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Mineral Deposits Studies in the Huntsville-Parry Sound-Powassan Area -- A Progress Report

by

C. Marmont and M. Johnston

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Foreword

The economic importance and value of industrial minerals and building stone are continually increasing and a resurgence of interest in industrial mineral commodities is taking place. This resurgence has underlined the need to increase efforts to compile and publish information on the industrial mineral deposits of Ontario.

Industrial mineral and building stone production in the Huntsville - Parry Sound - Powassan area is currently limited to aggregate and flagstone, but in the past, small amounts of silica, feldspar, mica and limestone have been produced. Considerable interest is currently being shown in a number of graphite deposits. The geology of the area is complex and the greater part has not been mapped geologically. Consequently, the mineral potential of the area has not been fully assessed.

The study area has good infrastructure and is favourably located to supply raw materials to the industries of the Great Lakes Basin.

This report presents the results of the first year's work of a three year program designed to evaluate the industrial mineral, rare element and building stone potential of the Huntsville-Parry Sound - Powassan area. It should be of interest to the minerals industry, and to local municipalities and developers.

V.G. Milne
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ABSTRACT

This report presents the results of the first year's work in a three year program to evaluate the mineral potential of the Huntsville - Parry Sound - Powassan area, with an emphasis on industrial minerals. Field work performed in 1986 focussed on anorthosites, which have potential applications in the insulation, glass, ceramics and filler industries; on calcitic and dolomitic marbles, which are used in agriculture, in cement, and as fillers and extenders; on pegmatites which are possible sources of silica, feldspar, mica and rare elements; and on building stone. The evaluation of these commodities will continue in 1987, and an attempt will be made to identify additional potentially economic targets. Such commodities include graphite, garnet, aluminosilicates, platinum group elements, quartzite, alkaline and mafic-ultramafic igneous intrusions. The area has good infrastructure and is well located to service the industrial complexes of the Great Lakes basin. The area is underlain by the Central Gneiss Belt of the Grenville Province, and is largely unmapped. An understanding of the complex geology is essential to the evaluation of the area's mineral potential.

EXECUTIVE SUMMARY

This report describes the results of the first year's work of a three year program to evaluate the industrial mineral, rare element and building stone potential of the Huntsville -Parry Sound - Powassan area of central Ontario. Mineral production in the area is currently on a small scale, being mainly aggregate and flagstone. In the past, small amounts of quartz, feldspar and mica have been won from a number of pegmatites, and lime has been produced from crystalline marbles in the Parry Sound area. Several graphite deposits are currently being evaluated by private companies, and production decisions are pending on two of these. The area is well serviced by road, rail and hydro and is well located geographically to supply the industries of the Great Lakes Basin.

The study area is located in the western part of the Ontario segment of the Central Gneiss Belt of the Grenville Province, and comprises a variety of structurally complex ortho- and para-gneisses, metamorphosed to upper amphibolite and granulite grade. The area has not been systematically mapped geologically. The most recent work is that of Davidson and colleagues of the Geological Survey of Canada, which has resulted in the identification of a number of distinct litho-tectonic domains and subdomains separated by relatively narrow ductile shear zones. The domains and subdomains apparently represent allochthonous blocks emplaced into their present position by northwesterly-directed thrusting. This concept greatly facilitates the geological interpretation of the area, and helps rationalise the distribution of lithologies and structures in what has previously been referred to as an "intractable sea of gneisses".

In the current study, work performed in 1986 concentrated on anorthosite, marbles and pegmatites, since they were believed to have some economic potential, and the location of many deposits was known. A limited amount of reconaissance work was also undertaken.

The main points to emerge from the study to date are summarized below.

Anorthosite is a basic intrusive igneous rock consisting largely of plagioclase feldspar (commonly labradorite), with less than ten percent mafic minerals (generally pyroxene or hornblende). It is therefore characterized by high contents of alumina and calcium; low silica, potassium, iron, magnesium and loss-on-ignition; and moderate soda. This composition renders it potentially useful in the insulation, glass, ceramics and filler industries. Some massive and gneissic varieties may provide building stone material. Anorthosites may also be host to economic concentrations of platinum, chromium, titanium, vanadium, magnetite and phosphorus (apatite). Two large bodies of anorthosite were reconnoitred during 1986. One of these, the Whitestone Anorthosite, appears to have good potential as a source of material for industrial applications. However, more detailed work will have to be done to determine whether a readily accessible, mineable body of material of consistent composition exists. This will be attempted during 1987, in conjunction with examination of favourably located bodies not yet visited.

Some of the more significant geological observations on the anorthosites are as follows:-

The anorthosites are of the "massif" type, and are not obviously related to, nor are they parts of, layered mafic intrusions such as the Stillwater Complex.

Parts of the Whitestone Anorthosite are undeformed and do display primary compositional layering. The composition ranges from anorthosite with less than 5% mafic minerals, to anorthositic gabbro with as much as 30% mafic minerals.

The primary structure and mineralogy of anorthosites in the study area may be almost pristine or totally obliterated depending on the intensity of ductile deformation. The inter-relationship of structure and primary layering will have a bearing on the distribution and homogeneity of different compositional phases of the anorthosite.

The plagioclase is usually white, rather than the dark blue-black, schillered colour commonly associated with anorthosite. This makes it better suited to filler applications, and could permit it to be used in a range of exterior building stone applications where marble of similar colour and texture is not sufficiently durable.

The anorthosites seen to date appear to have a fairly low potential for platinum, chromium, titanium, vanadium, magnetite and apatite mineralization.

Limestone and dolomite, and their metamorphic equivalents - marbles - find numerous industrial applications: as fillers and extenders in paint, plastic, paper, sealing compounds, rubber, adhesives; in agriculture (as lime and limestone), as an acid neutralizer in tailings ponds, in flue gas de-sulphurization, in cement and terrazzo, as chicken feed and many other uses.

In the study area, marbles are almost entirely restricted to the Parry Sound Domain (Davidson and Morgan, 1981) and all appear to be tectonic breccias. Consequently, they contain a significant proportion of lithic inclusions and disseminated silicate minerals. They are mainly calcitic, but magnesian calcite and dolomite also occur. Although the marbles' bulk compositions are relatively impure, the carbonate phases appear to be quite pure. Over twenty diluent minerals have been recognized to date, the most abundant being diopside, tremolite, olivine, chondrodite, phlogopite, serpentine, quartz and feldspar. The carbonate is generally coarse grained (greater than 5mm), and the silicates are commonly equant or rounded. Consequently, the carbonate should be readily separated from the contaminant minerals upon crushing and grinding. This supposition is supported by results obtained by Burcal Mines Limited in the early 1970s, using marble from Spence Township. That company shipped some 4,000 tons of pulverized calcitic marble for use as a filler in carpet-backing material, and the product was also of a grade acceptable to the pharmaceutical industry. It is possible that a different source of marble and a different plant design could produce a consistent, high quality product. Future work will attempt to ascertain the distribution of the magnesian and calcitic types, test their purity, attempt to define areas containing a minimal amount of waste material, and research methods of beneficiation currently employed in the industry, which might be applicable to the marbles in the study area.

Approximately one hundred pegmatite occurrences have been recorded in the study area. They are widely distributed throughout the area, with no obvious geological control. Some have been mined in the past for their quartz, feldspar or mica, while others have been explored as possible sources of uranium and rare earth elements. One, The Blue Star Mine in Chapman Township (amazonite), is currently being operated as a tourist and mineral collecting site. Several pegmatites were visited, sampled and mapped during 1986. None of the pegmatites visited appears to have much economic potential, mainly because of their small size. Many display simple zoning, and consist mainly of quartz, plagioclase, potassium feldspar and biotite. Allanite is a common but minor constituent. Most, if not all, of the pegmatites are probably syn- to late-tectonic features formed by anatectic processes: some grade into migmatitic leucosomes.

Consequently, lithium- and rare element-bearing pegmatites are not likely to be found in this terrain. Future work will continue to evaluate the pegmatites on a systematic basis in concert with other aspects of the program.

Two potential sources of conventional dimensional stone were identified at the start of the program: the Powassan Batholith, and coronitic metagabbros. The former is located astride Highway 11, and extends from just north of Burk's Falls to Callander. The very size of the body is an impediment to its evaluation. However, the area contains good road access, and many of these were travelled and all roadside outcrops investigated. Three main phases were identified, but further work is required to properly evaluate both the geology and the building stone potential of the complex. Of significance is the recognition that the complex is not a post-tectonic intrusion: it appears to have suffered the same severe metamorphic and tectonic history as the enveloping gneisses, and is transected by several major ductile shear zones.

The coronitic metagabbros are so-called because of the corona textures developed around primary olivine and/or ilmenite crystals when they are in contact with plagioclase. The coronas around the olivine consist of successive shells of orthopyroxene, clinopyroxene, hornblende and garnet; and around the ilmenite, of biotite, amphibole and garnet. The pattern is commonly visible to the naked eye. The gabbros are also, at least in part, syn-tectonic and reveal various degrees of deformation: from virtually none to complete recrystallization, yielding a strongly sheared amphibolite. The pristine and least deformed varieties take a good polish to yield a "black granite" which may have a greenish or a purple tinge. Some ilmentine-rich varieties have a metallic grey sheen. Although none of the bodies is very large, it is calculated that they may well be adequate to sustain an economic operation, and their positive relief would expedite the opening of a test quarry. Many bodies display variable texture and grain size, and joint spacing is commonly too close to permit economic extraction of large blocks. However, at one of the bodies visited, at Ashworth, these constraints appear to be less severe than elsewhere, and detailed investigations are planned to quantify these features. Other bodies not yet visited will be investigated during 1987.

The study area is best known for its flagstone and gneiss. These were not studied during 1986, but a systematic evaluation is planned for the coming year. Of particular interest are the various contorted gneisses, which are commonly associated with ductile shear zones. Some of these may be comparable with gneisses from Brazil which are currently making a significant impression on the building stone market, competing with similarly patterned, but less durable, marble.

Several so-called "skarn" deposits of magnetite and garnet were visited in Lount Township. All are very small, and sparse outcrop prevents a thorough evaluation of their setting. It is not clear to the authors whether these deposits represent true skarns, metamorphosed skarns or simply mafic rocks which have developed a "calc-silicate" mineral assemblage during high grade metamorphism.

In addition to following-up on leads developed during 1986, the 1987 program will include some reconnaissance work in an attempt to identify additional targets for evaluation. Some possibilities are garnet associated with mafic rocks or meta-pelitic units; alumino-silicates, garnet and graphite associated with pelitic units; quartzites and alkaline intrusions in the Britt Domain.

MINERAL DEPOSIT STUDIES IN THE HUNTSVILLE - PARRY SOUND - POWASSAN AREA, ONTARIO; a progress report.

C. Marmont and M. Johnston. (1).

1. INTRODUCTION

Under the terms of the Canada-Ontario Mineral Development Agreement (COMDA), which is a subsidiary agreement to the Economic and Regional Development Agreement (ERDA) signed by the governments of Canada and Ontario, a study was initiated to evaluate the industrial mineral and rare-earth element potential of the western half of the Algonquin District (see figure 1.1). The area is bounded to the east by Algonquin Park, to the north by the French River and Lake Nipissing, to the west by Georgian Bay, and to the south by Lake Muskoka. This is a three year project initiated in the Spring of 1986, and scheduled for completion in 1989.

The results presented here are consequently incomplete and preliminary, but the report serves to indicate the nature of the program, its objectives, and future course.

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The initial objectives of the program are as follows:

1) to test known occurrences of anorthosite for their potential use as a source of high-alumina ceramic material, feed for the glass and insulation industries, and as a potential host for titanium or vanadium. Additional elements which may be associated with anorthosites include phosphorus, chromium, manganese, and platinum group metals; some varieties have potential as a source of building stone.

2) to re-evaluate known occurrences of marble as a potential source of basic refractories, and for use in the filler industries, as a flux, and as a source of lime for use in agriculture and environmental applications. Some varieties may have possibilities for use as building or decorative stone. Associated minerals with economic potential include talc and tremolite.

3) to investigate pegmatite occurrences as a source of rare earth elements, high purity silica and potash felspar.

4) to evaluate various rock types as sources of stone for use in a variety of applications in the building and construction industries and as decorative and ornamental stone.

5) to evaluate the economic potential of other industrial rocks and minerals reported in the western part of the Central Gneiss Belt, and conduct regional reconnaissance work to identify additional prospective geological environments.

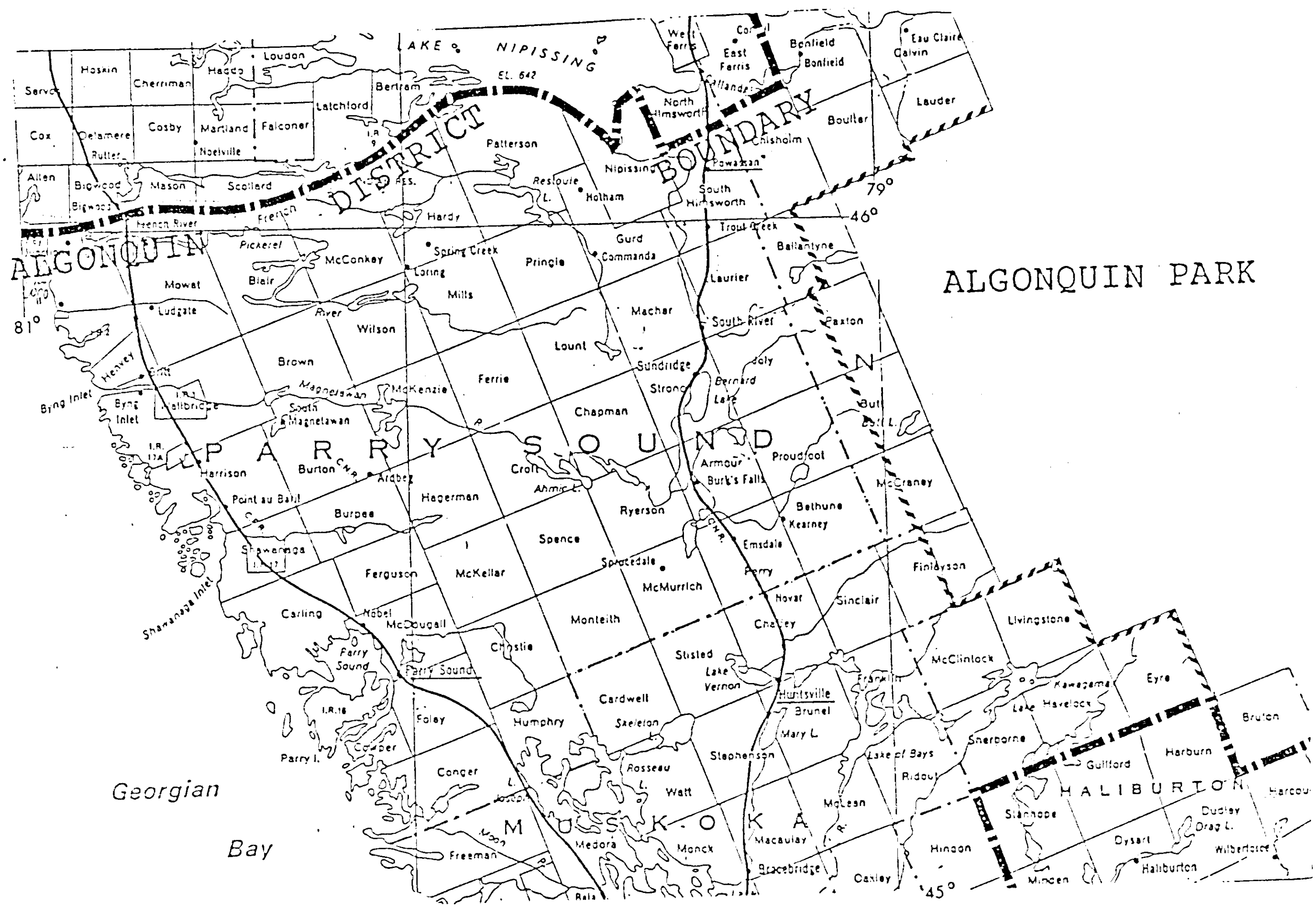

Figure 1.1 Location of the Study Area.

The program will detail the geology of known mineral deposits and occurrences, and appraise their economic potential; provide a base of lithochemical and, where appropriate, physical characteristics of the industrial rocks and minerals of the area. Results will be published in two annual progress reports, of which this report is the first, with a final report in 1989. Other ongoing COMDA projects in the project area are being conducted by the Precambrian Geology and Engineering and Terrain Geology sections of the Ontario Geological Survey and by the Geological Survey of Canada. Some aspects of the research being conducted by the Industrial Minerals Section of the Mineral Development and Lands Branch of MNDM under other COMDA programs will also have some impact upon the later stages of this project. These include studies on the potential applications of high feldspar intrusive rocks, and the exploration, quarrying and processing of flagstone and gneiss (Mid-Ontario Building Stone Project).

Current Program

Field work in 1986 was directed primarily towards reconnaissance of previously identified targets, such as anorthosite, selected marble and pegmatite occurrences, potential dimension stone sites, a cross-section of mineral occurrences and an overview of the regional geology in order to establish priorities for the duration of the program.

Reconnaissance traverses have been completed over the Whitestone and Arnstein anorthosite bodies, and samples from them have been analyzed. Future work will be directed towards identifying areas of uniform composition which are suitable for various industrial applications.

Several pegmatite bodies have been mapped and sampled in Conger and McDougal Townships. Several are former minor producers of mica, potash feldspar and quartz, and three contain radioactive minerals, including allanite crystals up to 15cm long, and uraninite. Future work will attempt to establish the geological controls of pegmatite occurrences, and determine the distribution and potential of economic mineral phases. (A detailed study of pegmatites of the Central Metasedimentary Belt is also being undertaken by staff of the Bancroft office of MNDM, and it is expected that liaison with this group will benefit the current program.)

