE — REEKIE LAKE — GOOSE LAKE (UTM GRID ZONE #15)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
41	1	53L7SE	Goose Lake — East. N: 6016750 E: 395750	outcrop, associated aeromagnetic anomaly	unexplored	unknown	Isolated ultramafic reef.	none reported	Elbers (in prep.) Federal-provincial aero-magnetic map series #4043
41	2	53L7SE	Goose Lake — Center. N: 6018000 E: 394250	outcrop associated aeromagnetic anomaly	unexplored	mafic metavol-canic rocks	Serpentinized peridotite.	none reported	Elbers and Marten (1973) Scoates (1971)
41	3	53L7SE	Goose Lake — West. N: 6078500 E: 392500	outcrop, associated aeromagnetic anomaly	unexplored	quartzwacke, mafic metavol-canic rocks	Serpentinized peridotite approxi-mately 600 x 100 m	none reported	Elbers and Marten (1973)
41	4	53L7SW	Beaver Hill Lake — Northwest. N: 6029000 E: 373000	outcrop, associated aeromagnetic anomaly	unexplored	gabbro	Layered serpentinized peridotite and dunite; serpentinized feld spathic peridotite and pyroxenite associated with a gabbroic body.		Elbers (1972) Macek and Trueman (1972)
41	5	53L7SW	Beaver Hill Lake — North. N: 6030250 E: 372750	outcrop	unexplored	gabbro, inter-mediate tuff(?) Breccia(?)	Serpentinized peridotite.	fine grained sulphides	Elbers (1972) Elbers and Marten (1973) Macek and Trueman (1972) Scoates et al., (1972)
3A	6	53L12SW	Max Lake (eastern occurrence) N: 6049250 E: 311750	outcrop	unexplored	metabasalt	Olivine hornblendite.	none reported	Federal-provincial aero-magnetic map series #17294G Oxford House (53L). Hubregtse (1974)

KNOWN ULTRAMAFIC OCCURRENCES 53L: KNEE LAKE — REEKIE LAKE — GOOSE LAKE (UTM GRID ZONE #15) (Cont)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
4C	7	53L11SW	Western Colen Lake — North shore of bay adjoining Reekie Lake. N: 6051250 E: 348000	outcrop	unexplored	basic tuff, greywacke, lapilli tuff	Highly altered, recrystallized ultramafic rock with hornblende and serpentine composing the majority of minerals.	none reported	Elbers and Gilbert (1972a) Scoates (1971)
4C	8	53L11SE	Rifle Lake — reefs on south shore. N: 6052500 E: 355500	outcrop, drill core	examined	basic tuff, argillite, biotite sericite schist, quartzite, metasedimentary rocks	Ultramafic sill approximately 2500 x 50 m occurs in metasedimentary rocks in close proximity to gabbro. Metasedimentary rocks are predominant surrounding rock type.	from 1% to 80% po in basic tuff and argillite	Barry (1962) Man. MRD File #92005
4C	9	53L11SE	Reekie Lake — western end. N: 6049500 E: 358250	drill core, associated aeromagnetic anomaly	examined	quartzite, mafic lava, tuff greywacke, basalt(?)	Serpentinized peridotite in basalt and greywacke.	1-2% po and py in tuffaceous layers	Elbers and Gilbert (1972a)
4C	10	53L1SE	Reekie Lake — center. N: 6049000 E: 359500	drill core	examined	quartzite, mafic lava, tuff	Serpentinite, serpentinite schist, carbonate-chlorite-serpentinite schist.	traces to 20% po and py in tuffaceous layers	Man. MRD-Files #91179 and #92005. Falconbridge Nickel Mines Ltd. Elbers and Gilbert (1972a) Elbers and Gilbert (1972b)
4C	11	53L11SE	Reekie Lake — eastern end. N: 6048000 E: 362000	outcrop, drill core	examined	andesite, tuff	Serpentinite and talc-carbonate-chlorite schist.	none reported	Scoates (1971)
Index	12	53L10SW	Vermilyea Lake North. N: 6048000 E: 383000	drill core associated aeromagnetic anomaly	examined	diorite, chlorite schist	Diorite interbanded with peridotite, iron formation, talc, and chlorite schist surrounded by amphibolite schist and granodiorite.	none reported	Man. MRD-File #91178 — Canico Federal-provincial aeromagnetic map series #4044, Vermilyea Lake (53L10) Marten (1973) Marten, et al., (1973)
3B	13	53L15NW	Central Knee Lake. N: 6092500 E: 386500	outcrop	unexplored	acid to intermediate metavolcanic rocks, greywacke	Serpentinized peridotite.	sparsely disseminated sulphides	Gilbert and Elbers (1972a) Scoates (1971)

INFERRED ULTRAMAFIC OCCURRENCES 53L, 63H, 63I, GOOSE LAKE — CROSS LAKE — OXFORD LAKE (UTM GRID ZONE #14, 15)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
F	I	53L7SE	Goose Lake.	aeromagnetic anomaly	unexplored	metasedimentary rocks, metavolcanic rocks	Aeromagnetic anomaly with fairly steep gradient, 600 gammas above background striking east-west and northeast of the proven ultramafic occurrences #1 and #2. Water covered, straddling the north shore of Goose Lake.		Federal-provincial aeromagnetic map series #4043 Elbers and Marten (1973) Scoates (1971)
F	II	53L7SW	Kanuchuan Rapids.	aeromagnetic anomaly	unexplored	basic crystal tuff, lapilli tuff, agglomerate, greywacke	Elongated aeromagnetic anomaly with fairly flat gradient, 200 gammas above background, located in a rock sequence mapped as basic volcanic rocks and minor greywacke.		Federal-provincial aeromagnetic map series #4043 Elbers and Marten (1973) Marten and Elbers (1973)

INFERRED ULTRAMAFIC OCCURRENCES 53L, 63H, 63I: GOOSE LAKE — CROSS LAKE — OXFORD LAKE (UTM GRID ZONE #14, 15) (Cont)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	References
E	III	53L10, 11.	Reekie Lake — Touchwood Lake.	aeromagnetic anomaly	unexplored	massive acid pillowed basalt, andesite, gabbro?, hornblendite	Elongated fairly weak aeromagnetic anomaly, 100-120 gammas above background with three minor peaks. It is the eastern extension of major anomaly over known ultramafic bodies on Reekie Lake.	Federal-provincial aeromagnetic map series #4063 and #4044 Barry (1962) Elbers and Gilbert (1972)
E	IV	53L11	Reekie Lake — Colen Lake.	aeromagnetic anomaly	unexplored	basic crystal tuff, lapilli tuff, agglomerate, greywacke	Elongated fairly weak aeromagnetic anomaly, 120-140 gammas above background with two minor peaks. It is the western part of the anomaly over the known ultramafic occurrences on Reekie Lake.	Federal-provincial aeromagnetic map series #4063. Barry (1962) Elbers and Gilbert (1972)
D	V	53L14 53L15	Northern Oxford Lake Western Knee Lake East of Lake T	aeromagnetic anomalies	unexplored	straddling the contact of a metavol canic and metasedimentary series of rocks	A series of eleven discrete aeromagnetic anomalies, up to 2000 gammas above background, straddling the contact of a volcanic and a sedimentary series of rocks.	Federal-provincial aeromagnetic map series #7294G Barry (1959, 1960) Elbers (1972) Gilbert and Elbers (1972) Hubregtse (1973) Hubregtse and Gilbert (1973)
	VI	63H16NW	Approx. 4 km WNW of the northeast end of Ponask Lake.	aeromagnetic anomaly	unexplored	close to the contact of a metavolcanic and a metasedimentary group of rocks	Elongated steep aeromagnetic anomaly, approximately 700 gammas above background. This anomaly in the northeastern prolongation of the anomaly over a known ultramafic body (Index No. 1).	Federal-provincial aeromagnetic map series #4018 Ermanovics (1972)
A	VIII	63 I12	Cross Lake — section south of Cross Island.	aeromagnetic anomalies	unexplored	located on or immediately adjacent to the contact of a predominantly metvolcanic group of rocks (Hayes River Group) and a predominantly metasedimentary group of rocks (Cross Lake series)	Discrete lensoid aeromagnetic anomalies of steep gradient, approximately 400-800 gammas above background.	Federal-provincial aeromagnetic map series #2597. Bell (1962) Rousell (1962)
A	IX	63 I12	Cross Lake — section north and northeast of Cross Island	aeromagnetic anomalies	unexplored	located on or immediately adjacent to the contact of a predominantly metavolcanic group of rocks (Hayes River Group) and a predominantly metasedimentary group fo rocks (Cross Lake series)	Discrete lensoid aeromagnetic anomalies of a steep gradient, approximately 800 gammas above background.	Federal-provincial aeromagnetic map series #2597. Bell (1962) Rousell (1962)
kB	VII	63 I 7.8	Pipestone Lake east Butterfly Lake.	aeromagnetic anomalies	unexplored	metasedimentary rocks, metavolcanic rocks	Four lensoid aeromagnetic anomalies with a steep gradient; up to 600 gammas above background, located on the contact of metavolcanic and metasedimentary rocks.	Federal-provincial aeromagnetic map series #2597, 2604 Bell (1962) Rousell (1962)