Calcitic marble pits in Hagerman and Spence Townships, which have been tested in the past for their suitability for use as fillers, were mapped in detail and sampled. Several other occurrences were visited and sampled. Further work will be directed towards mapping the distribution and composition of the marble units and determining which areas contain relatively pure carbonate, and whether such material can be readily beneficiated to a desirable product.

A preliminary evaluation was begun of potential dimension stone prospects, previously defined by Verschuren et al.

(1986): the Powassan Batholith was reconnoitered and a number of coronitic metagabbroic intrusions were visited and sampled. This will continue in 1987, and in addition, flagstone and gneiss occurrences will also be evaluated.

2. GENERAL GEOLOGY OF THE CENTRAL GNEISS BELT

Introduction

The study area encompasses a large part of the Ontario Gneiss Segment of the Central Gneiss Belt (Wynne-Edwards, 1972). The Ontario Gneiss Segment lies between the Grenville Front to the northwest and the Central Metasedimentary Belt to the southeast (figure 2.1). Rocks of the Grenville Front display a prominent northeasterly trending foliation, while the foliations in the adjacent Central Gneiss Belt (CGB) lack any consistent orientation. The boundary between the CGB and the Central Metasedimentary Belt (CMB) has been interpreted as either a broad tectonic zone (Central Metasedimentary Belt Boundary Zone) across which sharply contrasting lithologies are juxtaposed (Culshaw et al., 1983), or a tectonically modified boundary zone between the Algonquin Batholith to the north and the Central Metasedimentary Belt to the southeast (Schwerdtner and Lumbers, 1978).

Previous Work

In spite of the relative ease of access, most of the study area has not been systematically mapped. Lumbers (1970, 1978) mapped the portion of the study area north of latitude 46 N. at a scale of 1 inch to 2 miles. No large scale maps of the area south of this latitude are available except Satterly's (1956)

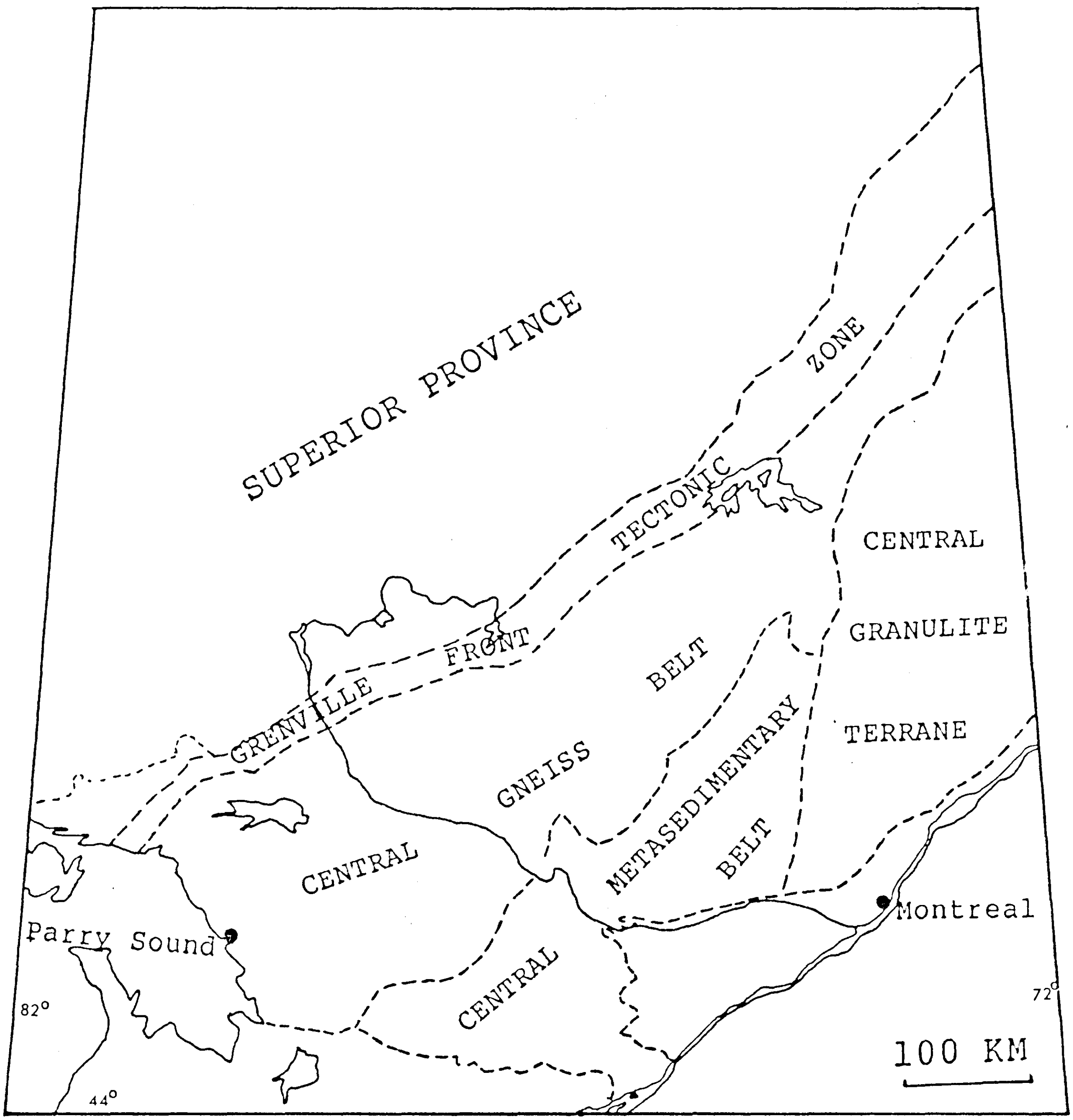

Figure 2.1: Sketch map showing the internal divisions of the Ontario portion of the Grenville Province (Modified after Wynne - Edwards, 1972).

map of Lount Township; Quirk's (1930) map of the Key Harbour area; a preliminary map with marginal notes of the Moon River area (Van Berkel and Schwerdtner, 1986), and a preliminary map with marginal notes of the Dunchurch area (Bright, 1987). In addition, Lacy (1960) provided a small scale map which accompanied a brief description of the geology of the Dunchurch area. Maps accompany the geological reports on the Memasagamesing (Friedman, 1955) and Caribou Lake (Friedman, 1957) gabbroic intrusions.

Davidson and co-workers (Davidson and Morgan, 1981; Davidson et al., 1982; Lindia et al., 1983; Culshaw et al., 1983; Davidson et al., 1985; Davidson and Grant, 1986) conducted reconnaissance style mapping over much of the Ontario Gneiss Segment (south of latitude 46 N.).

Several summaries describing the mineral deposits of the area have been published. Satterly (1942) and Hewitt (1967a) described the geology and mineral deposits of the Parry Sound area. Satterly (1956) described mineral deposits of Lount Township. Notes concerning mineral deposits accompany Lumber's (1970, 1978) reports. Villard et al. (1984) conducted reconnaissance sampling of gold showings in the Huntsville-Parry Sound area. Martin (1983) prepared an inventory of industrial minerals of the Algonquin Region. Davidson (1982) and Garland (1987) described graphite occurrences and deposits of the CGB. Verschuren et al. (1986) conducted a reconnaissance survey of building stone potential which included part of the study area. A number of theses have been completed on various aspects of the local geology. These are listed among the references cited at the end of this report. A list of other workers active in the area is contained in appendix 1.

Geological Synthesis

Davidson and Morgan (1981) conducted a reconnaissance survey of the western portion of the CGB and recognized that it was possible to subdivide the "intractable sea of gneisses" into discrete lithotectonic domains. Each of the domains is characterized by a distinctive assemblage of lithologies, structural features, and grade of metamorphism. Each domain is separated from adjacent domains by narrow zones of intensely tectonized rocks. The attitudes of the tectonite zones suggest that some domains structurally overlie others. This led Davidson and Morgan (1981) to conclude that thrust faulting was the most likely means of achieving the observed succession of lithotectonic domains, and that this thrusting took place under conditions of high pressure and temperature with movement occurring by means of ductile shearing.

The structural arrangement of the Central Gneiss Belt is regarded by Davidson and co-workers as a series of stacked thrust sheets (domains) which were emplaced from the southeast. Figure 2.2 shows the order of tectonic stacking of domains (Davidson and Grant, 1986). The lowest stack consists of the Britt, Kiosk, Ahmic and Algonquin domains and the Rosseau and

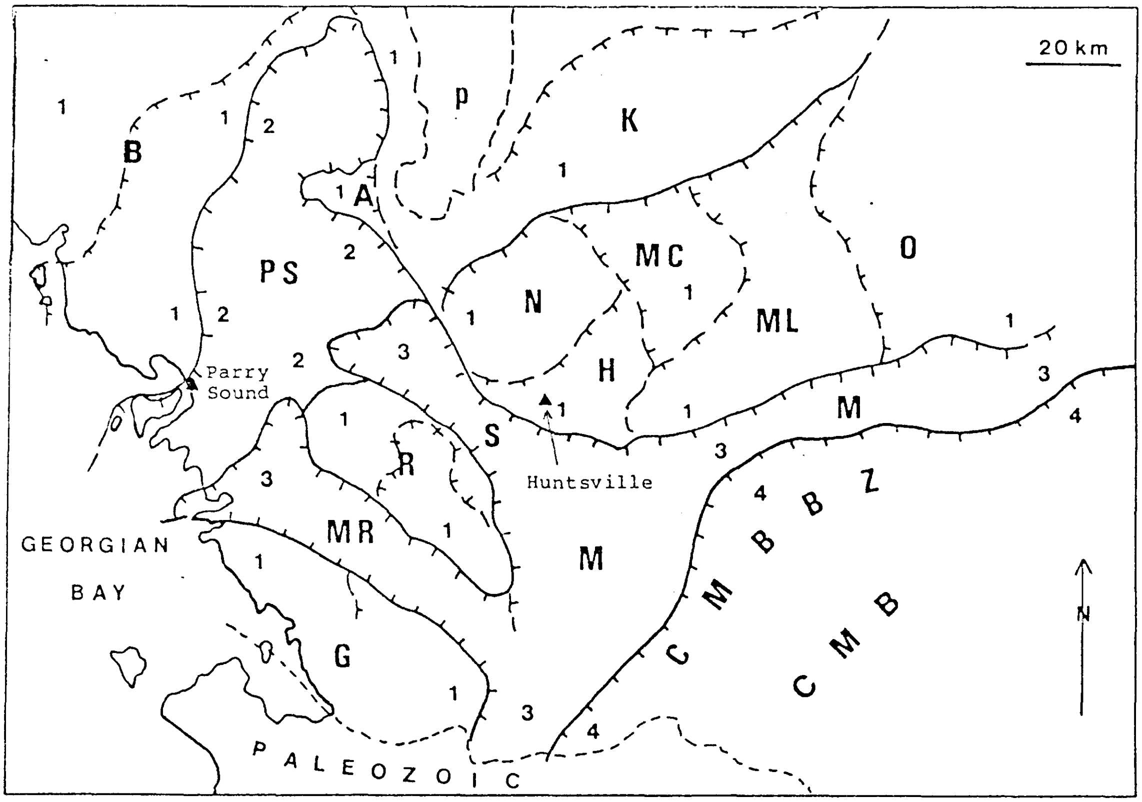

Figure 2.2: Lithotectonic domains and subdomains of the Central Gneiss Belt (after Davidson and Grant, 1986). CMBBZ - Central Metasedimentary Belt Boundary Zone. Numbers refer to stacking order.

Stack 1: DOMAINS: B - Britt, K - Kiosk, A - Ahmic, Subdomains of the Algonquin Domain: Huntsville (H), McCraney (MC), McClintock (ML), Opeongo (O) and Novar (N) subdomains)
  Subdomains of the Muskoka Domain: R - Rosseau and G - Go Home.
  p - Powassan Batholithic Complex

Stack 2: Parry Sound Domain.

Stack 3: M - Muskoka Domain (including the Moon River (MR) and Seguin (S) subdomains, but excluding the Go Home and Rosseau subdomains).

Stack 4: Central Metasedimentary Belt (CMB), including the CMB Boundary Zone.

Go Home Subdomains. The Parry Sound Domain was thrust over the lowest stack; the Muskoka Domain (including the Moon River and Seguin Subdomains) was emplaced above the Parry Sound Domain. The rocks of the Central Metasedimentary Belt constitute the structurally highest (fourth) sheet within the stack (Culshaw et al., 1983), but are outside the limits of the present study area.

Each of the domains is described briefly below.

Britt Domain

The Britt Domain (Davidson and Morgan, 1981) is the largest of the lithotectonic domains which constitute the structurally lowermost stack. The rocks of the Britt Domain have been subjected to at least two separate phases of deformation. Older ortho- and paragneisses are intruded by younger plutonic rocks which have been subsequently deformed and metamorphosed (Davidson and Morgan, 1981). The presence of large, southeasterly plunging folds enabled Davidson et al. (1982) to establish the regional stratigraphy among the younger plutonic rocks (units 1 to 10 on the accompanying regional compilation map). Davidson and Morgan (1981) observed that the country rocks vary along the contacts with the younger plutonic rocks and concluded that the plutons were originally disconcordant; subsequent deformation has produced structural concordance between the plutons and the enveloping country rocks. The Ahmic Domain, which forms a small enclave on the eastern side of the

Parry Sound Domain, is equivalent to the Britt Domain. As there is no known tectonite zone which separates it from the Britt Domain (the Parry Sound Domain overlies both), the domain, or even subdomain status, of the originally defined Ahmic Domain may not be valid.

Kiosk Domain

The Kiosk Domain lies to the east of the Britt Domain and is at the same structural level (ie. it is a part of the lowermost stack). The predominant structural trend within the Kiosk is toward the east-northeast, except near the southern end of the Powassan Batholith where the predominant structural trend swings into parallelism with the batholith-country rock contact (Davidson and Grant, 1986).

The Kiosk Domain includes a large proportion of monzonitic plutonic rocks, including the Powassan Batholithic Complex.

Algonquin Domain

The Algonquin Domain was briefly examined by Davidson and Morgan (1981) who recognized its internal heterogeneity and suggested it may be further subdivided. Subsequent investigations by Culshaw et al. (1983) and Davidson and Grant (1986) resulted in the division of the Algonquin Domain into five subdomains. These are the Novar, Hunstville, McCraney, McClintock and Opeongo Subdomains. Each subdomain is separated from adjacent subdomains by narrow zones of "straight gneiss"

(Davidson et al., 1982) which mark the position of major zones of shearing. Each of the subdomains is characterized by a distinctive assemblage of lithologies and by distinctive structural trends.

Parry Sound Domain

The Parry Sound Domain represents the second structural level or stack. The Parry Sound Domain is separated from the underlying domains of the first stack by inward dipping zones of tectonite gneiss. A regional gravity survey (Lindia et al., 1983) showed that the Parry Sound Domain is associated with a positive gravity anomaly with respect to the domains of the first stack. Gravity modelling shows that the Parry Sound Domain underlies the Moon River and Seguin Subdomains (third stack). High density rocks, characteristic of the Parry Sound Domain, do not dip beneath the Rosseau and Go Home Domains, adding further evidence that the Parry Sound Domain was structurally emplaced above the domains and subdomains of the first stack.

The Parry Sound Domain is lithologically distinct from the other domains: it contains a large proportion of mafic rocks, a large proportion of marbles and other supracrustal rocks, and includes a substantial proportion of gabbroic anorthosite.

Muskoka Domain

The name "Muskoka Domain" (Davidson and Morgan, 1981) was applied to a large area of variously deformed rocks lying southeast of the Parry Sound Domain. Subsequent studies (Davidson et al., 1982; Culshaw et al., 1983) revealed that the Muskoka Domain defined by Davidson and Morgan (1981) included subdomains which belong to the first and third stacks in the structural succession: the Rosseau and Go Home subdomains belong to the structurally lowermost stack, while the Moon River and Seguin subdomains belong to the third stack.

The Rosseau and Go Home Subdomains are structurally equivalent to the Algonquin Domain. The Rosseau Subdomain contains an internal tectonite zone which is broadly similar to the tectonite zones which subdivide the Algonquin Domain.

The Moon River and Seguin Subdomains merge into a single unit to the southeast, which is shown on the most recent synthesis (Davidson and Grant, 1986) as the "Muskoka Domain". The tectonite zone between the Moon River and Seguin Subdomains and the Parry Sound Domain dips away from the latter, indicating that the Moon River and Seguin Subdomains are structurally above the Parry Sound Domain (further substantiated by the regional gravity survey (Lindia et al., 1983) described previously).

Summary

Two general observations can be made concerning the geology of the study area:

a) overall, the geology of the area is extremely complex. This complexity is the result of polyphase deformation, and medium to high grade regional metamorphism,

b) major shear zones juxtapose contrasting lithologies and divide the area into discrete domains.

The observations described above have numerous implications when evaluating the economic potential of the study area. Obviously it is futile to attempt to trace a favourable unit from the Parry Sound Domain into either the Britt or Kiosk Domains. It may be possible to trace a favourable unit between adjacent domains or subdomains at the same structural level but it is likely to be very difficult since displacement of unknown magnitude undoubtedly has occurred across the intervening tectonite zones.

Davidson (Geologist, Geological Survey of Canada, personal communication, 1987) suggests that, in large part, it is impossible to determine protoliths with certainty. In many cases, it is therefore impossible to apply coventional exploration models for various types of mineral deposits. The Parry Sound Domain, for example, contains a large proportion of mafic rocks which are thought to be of volcanic origin (Freeman, 1979) and consequently this area may be viewed as a potential host for volcanogenic base metal deposits. Unfortunately there is no conclusive evidence (pillow structures, flow top/foot breccias, hyloclastites, etc.) that these rocks are actually volcanic: the probability of discovering volcanogenic base metal deposits is eliminated if, in fact, the rocks are not volcanic!