KNOWN ULTRAMAFIC OCCURRENCES 53L: OXFORD LAKE — KNEE LAKE (UTM GRID ZONE #15)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
3B	14	53L15NW	Southern Knee Lake. N: 6084750 E: 384750	outcrop	unexplored	acid to intermediate metavolcanic rocks, gabbro, greywacke	Serpentinized peridotite and serpentinite associated with gabbro and volcanic rocks.	sparsely disseminated sulphides	Gilbert and Elbers (1972a) Gilbert and Elbers (1972b)
3B	15	53L15NW	Southern Knee Lake. N: 6084750 E: 378000	drill core	examined	bore hole started and stopped in peridotite	Serpentinized peridotite approximate drilled thickness 90 metres.	minor po	Man. MRD-File #91191. Selco
3B	16	53L15NW	Knee Lake — West end of Painkiller Bay. N: 6082750 E: 375000	outcrop	unexplored	gabbro, acid to intermediate metavolcanic rocks	Serpentinized peridotite, approximate dimensions 1000 metres x 180 metres		Barry (1959) Elbers and Gilbert (1972a) Scoates (1971)
3B	17	53L14NE	Southern Knee Lake. N: 6082250 E: 370250	drill core	examined	porphyritic andesite	Serpentinized peridotite, apparent thickness 100-130 metres.	disseminated po rare stringers with 5-12% po	Man. MRD-File #91190, Caf #91193, Selco Man. MRD-File #91192, Canico
3B	18	53L14NE	Southern Knee Lake. N: 6083000 E: 367500	outcrop	unexplored	gabbro, mafic to acid metavolcanic rocks	Concentrically zoned ultramafic, Core: fine grained serpentinite; intermediate zone: medium grained serp. peridotite-pyroxenite; and outer zone: fine grained serpentinite.	none reported	Barry (1959) Gilbert and Elbers (1972a) Gilbert and Elbers (1972b) Hubregtse and Gilbert (1973) Scoates (1971)
3B	19	53L13NE	Oxford Lake "Bleak Island" N: 6085250 E: 332250	outcrop	unexplored	gabbro, conglomerate, pillowed basalt	No description given.	none reported	Hubregtse (1973)
3B	20	53L13SW	Oxford Lake Jackson Bay. N: 6078000 E: 318250	outcrop	unexplored				Scoates (1971)
3B	21	53L13SW	Oxford Lake "High Rock Island" N: 6075250 E: 318500.	outcrops	unexplored	pillowed basalt	2.9 km long layer of peridotite showing differentiation to hornblendite, cumulate textures and quench textures. Iron formation xenoliths are partially assimilated at the bottom of the layer.	none reported	Hubregtse (1973) Hubregtse (1978)
3B	22	53L13SW	Oxford Lake Lynx Bay. N: 6071750 E: 310000	outcrops on reefs and small islands	unexplored	metagabbro, metasedimentary rocks, granodiorite	Serpentinite-serpentinized peri dotite, serpentinized diorite, talc serpentine. Gradational contacts with adjacent rocks.	rare disseminated sulphides	Barry (1960) Hubregtse (1973b) Haskins and Stephenson (1974)

KNOWN ULTRAMAFIC OCCURRENCES 63I: CROSS LAKE — ECHIMAMISH RIVER — MAX LAKE — CARROT RIVER (UTM GRID ZONE #14)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
Index	1	63 I9SE	Max Lake — west occurrence. N: 6043500 E: 692000	outcrop	unexplored	metabasalt, meta-sedimentary rocks	Serpentinite located in mafic meta-volcanic rocks adjacent to meta-sedimentary rocks.	none reported	Bell (1962) Hubregtse (1973a) Hubregtse (1974)
3A	2	63 I6NE	Echimamish River. N: 6030000 E: 631000	drill core	examined	andesite, talc-serpentine schist	Talc-serpentine schist.	none reported	Man. MRD-File #91260, Mike 16, 41 claims; Robo & Bergun Syndicate Bell (1962)
4G	3	63 I12SW	Pipestone Lake — west end. N: 6044500 E: 579500	outcrop	unexplored	mafic metavolcanic rocks, clastic meta-sedimentary rocks, mafic metavolcanic rocks	Peridotite, serpentinite located in mafic metavolcanic rocks.	none reported	Bell (1962) Rousell (1965)
4E	4	63 I12NE	Cross Lake, Sandy Bay. N: 6053000 E: 581750	drill core	examined	polymictic con-glomerate, pillowed basalt	Peridotite, and serpentinized peridotite.	disseminated (po and py)	Bell (1962) Man. MRD-File #91262 Mile No. 11 claim, Noranda Rousell (1965)
4E	5	63 I10NE	Carrot River — 2 occurrences along the south shore of the western end of the river. (Hubregtse, pers. comm.) West: N: 6063000 E: 652250 East: N: 6065000 E: 651500	outcrops	unexplored	mafic meta-volcanic rocks, tonalite porphyry	Silicified serpentinite in contact with tonalite porphyry, located within pillowed basalt.	(po and py)	(Hubregtse, pers. comm.)
4E	6	63 I10NE	Carrot River — north shore. N: 6068750 E: 660000	outcrop	unexplored	mafic metavol-canic rocks	Dunite.	none reported	Hubregtse (1973b)
4E	7	63 I16SW	Carrot River — north shore of central Carrot River. N: 6075000 E: 672000	outcrop	examined	mafic metavol-canic rocks, minor acid to intermediate meta-volcanic rocks	Serpentinite and serpentinized peridotite, at least 100 metres wide by a thousand metres in length, exposed on the north shore of Carrot River, located mainly in mafic metavolcanic rocks.	fine grained dis-seminated sul-phides, 2% on the average (py, po, cp)	Barry (1960), pp. 28, 35 Bell (1962) Hubregtse (1973c) Man. MRD-File #98164: CB4480, 5043-44, Kim 1-15, Canex Placer Ltd. Scoates (1971)
4E	8	63 I16SW	Carrot River — north shore of central Carrot River. N: 6076500 E: 671250	outcrop	unexplored	gabbro	No description given.	none reported	Hubregtse (1973c)
4E	9	63 I16SE	Carrot River — Peridotite Island area. West: N: 6077750 E: 680000 East: N: 6078250 E: 681500	outcrop	examined	pillowed mafic metavolcanic rocks, gabbro, granodior-ite, diorite	Peridotite — serpentinite sill dis-playing a crude zoning with a marginal pyroxenite to feldspathic pyroxenite, surrounding a highly serpentinized peridotite core. Approximate dimensions of 300 metres by 3500 metres, follows the south shore line of Peridotite Island, along some reefs on strike, and onto the south shore of the river.	sparse dissem-inated sulphides (py)	Barry (1960), pp. 228, 34 Bell (1962) Hubregtse (1973c) Man. MRD-File #98164; CB 4480; 5043-44, Jim 1-15; Canex Placer Ltd. Scoates (1971)
4E	10	63 I16SE	Carrot River — along south and approximately 2 km east of Peridotite Island (Hubregtse, pers. comm.) N: 6078750 E: 685000	outcrop	unexplored	pillowed basalt, tonalite, feld-spar porphyry	No description given.	none reported	Hubregtse (1973c)

KNOWN ULTRAMAFIC OCCURRENCES 62P: ENGLISH BROOK (UTM GRID ZONE #14)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
4H	1	62P1NE	North of Wanipigow Lake N: 5674500 E: 708100	outcrop	examined	diorite	serpentinized pyroxenite	unknown	Man. MRD-Files #91214
4H	2	62P1NE	North of Wanipigow Lake N: 5668900 E: 708000	outcrop	examined	diorite	serpentinized pyroxenite	unknown	Man. MRD-File #91214
4H	3	62P1NE	North of Wanipigow Lake N: 5674500 E: 707850	drill core	examined	gabbro	serpentinized pyroxenite	"positive Ni tests"	Man. MRD-File #91215
4H	4	62P1NE	Northwest of Wanipigow Lake N: 5668000 E: 705500	outcrops drill core	examined	quartz diorite	serpentininzed pyroxenite	unknown	Man. MRD-File #91216, 91218, 91219
4H	5	62P1NE	English Lake N: 5676300 E: 703800	drill core	examined	unknown	serpentinized pyroxenite	millerite traces	Man. MRD-File #91221
4H	6	62P1NE	English Brook N: 5672300 E: 702350	drill core	examined	hornblende-plagioclase gneiss	serpentinized pyroxenite	pentlandite, chalcopyrite, pyrite, violarite, millerite, bravioite, up to 4.5% Ni in fractures	Man. MRD-File #91224 Karup Møller (1968)
4H	7	62P1NE	English Brook N: 5669500 E: 700000	outcrop	unexplored	hornblende-quartz diorite	serpentinized pyroxenite	none reported	Russell (1948)
4H	8	62P1NE	North of English Brook N: 567000 E: 697800	outcrop	unexplored	hornblende-quartz diorite	serpentinized pyroxenite	none reported	Russell (1948)
4H	9	62P1NE	North of confluence of English Brook and Wanipigow River N: 567050 E:695500	outcrop	examined	acid to intermediate intrusives	serpentinized ultrabasic	none reported	Man. MRD-File #91222
4H	10	62P1NE	East of Clangula Lake N: 567200 E:692300	outcrop quarry	examined	acid to intermediate intrusives	serpentinized ultramafic	not mineralized	Man. MRD-File #91226 Wright (1932c)
4H	11	62P1NE	West of Clangula Lake on Wanipigow River N: 567150 E:691000	outcrop	unexplored	quartz diorite	peridotite	none reported	Davies (1951)
4H	12	62P1NE	West of Clangula Lake N: 567250 E: 691500	outcrop	unexplored	diorite, gabbro	peridotite	none reported	Davies (1951) McRitchie and Weber (1971)
4H	13	62P1NE	Wanipigow Bay N: 567500 E: 690000	several outcrops	examined	iron formation	serpentine schist	0.39% Ni maximum	Ermanovics (1969) Scoates (1969) McRitchie & Weber (1971) Man. MRD-File #912333, 91242, 92086
4H	14	62P7NE	Pipestone Islands N: 5696500 E: 670050	drill core	examined	unknown	altered fractured peridotite	0.28% Ni maximum	Man. MRD-File #91249

KNOWN ULTRAMAFIC OCCURRENCES 52M: CARROLL LAKE (UTM GRID ZONE #15)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
Index	1	52M3SW	Wallace Lake east shore N: 5654800 E: 337000	outcrop	unexplored	metasediments	serpentinized ultramafic lense	none reported	Scoates (1968)
Index	2	52M4SW	East of Saxton Lake N: 5664000 E: 302500	outcrop	unexplored	hornblende-quartz diorite	serpentinized ultramafic lense	none reported	Davies (1949) Scoates (1971d)
Index	3	52M4SW	Saxton Lake N: 5664500 E: 301800	outcrop	unexplored	hornblende-quartz diorite	serpentinized ultramafic lense	none reported	Davies (1949) Scoates (1971d)
Index	4	52M4SW	West of Saxton Lake N: 5665500 E: 298500	outcrop	unexplored	hornblende-quartz diorite	serpentinized ultramafic lense	none reported	Davies (1949) Scoates (1971d)
Index	5	52M4SW	North of Wanipigow Lake N:5666000 E: 294000	outcrop	unexplored	hornblende-quartz diorite	serpentinized ultramafic lense	none reported	Davies (1949) Scoates (1971d)
79-2	6	52M35E	Crystal Lake N: 5650000 E: 347700	outcrop	unexplored	quartz diorite	hornblendite	none reported	McRitchie (1971)

KNOWN ULTRAMAFIC OCCURRENCES 52E: (UTM GRID ZONE #15)

Map	Occurrence	NTS	Location of Occurrence	Type of Occurrence	Exploration Status	Geological Contacts	Description	Mineralization	References
Index	1	52E5NW	South of McMunn on Whitemouth River N: 5483500 E: 294500	drill core	examined	unknown drill stopped in ultra-mafics	serpentinized peridotite and pyroxenite	none reported	Man. MRD-File #91069
Index	2	52E11NE	Approx. 1 km East of West Hawk Lake N: 5512000 E: 342500	drill core	examined	gabbro, grey schist	peridotite	iron and nickel sulphides	Man. MRD-File #91071
Index	3	52E14SE	Approx. 1 km south of Lily Lake on the Trans Canada Highway N: 5518300 E: 338800	outcrops	unexplored	porphyritic granites	hypersthene — pyroxenite	none reported	Springer 1952

APPENDIX B

Island Lake Area: bore hole data from Cancelled Assessment Files (Map ER 79-2-5)

NOTE: Rock and mineralization descriptions are either direct quotes, or attempt to resemble the original as close as possible.