Mineral Potential of the Study Area.

Few mineral deposits in the study area have reached the production stage. Only one deposit (the Mill Lake Quarry) has been able to sustain production for more than a few seasons. Exploration activity has remained at a very low level for a long period of time. The Wilcox Mine (Cu) and McGown Mine (Cu-Au) are the only two metallic mineral occurrences which have been explored in any detail (Satterly, 1942; Hewitt, 1967a). Lack of success of previous exploration efforts might be interpreted as an indication that the base and precious metal potential of the area is low. However, the structural complexity of this area is only now beginning to be understood, and it is likely that deposits have been deformed into complex shapes which may have defied past exploration efforts.

Recently, a number of graphite occurrences have been tested in the area. Cal Graphite Corporation is currently "proceeding with development leading to production" of its graphite property in Butt Township (Cal Graphite Corp., news release, January 23, 1987; Chart A, back pocket of this report). The company had previously reported reserves of 29,451,840 short tons containing 736,454 short tons of graphite flake (George Cross Newsletter, October 30, 1986). In Maria Township (northeast of the project area), Princeton Resources Corporation is operating a pilot plant on a graphite deposit which contains "indicated or inferred reserves of more than 14.5m. tons of ore grading 2.72% flake graphite" (Industrial Minerals, March, 1987). These and other graphite occurrences in the region are the subject of a report by Garland (in press).

A major emphasis in the present study is the evaluation of the area's industrial mineral resources. Most industrial minerals have relatively low unit value, and as a consequence the location of an industrial mineral deposit is a major factor in the economic equation. The area is well serviced by a dense network of roads, several railways and has port facilities on Lake Huron. Most of the study area is within 250 km. of the major markets of southern and southwestern Ontario. These attributes, combined with local sources of labour, make the study area an ideal location for the development of industrial mineral deposits, should such deposits be located.

Regional Distribution of Mineral Deposits

In light of the interpretation of the regional geology by Davidson and co-workers, it is useful to view the distribution of mineral deposits in a regional sense (the term "deposit" is used in a very broad sense and encompasses all rocks types and mineral showings of potential economic interest). It is immediately obvious that some deposit types are widely distributed throughout all lithotectonic domains, while other deposits are restricted to a singe tectonic level (stack) and/or are restricted to a single lithotectonic domain.

Pegmatite dikes occur in all lithotectonic domains at all structural (stack) levels. All of the pegmatite dikes within the study area possess relatively simple mineralogy; none contain lithium; and beryllium- and tantalum-bearing minerals are rare. Some of the pegmatitic dikes may be related to the large granitic and monzonitic intrusions; most, however, are not spatially related to large intrusions and were probably formed during migmatization, accompanying high grade regional metamorphism.

Numerous ages of pegmatite development can be discerned, often in a single outcrop. Some pegmatitic dikes are transposed into the plane of foliation; some are completely disaggregated and form the porphyroclastic mylonites characteristic of the tectonite zones; others crosscut the regional fabric and post-date the tectono-metamorphic event. The intrusion of pegmatitic liquids was a widespread event of long duration.

Anorthositic rocks occur within domains of the first, second and third stack (and in other parts of the Grenville Province east of the study area). The vast majority, however, occur within the Parry Sound Domain (second stack); those in the Rosseau and Moon River subdomains are narrow tectonic slices.

The tectonite gneisses, which represent a possible source of flagstone, are not restricted to any particular structural level although they are largely restricted to domain and subdomain boundaries.

All other mineral deposits exhibit some degree of restriction in terms of their distribution within the tectonic framework. Marble is almost entirely restricted to the Parry Sound Domain. All marble deposits which have been explored and, in some cases, have supported limited production are located within the Parry Sound Domain.

The "skarn-type" iron deposits described by Satterly (1956) are restricted to the Parry Sound Domain. In some instances, these "skarn-type" deposits are not spatially related to the marble bands and therefore the restricted distribution of these deposits does not by necessity follow the restriction of marbles to the Parry Sound Domain. In similar fashion, there are comparatively few deposits of this type known outside of Lount Township and therefore the occurrence of skarn-type iron deposits may be entirely coincidental in terms of their relationship to the tectonic framework.

Rocks which may have potential as building stones are not restricted to any particular domain or structural level by virtue of the fact nearly all rock types may have potential as building stones. The two rock types investigated for their building stone potential during the past season are, however, restricted in their distribution. Large quartz monzonitic and granitic plutons (similar to and including those of the Powassan Batholith) are restricted to the domains of the first stack (in particular, to the Kiosk and Britt Domains). Coronitic olivine metagabbros occur in the first and third structural levels but have not been found in place within the Parry Sound Domain (several boulders with coronitic textures were discovered by the authors in Lount Township). Coronitic gabbros may occur within the Parry Sound Domain but may have gone unrecognized owing to the large proportion of mafic rocks within this domain.

Other mineral deposits, not investigated during this study, also are restricted to particular structural levels. Graphite, for example, occurs in lithotectonic domains of the first and second stack, but the host rocks for deposits in the second stack contrast sharply with the host rocks in the first stack. Graphite deposits in the first stack are hosted by siliceous metasediments, while those in the second stack are hosted by impure marbles.

3. ANORTHOSITE

Introduction

Several large bodies of anorthosite occur in the Parry Sound area. These have potential applications as a source of high-alumina ceramic material, as a component of insulation products, and as a potential host for titanium, iron, chromium and vanadium deposits. Anorthosites have also been considered as sources of alumina, but, although considerable metallurgical work has explored this possibility in the past, this is unlikely to be an economic proposition for the foreseeable future. Anorthositic rocks also host platinum deposits in layered igneous intrusions; the potential for such mineralization in the Parry Sound anorthosites is discussed in the following text. Like most other rock types, they also have various possible applications in the building and construction industry.

In 1986, two of the larger bodies, the Whitestone and Arnstein Anorthosites, were reconnoitred and sampled. Future work will focus upon evaluating the most accessible anorthosites, primarily to define areas of consistent composition suitable for industrial applications, as well as continued reconnaissance of bodies not yet visited. The following text describes the results of preliminary investigations of the Whitestone and Arnstein anorthosites, and gives a brief overview of anorthosite occurrences in the study area.

Another COMDA project, operated by the Industrial Minerals Section of the Mineral Development and Lands Branch of the Ministry of Northern Development and Mines, Toronto, is investigating the industrial applications of high-alumina intrusive rocks, including anorthosite.

Terminology and Classification of Anorthosites

The term "anorthosite" is used by different workers in different ways. There are two main usages: the first is a broad definition decribing an igneous or metamorphic BODY composed of rocks whose chief constituent mineral is plagioclase. The second, more specific, usage defines a ROCK in which plagioclase is the dominant mineral, usually exceeding 90% of the rock by volume. The latter definition can be expanded as follows:-

Gabbroic Anorthosite contains 10 - 22.5% mafic minerals.

Anorthositic Gabbro contains 22.5 - 35% mafic minerals.

Gabbro contains more than 35% mafic minerals.

Anorthosites (sensu lato) may be subdivided into two broad classes (Buddington, 1957):

a) stratiform accumulations of plagioclase crystals occurring within layered mafic and ultramafic intrusions. It is widely accepted that such rocks formed by gravitative separation of plagioclase crystals from a differentiating magma.

b) Massif-type anorthosites. Massif-type anorthosites are large, relatively homogeneous bodies consisting predominantly of anorthosite and gabbroic anorthosite.

While the genesis of the stratiform anorthosites is reasonably well understood, there is considerable controversy concerning the genesis of the Massif-type anorthosites (see Emslie (1973, 1984) and Rose (1969) for brief summaries). Lumbers (1975) has identified a spectrum of plagioclase-dominant rocks, which he termed the "anorthositic suite" and which occur widely within the Grenville Province. Detailed discussion of the genesis of anorthosites and associated felsic kindred are beyond the scope of this report.

Distribution and Overview

The largest anorthosites in the study area are the Parry Island, Whitestone and Arnstein bodies which form ovoid to crescent-shaped masses near the western edge of the Parry Sound domain (see chart A). The largest is the Whitestone Anorthosite which is exposed over an area of some one hundred square kilometres. All have been metamorphosed to upper amphibolite or granulite facies, and deformed to various degrees. They are white (thought to be the result of recrystallization) rather than the schiller blue - black colour of most anorthosites currently employed in the building stone industry. Bright (1986) has mapped additional smaller bodies to the east of the Whitestone Anorthosite, and it seems likely that more remain to be identified.

Anorthosites are also found in close association with ductile shear zones, notably along the margins of the Moon River Synform, along the western edge of the Parry Sound Domain (west of the Whitestone Anorthosite) and on the eastern and western edges of the Ahmic Domain. They occur as long, narrow bodies, and in places occur as discontinuous pods which can be traced along the same structural horizon. They also form distinct mappable units within internal shear zones in the Rosseau and Moon River Domains. The relationship of these bodies to the larger bodies is uncertain, although it is probable that they are tectonic slices of massif-type anorthosites (van Kranendonk, 1984).

Previous Work

Satterly first documented the occurrence of anorthosite on Parry Island in 1941. Lacy (1960) mapped a part of the Whitestone Anorthosite in 1940, and Hewitt (1967) recorded additional occurences at Five Mile Bay, Mill Lake and Waubamik.

No detailed study was made of any of the anorthosites until Mason's (1969) Ph.D. study of the Whitestone Anorthosite. Subsequently, Thompson (1983) conducted a detailed study of the anorthosite-country rock relations in the vicinity of

Whitestone Lake. Kretschmar (1968), and Kretschmar and McNutt (1971) described the oxide minerals from selected localities within the Whitestone Anorthosite.

Bright (1986) has mapped the northern portion of the Whitestone Anorthosite in the course of mapping the Dunchurch area.

Although members of the "Anorthosite Suite" had been identified in the Arnstein area (Freeman, 1979), it was not until 1980 that the Arnstein Anorthosite was recognized (Davidson and Morgan, 1981).

Anorthosites in the Rosseau and Moon River domains have been described by Schwertdner and Waddington (1978), Davidson et al. (1982), Van Kranendonk (1984) and Van Berkel and Schwertdner (1986).

GEOLOGY OF THE WHITESTONE ANORTHOSITE

The Whitestone Anorthosite (1) is a northerly trending, tadpole-shaped body which lies on the west side of Highway 124, north east of Parry Sound (chart A). It is the largest (exposed over an area of about 100 km2) of the anorthositic bodies which occur within the Parry Sound Domain (Davidson and Morgan, 1980; Davidson et al., 1982). Its margin and southern "tail" are tectonically foliated, and primary textures have been largely destroyed. Primary igneous textures are preserved in the core of the body and in undeformed remnant blocks within the more sheared portions (Nadeau, 1984).

The Whitestone Anorthosite exhibits a comparatively wide variation in modal mineralogy from anorthosite to anorthositic gabbro. The margins of the anorthosite have been subjected to varying degrees of ductile shearing, which have caused recrystallization of plagioclase and the development of a metamorphic mineral assemblage consisting of variable.

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(1) In the limited literature descibing various aspects of this body, it has variously been referred to as the Waubamik Anorthosite (Hewitt, 1967a), the Whitestone Anorthosite (Mason, 1969), Whitestone Diorite (Dallmeyer and Sutter, 1980), and Whitestone Pluton (van Breeman et al., 1986). Given the essentially anorthositic and gabbroic anorthositic composition of the body, one wonders whether the references cited above refer to the same body or to one of the satellite bodies of anorthosite in the Dunchurch area (Bright, 1986), or even to one of the number of basic to granitic plutonic bodies in its vicinity. In this report the Whitestone Anorthosite is taken to be the large body of predominantly anorthositic to gabbroic anorthositic composition which lies between Highway 124 in the east and the Canadian National Railway tracks in the west; and extending from Highway 520 in the north, southward through Waubamik to Mill Lake on Highway 69. It is suggested that the name Whitestone Anorthosite be applied consistently to the main mass described above.

proportions of plagioclase, scapolite, hornblende, garnet, epidote and titanite. Within the core of the anorthosite igneous textures and primary minerals have largely been preserved.

Contact Relationships

The Whitestone Anorthosite is enclosed by a variety of orthogneisses, paragneisses and narrow bands of marble tectonic breccia. The rocks at the margins of the anorthosite are moderately to strongly foliated. Conclusive evidence of an intrusive relationship between the anorthosite and the country rocks has not been discovered. The presence of narrow dikelets of pyroxene + plagioclase +/- garnet +/- hornblende, which intrude the enclosing country rocks and trend normal to the anorthosite contact is perhaps the best evidence of an intrusive relationship between the anorthosite and the country rocks (Thompson, 1983).

Primary Mineralogy and Textures

The undeformed rocks of the Whitestone Anorthosite may be conveniently subdivided into three primary facies based on texture and mineralogy: the oikocrystic facies, the porphyritic facies and the orthopyroxene-bearing facies (chart B - back pocket). These are equivalent to the glomeropoikilitic, porphyritic and green feldspar facies described by Mason (1969).

The oikocrystic facies is the most widely distributed. Rocks belonging to this facies contain large, spherical clinopyroxene crystals which subophitically enclose subhedral crystals of plagioclase. Mason (1969) described this texture as "glomeropoikilitic". In the authors' opinion, the texture exhibited by these rocks is more likely to have been formed by single crystals of clinopyroxene, rather than agglomerations of crystals as has been suggested by Mason. The oikocrysts range from less than 1 cm to almost 30 cm in diameter and are distributed in such a fashion that the rock assumes a "leopard spot" appearance.

The porphyritic facies is mineralogically identical to, but texturally distinct from, the oikocrystic facies. Clinopyroxene occurs as subhedral crystals in the porphyritic facies and the subophitic texture characteristic of the oikocrystic facies is absent. In general, rocks of the porphyritic facies tend to contain a larger proportion of mafic minerals than rocks of the oikocrystic facies. The porphyritic facies is apparently randomly distributed within the oikocrystic facies and, as a consequence, the two are not distinguished on the accompanying geological map (chart B).

The orthopyroxene-bearing facies is restricted to the central portion of the Whitestone Anorthosite. In this facies, pale pink, distinctly pleochroic orthopyroxene coexists with clinopyroxene; in the porphyritic and oikocrystic facies, orthopyroxene does not occur. Mason (1969) referred to the orthopyroxene-bearing facies as the "green feldspar facies", emphasizing the greenish hue of plagioclase crystals. A characteristic feature of the orthopyroxene-bearing facies is the presence of minute (<0.1 mm), euhedral garnet crystals. Mason (1969) concluded that the orthopyroxene and garnet were formed by late stage magmatic (pneumatolytic) processes or by post-magmatic metamorphism. It is equally possible that orthopyroxene was a primary phase which crystallized from a magma.

Igneous layering occurs sparingly within the Whitestone Anorthosite. This layering presumably controls the distribution of each of the three primary facies.

In a small outcrop at the northern tip of the anorthosite, layers consisting of varying proportions of plagioclase, hornblende (after cpx ?) and magnetite range from 20 to 80 cm thick (location shown on chart B). A small (3m x 40 cm deep) channel-like feature may have been produced by convection currents within the magma chamber. If this interpretation is correct, stratigraphic tops at this location face west-north-west.

The small scale at which layering is developed in the outcrop described above is exceptional. In most instances, only the contact between two adjacent layers can be recognized. This observation has several possible interpretations:

a) igneous layering is only locally developed,

b) the scale of layering is large and on an outcrop of average size only one or two layers are exposed,

c) the dip of the layering is gentle and consequently the apparent thickness of the layers is large,

d) the restricted mineralogy and the slight variations in proportions of minerals result in failure of the observer to identify successive layers.

Igneous layering can be identified in widely separated localities but to date no attempt has been made to systematically study the distribution of layering. None of the possibilities listed above can be eliminated; igneous layering has been observed to dip gently at several localities and in several instances thick layers (> 5m) have been observed. The importance of determining the nature and attitude of primary layering, beyond obvious academic interest, lies in the fact that individual layers should be largely homogeneous and therefore may provide a source of industrial raw material of consistent grade. In addition, the attitude of the layering relative to the direction of shearing (particularly at the margins and "tail" of the body) will determine whether material in the shear zones is homogeneous (shearing parallel to primary layering should preserve original homogeneity while shearing perpendicular to original layering will tend to mix adjacent layers resulting in considerable heterogeneity).

Metamorphism

The effects of ductile deformation and consequent recrystallization are superimposed on the oikocrystic and porphyritic facies near the margins of the anorthosite. The principal mineral assemblage developed in the foliated rocks consists of plagioclase, hornblende, garnet, scapolite, epidote and titanite (sphene). The anorthite (An) content of plagioclase in the foliated marginal facies is somewhat lower (An45) than in the core of the complex (An56). This appears to be the result of metamorphic re-equilibration of plagioclase with coexisting scapolite (Mason, 1969).

Clinopyroxene is commonly present in the foliated marginal facies but is always rimmed by hornblende (+/- garnet +/- epidote); there is no doubt that hornblende is forming at the expense of clinopyroxene. In the unfoliated rocks, patches of hornblende after clinopyroxene are present as are clinopyroxene crystals rimmed by hornblende. In similar fashion, orthopyroxene, present in the core of the anorthosite, is commonly rimmed by finely crystalline hornblende.

On the basis of the observations described above, the Whitestone Anorthosite appears to have been metamorphosed to upper amphibolite grade. Clinopyroxene is a primary phase of the anorthosite and therefore its presence is not necessarily indicative of granulite facies metamorphic conditions. As suggested previously, orthopyroxene may be a primary phase and therefore its presence is also not necessarily indicative of granulite facies metamorphism. Thompson(1983) determined that the country rocks were metamorphosed to granulite grade (clinopyroxene-garnet-hornblende subfacies) and were then partially retrograded. Geochronological investigations of the Whitestone Anorthosite in the vicinity of Parry Sound (Van Breeman et al., 1986) reveal a metamorphic culmination dated at 1160 Ma.