File Number	Claim Name and Number	Company	Year Drilled	Drill Hole Number	Compilation Company	Geophysical Surveys	Intersected Ultramafic	Reported Sulphides	Stratigraphic Units in Order of Intersection	Comments
91153	Lin #10	Inco Ltd.	1956	1	15467	Mag	none	sulphide bands	slate, greywacke, iron formation	Sulphides from 300'-336' no description given
91153	Lin #35	Inco Ltd.	1960	2	15468	Mag	none	none	greywacke, slate, iron formation	
91153	Lin #53	Inco Ltd.	1960	3	15469	Mag	peridotite	none	slate, quartzite, peridotite	
91153	Talc 14	Inco Ltd.	1959	5	15424	Mag	peridotite	none	granite, pyroclastic, quartzite, peridotite, quartzite	
99283	Ile 193	Inco Ltd.	1957	8	14015	Mag	peridotite	none	tuff, limestone, peridotite, granite	
99283	Ile 132	Inco Ltd.	1957	24	14704	Mag	peridotite	none	greenstone, quartzite, chlorite schist, peridotite, greenstone	
99283	Ile 132	Inco Ltd.	1958	25	14022	Mag	peridotite	none	quartzite, limestone, slate, peridotite	
99283	Ile 132	Inco Ltd.	1958	26	14021	Mag	peridotite	none	limestone, slate, peridotite, talc, chlorite schists	
99283	Ile 132	Inco Ltd.	1957	27	13249	Mag	peridotite	none	greenstone, limestone, quartzite, peridotite	
99283	Cirrus 5	Inco Ltd.	1957	28	11377	Mag	none	none	tuff, iron formation, quartzite	
99285	Pan 2	Cominco Ltd.	1974	39	Pan 9	I.P. Mag E.M.	ultramafic	none	ultramafic	Max Ni assay 0.24%
99285	Pan 2	Cominco Ltd.	1974	40	Pan 10	I.P. Mag E.M.	ultramafic	py, po	ultramafic, metavolcanic	Sulphides in narrow veins
99285	Pan 1	Cominco Ltd.	1974	41	Pan 6	I.P. Mag E.M.	ultramafic	po	ultramafic, metavolcanic, pyroxenite	Max Ni assay 1.42% over 0.3 m.
99285	Pan 1	Cominco Ltd.	1974	42	Pan 7	I.P. Mag E.M.	ultramafic	unspecified	metavolcanic, ultramafic	Max Ni assay 0.26%
99285	Pan 1	Cominco Ltd.	1974	43	Pan 8	I.P. Mag E.M.	ultramafic	unspecified	ultramafic	Peridotite becomes pyroxenitic at depth
99785	Pan 4	Cominco Ltd.	1974	44	Pan 5	Mag. E.M. I.P.	pyroxenitic peridotite	py	metavolcanic, ultrabasic rock	Max Ni assay 1.32% Cumulate texture in ultramafic
99285	Rita 25	Cominco Ltd.	1974	45	Rita 1	Mag. E.M. I.P.	ultrabasic	unspecified	metavolcanic, ultrabasic rock	Very fine grained amounts of unspecified sulphides in ultrabasic rock
99285	Rita 26	Cominco Ltd.	1974	46	Rita 2	Mag. E.M. I.P.	ultrabasic	py, po	metavolcanic, ultrabasic, metavolcanic	
99287	Pan 2	Cominco Ltd	1972	47	P-1	Mag. E.M. I.P.	ultramafic	traces	ultramafic	Distinguished between dark grey green and bright green ultramafic
99287	Pan 48	Cominco Ltd.	1972	48	P-2	Mag. E.M. I.P.	ultramafic	traces	ultramafic	
99287	Pan 1	Cominco Ltd.	1972	49	P-3	Mag. E.M. I.P.	ultramafic	py (traces)	ultramafic, metavolcanic	

File Number	Claim Name and Number	Company	Year Drilled	Drill Hole Number Compilation Company	Geophysical Surveys	Intersected Ultramafic	Reported Sulphides	Stratigraphic Units in Order of Intersection	Comments
99287	Pan 1	Cominco Ltd.	1972	50 P-4	Mag. E.M. I.P.	ultramafic	unspecified disseminated	ultramafic	Patchy sulphides
91156	Ni-2	Phelps Dodge	1960	51 Ni-1	unknown	peridotite	py (minor)	hbl. schist, granite gneiss, peridotite, hbl. schist, hbl. gneiss	
91156	Ni-2	Phelps Dodge	1960	52 Ni-2	unknown	peridotite	py, po (5%)	hbl. schist, granite, diorite, granite gneiss, peridotite	
91156	Ni-2	Phelps Dodge	1960	53 Ni-3	unknown	peridotite	po, py, cpy	biotite, gneiss, hbl. schist, amphibolite, granodiorite, serpentinized peridotite	Sulphides concentrated in amphibolite
91156	Ni-1	Phelps Dodge	1960	54 Ni-4	unknown	none	py (minor)	Hbl. schist, biotite granite, hbl. schist	
91156	Ni-1	Phelps Dodge	1960	55 Ni-5	unknown	none	po (3%)	Hbl. schist, hbl. gneiss, diorite, amphibolite	Pyrrhotite in diorite
91156	Ni-2	Phelps Dodge	1960	56 Ni-6	unknown	none	py (minor)	Hbl. gneiss, amphibolite, hbl. gneiss, diorite, hbl. gneiss, andesite	
91156	Ni-2	Phelps Dodge	1960	57 Ni-7	unknown	none	py (minor)	Gneissic granite, hbl. gneiss, hbl. schist	
91153	Lin 68	Inco Ltd.	1959	58 15420	Mag	none	none	Slate, tuff, iron formation, slate, tuff, greywacke, quartzite	
91153	Lin 60	Inco Ltd.	1959	59 15422	Mag	none	streaks of undetermined sulphides	Slate, quartzite, iron formation, quartzite with slate	
91153	Lin 23	Inco Ltd.	1959	60 15419	Mag	peridotite	"sulphides"	Iron formation, sediments, peridotite, sediments and iron formation, slate, greywacke	Peridotite in contact with iron formation
91153	Lin 21	Inco Ltd.	1959	61 15421	Mag	talc schist, peridotite	"streaks of sulphides"	Slate, sediments, iron formation, talc schist, sediments, peridotite, sediments	
91152	Asbestos 8	Inco Ltd.	1956	62 11388	Mag	peridotite	none	Peridotite, talc schist, limestone, quartzite	Peridotite and its alteration products in contact with quartzite
91152	Asbestos 8	Inco Ltd.	1956	63 11387	Mag	peridotite	none	Peridotite, talc schist, slate and quartzite	Peridotite in contact with quartzite
91152	Asbestos 27	Inco Ltd.	1956	64 11389	Mag	altered peridotite	none	Greenstone, "limestone and quartzite interbanded", chlorite schist, talc	
91152	Asbestos 30	Inco Ltd.	1956	65 11390	Mag	peridotite	none	Greenstone, quartzite and limestone interbanded, greenstone, peridotite, greenstone, peridotite, quartzite	Peridotite in contact with quartzite
91502	CB 6622	Canadian Occidental Ltd.	1976	66 Li 1-76	Mag E.M.	peridotite	po	Peridotite	Borehole bottomed in peridotite

File Number	Claim Name and Number	Company	Year Drilled	Drill Hole Number Compilation Company	Geophysical Surveys	Intersected Ultramafic	Reported Sulphides	Stratigraphic Units in Order of Intersection	Comments
91502	CB 6623	Canadian Occidental Ltd.	1976	67 Li 2-76	Mag E.M.	peridotite	py, cp	Peridotite	Specks and stringers of cp in serpentinite Borehole bottomed in peridotite
91502	Lucie 2	Canadian Occidental Ltd.	1976	68 Li 3-76	Mag E.M.	peridotite	py, cp	Peridotite	Borehole bottomed in peridotite

APPENDIX C

Thompson Nickel Belt; bore holes intersecting ultramafic rocks (Maps ER 79-2-8, 79-2-9, 79-2-10, 79-2-11, 79-2-12)

2/01/80

THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63G05

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63G05NE	1	91829	MXD-72-2	AMAX EXPLORATION	14	5916750	453150	180	60	908.0	276.75	72/04
63G05NE	2	91829	MXD-72-1	AMAX EXPLORATION	14	5918200	456000	200	60	1294.0	394.41	72/04

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63G12

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63G12SE	3	91255	MXC-71-7	AMAX EXPLORATION	14	5939800	460150	54	50	1394.0	424.89	71/04

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63G14

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63G14NE	13	99304	MXB-70-66	AMAX EXPLORATION	14	5976300	484250	289	50	1357.0	413.61	71/01
63G14NE	15	99304	MXB-71-71	AMAX EXPLORATION	14	5976500	485400	305	50	1057.0	322.17	71/01
63G14NE	17	99304	MXB-70-46	AMAX EXPLORATION	14	5978050	486250	227	50	987.0	300.83	70/03
63G14NE	19	99304	MXB-70-35	AMAX EXPLORATION	14	5980500	487100	90	52	1353.0	412.39	70/02
63G14NE	22	99304	MXB-71-77	AMAX EXPLORATION	14	5979700	485150	270	50	1227.0	373.98	71/02
63G14SE	6	92041	72-181	COMINCO	14	5965850	485550	280	50	1623.0	494.69	72/03
63G14SE	7	92041	72-182	COMINCO	14	5967300	485750	96	50	1959.0	597.10	72/04
63G14SE	9	92041	72-178	COMINCO	14	5960000	484150	109	50	998.0	304.19	72/02
63G14SW	1	91717	72-177	MINAGO MINES	14	5955800	482900	93	50	1568.0	477.92	72/03
63G14SW	2	91456	74-187	COMINCO	14	5964850	483000	17	45	2484.0	757.12	74/04
63G14SW	3	91456	74-188	COMINCO	14	5965750	482950	160	45	2518.0	767.48	74/04
63G14SW	4	91457	73-186	COMINCO	14	5968250	483350	100	45	1631.0	497.12	73/04
63G14SW	5	91457	73-185	COMINCO	14	5966600	483100	292	46	1967.0	599.54	73/04
63G14SW	8	92041	72-183	COMINCO	14	5964250	482850	106	45	1817.0	553.82	72/04

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63J03

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63J03NE	8	90551	72-172	COMINCO	14	6010650	492850	109	45	704.0	214.57	72/02
63J03NE	10	91522	69-32	COMINCO	14	6004100	489450	289	50	608.0	185.31	69/04
63J03NE	11	91522	69-35	COMINCO	14	6007050	484900	109	51	1114.0	339.54	69/01
63J03NE	12	91522	69-40	COMINCO	14	6010450	485550	105	49	983.0	299.61	69/03
63J03NE	13	91522	69-41	COMINCO	14	6004250	487750	109	50	688.0	209.70	69/03
63J03NE	14	91522	69-42	COMINCO	14	6007400	484850	106	52	914.0	278.58	69/02
63J03NE	47	91717	72-173	MINAGO MINES	14	6001700	488650	289	45	493.0	150.26	72/02
63J03NE	70	99304	MXB-71-65	AMAX EXPLORATION	14	6007250	494300	270	50	1047.0	319.12	71/01
63J03NW	15	91522	69-43	COMINCO	14	6008950	483200	111	50	801.0	244.14	69/02
63J03NW	17	91522	69-36	COMINCO	14	6009150	482300	109	50	690.0	210.31	69/02
63J03NW	18	91522	69-37	COMINCO	14	6010800	482750	109	50	751.0	228.90	69/03
63J03NW	19	91522	69-38	COMINCO	14	6010450	480200	110	50	990.0	301.75	69/03
63J03SE	49	91717	72-175	MINAGO MINES	14	5995300	486200	199	45	930.0	283.46	72/02
63J03SE	50	91717	72-176	MINAGO MINES	14	5992300	485150	199	45	940.0	286.51	72/02
63J03SE	58	99304	MXB-71-75	AMAX EXPLORATION	14	5989500	491100	90	51	837.0	255.11	71/02
63J03SE	60	99304	MXB-70-61	AMAX EXPLORATION	14	5989150	492150	180	50	1519.0	462.99	70/12
63J03SE	62	99304	MXB-71-79	AMAX EXPLORATION	14	5994250	491950	90	51	867.0	264.26	71/02
63J03SE	63	99304	MXB-71-82	AMAX EXPLORATION	14	5995200	492950	312	50	897.0	273.40	71/02
63J03SE	64	99304	MXB-70-47	AMAX EXPLORATION	14	5996050	492200	270	50	1116.0	340.15	70/03
63J03SW	3	90537	2	O'BRIEN GOLD MINES	14	5996850	483700	325	50	854.0	260.29	72/03
63J03SW	4	90537	1	O'BRIEN GOLD MINES	14	5997000	481900	275	52	766.0	233.47	72/03

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63J06

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63J06NE	15	90548	72-168	COMINCO	14	6026150	494850	109	060	415.0	126.49	72/01
63J06SE	24	91409	69-23	COMINCO	14	6016750	486000	109	045	737.0	224.63	69/03
63J06SE	25	91408	68-2	COMINCO	14	6017250	486300	109	052	849.0	258.77	68/02
63J06SE	30	91522	69-20	COMINCO	14	6023100	489100	109	050	639.0	194.76	69/03
63J06SE	33	91522	69-15	COMINCO	14	6019450	486150	109	050	760.0	231.64	69/02
63J06SE	34	91522	69-14	COMINCO	14	6019100	487000	129	050	974.0	296.87	69/02
63J06SE	37	91522	69-30	COMINCO	14	6013150	491700	109	050	724.0	220.67	69/02
63J06SE	48	91711	70-68	COMINCO	14	6013000	492950	109	050	638.0	194.46	70/02

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63J10

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63J10NE	50	91606	W21A	FALCONBRIDGE NICKEL MINES	14	6065950	520200	270	50	595.0	181.35	61/03
63J10NW	25	90565	GR27-G	FALCONBRIDGE NICKEL MINES	14	6054300	504950	315	50	535.0	163.06	67/02
63J10NW	43	91495	MXA-72-61	AMAX POTASH	14	6055150	505200	270	50	718.0	218.84	72/01
63J10NW	47	91495	MXA-72-66	AMAX POTASH	14	6054600	504900	270	50	529.0	161.23	72/03
63J10NW	49	91495	MXA-72-68	AMAX POTASH	14	6055000	505600	270	53	397.0	121.00	72/03
63J10SW	33	90579	MXA-72-65	AMAX POTASH	14	6051550	503150	300	50	697.0	212.44	72/03
63J10SW	34	90579	MXA-72-69	AMAX POTASH	14	6050750	502700	300	50	637.0	194.15	72/03
63J10SW	44	91495	MXA-72-62	AMAX POTASH	14	6052550	503000	270	50	698.0	212.75	72/02
63J10SW	46	91495	MXA-72-64	AMAX POTASH	14	6052500	502900	300	50	350.0	106.68	72/02

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63J11

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63J11NE	10	91590	S8	FALCONBRIDGE NICKEL MINES	14	6062525	497125	270	50	1455.0	443.48	69/01
63J11NE	11	91590	S9	FALCONBRIDGE NICKEL MINES	14	6064100	496375	270	50	541.0	164.89	69/01
63J11SE	2	90567	MXA-70-43	AMAX EXPLORATION	14	6042250	496800	300	50	700.0	213.36	69/12
63J11SE	3	90567	MXA-70-45	AMAX EXPLORATION	14	6039250	499050	300	50	869.0	264.87	70/01
63J11SE	7	90567	MXA-71-54	AMAX EXPLORATION	14	6039350	498850	120	50	1075.0	327.66	71/01