The problem of the relative age of the Whitestone Anorthosite and its metamorphic grade is difficult, if not impossible, to resolve because pyroxene is a phase typical of both unmetamorphosed anorthositic rocks and rocks at granulite facies.

Structure

The structural history of the Whitestone Anorthosite is unknown.

The variable orientation of primary layering suggests that the anorthosite has been either folded or faulted. Insufficient data have been collected to conclude anything definitive about the structure of the anorthosite itself.

The anorthosite is transected by several prominent east trending lineaments. Several of these lineaments appear to be occupied by mafic dikes (indicated by aeromagnetic data).

A prominent set of lineaments trends at 020. Their significance has not been determined beyond the fact that they are roughly parallel to the eastern contact of the anorthosite.

GEOLOGY OF THE ARNSTEIN ANORTHOSITE

A crescent-shaped body of anorthositic rocks, southeast of the village of Arnstein, extends over an area of 80 km2 and is referred to informally as the Arnstein Anorthosite (charts A and C).

No detailed description of the geology of the Arnstein Anorthosite has been published. The Arnstein Anorthosite is the most northerly of the anorthositic bodies which extend along the western boundary of the Parry Sound Domain (Davidson and Morgan, 1981; Davidson et al., 1982).

The Arnstein Anorthosite is more highly deformed and thoroughly recrystallized than the Whitestone Anorthosite. The most common mineral assemblage (plagioclase-scapolite-clinopyroxene-garnet-hornblende) is consistent with granulite facies metamorphism. Contact relationships suggest that the Arnstein Anorthosite has been tectonically emplaced at its present location.

Contact Relationships

The Arnstein Anorthosite is surrounded by marble tectonic breccia, quartzo-feldspathic paragneisses and mafic gneisses of unknown protolith (see chart C - back pocket). The contact between the country rock and the anorthosite has not been observed; however, it is probable that the contacts are tectonic rather than intrusive. Evidence to support this tentative conclusion is provided by the common occurrence of marble tectonic breccias topographically below the anorthosite-country rock contact and by the occurrence of mafic boudins in the anorthosite along the western contact (chart C). The breccias, which occur along the shorelines of Empy, Le Grou and Chartier Lakes, consist of impure crystalline marbles containing highly contorted amphibolitic inclusions. It is probable that the Arnstein Anorthosite was tectonically emplaced along a ductile zone composed of the underlying marbles. Such a mode of emplacement would account for the extreme deformation of amphibolitic fragments in the marble tectonite.

A thin slice of marble tectonite and impure quartzite occurs within the anorthosite approximately 1 km from the western contact. These rocks occur within a pronounced lineament which parallels the western margin of the body. The tectonic significance of this "raft" of country rocks within the anorthosite is not yet fully understood.

Primary Mineralogy and Textures

In contrast to the Whitestone Anorthosite, preserved primary textures in the Arnstein Anorthosite are quite rare. In isolated locations, remnants of oikocrysts can be discerned. These are invariably flattened and elongated in the plane of foliation. The only consistently recognizable primary facies is the megacrystic clinopyroxene facies. Clinopyroxene megacrysts (ranging from 5 to 30 cm) are commonly rimmed by hornblende.

There appears to be no systematic distribution of the pegmatitic facies although it is more common in the eastern portion of the anorthosite.

Near the eastern contact of the anorthosite, melanogabbro, consisting of titaniferous augite, garnet, scapolite and titanite (sphene), was discovered (map unit 1c). These rocks contain very low chromium contents (< 90 ppm) which precludes the possibility that they are metamorphosed ultramafic rocks. Their chemical composition closely resembles that of a pyroxene megacryst collected from a pegmatitic dike on Irish Lake. The contact between the melanogabbro and the anorthositic rocks was not observed. The melanogabbro unit is either a mafic cumulate or an exceptionally large clinopyroxene pegmatite. Further mapping is required to establish the boundaries of this unit and its genesis.

Mesoscopic igneous layering was not observed in the Arnstein Anorthosite. Nearly complete recrystallization, combined with widespread development of gneissic textures, has obliterated any evidence of original stratification.

Metamorphism

The Arnstein Anorthosite has been almost entirely recrystallized. The predominant mineral assemblage consists of plagioclase, hornblende, clinopyroxene, garnet, scapolite, titanite, +/- epidote, calcite, magnetite and biotite. Commonly clinopyroxene, without hornblende, occurs in discrete bands in the melanosome. In these cases, there is no textural evidence that clinopyroxene is unstable. Presumably the development of the melanosome accompanied metamorphic recrystallization and therefore clinopyroxene was a stable phase at the prevailing metamorphic conditions. The mineral assemblage present in the anorthosite (hornblende-clinopyroxene-garnet-plagioclase) is diagnostic of high pressure granulites (de Waard, 1965).

Structure

The strike of gneissosity generally parallels the contacts with the country rocks. Dips range from 18 to 50 to the east and southeast. Mesoscopic isoclinal folds were observed in several locations.

Two sets of lineaments occur within the anorthosite: one set consists of arcuate, northeasterly trending valleys and ridges which parallel the contact with the country rocks; the other set consists of prominent easterly trending valleys which extend into the adjacent country rocks.

Chains of lakes at the base of a moderate slope mark the boundaries of the anorthosite. An internal lineament, parallel to the contacts, passes through the anorthosite approximately 1km from the western margin. This lineament appears to have formed as a result of erosion of a slice of impure marbles which are wholly contained within the anorthosite.

There are three prominent lineaments in the easterly trending set. The most northerly of this set includes Wing and Irish

Lakes. Isolated outcrops of diabase occur on the shores of both lakes and microporphyritic dikelets (augite + plagioclase microphenocrysts in an aphanitic groundmass) occur on the southern shore of Irish Lake. Aeromagnetic maps of the area indicate that the three major east trending lineaments contain diabase dikes. Petrographic examination of samples of the dike from Irish Lake reveals well preserved primary minerals indicating that the dikes post-date the last metamorphic episode. The easterly trending diabase dike swarms of the Grenville Province have been dated (K/Ar) at 880 Ma and younger (Douglas, 1970).

The Arnstein Anorthosite is compositionally similar to the Whitestone Anorthosite, however, there also several significant differences:

a) primary textures are generally not preserved in the Arnstein Anorthosite while they are comparatively well preserved in the Whitestone Anorthosite,

b) meta-clinopyroxenite cumulate rocks occur within the Arnstein Anorthosite but have not been reported from the Whitestone Anorthosite,

c) the occurrence of marble tectonic breccia topographically below the Arnstein Anorthosite strongly suggests that the Arnstein body was tectonically emplaced rather than intruded into its present location. While the evidence is not conclusive, several researchers (Mason, 1969; Thompson, 1983) have described features of the Whitestone Anorthosite which are consistent with its intrusion into the enclosing country rocks.

Economic Potential of Anorthositic Rocks

Anorthositic rocks are known to host significant metallic deposits, to have potential applications in industrial processes, and may host precious metal mineralization.

Metallic Minerals

Titanium, iron, chrome and vanadium have been produced from Massif anorthosites in the Grenville Province of Quebec (Rose, 1969). Kretschmar (1968) and Kretschmar and McNutt (1971) described the oxide mineralogy of the Whitestone Anorthosite. The titanium content of the magnetite is low; Rose (1973) identified a direct relationship between the Ti content of magnetite and the potential for vanadium mineralization in anorthosites. It appears on this basis that the potential for vanadium mineralization in the Whitestone Anorthosite is low. Small patches of magnetite and hemo-ilmenite are common, but to date no significant mineralization has been discovered. The locations of these small occurrences are shown on chart B. Airborne magnetic surveys (GSC-ODM, 1965) identified two moderate positive anomalies within the Whitestone Anorthosite. The two anomalies occur near the northern contact of the anorthosite with the country rocks. Both anomalies were investigated briefly by the authors; both are attributed to disseminated magnetite. Further investigation of these anomalies is planned because there is some doubt as to whether the disseminated magnetite is hosted by a marginal phase of the anorthosite or is hosted by mineralogically similar country rocks.

There are no magnetic anomalies in the Arnstein Anorthosite except those attributable to mafic dikes.

Industrial Minerals

Investigation of the potential applications of high-feldspar rocks is planned under a separate COMDA project (see chapter 1). In the course of the present study, representatives of the rock wool, glass fibre and glass industries have been contacted. Initial indications are that anorthositic rocks could be employed as a substitute for, or in combination with, materials already in use (slag, trap rock, silica sand and nepheline syenite).

In general, low-iron (<1 % Fe) raw materials are required for all the products listed above. The iron content of some samples from the Whitestone and Arnstein Anorthosites is somewhat higher than the preferred maximum value (Tables 3.1, 3.2). However, the relatively simple mineralogy and coarse grain size of the anorthositic rocks should permit considerable reduction in iron contents by relatively inexpensive processing (dry grinding and magnetic separation).

Since the anorthosites are bright white, and are low in silica, it may be possible to use finely ground plagioclase products as fillers and extenders.

Emphasis in the current program will be placed on locating suitable material, both high-iron and low-iron types, near existing infrastructure (roads, power supplies etc.), as the potential market for the product is not large enough to justify substantial capital investment.

Since transportation costs are a significant component of the cost of the material, assessment will concentrate on the the more accessible parts of the southern anorthositic bodies. (The Arnstein Anorthosite is less accessible than some of the other bodies, and more remote from potential markets.) The most accessible areas of the Whitestone Anorthosite are highly sheared and as a consequence the attitude of primary layering relative to the predominant shearing direction becomes an important factor.

Building Stone

The Whitestone Anorthosite contains rocks with interesting and attractive textures which have a variety of building stone applications. Since these rocks are generally free from deleterious minerals (sulphides, carbonates), they are potentially suitable for both interior and exterior use.

Joints are generally widely spaced (> 3m) and large outcrops of essentially homogeneous material are common. At the other end of the scale there are some spectacularly contorted gneissic varieties which may also warrant investigation.

Table 3.1: Representative analyses of samples from the Whitestone Anorthosite.

SAMPLE	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	S.G.
86CCM-0082	51.2	22.5	4.46	2.25	13.8	3.99	0.48	0.41	0.02	0.04	2.83
86CCM-0085	51.6	29.3	1.09	0.14	12.1	4.14	0.44	0.15	0.01	0.01	2.71
86CCM-0086	51.7	29.3	1.06	0.05	12.1	4.19	0.47	0.05	0.01	0.01	2.71
86CCM-0089	52.0	25.0	3.17	1.32	12.0	4.39	0.53	0.34	0.03	0.02	2.75
86CCM-0090	50.6	23.2	4.47	2.18	13.4	4.04	0.44	0.39	0.01	0.04	2.79
86CCM-0095	52.0	27.6	1.50	0.64	11.8	4.32	0.50	0.14	0.07	0.01	2.79
86CCM-0105	51.3	28.7	1.02	0.39	11.9	4.66	0.36	0.19	0.01	0.01	2.71
86CCM-0106	51.1	27.7	1.73	1.30	12.4	4.23	0.32	0.27	0.00	0.01	2.77
86CCM-0108	49.5	25.8	3.97	3.51	10.5	4.06	0.64	0.16	0.01	0.03	2.80
86CCM-0109	51.6	22.0	5.29	3.19	10.8	3.92	0.68	0.71	0.04	0.06	2.83
86CCM-0110	51.3	28.9	1.23	0.40	12.6	4.25	0.32	0.12	0.01	0.01	2.75
86MMJ-3003	50.9	26.6	2.02	1.58	12.1	3.69	0.64	0.21	0.01	0.01	2.77
86MMJ-3005	55.9	24.2	1.97	1.34	6.2	5.69	1.83	0.55	0.25	0.01	2.90
86MMJ-3006	51.0	27.8	2.68	1.22	12.2	4.04	0.33	0.30	0.02	0.01	2.79
86MMJ-3008	52.1	29.1	1.03	0.29	11.5	4.05	0.47	0.17	0.01	0.02	2.69
86MMJ-3010	51.5	29.2	0.96	0.58	11.3	4.00	0.52	0.23	0.01	0.01	2.70
86MMJ-3015	51.5	28.8	1.13	0.18	12.1	4.22	0.45	0.14	0.01	0.02	2.73
86MMJ-3018	51.7	29.4	1.05	0.00	11.9	4.27	0.71	0.15	0.03	0.02	2.71
86MMJ-3023	47.3	19.3	12.5	2.63	10.2	3.91	0.48	2.12	0.15	0.14	2.95
86MMJ-3030	50.2	26.0	2.42	1.91	12.1	3.91	0.52	0.46	0.01	0.02	2.73
86MMJ-3033	50.1	22.5	5.27	2.31	11.8	3.22	0.61	0.82	0.27	0.06	2.80

SAMPLE	V (ppm)	Cr (ppm)	Pt (ppb)	Pd (ppb)	CO2 (wt.%)	S (wt.%)
86CCM-0082	76	25	<1	<1	0.32	0.06
86CCM-0085	2	<10	<1	<1	0.19	0.02
86CCM-0086	<1	<10	<1	2	0.35	0.02
86CCM-0089	44	12	<1	<1	0.71	0.07
86CCM-0090	76	29	<1	<1	0.48	0.02
86CCM-0095	11	<10	<1	<1	0.31	0.04
86CCM-0105	5	<10	<1	<1	0.46	0.02
86CCM-0106	24	42	<1	<1	0.37	0.02
86CCM-0108	7	<10	<1	<1	0.36	0.02
86CCM-0109	95	71	<1	<1	0.53	0.06
86CCM-0110	11	18	<1	<1	0.36	0.01
86MMJ-3003	35	46	-	-	0.16	0.01
86MMJ-3005	41	15	-	-	0.32	0.01
86MMJ-3006	58	15	<1	<1	0.16	0.01
86MMJ-3008	6	<10	-	-	0.16	0.01
86MMJ-3010	3	<10	-	-	0.26	0.03
86MMJ-3015	7	<10	-	-	0.19	0.01
86MMJ-3018	3	<10	-	-	0.20	0.01
86MMJ-3023	304	<10	-	-	0.72	0.04
86MMJ-3030	49	61	-	-	0.43	0.02
86MMJ-3033	96	23	-	-	1.15	0.10

Analyses by the Geoscience Laboratory of the Ontario Geological Survey. Major and minor oxides by X-ray fluorescence, V by ICP - MS, other trace elements by AA.

Table 3.2: Representative analyses of samples from the Arnstein Anorthosite.

SAMPLE	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	S.G.
86MMJ-2002	48.7	30.2	1.47	0.63	13.7	3.41	0.39	0.14	0.01	0.00	2.78
86MMJ-2005	50.2	28.5	1.84	0.45	12.7	3.91	0.80	0.16	0.01	0.01	2.80
86MMJ-2023	53.2	29.0	0.67	0.14	10.5	4.96	0.55	0.20	0.01	0.01	2.70
86MMJ-2025	51.1	28.7	1.36	1.20	12.4	3.47	0.18	0.17	0.01	0.00	2.78
86MMJ-2030	55.6	19.3	7.83	2.49	7.59	3.95	0.82	1.16	0.06	0.10	2.90
86MMJ-2033	54.5	24.0	2.23	1.02	5.71	5.92	2.46	0.13	0.01	0.01	2.78
86MMJ-2035	47.1	25.8	4.41	5.07	11.1	3.21	0.70	0.10	0.01	0.03	2.81
86MMJ-2037	51.1	27.0	2.08	1.40	12.6	3.66	0.35	0.27	0.02	0.00	2.75
86MMJ-2042	51.7	29.7	0.67	0.04	11.4	4.33	0.57	0.12	0.01	0.01	2.66
86MMJ-2048	45.7	8.80	12.3	8.67	21.1	0.47	0.05	1.37	0.01	0.10	3.38
86MMJ-2050	51.8	26.0	2.47	2.39	11.9	4.02	0.40	0.30	0.04	0.01	2.79
86MMJ-2052	46.2	8.46	13.0	7.73	20.0	0.95	0.15	1.69	0.05	0.14	3.35
86MMJ-2053	44.4	11.5	10.4	8.58	21.0	0.46	0.13	1.52	0.26	0.10	3.35
86MMJ-2054	45.7	20.0	7.26	4.67	17.5	1.73	0.33	1.31	0.05	0.06	3.12
86MMJ-2055	44.9	10.6	11.9	8.44	20.5	0.38	0.11	2.07	0.06	0.12	3.34
86MMJ-2056	45.4	9.35	12.2	8.36	20.7	0.40	0.12	1.65	0.04	0.11	3.32
86MMJ-2057	51.8	29.0	0.69	0.06	11.2	4.16	1.02	0.18	0.01	0.01	2.69
86MMJ-2065	48.5	26.0	3.42	3.68	13.4	2.15	0.51	0.45	0.01	0.04	2.79
86MMJ-2073	49.9	20.2	6.72	4.52	12.3	2.95	0.43	0.55	0.04	0.08	2.85

SAMPLE	V (ppm)	Cr (ppm)	Pt (ppb)	Pd (ppb)	CO2 (wt.%)	S (wt.%)
86MMJ-2002	10	<10	-	-	0.32	0.02
86MMJ-2005	15	<10	-	-	0.36	0.01
86MMJ-2023	<1	<10	-	-	0.12	0.01
86MMJ-2025	18	39	-	-	0.27	0.01
86MMJ-2030	179	17	<1	<1	0.24	0.06
86MMJ-2033	14	22	<1	<1	0.48	0.36
86MMJ-2035	7	<10	-	-	0.58	0.02
86MMJ-2037	49	37	-	-	0.47	0.01
86MMJ-2042	<1	<10	-	-	0.32	0.01
86MMJ-2048	244	69	-	-	0.32	0.01
86MMJ-2050	46	39	-	-	0.36	0.01
86MMJ-2052	269	47	2	<1	1.01	0.08
86MMJ-2053	201	82	1	<1	1.17	0.02
86MMJ-2054	164	36	<1	<1	0.92	0.08
86MMJ-2055	294	48	<1	<1	0.36	0.06
86MMJ-2056	217	39	<1	<1	0.86	0.01
86MMJ-2057	2	<10	-	-	0.12	0.01
86MMJ-2065	63	97	-	-	0.37	0.02
86MMJ-2073	135	31	-	-	0.62	0.02

Analyses by the Geoscience Laboratory of the Ontario Geological Survey. Major and minor oxides by X-ray fluorescence, V by ICP - MS, other trace elements by AA.

Precious Metals

No data has been found concerning the potential for platinum group element (PGE) deposits in Massif-type anorthosites; however, several features present in rocks of this type suggest that there is potential for PGE mineralization.

Recent research and intensive exploration for PGE deposits has necessitated re-examination of the rather restrictive genetic models (based upon a handful of well-described examples), and a wide variety of geologic environments are now considered as potential hosts of PGE mineralization. In the absence of a generally accepted working hypothesis concerning the genesis of Massif-type anorthosites, it is impossible to consider their potential on a theoretical basis (whether they are partial melts, crystal cumulates or evolved liquids will dictate their initial PGE concentrations and their potential for producing PGE deposits). Since there is no theoretical basis for eliminating anorthosites as a potential host of PGE mineralization, and because there are certain features of the anorthosites (igneous layering, minor disseminated sulphides, pegmatitic phases) which are common to rocks hosting PGE deposits, a number of samples were collected for Pt and Pd analyses.

Assaying for PGE among rocks from the Whitestone and Arnstein anorthosites was guided by the following criteria:

a) random sampling of all representative rock types to determine background values,

b) selective sampling of pegmatitic clinopyroxene-rich dikes which crosscut the igneous layering,

c) assaying all samples containing sulphides (principally pyrite but also traces of chalcopyrite).

The logic behind assaying the pegmatitic samples lies in the fact that the PGE are incompatible with plagioclase (the main liquidus phase) and therefore should remain in the residual liquid during progressive fractional crystallization. Recent preliminary reports of pegmatitic minerals in the Bushveld and Stillwater complexes suggest that a fluid phase may be an important factor in concentrating PGE (Ballhaus and Stumpfl, 1985; Johan and Watkinson, 1985; Mathez et al., 1985). A fluid phase was evolved during late stage crystallization of the Whitestone Anorthosite (indicated by the pegmatitic texture of the dikes and by cross cutting relationships) and therefore the pegmatitic dikes are considered to be a likely candidate to host PGE mineralization.

Selection of rocks containing sulphides is based on the well-known association of PGE (particularly Pt, Pd and Rh) with base metal sulphides (Barnes et al., 1985).

The results of 18 Pt and Pd analyses are not encouraging (table 3.1 and 3.2); the concentrations of both elements are below the detection limit in most samples. There is essentially no difference in Pt and Pd concentrations between samples from the pegmatitic dikes, sulphide-bearing samples and random samples from the anorthosite. These data suggest that the average abundances of Pt and Pd are very low in anorthositic rocks and as a consequence Pt and Pd mineralization is unlikely to be present.

However, the recognition of primary layering within the Whitestone Anorthosite provides a faint glimmer of hope, since it indicates that magmatic processes similar to those operating in PGE-bearing, layered igneous intrusions also operated in the Whitestone Anorthosite. If the stratigraphy of the Whitestone Anorthosite could be elucidated it is possible that sampling for PGE could be more sensibly directed. It is well established that platiniferous units in host intrusions are very narrow, and the semi-random sampling conducted during reconnaissance traversing has a very low chance of sampling key horizons (if such horizons exist).

Conclusions

Evaluation of the economic potential of the anorthosites is at an early stage. Initial indications are that the highest potential for economic exploitation of the anorthosites lies in their use in industrial processes and as building stone. Field investigations during the summer of 1987 will be directed primarily toward locating material suitable for industrial applications.

4. MARBLES

Introduction

The occurrence of "limestone" in the Parry Sound area has been known for a long time: lime was produced from a kiln operating in Lount Township in 1880, and another kiln operated at Limestone Lake early in this century. Over the years the limestone has been used locally for agricultural purposes and road surfacing, and in the early 1970s a small amount of pulverized filler grade calcite was produced at Burk's Falls with material from Spence Township.

The current survey was designed to obtain an overview of the limestone (marble) occurrences in the area, and attempt a more systematic evaluation of their economic potential than had been undertaken previously.

PREVIOUS WORK

Miller (1904) described marble occurrences in the Parry Sound District, and interpreted them as three bands: the Burton Band extending south-southwest from Wawashkesh Lake to just north of Parry Sound; the Parry Sound Band roughly paralleling Highway 124; and the Nipissing Road Band.

Goudge (1938) distinguished two types of marble: calcitic near Parry Sound, and magnesian at Seguin River (Christie Township). The most comprehensive study of the Parry Sound marbles is that of Satterly (1941), which listed numerous occurrences in fifteen townships, and described many of their geological features. Additional descriptions are to be found in Satterly's (1956) report on the geology of Lount Township.

Lacy (1960) described the marble bands of the Dunchurch - McKellar area which he had mapped at a scale of 1 inch = 2 miles in 1941. The distribution of marbles was seen to be more complex than perceived by Miller (1904).

Hewitt (1967), who was primarily concerned with the metallic mineral occurrences in the area, gives brief mention to marble occurrences.

Martin (1983) provided an inventory of marble deposits.

Bright (1986) recorded the distribution of marble units, during the course of a 1 inch = 1/4 mile mapping program, in the Dunchurch area.

Distribution and Setting

Whilst minor marble occurrences have been noted in the Moon River Synform, in the Algonquin Domain near Huntsville, and near Gravenhurst in the Muskoka Domain, the most extensive deposits occur in the Parry Sound Domain (see Chart A, back pocket). They are interlayered with mafic gneisses, quartzites, and a variety of plutonic rocks ranging in composition from gabbro, norite and anorthosite to granite. All are coarsely crystalline, having been metamorphosed to upper amphibolite and granulite facies. Some retrogression is apparent. All are highly deformed and are best referred to as marble tectonic breccias. They appear to have flowed during tectonism, and in the process have incorporated (and/or have been intruded by) a variety of igneous rocks, now present as dislocated, boudinaged and contorted tectonic inclusions. Much work remains to be done in order to establish the structural/stratigraphic relationships of the different marble bands and the regional variation in their composition.

Exploitation

A number of marble deposits in the Parry Sound area have been exploited in the past, but on a fairly small scale. They have been used mainly as road gravel or have been burnt to produce lime. The most concerted attempts to use the marble for various industrial applications were made by Cononaco Mines Ltd. in the late 1960s and by Burcal Mines Ltd. in the early 1970s. The latter shipped 4,000 tons of pulverized filler-grade calcite for use in rubber carpet-backing from its mill located at Burk's Falls. Chart A shows the locations of marble units and occurrences described by the various authors cited above, and highlights the best documented occurrences which are described below.

DESCRIPTIONS OF MARBLE OCCURRENCES

CHRISTIE TOWNSHIP

Concession 11, Lot 9.

The most notable occurrence of marble in Christie Township is exposed in the gorge of the Seguin River immediately north of Highway 518, some 4 kilometres east of Orrville (formerly Edgington). The occurrence has been described by Satterly (1941), and was briefly visited and sampled by the authors during 1986. Like the other marble occurrences in the district it is highly tectonized, and contains inclusions of garnet pyroxenite and pegmatite, and a variety of disseminated silicate minerals (see table 4.2). Of mineralogical interest is the occurrence of clinohumite(?) rimming olivine, which was not observed in thin sections from other locations. As Goudge (1938) observed, the Seguin River section contains bands of dolomite and magnesian calcite as well as pure calcitic marble (see Table 4.2), some of which has a delicate pale blue or pink hue. In thin section, two carbonate species are apparent, occurring as distinct equant grains, the calcite being dusty, and the dolomite clear, forming more distinct rhombs and displaying characteristic twin planes. In some sections dolomite occurs as rhombic exsolutions within the calcite (see photo 4.1). On the south side of Highway 124, calcitic marble contains abundant chondrodite, and mafic inclusions with well-developed reaction rims of phlogopite and amphibole (?) (figure 4.1).

CROFT TOWNSHIP

Roadside outcrops along Highway 520 north of Dunchurch, in Concession 11, Lot 34, consist of marble tectonic breccia in which the inclusions constitute about 40% of the rock volume. The inclusions consist mainly of amphibolite, while the marble contains a small amount of disseminated silicate minerals. The occurrences are notable for the pale pink to red and orange colour of the marble for a few centimetres around the mafic inclusions.

FERRIE TOWNSHIP

Calcitic marble tectonic breccia is exposed at a bridge across the Ferrie River in Concession 7, Lot 32, and at Maple Island in the Magnetawan River. The marble is white, pink and pale green, and contains inclusions of amphibolite and dioritic gneiss. The marble is generally coarse grained and contains up to 15% of 1-2 mm sized grains of garnet, chondrodite, clinopyroxene, and minor titanite and cummingtonite (photo 4.2).

HAGERMAN TOWNSHIP

Satterly (1941) recorded a number of marble occurrences in Hagerman Township, most lying alongside Highway 124; all are tectonites. Marble has been extracted from large pits in Concession A, Lot 33 and Concession B, Lot 32 for road gravel and for testing as a possible source of high purity calcite.

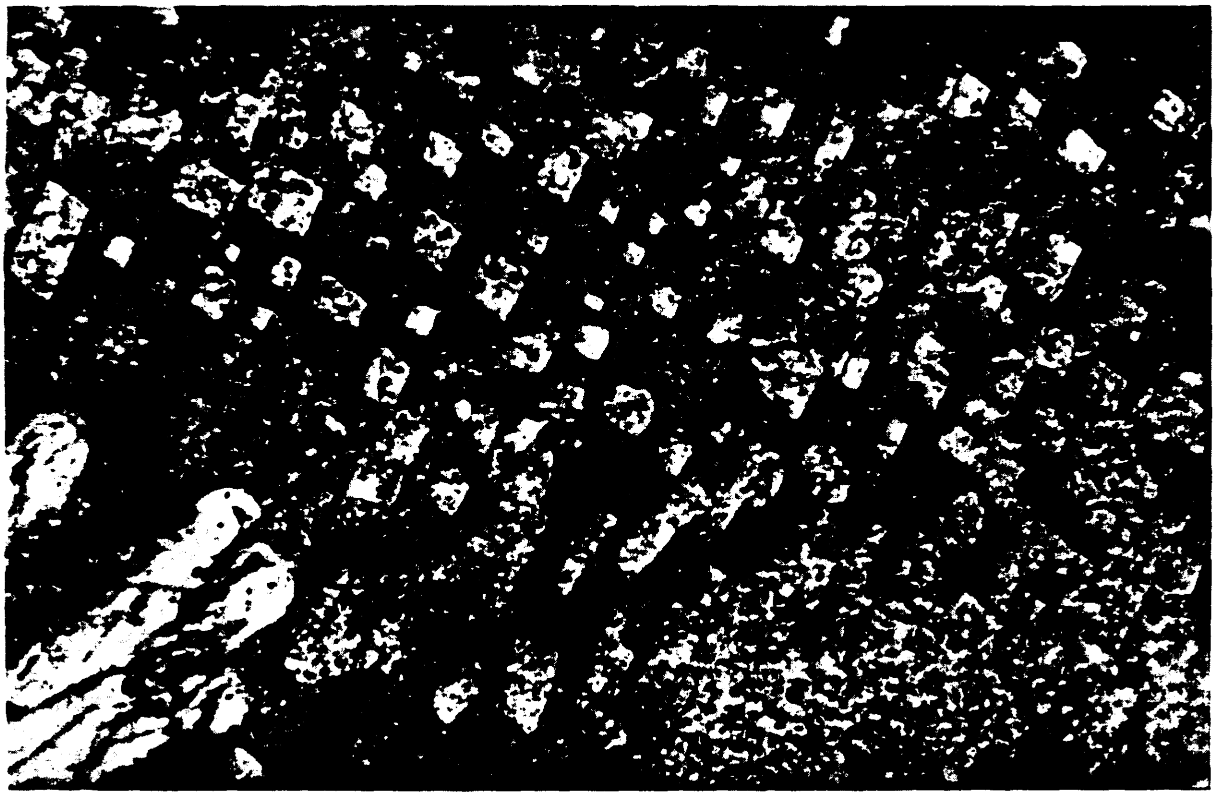

Photo 4.1 Dolomitic marble, Seguin River gorge, Christie Twp., Con. 11, Lot 9. Note small rhombs of clear dolomite exsolved from a cloudy groundmass of calcite. Field of view: 3.5mm x 2.5mm.

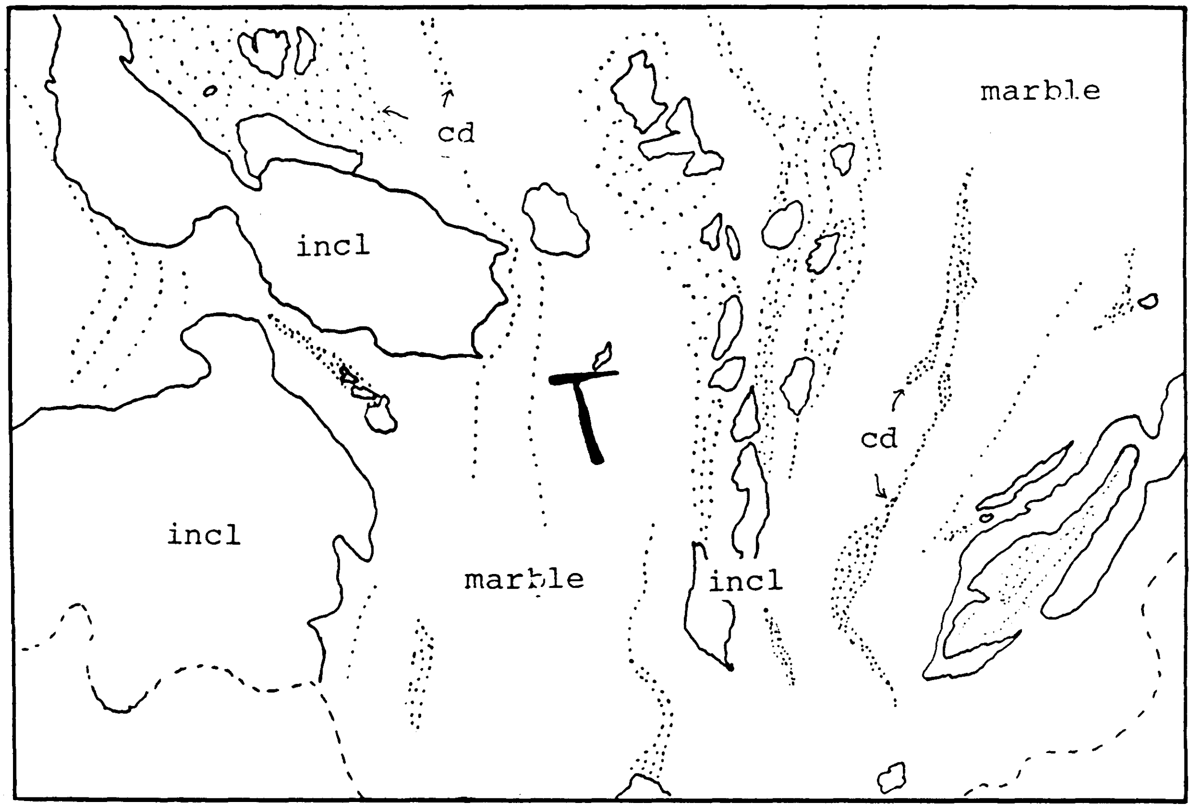

Figure 4.1: Tracing from a photograph of impure calcitic marble containing numerous lithic inclusions (incl). Dots indicate the location of lenses and bands composed chiefly of chondrodite (cd). Note that bands of silicates are deflected adjacent to the larger inclusions (right foreground) and are particularly abundant adjacent to clusters of small inclusions. The surface of the outcrop dips steeply to the left and the banding dips less steeply, consequently the large inclusion in the upper left has a rather unusual shape in the plane of the outcrop (it is actually tabular and dips in the same direction as the banding).