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63J14

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63J14NW	85	90608	8	JAY KAY EXPL.SYND.	14	6081350	475750	135	55	351.0	106.98	57/07
63J14NW	85	90608	7	JAY KAY EXPL.SYND.	14	6081350	475750	135	45	348.0	106.07	57/07
63J14NW	87	90608	10	JAY KAY EXPL.SYND.	14	6081800	474450	90	45	261.0	79.55	55/08
63J14NW	88	90608	A	JAY KAY EXPL.SYND.	14	6081650	476350	90	60	361.0	110.03	56/04
63J14SE	40	91592	S-81A	FALCONBRIDGE NICKEL MINES	14	6070300	496450	280	50	520.0	158.49	70/03
63J14SE	42	91592	S-83	FALCONBRIDGE NICKEL MINES	14	6068600	496300	280	50	427.0	130.14	70/03
63J14SE	54	91590	S-13	FALCONBRIDGE NICKEL MINES	14	6066800	498800	280	50	630.0	192.02	69/02

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63J15

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63J15NE	77	90618	IMP #1	DUNLOP,W.B.	14	6093950	531850	90	45	700.0	213.36	72/06
63J15NE	78	90618	IMP #2	DUNLOP,W.B.	14	6093750	532000	270	45	800.0	243.84	72/07
63J15NE	83	98348	W120-38	FALCONBRIDGE NICKEL MINES	14	6082150	525875	315	50	401.0	122.22	71/02
63J15NE	93	98359	W-76A	FALCONBRIDGE NICKEL MINES	14	6082000	527100	332	50	640.0	195.07	62/03
63J15NE	94	98359	W-76B	FALCONBRIDGE NICKEL MINES	14	6081775	527400	332	50	635.0	193.54	62/03
63J15NE	95	98359	W-76-D	FALCONBRIDGE NICKEL MINES	14	6081950	526600	332	50	625.0	190.50	62/04
63J15NE	96	98359	W-76-E	FALCONBRIDGE NICKEL MINES	14	6082225	526850	332	50	638.0	194.46	62/04
63J15NE	97	98359	W-76C	FALCONBRIDGE NICKEL MINES	14	6081675	526900	332	50	626.0	190.80	62/03
63J15SE	26	90623	23	SULMAC EXPLORATION	14	6074200	516350	310	50	625.1	190.53	50/90
63J15SW	25	90622	50A-2	NATIONAL MALARTIC GOLD	14	6079950	518800	343	55	626.1	190.83	61/02
63J15SW	28	90631	B-1	CONSOLIDATED MARBENOR	14	6074150	515200	270	55	636.0	193.85	61/02
63J15SW	29	90631	B-2	CONSOLIDATED MARBENOR	14	6074250	515350	270	50	681.0	207.56	61/03
63J15SW	57	91553	W91D	FALCONBRIDGE NICKEL MINES	14	6068500	507900	270	50	507.0	154.53	68/03

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63J16

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63J16SW	12	90638	20799	CANADIAN NICKEL	14	6071400	534300	90	50	674.1	205.46	62/02

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63001

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63001NE	3	91538	P17-G	FALCONBRIDGE NICKEL MINES	14	6114200	552100	350	50	940.0	286.51	66/02
63001NW	12	90704	31221	CANADIAN NICKEL	14	6121750	531800	115	50	366.3	111.64	67/02
63001NW	19	90706	M-16-A	FALCONBRIDGE NICKEL MINES	14	6111100	541500	345	50	757.0	230.73	62/04
63001NW	21	90707	5598	INTERNATIONAL NICKEL	14	6116750	536750	129	45	698.0	212.75	51/04
63001NW	22	90707	5600	INTERNATIONAL NICKEL	14	6115375	536050	309	50	570.0	173.73	51/05
63001NW	23	90707	5599	INTERNATIONAL NICKEL	14	6117150	537050	112	45	418.0	127.40	51/04
63001NW	24	90707	5597	INTERNATIONAL NICKEL	14	6116200	537700	219	45	618.0	188.36	51/04
63001NW	25	90707	5596	INTERNATIONAL NICKEL	14	6115000	537275	34	45	648.0	197.51	51/03
63001NW	26	90707	9401	INTERNATIONAL NICKEL	14	6115375	535625	309	50	701.0	213.66	51/05
63001NW	38	92102	14723	INTERNATIONAL NICKEL	14	6121850	543500	90	50	1236.0	376.73	57/09
63001NW	39	92102	14737	INTERNATIONAL NICKEL	14	6121250	543500	270	45	1530.0	466.34	58/01
63001NW	40	92102	14783	INTERNATIONAL NICKEL	14	6121650	543275	90	50	1304.2	397.52	58/05
63001NW	41	92102	14784	INTERNATIONAL NICKEL	14	6122450	543600	90	50	874.0	266.39	58/04
63001NW	42	92102	14787	INTERNATIONAL NICKEL	14	6121600	544275	270	50	1306.0	398.06	58/01
63001NW	43	92102	15600	INTERNATIONAL NICKEL	14	6121300	543000	90	55	1211.0	369.11	58/05
63001NW	44	92103	16762	INTERNATIONAL NICKEL	14	6122000	544600	270	50	810.0	246.88	60/04
63001SE	7	90697	31210	INTERNATIONAL NICKEL	14	6102150	550950	0	50	703.0	214.27	67/04
63001SW	9	90700	IMP 3	DUNLOP,W.B.	14	6095500	534500	270	45	610.0	185.92	73/03

THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63002

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63002NE	20	90704	31221	CANADIAN NICKEL	14	6121425	531750	90	50	432.0	131.67	67/02
63002SE	28	90717	F-31	FALCONBRIDGE NICKEL MINES	14	6097150	516100	282	50	802.0	244.44	70/03
63002SE	30	90717	S-91	FALCONBRIDGE NICKEL MINES	14	6099900	522000	118	50	1002.0	305.40	70/03
63002SE	47	90728	5584	CANADIAN NICKEL	14	6099050	527800	305	45	797.0	242.92	50/08
63002SE	48	90729	22-1	CONSOLIDATED MARBENOR	14	6095550	530100	115	50	354.0	107.89	61/02
63002SE	54	91420	F-29	FALCONBRIDGE NICKEL MINES	14	6097050	516100	264	50	601.0	183.18	69/03
63002SE	65	91420	S-26	FALCONBRIDGE NICKEL MINES	14	6100000	522100	118	50	537.0	163.67	69/02
63002SE	87	91523	S-120	FALCONBRIDGE NICKEL MINES	14	6107000	530400	309	50	667.0	203.30	74/02
63002SE	96	91572	S-99	FALCONBRIDGE NICKEL MINES	14	6098400	525800	312	50	505.0	153.92	70/03
63002SE	97	91572	S-100	FALCONBRIDGE NICKEL MINES	14	6098150	525000	312	50	500.0	152.40	70/03
63002SE	121	91877	S-39	FALCONBRIDGE NICKEL MINES	14	6107250	530400	304	50	517.0	157.58	69/01