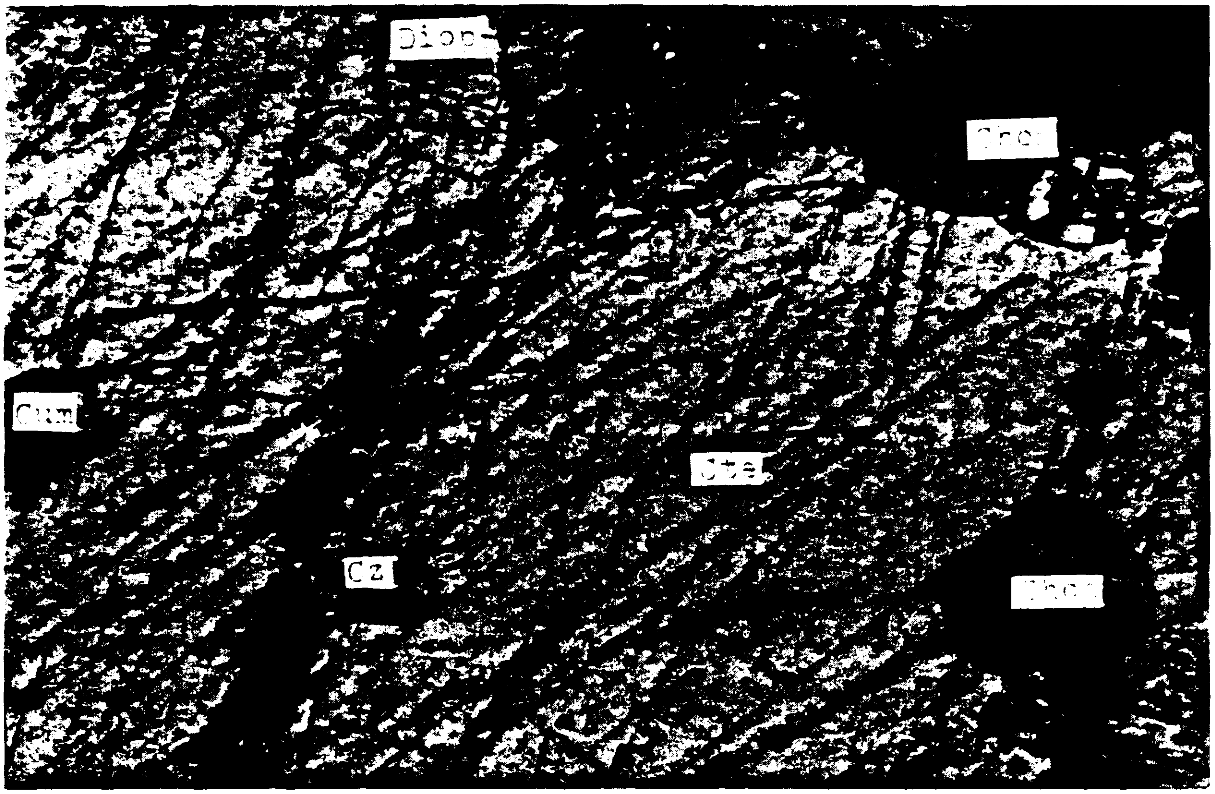

Photo 4.2: Photomicrograph of impure marble from Maple Island, Ferrie Twp. Abbreviations: Cte - calcite, Chon - chondrodite, Diop - diopside, Cum - cummingtonite, Cz - clinozosite. Field of view 3.5 x 2.5 mm. Crossed nichols. Note coarse grain size and sharp grain boundaries, which should facilitate beneficiation.

At Limestone Lake, just to the south, marble was burnt for the production of slaked lime (Macfie, 1983).

CONONACO MINES LIMITED

(Concession A, Lot 33; Concession B, Lot 32)

Martin (1983) recorded extraction of calcitic marble from pits on each side of Highway 124, in Concessions A and B, Lot 32. The pit in Concession A is actually located in Lot 33. In 1969, Cononaco Mines Ltd. extracted marble from both pits in an attempt to produce high purity ground calcite for use in the pharmaceutical, paint and rug manufacturing industries. Cononaco constructed a mill at Waubamik to crush and pulverize the marble from Lorimer Lake, and a rail spur was constructed from the CNR to enable the ground product to be loaded. To date, the authors have not traced any technical information or production figures on the operation.

The pit on the west side of Highway 124 near the Lorimer lake Resort (Concession A, Lot 33) was mapped in detail, and is described below.

Geology

The marble at Lorimer Lake is well exposed over a strike length of some 150m and a width of 50m. The area was mapped in detail during 1986. Chart D (back pocket) shows the geology of the pit and adjacent stripped area. The marble unit is a complex tectonic breccia whose contacts with the enclosing gneisses are not exposed.

Marble Units:

Four marble units (1a to 1d) were differentiated:

Unit 1a consists of fairly pure calcitic marble, with less than five percent disseminated silicate minerals. It occurs mainly as narrow units interlayered with the impure marbles of units 1b, 1c and 1d, but one wider band (3-4 metres) can be traced northward from the main pit for a distance of some 60 metres (200 feet). Previous blasting in this area has exposed a relatively pure marble with 1-2% disseminated flake graphite. The relatively pure band is white to translucent and consists of interlocking 2-5mm grains of calcite. Silicate minerals are disseminated evenly or in vague bands through the marble. The most common silicates are chondrodite and serpentinized olivine, and less abundant diopside, spinel, magnetite, muscovite, phlogopite and graphite (photo 4.3). Small ice-blue apatite grains were found in the main pit. When almost free of disseminated non-carbonate minerals, the rock is massive, equigranular and commonly weathers and disintegrates to a buff-coloured sand. This is most noticeable adjacent to inclusions of meta-diabase (eg 2+40E, 6+60N), and in the cores of isoclinal folds (eg 3+50E, 8+20N).

Unit 1b is a less pure marble than that of unit 1a. Disseminated silicate minerals may constitute over 30% of the rock.

Units 1c and 1d are simply units 1a and 1b respectively, which contain a significant number of lithic fragments too small or too numerous to be mapped.

Tectonic Inclusions:

A variety of inclusions occurs within the marble band. Individual inclusions range up to 30 metres long and 10 metres wide. Most of the larger inclusions are lozenge-shaped, whilst many of the smaller ones are tabular and contorted (Photo 4.5).

The most abundant type of inclusion is a meta-basite (Unit 3a) composed of plagioclase (50%), augite (20%), hornblende (15%), garnet (10-15%) and magnetite. It is generally only weakly foliated. A pegmatitic phase of unit 3a occurs within two large inclusions in the central part of the mapped area.

Unit 2 looks similar to unit 3a except that it contains no garnet, and petrographic examination reveals that it is an equigranular scapolite (35%)-augite (60%) rock with minor calcite. It occurs in contact with unit 3a in the main pit. A scapolite - augite pegmatite occurs in the northern part of the gridded area in association with pyroxenite and syenite. The

Photo 4.3: Photomicrograph showing typical mineralogy and textural relations, Cononaco pit, conc. A, lot 33, Hagerman Twp. Abbreviations: Cte - calcite, Chon - chondrodite, Sp- spinel, mgt - magnetite. Field of view 3.5 x 2.5 mm. Crossed nichols. Note sharp grain boundaries and simple shape of silicate minerals.

Photo 4.4: Coarse grained marble containing several complexly folded mafic inclusions. Cononaco pit, Con. A, Lot 33, Hagerman Twp. Scale card marked in inches and centimetres.

pyroxene is a bright green aegerine-augite, and there appear to be two generations of scapolite.

Other major inclusions are of granite (Unit 6) and syenite (Unit 5). Both have pegmatitic counterparts.

Structure:

The best impression one can gain of the structure of this marble band is to view Chart D, and photographs 4.4 and 4.7. A few fold axes and mineral lineations were measured, which showed a general plunge to the southeast. However, the kinematic indicators of contorted marble bands and mafic inclusions demonstrate that the whole tectonite has behaved in an extremely ductile fashion, and that inclusions have been rolled, stretched, boudinaged and broken. Photograph 4.5 shows calcite marble penetrating and bringing about the disintegration of a small inclusion of scapolite-augite gneiss in the northwestern part of the pit. The marble has a well-defined flow foliation around the inclusions and forms tight isoclinal folds, indicated by coarsely recrystallized cores (3+50E, 8+20N). These small scale features are themselves folded into broad open folds as shown on Chart D.

Reaction Rims:

In many parts of the mapped area, in common with almost all other exposures seen in the district, reaction rims surround many inclusions. In the eastern face of the main pit a good

example can be seen between the marble and an inclusion of scapolite-augite gneiss (see photo 4.6). In this instance, a medium to dark brown amphibole and lesser biotite form along the contact of the gneiss, followed outward by a paler amphibole (probably cummingtonite) and phlogopite.
Serpentine appears in the cummingtonite zone, and increases outward toward the calcite marble at the expense of cummingtonite.

In other locations chondrodite masses occur at the extremities of mafic inclusions and appear to tail out as disseminated grains within the marble (photo 4.1).

There is a possible late fault along the line of the northeastern edge of the pit. It corresponds to a minor lineament visible on air photographs, and coincides with a sharp change in direction of strike of the marble. Mafic inclusions are predominant to the northeast of this feature, but are fewer to the southwest, where most of the development work was done.

Analytical Results:

Unfortunately, at the time of writing, no records have been located which provide details of Cononaco's head assays, the chemical and physical characteristics of their ground product, and details of the processing plant. However, samples of marble collected from the pit at Lorimer Lake, and ground marble recovered from the site of the loading bins at Waubamik, have

Photo 4.5: Coarsely crystalline marble injected into brittle fractures in a scapolite-augite gneiss tectonic inclusion. Cononaco pit, Con. A, Lot 33, Hagerman Twp.

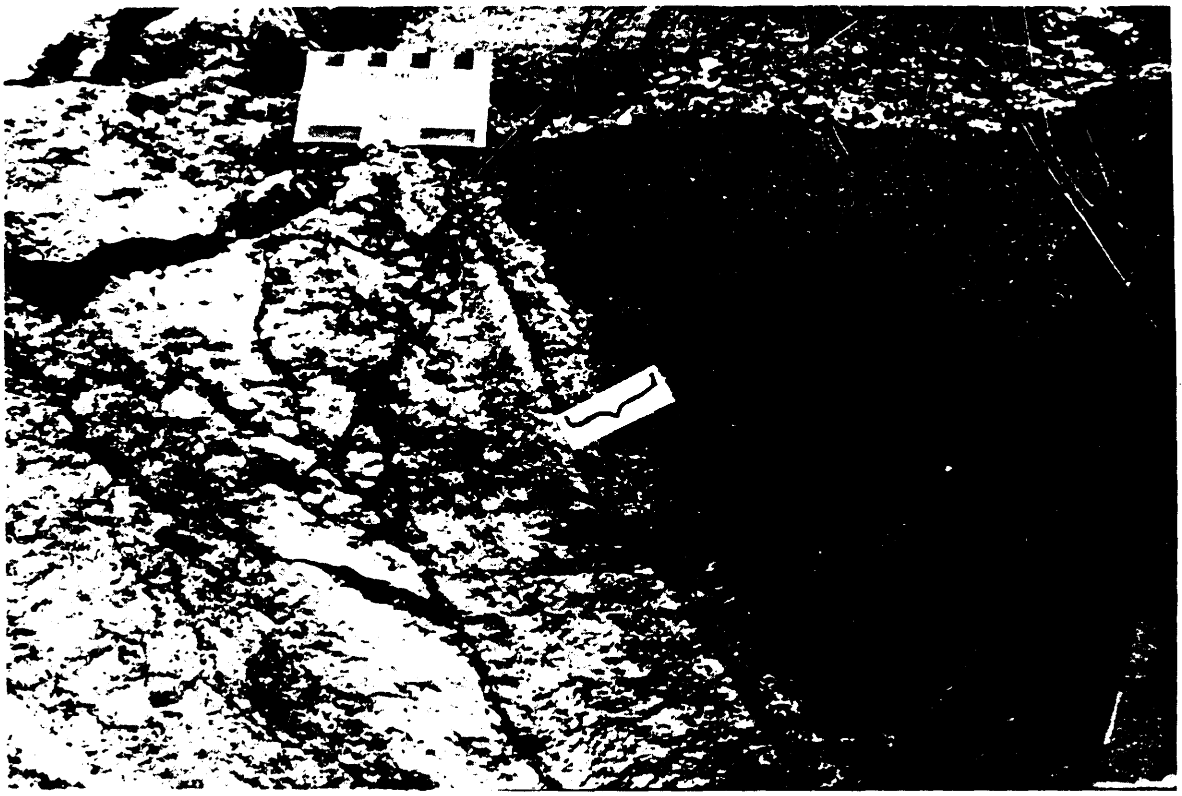

Photo 4.6: Detailed view of the reaction rim developed between relatively pure marble and a scapolite-augite gneissic inclusion.

been analyzed at the Geoscience Laboratories of the Ontario Geological Survey, Toronto. The analytical results received to date are presented in Table 4.1. A size fraction analysis of the material collected from the Mill site at Waubamik is presented in Appendix 2.

Concession B, Lot 32

An area approximately 100m x 50m has been stripped at this site, from which Martin (1983) reports that some 28,800 tons of stone were removed. It is probably part of the same marble unit described above, which it closely resembles. Photograph 4.7 shows a marble block from this location, which contains a crumpled and rolled band of amphibolite.

LOUNT TOWNSHIP

In the southern part of Lount Township and adjacent parts of Chapman Township a band of marble outcrops over a broad area (see Chart A). In Lount Township, the band has been mapped by Satterly (1956), and it has subsequently been the subject of several exploration programs. Some of this material has been used for local road surfacing. A lime kiln was operated further north in Con A, Lot 140 on what may be a different marble unit.

CONCESSION 1, LOT 26.

The following notes are taken from SMDR 001279:

"... the crystalline limestone breccia meanders to other

Table 4.1. Chemical Analyses, Marbles of the Parry Sound Domain.

Sample No.	SiO2	Al2o3	Fe2o3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	CO2	S	LOI	Total
86CCM-0116	0.66	0.14	0.89	20.80	30.80	0	0	0.02	0	0.17	43.50	0	46.10	99.60
86CCM-0117	0.88	0.06	0.09	5.11	51.20	0.09	0	0	0	0.02	41.70	0	42.20	99.60
86CCM-0118	3.88	0.84	0.43	8.65	46.70	0.12	0.16	0.04	0.01	0.02	39.40	0.04	38.80	99.60
86CCM-0160	1.84	0.55	0.33	3.11	52.90	0.04	0.06	0.02	0	0.02	40.60	0.01	41.20	100.00
86CCM-0161	1.71	0.45	0.48	4.01	52.00	0.11	0.02	0.05	0.02	0.02	41.30	0.02	41.00	99.90
86CCM-0162	3.04	0.44	0.38	0.08	55.80	0.07	0	0.03	0.01	0.02	38.20	0.01	38.20	98.10
86CCM-0034	0.62	0.10	0.12	2.35	52.90	0.09	0.01	0.02	0	0.01	42.70	0	43.40	99.60
86CCM-0037	1.00	0.10	0.18	2.66	53.40	0.10	0.03	0.01	0.06	0.01	42.20	0	43.40	99.60
86CCM-0166	2.38	0.44	0.37	2.08	51.90	0.11	0.07	0.03	0	0.01	40.50	0.01	41.80	100.20
86CCM-0167	4.20	0.45	0.36	1.71	52.50	0.06	0.09	0.04	0.01	0.01	40.00	0.01	40.40	99.80
86CCM-0169	1.26	0.22	0.56	4.63	50.40	0.06	0.13	0.01	0	0.03	41.70	0.03	41.90	99.20
86CCM-0137	0.77	0.11	0.21	10.90	43.50	0.06	0	0.02	0	0.03	42.80	0.01	43.60	99.20
86CCM-0164	0.50	0.02	0.07	0.58	55.40	0.07	0	0.01	0.01	0.01	42.40	0	42.90	99.60
86CCM-0065	0.27	0.04	0.07	1.39	54.60	0.08	0	0.01	0	0.01	41.70	0	43.40	99.80
86CCM-0074	2.10	0.47	0.63	1.22	52.80	0.10	0.11	0.02	0	0.02	40.10	0.01	41.70	99.20
86CCM-0075	4.10	0.96	0.57	1.78	51.70	0.24	0.22	0.04	0.01	0.02	39.50	0.01	40.00	99.60
86CCM-0076	4.73	1.01	0.50	2.24	51.20	0.13	0.23	0.04	0.01	0.02	39.20	0.01	39.10	99.20
86CCM-0263	1.25	0.23	0.36	1.73	53.70	0.02	0.13	0.02	0	0.02	41.50	0.01	42.40	99.50

Analyses by XRF, Ontario Geological Survey, Geoscience Laboratories, Toronto, Ontario.

Table 4.1 (continued)

86CCM-0116	Christie Township, Seguin River, Con. 11, Lot 9.
86CCM-0117	"
86CCM-0118	"
86CCM-0160	Croft Township, Con. 11, Lot 34.
86CCM-0161	Ferrie Township, Con. 7, Lot 32.
86CCM-0162	"
86CCM-0034	Hagerman Township, Con. A, Lot 33; Cononaco Mines Ltd.
86CCM-0037	"
86CCM-0166	Cononaco Mines Ltd., Waubamik Mill; coarse product
86CCM-0167	" fine product
86CCM-0169	McDougall Township, Con. 2, Lot 18.
86CCM-0137	McDougall Township, Con. 11, Lot 5.
86CCM-0164	McKenzie Township, Con. 2, Lot 2; Maple Island.
86CCM-0065	Spence Township, Con. 14, Lot 18; Burcal Mines Ltd.
86CCM-0074	Burcal Mines Ltd., Burk's Falls Mill; 1/4" crushed marble.
86CCM-0075	Burcal Mines Ltd., Burk's Falls Mill; coarse powder.
86CCM-0076	Burcal Mines Ltd., Burk's Falls Mill; fine powder.
86CCM-0263	Spence Township, Gene Pawlech, Con. 5, Lot 33.

Photo 4.7: Photograph of a highly contorted mafic band in coarsely crystalline calcitic marble. It is obvious that the folding of this inclusion was produced by continuous ductile deformation, during which time both the amphibolitic band and the marble were in a plastic state. Hagerman Twp, Con. B, Lot 32.

lots and concessions. It was located in 1967 by George W.Cannon and brother, of the Cannon Muskegon Corporation, Muskegon, Michegan. The limestone areas were explored by drilling, blasting pits and tested for pulverizing, chemical composition, reflectance, oil absorption, and screen analysis. Burcal Mines was formed and acquired 10 claims which contain the occurrence.

Six vertical drill holes, totalling 546 feet, were put down near a creek on claim EO 323933, outlining good grade limestone for 1,500 feet north-south and 500 feet east-west to a depth of 73 to 88 feet. Random core sampling indicated grades of 93.95% calcite.

In the area of holes 1, 2, 3, there are thought to be present 1,000,000 tons with 6,000,000 tons possible for the whole area. Four other holes were drilled at a dip of 45 but the calcite was overlain by too much impure limestone to be of interest."

Programs of trenching were performed in 1973 and 1978 by C.T. Ciglen and J. McVittie, respectively. An airborne magnetometer and radiometric survey was conducted in 1979 on behalf of Mr. McVittie. In 1980 Pominex Ltd. completed 9 diamond drill holes totalling 1380 feet (418m).

Limited metallurgical tests were performed by Lakefield Research of Canada Ltd. on a composite drill core sample submitted by Pominex Ltd. from Mr. J. McVittie's property in

Lount Township. The results of this work are presented in Appendix 3.

The calcite was relatively impure, and contained disseminated feldspar, quartz, actinolite, titanite, possibly anhydrite, opaque inclusions in the silicate minerals, and two or three unidentified species. Liberation of these minerals appeared to be complete at minus 100 mesh.

The result of an analysis of marble collected from this occurrence in 1986 is pending.

McDOUGALL TOWNSHIP

Mill Lake, Con. 2, Lot 18.

A band of pink, coarse-grained, tectonic marble breccia, about 25 metres, wide strikes northward across a small peninsula on the eastern side of Mill Lake. It contains about 30% metabasite inclusions up to one metre in length, and the calcite, which is slightly magnesian (see Table 4.1), has a pervasive bright pink colour, unlike the marble previously described in Croft Township, where the colouration was limited to the margins of mafic inclusions.

Con. 11, Lot 5.

A previously unmapped band of coarse grained dolomitic marble outcrops along a southwesterly trending bluff in McDougall Township (see figure 5.13). It is an off-white, coarse-grained rock, relatively free of disseminated minerals, but contains variable amounts of amphibolitic inclusions. An analysis of this marble is shown in Table 4.1.

MCKELLAR TOWNSHIP

JOHN McVITTIE (Concession 9, Lot 7, N 1/2)

The authors have not visited this property, which occurs in an area of complexly folded bands of marble which is on strike with the occurrence in Spence Township, Concession 5, Lot 33, described elsewhere in this report. The property is currently held by Mr. John McVittie of Bracebridge.

From December 1973 through February 1974, Burcal Mines Ltd. drilled 12 diamond drill holes for a total of 1841 feet (560m) on a broad outcrop of marble near Oliver Lake. Ten holes reached a depth of 150 feet (45m) entirely within marble. Inclusions of amphibolite were scattered through the marble, and constituted between 8 and 10 percent of the core. Significant reserves were estimated, a feasibility study was undertaken, and samples were collected, milled and analyzed. The results of these tests are presented in Appendix 4.

In 1978 John McVittie performed a programme of trenching in the area and in September 1979 an airborne magnetometer and radiometric survey was flown over the claims area. In 1980, the claims were optioned to Pominex Ltd. which drilled seven holes for a total of 759 feet (230m). In January 1984 some additional trenching was performed and in December of that year the claims were taken to lease.

SPENCE TOWNSHIP

Satterly (1943) lists six marble occurrences in Spence Township, but only one is of importance; that in Concession 14, Lot 18, and was exploited by Burcal Mines Ltd. in the early 1970s, which reportedly produced a ground calcite product suitable for use in the pharmaceutical, carpet and other filler industries. The authors visited and mapped the former Burcal pit, and visited another occurrence in Concession 5, Lot 33, owned by Mr. Gene Pawlech, which is along strike from the marble tested by Burcal Mines Ltd near Oliver Lake in McKellar Township.

BURCAL MINES LIMITED

In 1971-72, Burcal Mines Ltd. excavated a pit approximately 60m long, 10m wide and 7m deep in an impure marble tectonite unit (photo 4.8). The marble was trucked some 30km to their mill in Burk's Falls, where it was crushed, pulverized and bagged. Approximately 4,000 tons of finely ground calcite was shipped from the plant for use as a filler in rubber carpet backing material.

In 1974, Burcal recognized that the quality of the marble at Spence Township was not as high as it had first appeared, and that the specifications of their product needed to be improved if a viable operation was to be achieved. The marble occurrence in McKellar Township was investigated as an alternative source of supply for the Burk's Falls mill (see McKellar Township,

Photo 4.8: Photograph of the Burcall Pit, Con. 14, Lot 18, Spence Township.

this report). In addition, Burcal commissioned studies on the beneficiation of the marble. In 1975 Burcal Mines Ltd. went into receivership and its assets were eventually purchased by Mr. James Wade of James Wade Engineering Ltd. of Toronto.

GEOLOGY

The pit in Spence Township is now partially filled with water, but exposure is still sufficiently good that a fair impression of the geology of the marble unit can be obtained. Chart E shows the geology of the pit area.

The marble unit trends 020 and dips steeply to the west. Gneissosity is indicated by bands of different composition, and by trains of inclusions and disseminated silicate minerals. Isoclinal folds plunge to the south. The enclosing gneiss units are not exposed, but rusty amphibolite inclusions abound in the southwestern part of the stripped area, and may represent infolded rocks of the structural hanging wall. Apart from a line separating the area of rusty amphibolite from the rest of the marble, there are no readily identifiable map units within the marble.

As was done in the course of mapping the pit at Lorimer Lake (see Hagerman Township, this report), two main types of marble were mapped: a pure, coarse grained variety (Unit 1a), and an impure type with disseminated silicate minerals (unit 1b). The definitions of Units 1c and 1d used at the Lorimer Lake pit were refined using, an "Ix" subscript to identify the lithology of the larger inclusions.

The pit at Oranmore differs from that at Lorimer Lake in a number of ways. The marble is generally cleaner, whiter and coarser grained at Oranmore, the inclusions are smaller and more evenly dispersed throughout the body of marble, and the lithology of the inclusions is different.

A band of very coarse-grained (2-5 centimetres), white marble extends southward from the southern end of the pit, but it contains lozenge-shaped inclusions of white, augite-bearing granite which are commonly in the range of 0.1 - 1.0 metres in long dimension.

Non-carbonate minerals disseminated in the marble include quartz, scapolite, phlogopite, plagioclase, potassium feldspar, clinopyroxene, tremolite, magnetite, titanite, pyrite, apatite and graphite.

The predominant inclusion throughout the stripped area is a white, augite-bearing granite, with minor amphibolite, quartzite, diopsidic granite and biotite syenite inclusions.

The augite-bearing granite consists of potassium feldspar (25%), plagioclase (35%), quartz (20%), clinopyroxene (15%), calcite, hornblende, titanite, chlorite, and apatite.

On the eastern wall of the pit, several inclusions of meta-basite up to three or four metres high can be seen. They consist of hornblende (35%), clinopyroxene (20%), plagioclase (35%), titanite, calcite and magnetite, and minor apatite.

Analyses

Samples of marble were collected from dumps at the pit site and analyzed in the Geoscience Laboratories, Ontario Geological Survey, Toronto. In addition, samples of pulverized calcite overflow from Burcal's former mill site were collected and analyzed. The results are shown in table 4.1. A size fraction analysis of pulverized material recovered from Burcal's mill site is presented in Appendix 6. The reader should be aware that these samples are likely to be have been contaminated, and that the mill processed material from several different local sources. Nevertheless, the results are included here to give a rough indication of the type of product which has been produced in the past from tectonic marble breccias in the Parry Sound district.

Beneficiation Studies

In 1975 Consolidated Canadian Faraday Ltd. examined the marble property in Spence Township, drilled a single hole several hundred metres to the south of the pit, and evaluated means of upgrading the quality of the ground marble product. The results of analyses made by Lakefield Research of Canada Ltd. in 1975 of three marble samples collected from Burcal's pit in Spence Township by Consolidated Canadian Faraday Ltd. are summarized in Appendix 5.

GENE PAWLECH (Concession 5, Lot 33)

A brief visit was made to this large outcrop at the request of Mr. Pawlech. Like the deposits mapped at Lorimer Lake and Spence Township (Con. 14, Lot 18), the marble is a tectonic breccia consisting of coarse-grained calcite and blocks of garnet "amphibolite" up to 30 metres long, which amount to some 10% of the total rock volume. The calcite is an off-white, slightly translucent colour and contains less than 10% of silicate mineral impurities. The marble band is about 100m wide. There is some evidence of trenching, possibly related to lime burning in the past. An analysis of a representative sample of marble is given in Table 4.1.

COMPARISON OF MARBLE DEPOSITS

The following table summarises the mineralogy of the main marble units visited in 1986.

Table 4.2. Mineralogy of Parry Sound Marbles.

	Lorimer	Spence	Seguin	Oliver	Lount	Ferrie R.
Calcite	X	X	X	X	X	X
Dolomite			X			
Olivine	X		X			
Diopside	X	0	o	0		0
Serpentine	X		0			
Chondrodite	X		X			X
Clinohumite			o			
Spinel	X					
Cummingtonite	o		o			o
Tremolite		0				
Scapolite		X			0	
Garnet			o			X
Phlogopite	0	0	o	0		
Titanite	o	o		o	o	o
Quartz		X			0	
Plagioclase		0			0	
Orthoclase		0		o		
Apatite	o					
Graphite	o	o	o			
Magnetite	0	o		o	o	
Ilmenite			o			
Pyrite	0	o			o	
Pyrrhotite	o		o			

X=major, 0=minor (2% to 5%), o=accessory (up to 2%)

The difference in the number of mineral species noted at each location is partly a function of the number of thin sections studied. However, there appear to be more mineral species present in the marbles which are magnesian (Seguin River) or which contain a high proportion of ferro-magnesian inclusions (Lorimer Lake and Seguin River).

Satterly (1943, p.9) noted that, "Very little pure crystalline limestone occurs, and most of it is speckled with grains of silicate minerals. These are often arranged in lines or concentrated in zones or bands and indicate initial differences of composition between different laminae or beds of the limestone." In 1956 (p.14), he suggested that in Lount Township, "The rocks were originally interbedded crystalline limestone and gneiss." The results of the present, somewhat brief, study suggest that another mechanism may also have operated to produce the present complex marbles. The disseminated minerals in the marble at Oranmore and Lorimer Lake are essentially the same as the components of the lithic inclusions, or are the products of reaction between the marble and the inclusions. In both cases, the majority of the inclusions appear to be of intrusive origin: granitic at Oranmore and diabasic at Lorimer Lake. Thus it is unlikely that the original rock consisted of alternating beds of marble and intrusive rocks. It is more likely that the inclusions were either infolded and torn off from enclosing country rocks during tectonism or were intruded into the zone of weakness represented by the marble tectonite.

Distinct reaction rims around the mafic inclusions, seen at Lorimer Lake and Seguin River, indicate a progressive breakdown of the inclusion material. The disaggregated magnesian products (olivine, chondrodite, cummingtonite, etc.) would have been exposed to the current of the ductile marble flowing around them, to be swept away as trains of disseminated mineral grains within an otherwise clean carbonate rock. This is vaguely analogous to the generation of medial moraines entrained within confluent valley glaciers. Zones of intense microfracturing at the margins of the inclusions and within secondary minerals formed in the reaction rim provide testimony to the shear stresses present along the inclusion-marble boundary. The process is assisted by the continuing deformation of the unit as a whole, which brings about a reduction in the size of inclusions by means of bending, boudinage, and fracturing, and forcible intrusion of carbonate into inclusions, thus exposing a greater surface area for reaction. This is not to say that all impure marble bands are of metasomatic-syntectonic origin: the calcitic and dolomitic marble at Seguin River may well represent different primary compositions. More detailed studies, beyond the scope of this report, would be required to determine the nature of dolomitization/de-dolomitization reactions, and the extent to which the disseminated silicate minerals are the product of metamorphism of impure carbonates or are the products of reaction between the carbonate and its younger inclusions.

While the above interpretation is a very interesting possibility, and one which begs more detailed academic study, it also has some bearing on the economic evaluation of carbonate units in the Parry Sound Domain. Firstly it suggests that the carbonates might be pure, at least as they were originally deposited, and that good quality calcite or dolomite deposits may remain to be identified where tectonic and metamorphic processes have not contaminated them, or where there is a low density of inclusions and associated metasomatic disseminated minerals. Secondly, if inclusion-free deposits are not to be found, a quick appraisal of the types of inclusion present will indicate the likely disseminated minerals present (which, of course, can be confirmed by petrographic examination).

The effect which the variable mineralogy has upon beneficiation processes is not known. Future beneficiation studies should, at a first approximation, determine whether marble containing mafic or felsic inclusions (and hence, mafic or felsic disseminated minerals) can be better upgraded.

Potential Marble Applications

From the results available on the Burcal Mines operation it is apparent that a reasonably pure ground product can be produced by conventional methods (crushing, grinding, screening and air classification) from a less than ideal, impure marble source. This is largely attributable to the coarse grain size of the marble, which results in good separation of the deleterious silicate minerals from the softer calcite upon crushing and screening. These same properties: the presence of gneissic inclusions, disseminated silicate minerals and the coarse grain size of the calcite, mitigate against the marble's use as a construction material, as polished stone, rip-rap or coarse aggregate. The variable hardness hampers polishing, and the coarse grain size and well-developed rhombohedral cleavage would likely produce weak bonding between grains, resulting in plucking during polishing and subsequent spalling, and poor compressive and tensile strengths.

The most likely uses of the Parry Sound marbles are for cement production, in low- to medium-grade filler applications, as a neutralizing agent in mine tailings, agriculture and acid lakes, in flue gas desulphurization and poultry grit.

Future work will consist of further field evaluation, in order to determine the regional variation in composition, purity and volume of the marble units. In addition, research will be conducted into the processes applicable to the beneficiation of impure carbonates (such as wet grinding, flotation, heavy media separation, magnetic and electromagnetic methods) in order to assess whether such material can be realistically considered a potentially economic resource of calcite and/or dolomite.

5. PEGMATITES

Introduction

Almost one hundred pegmatite occurrences have been documented in the study area by Martin (1983). Although none is very large, several have been exploited on a small scale as sources of silica, feldspar, mica and uranium. Most of this work was done during the early part of the 20th century, but there was a resurgence of activity during the 1950s and 1970s for uranium and feldspar.

The objective of the current program is to obtain an overview of the geology of the pegmatite occurrences (which have hitherto been incompletely described in several unrelated studies), and evaluate their potential as sources of high purity silica, potash feldspar and rare elements including rare earth elements (REE). In 1986, fourteen pegmatite occurrences were visited and sampled. Where there was sufficient exposure, sketch maps of the former workings were made, or a small grid was constructed to facilitate systematic mapping. A scintillometer (McPhar TV1) was used to prospect the pits for radioactive minerals. The following sections describe the pegmatites seen in 1986.

PREVIOUS WORK

Pegmatites of the Parry Sound-Huntsville area have previously been described in publications by Ellsworth (1932), Satterly (1943, 1956), Hoadley (1960) and Hewitt (1967b). Friedman (1957) described the pegmatites in the vicinity of the Caribou Lake layered noritic and ultramafic intrusion. Boyd (1979) described radioactive pegmatites in Conger Township. Martin (1983) lists several dozen pegmatitic mica, silica and feldspar occurrences in the study area.

PRODUCTION HISTORY

Hewitt (1967b, p.21-22) lists the pegmatites which have acheived production in the Parry Sound District. The largest producers were the Brignall Mine in Conger Township, which produced over 9,000 tons of feldspar in the periods 1923-25 and 1948-49; and the Besner Mine in Henvey Township, which produced 2,500 tons of feldspar between 1926 and 1929. The part of Hewitt's table which relates to the production of feldspar in the present study area is reproduced as Table 5.1.

DISTRIBUTION

The locations of selected pegmatites within the study area are shown on Chart A (back pocket)1. The ones visited in 1986

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1 For the location of all pegmatites see Martin, 1983, under the headings of feldspar, quartz, mica etc.