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63008

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63008SE	16	91936	P15E	FALCONBRIDGE NICKEL MINES	14	6136300	558600	311	50	630.6	192.20	69/03
63008SE	28	92103	22205	INTERNATIONAL NICKEL	14	6132200	548550	303	50	983.0	299.61	61/08
63008SE	35	92102	15598	INTERNATIONAL NICKEL	14	6125850	547150	303	50	1266.0	385.87	58/07
63008SE	37	92122	16712	INTERNATIONAL NICKEL	14	6130700	553600	123	50	1816.0	553.51	59/06
63008SE	38	92045	13899	INTERNATIONAL NICKEL	14	6130850	553700	123	50	1436.0	437.69	57/08
63008SE	39	92122	15592	INTERNATIONAL NICKEL	14	6130950	553700	123	50	1500.0	457.20	59/05
63008SE	40	92045	14724	INTERNATIONAL NICKEL	14	6131300	553900	123	50	2025.0	617.22	57/10
63008SE	41	92122	15593	INTERNATIONAL NICKEL	14	6131700	554100	123	50	1642.0	500.48	59/05
63008SE	43	92046	15589	INTERNATIONAL NICKEL	14	6130300	553800	303	45	1208.0	368.19	58/05
63008SE	45	92045	14752	INTERNATIONAL NICKEL	14	6130500	553950	303	50	1276.0	388.92	58/02
63008SE	47	92123	15585	INTERNATIONAL NICKEL	14	6130500	554150	303	45	1449.0	441.65	58/10
63008SE	48	92122	15595	INTERNATIONAL NICKEL	14	6131200	554100	123	50	1124.0	342.59	59/03
63008SE	49	92045	14760	INTERNATIONAL NICKEL	14	6131000	554400	303	60	1394.0	424.89	58/03
63008SE	50	92102	15586	INTERNATIONAL NICKEL	14	6131200	554800	303	50	1509.0	459.94	59/10
63008SE	52	92122	15594	INTERNATIONAL NICKEL	14	6131850	554700	123	50	1208.0	368.19	59/04
63008SE	53	92102	15587	INTERNATIONAL NICKEL	14	6131600	555100	303	50	1487.0	453.23	58/09
63008SE	55	92102	14766	INTERNATIONAL NICKEL	14	6132100	555350	303	50	982.0	299.31	58/04
63008SE	56	92102	14774	INTERNATIONAL NICKEL	14	6133400	555950	123	50	1409.0	429.46	58/05
63008SE	57	92123	15582	INTERNATIONAL NICKEL	14	6133400	556750	303	50	1060.0	323.08	58/12
63008SE	58	92122	16717	INTERNATIONAL NICKEL	14	6131400	554850	303	55	1470.0	448.05	59/06
63008SE	67	92103	16729	INTERNATIONAL NICKEL	14	6127000	548050	303	45	829.0	252.67	60/02
63008SE	70	92103	22204	INTERNATIONAL NICKEL	14	6131850	547800	303	45	473.0	144.17	61/08
63008SE	72	92103	22209	INTERNATIONAL NICKEL	14	6133650	554550	123	45	330.0	100.58	61/10
63008SE	81	91632	P15-A	FALCONBRIDGE NICKEL MINES	14	6134750	557950	270	50	900.0	274.32	68/03
63008SE	83	91632	P15-C	FALCONBRIDGE NICKEL MINES	14	6135400	558575	270	50	800.0	243.84	68/03
63008SW	14	91920	6295	CANADIAN NICKEL	14	6127350	545650	270	55	867.0	264.26	51/05
63008SW	27	92103	22203	INTERNATIONAL NICKEL	14	6130100	547450	303	45	750.0	228.60	61/08
63008SW	65	92123	15597	INTERNATIONAL NICKEL	14	6123250	547000	123	50	1265.0	385.57	58/08
63008SW	66	92103	16730	INTERNATIONAL NICKEL	14	6123000	545950	140	50	1205.0	367.28	60/03
63008SW	69	92103	16728	INTERNATIONAL NICKEL	14	6126300	547500	303	50	816.0	248.71	60/02
63008SW	73	92103	20094	INTERNATIONAL NICKEL	14	6127950	546200	303	50	484.0	147.52	61/07
63008SW	76	92103	22202	INTERNATIONAL NICKEL	14	6128950	546800	303	50	660.0	201.16	61/08
63008SW	79	92102	14786	INTERNATIONAL NICKEL	14	6123050	545550	303	50	1263.0	384.96	58/03
63008SW	80	92102	14785	INTERNATIONAL NICKEL	14	6122650	546250	303	50	1121.0	341.68	58/04

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63009

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63009NE	15	90756	30238	CANADIAN NICKEL	14	6178075	556650	0	60	805.0	245.36	66/04
63009NE	103	91918	24858	CANADIAN NICKEL	14	6177450	556250	180	50	457.0	139.29	64/04
63009NE	104	91919	24856	CANADIAN NICKEL	14	6178200	556450	180	50	311.0	94.79	64/04
63009NE	104	91918	24885	CANADIAN NICKEL	14	6178200	556450	180	50	784.0	238.96	64/08
63009NE	105	91918	24880	CANADIAN NICKEL	14	6176575	554750	180	45	501.0	152.70	64/07
63009NE	109	91919	30236	CANADIAN NICKEL	14	6177600	556050	180	50	740.0	225.55	66/03
63009SE	26	90759	28200	CANADIAN NICKEL	14	6153150	548750	90	50	527.0	160.62	67/02
63009SE	28	90761	1	CENTRAL MANITOBA MINES	14	6158900	560075		90	295.0	89.91	47/12
63009SE	29	90761	2	CENTRAL MANITOBA MINES	14	6159050	560050	315	60	387.0	117.95	47/12
63009SE	31	90761	4	CENTRAL MANITOBA MINES	14	6159600	560050	135	66	541.0	164.89	48/01
63009SE	32	90761	5	CENTRAL MANITOBA MINES	14	6159625	559700		90	600.0	182.88	48/02
63009SE	33	90761	8	CENTRAL MANITOBA MINES	14	6158950	560600	90	55	500.0	152.40	48/03
63009SE	34	90761	1763	INTERNATIONAL NICKEL	14	6159250	560100	135	45	1135.0	345.94	49/01
63009SE	35	90761	1764	INTERNATIONAL NICKEL	14	6159150	559750	135	60	866.0	263.95	49/01
63009SE	37	90761	1766	INTERNATIONAL NICKEL	14	6162825	561900	301	60	540.0	164.59	49/02
63009SE	38	90761	1767	INTERNATIONAL NICKEL	14	6162300	561700	150	60	802.0	244.44	49/02
63009SE	40	90761	1769	INTERNATIONAL NICKEL	14	6159750	562200	135	60	787.0	239.87	49/03
63009SE	41	90761	1770	INTERNATIONAL NICKEL	14	6158400	558850	135	60	376.0	114.60	59/04
63009SE	42	90761	1771	INTERNATIONAL NICKEL	14	6159000	560300	135	60	477.0	145.38	49/04

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63016

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63016SE	9	91919	25602	CANADIAN NICKEL	14	6179700	558250	180	55	602.0	183.48	64/08

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63P05

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63P05NE	6	90777	1	CHIMO GOLD MINES	14	6142350	590550	180	53	395.0	120.39	57/09
63P05NE	13	90781	1	INT'L BASE METALS	14	6149300	589400	140	43	602.0	183.48	57/06
63P05NE	20	90782	W-3	CONSOLIDATED SKEENA MINES	14	6149450	589900	0	45	567.0	172.82	70/04
63P05NE	21	90782	W-4	CONSOLIDATED SKEENA MINES	14	6149850	590500	0	45	495.0	150.87	70/04
63P05NE	22	90785	W-1	FALCONBRIDGE NICKEL MINES	14	6141300	584800	90	45	649.8	198.05	55/02
63P05NE	22	90784	1	FALCONBRIDGE NICKEL MINES	14	6141300	584800		90	263.0	80.16	57/06
63P05NE	22	90784	4	FALCONBRIDGE NICKEL MINES	14	6141300	584800		90	105.0	32.00	57/06
63P05NE	22	90784	5	FALCONBRIDGE NICKEL MINES	14	6141300	584800		90	213.0	64.92	57/06
63P05NE	22	90784	6	FALCONBRIDGE NICKEL MINES	14	6141300	584800		90	197.3	60.13	57/06
63P05NE	22	90784	7	FALCONBRIDGE NICKEL MINES	14	6141300	584800		90	110.0	33.52	57/07
63P05NE	23	90784	10	FALCONBRIDGE NICKEL MINES	14	6141400	584825		90	380.6	116.00	57/07
63P05NE	23	90784	2	FALCONBRIDGE NICKEL MINES	14	6141400	584825		90	92.8	28.28	57/06
63P05NE	23	90784	3	FALCONBRIDGE NICKEL MINES	14	6141400	584825		90	186.4	56.81	57/06
63P05NE	23	90784	8	FALCONBRIDGE NICKEL MINES	14	6141400	584825		90	161.0	49.07	57/07
63P05NE	24	90785	W-2	FALCONBRIDGE NICKEL MINES	14	6141450	584950	90	45	599.0	182.57	55/02
63P05NE	25	90785	W-3	FALCONBRIDGE NICKEL MINES	14	6141350	584575	90	45	345.0	105.15	55/02
63P05NE	26	90785	W-4	FALCONBRIDGE NICKEL MINES	14	6142300	584050	0	45	400.0	121.92	55/02

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63P11

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63P11NE	1	90810	1-A	CHIPMAN LAKE MINES	14	6168325	611050	320	60	695.0	211.83	57/03
63P11NE	2	90810	2	CHIPMAN LAKE MINES	14	6168400	610950	320	45	225.0	68.58	57/04
63P11SW	9	90816	1	COVE URANIUM	14	6155650	600100	270	45	323.0	98.45	54/00
63P11SW	11	90816	5	COVE URANIUM	14	6157350	603300	90	45	406.0	123.74	54/00
63P11SW	13	90816	7	COVE URANIUM	14	6157050	601000	180	45	607.0	185.01	54/00
63P11SW	15	90816	9	COVE URANIUM	14	6157500	600950	180	45	425.0	129.54	54/00
63P11SW	18	90820	3	COVE URANIUM	14	6155300	600650	270	45	129.0	39.31	54/00
63P11SW	19	90820	4	COVE URANIUM	14	6157400	601100	0	60	361.0	110.03	54/00

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THOMPSON NICKEL BELT
LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63P12

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63P12NE	7	90829	P9-C	FALCONBRIDGE NICKEL MINES	14	6170200	578950	270	50	350.0	106.68	68/02
63P12NE	44	91478	P9H	FALCONBRIDGE NICKEL MINES	14	6168450	578300	270	50	400.0	121.92	70/01
63P12NE	53	91865	P7G	FALCONBRIDGE NICKEL MINES	14	6169900	586100	270	50	300.0	91.44	70/02
63P12NE	59	91865	P7L	FALCONBRIDGE NICKEL MINES	14	6171100	586050	270	50	497.0	151.48	70/02
63P12NE	64	91917	P5A	FALCONBRIDGE NICKEL MINES	14	6172700	588400	270	50	550.0	167.64	69/02
63P12NE	67	91917	P7A	FALCONBRIDGE NICKEL MINES	14	6169800	587050	270	50	806.0	245.66	69/01
63P12NE	68	91917	P7C	FALCONBRIDGE NICKEL MINES	14	6168450	586900	270	50	462.0	140.81	69/01
63P12NE	69	91917	P7B	FALCONBRIDGE NICKEL MINES	14	6170000	586400	270	50	504.0	153.61	69/01
63P12NE	70	91917	P7D	FALCONBRIDGE NICKEL MINES	14	6171200	585000	270	50	517.0	157.58	69/01
63P12NW	17	90836	5	KENNCO EXPLORATIONS	14	6175450	566400	312	45	420.0	128.01	58/11
63P12NW	25	90845	TE-3	FALCONBRIDGE NICKEL MINES	14	6169650	574950	105	50	527.0	160.62	62/03
63P12SE	4	90828	P3-B	FALCONBRIDGE NICKEL MINES	14	6162850	588750	294	50	896.0	273.10	63/01

LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63P13

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63P13NE	3	90852	AGE 2	SHERRITT GORDON MINES	14	6205100	587450		90	221.0	67.36	56/04
63P13NE	61	90914	S1-A	FALCONBRIDGE NICKEL MINES	14	6206350	586650	299	50	557.0	169.77	63/03
63P13NE	146	91994	38709	CANADIAN NICKEL	14	6202150	580925	270	50	1228.0	374.29	71/03
63P13NW	47	90878	2	NORTH VENTURE	14	6202850	570175	155	45	591.0	180.13	63/01
63P13NW	52	90878	7	NORTH VENTURE	14	6204250	572425	155	45	277.0	84.42	63/01
63P13NW	150	91994	38713	CANADIAN NICKEL	14	6203475	580475	270	50	417.0	127.10	71/05
63P13NW	153	91994	38716	CANADIAN NICKEL	14	6199675	579675	270	50	450.0	137.16	71/05
63P13SE	7	90853	P12A	FALCONBRIDGE NICKEL MINES	14	6185500	592150	270	50	357.0	108.81	70/03
63P13SE	8	90853	P12B	FALCONBRIDGE NICKEL MINES	14	6185850	591950	315	50	279.0	85.03	70/03
63P13SE	9	90853	P12C	FALCONBRIDGE NICKEL MINES	14	6186600	592000	315	50	297.0	90.52	70/03
63P13SE	10	90853	P12D	FALCONBRIDGE NICKEL MINES	14	6185600	591700	315	50	297.0	90.52	70/03
63P13SE	13	90854	P12G	FALCONBRIDGE NICKEL MINES	14	6186450	592500	315	50	307.0	93.57	71/03
63P13SW	65	91886	3	KENNCO EXPLORATIONS	14	6186350	572700	105	60	776.0	236.52	65/02
63P13SW	71	91890	9	KENNCO EXPLORATIONS	14	6186950	572700	100	60	850.0	259.08	65/04
63P13SW	73	91907	K-2	KENNCO EXPLORATIONS	14	6190150	575500	295	45	922.0	281.02	64/04
63P13SW	112	91921	25667	CANADIAN NICKEL	14	6187900	573000	90	60	950.0	289.56	65/02

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LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 63P14

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
63P14NW	4	90882	4	QUINN LABINE MINES	14	6202525	607050	325	45	553.0	168.55	59/70
63P14NW	11	90886	T1	SHERRITT GORDON MINES	14	6201400	604350	128	45	774.0	235.91	55/07
63P14NW	13	90886	T3	SHERRITT GORDON MINES	14	6201500	604400	128	45	750.0	228.60	55/07

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LISTING OF DRILL HOLES INTERSECTING ULTRAMAFIC ROCKS 64A04

NTS AREA	MAP LOCALITY	ASSESSMENT FILE NO	COMPANY DDH NO	COMPANY NAME	UTM ZONE	NORTHING	EASTING	AZIMUTH	PLUNGE	LENGTH FEET	LENGTH METRES	YR/MO DRILLED
64A04SE	5	90852	AGE 12	SHERRITT GORDON MINES	14	6212000	580250	180	45	534.0	162.76	56/06
64A04SE	6	90852	AGE 11	SHERRITT GORDON MINES	14	6211500	580000	144	45	610.0	185.92	56/06
64A04SE	8	90852	AGE 9	SHERRITT GORDON MINES	14	6212250	577500		90	395.0	120.39	56/06
64A04SE	9	90852	AGE 8	SHERRITT GORDON MINES	14	6212500	579000	95	45	552.0	168.24	56/05