County or District	Township	Location	Name of Mine	Operators	Years of Operation	Approximate Production	Reference	Descriptive Remarks
Parry Sound	Burton	Lot 37, Con. XIV		Magnetawan Feldspar Syndicate	1940-41, 1943	46 tons		
	Chapman	Lots 26, 21, Con. I	Macdonald	J. Bell	1948	2 cars		Graphic granite pegmatite.
		S½ Lot 13, Con. II		W. E. Brandt	1949	Prospect		Large graphic granite pegmatite.
		Lot 26, Con. II		Wheeling Feldspar Co.	1920-23	868 tons	Satterly 1942, p. 56	Granite pegmatite with biotite, used for stucco.
		Lot 18, Con. IV	Hungry Lake	T. B. Tough	1941	Prospect	Satterly 1942, p. 56	5 foot dike of microcline and quartz.
		Lot 10, Con. VIII			1942	Prospect		25 foot pegmatite dike with K spar, peristerite, quartz, muscovite.
	Christie	Lot 27, Con. VI		Industrial Minerals Corp.	1923-24	200 tons	Satterly 1942, p. 56	15 foot granite pegmatite with biotite.
	Conger	Lot 5, Con. VIII		Standard Feldspar and Silica Co.	1911-12	Prospect	Satterly 1942, p. 56	Small dike with pink microcline, quartz, biotite.
		Lot 4, Con. IX		Ojaipee Silica-Feldspar Ltd.	1910-12	3890 tons	Satterly 1942, p. 57	12 foot pegmatite dike with microcline, quartz, plagioclase, allanite, biotite.
		Lot 10, Con. IX	McQuire	McQuire & Robinson	1925	618 tons	Satterly 1942, p. 57	Pegmatite dike with uraninite, calciosarmarskite, thucolite, cyrtolite.
		N½ Lot 6, Con. X		Conger Feldspar Mining Co.	1945	1000 tons	{ Satterly 1942, p. 57 }	Pegmatite with euxenite, monazite, columbite.
		Lot 7, Con. X	Brignall	McQuire & Robinson	1923-25	4239 tons	{ Rose 1960, p. 22 }	
		Lot 8, Con. X		Conger Feldspar Mining Co.	1946	417 tons		
	Foley	Lot 10, Con. III				Prospect	Satterly 1942, p. 57	8 foot pegmatite dike of microcline, quartz, plagioclase.
	Harrison	Lots 38 & 39, Con. XIII		General Mica Mining Co.	1927	Prospect	Spence 1932, p. 55	Pink microcline, plagioclase, quartz, biotite, magnetite.
	Henvey	Lot 3, Con. A	Ambeau	Wanup Feldspar Mines Ltd.	1926-27	1000 tons	{ Satterly 1942, p. 58 / Rose 1960, p. 18, 19 }	Pegmatite carries euxenite.
		Lot 5, Con. B	Besner	Wanup Feldspar Mines Ltd.	1926-29	2500 tons	{ Satterly 1942, p. 58 / Rose 1960, p. 19 }	60 foot dike carries cyrtolite, beryl, thucolite, uraninite, allanite.
		Lots 5 & 6, Con. IV		D. H. Hooey	1929-30	Prospect	Spence 1932, p. 56	2 narrow dikes of impure pegmatitic granite.
	Lount	Lot 137, Con. B		T. R. Russell	1953	Prospect	Satterly 1955, p. 42	6 foot pegmatite dike carries microcline, quartz, biotite.
		Lot 3, Con. V		J. Bell	1941	Prospect	Satterly 1955, p. 41	20 foot pegmatite dike carrying muscovite.
	Machar	S½ Lot 30, Con. VI		T. B. Tough	1942	Prospect		Graphic granite pegmatite.
	McConkey	Lot 11, Con. II				Prospect	Satterly 1942, p. 58	30 foot pegmatite dike with microcline, quartz, plagioclase, muscovite.
		Lot 20, Con. V		General Mica Mining Co.	1919	Prospect	Satterly 1942, p. 58	Coarse granite pegmatite with muscovite.
		Lot 22, Con. V		J. W. Keenan	1940	Prospect	Satterly 1942, p. 59	100 foot pegmatite dike with quartz, microcline, plagioclase, biotite.
		Lot 17, Con. VI				Prospect	Satterly 1942, p. 59	3 pegmatite dikes with microcline, quartz, allanite, biotite.
	McDougall	Lot 5, Con. X			1926	Prospect	Satterly 1942, p. 59	3 pegmatite dikes with microcline, quartz, allanite, biotite.
		Lot 3, Con. XI				Prospect	Satterly 1942, p. 59	12 foot dike with pink microcline, quartz, rare biotite, garnet.
	McKellar	Lot 4, Con. VI		C. F. McQuire	1937-38	600 tons	Satterly 1942, p. 60	
	Nipissing	Lot 30, Con. X		Holden & Waltenbury	1941	Prospect	Satterly 1942, p. 60	Coarse granite pegmatite with microcline to 1 foot in size.
	Ryerson	Lot 18, Con. XIII		T. B. Tough	1941	190 tons	Satterly 1942, p. 61	Zoned granite pegmatite with microcline, quartz, plagioclase, muscovite.
	Strong	Lot 19, Con. I		T. B. Tough	1942	Prospect		10 foot granite pegmatite.
		Lot 19, Con. III		T. B. Tough	1942	Prospect		5 foot granite pegmatite with microcline, amazonite, quartz.

Table 5.1 Main Feldspar-Bearing Pegmatites, Parry Sound District, Ontario (from Hewitt, 1967b).

and described in this report are labelled. There is no obvious regional zonation of the pegmatites or spatial relationship with plutons or the major geological elements. Four clusters of pegmatite occur: in Conger Township in the Moon River Subdomain (see chapter 2), Ferguson-McDougall Townships in the Parry Sound Domain, and in McConkey Township and Henvey Township in the Britt Domain.

DESCRIPTIONS OF PEGMATITE OCCURRENCES

CONGER TOWNSHIP

Nickel Rim Mines Ltd., Con. 3, Lots 10-12.

Figure 5.1 shows the location of this prospect, which is five kilometers west of Highway 612, on the road from Mactier to Blackstone Harbour. The radioactive occurrences were first staked in January, 1974. An airborne radiometric survey performed in 1975 revealed areas of anomalous radioactivity, which were confirmed by follow-up ground radiometric surveys. Geological and geophysical surveys, and trenching in 1975 were followed by diamond drilling in 1976. The best assay obtained was 0.12% $U3O8$ over a core length of 0.5 feet (Assessment files, Resident Geologist's Office, MNDM, Dorset).

The prospect was visited in the summer of 1986. Four of the radiometric anomalies detected by Nickel Rim Mines Ltd were located, sampled and are presently being analyzed for uranium and rare earth elements.

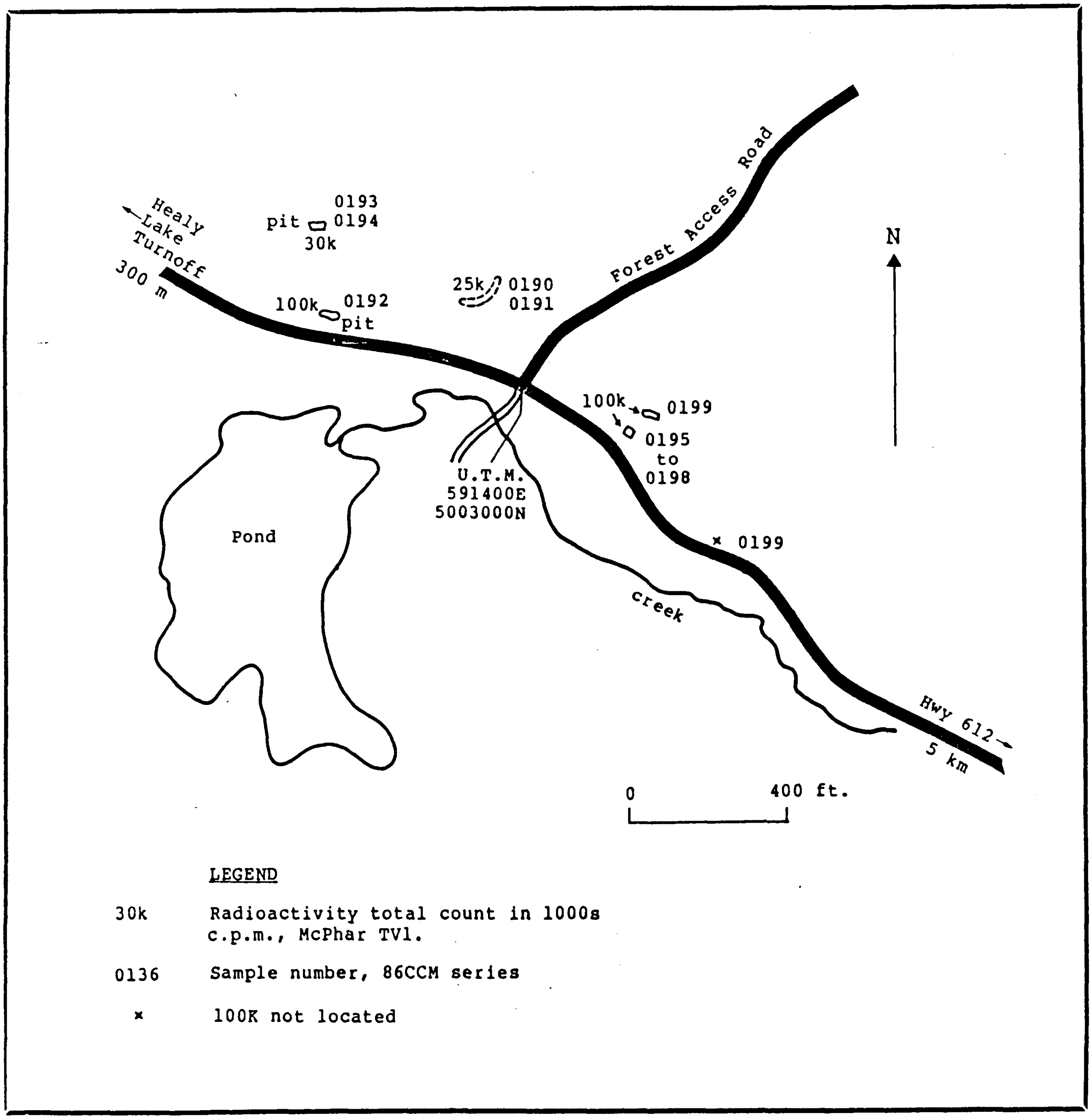


Figure 5.1: Location plan and sample location sketch, Nickel Rim Prospect, Con. 3, Lots 10, 11, and 12, Conger Township.

Anomalous radioactivity at sample sites 0192, 0193 and 0194 (Figure 5.1) is associated with banded and migmatitic, pink and black gneisses, but at the other sites is located within irregular pegmatitic bodies. In the former case, the migmatitic leucosome consists of potassium feldspar, smoky quartz, plagioclase and minor biotite and pyrite. The melanosome is mainly hornblende, with biotite developed adjacent to the leucosome. The rock is ptygmatically folded (figure 5.2). Diamond drill hole No. NR77-2, which was drilled below this anomaly, intersected amphibolite, granite gneiss and aplite dikes, and a 0.15 metre wide radioactive pegmatitic dikelet which assayed 0.12% U3O8. The dikelet contains pyrrhotite, chalcopyrite, molybdenite and biotite.

Sixty metres west of the forest access road, a band of pegmatite rubble exhibits anomalous radioactivity of up to 25,000 cpm. The pegmatite consists of pink potassium feldspar, white plagioclase, biotite and smoky quartz. No radioactive minerals were identified (samples have been submitted for analyses but no results were available at the time of writing).

In a pegmatite body 100 metres east of the forest access road, cubes of uraninite occur in the marginal parts of large potassium feldspar crystals adjacent to books of biotite. The pegmatite is about one metre thick and can be traced for about 50 metres along the side of the ridge overlooking the main road. It appears to dip moderately northward within the enclosing hornblende-biotite gneiss. The feldspar crystals

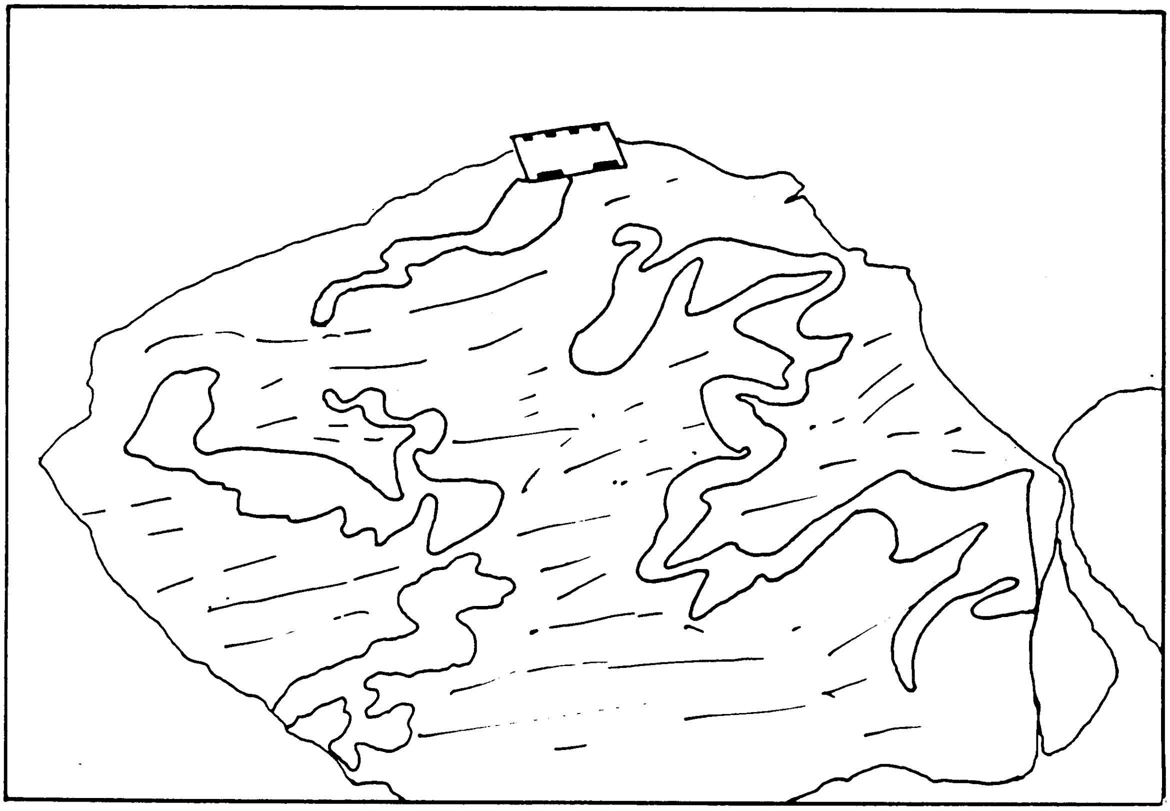


Figure 5.2: Sketch from a photograph showing ptygmatically folded leucosome (outlined) in migmatic gneiss. Nickel Rim Prospect, Con. 3, Lots 10, 11, 12, Conger Township.

range up to 30 cm across, and the biotite up to 20 cm in diameter. Smoky to clear quartz is abundant. Analyses of the uraninite-rich material, potassium feldspar and quartz are shown in Tables 5.2, 5.3 and 5.4. Some 20 to 30 metres uphill to the northeast, a larger, irregularly shaped granitic pegmatite is exposed within contorted migmatitic gneisses. Isolated spots of anomalous radioactivity occur within the pegmatite, but no radioactive mineral species were recognized.

Brignall Mine (McGuire-Robinson) Con. 10, Lot 7.

The Brignall Mine is the largest pegmatite body visited during 1986. Martin (1983) reports that about 4,240 tons of feldspar were produced between 1923 and 1925, and a further 5,188 tons were produced in 1948 and 1949. Minor columbite-tantalite and uraninite have also been noted (Ellsworth, 1932, p.187). Figure 5.3 shows the location of the pit, and figure 5.4 is a geological sketch of the pit area. The pit is approximately 30 m long, 23 m wide and 20 m deep, and is partly filled with water.

Most of the country rock is massive to weakly foliated granite, but on the southern edge of the pit a raft of amphibolite overlies the pegmatite. On the western side of the pit the contact between the pegmatite and the granite is exposed over a short distance only, but the contact is sharp and dips steeply to the east. On the eastern side, of the pit

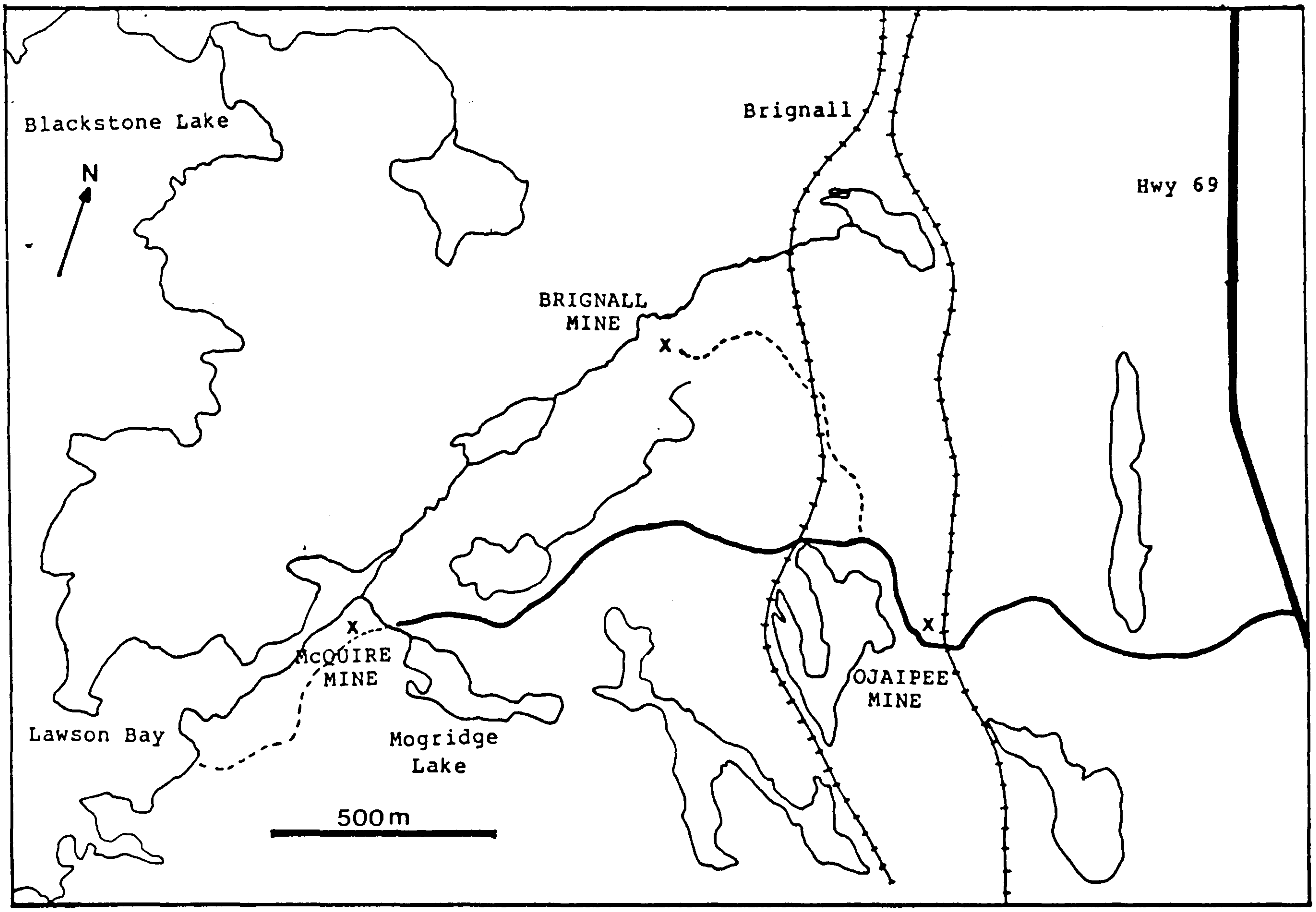


Figure 5.3: Location plan of the McGuire, Brignall and Ojaipee mines, Conger Township.

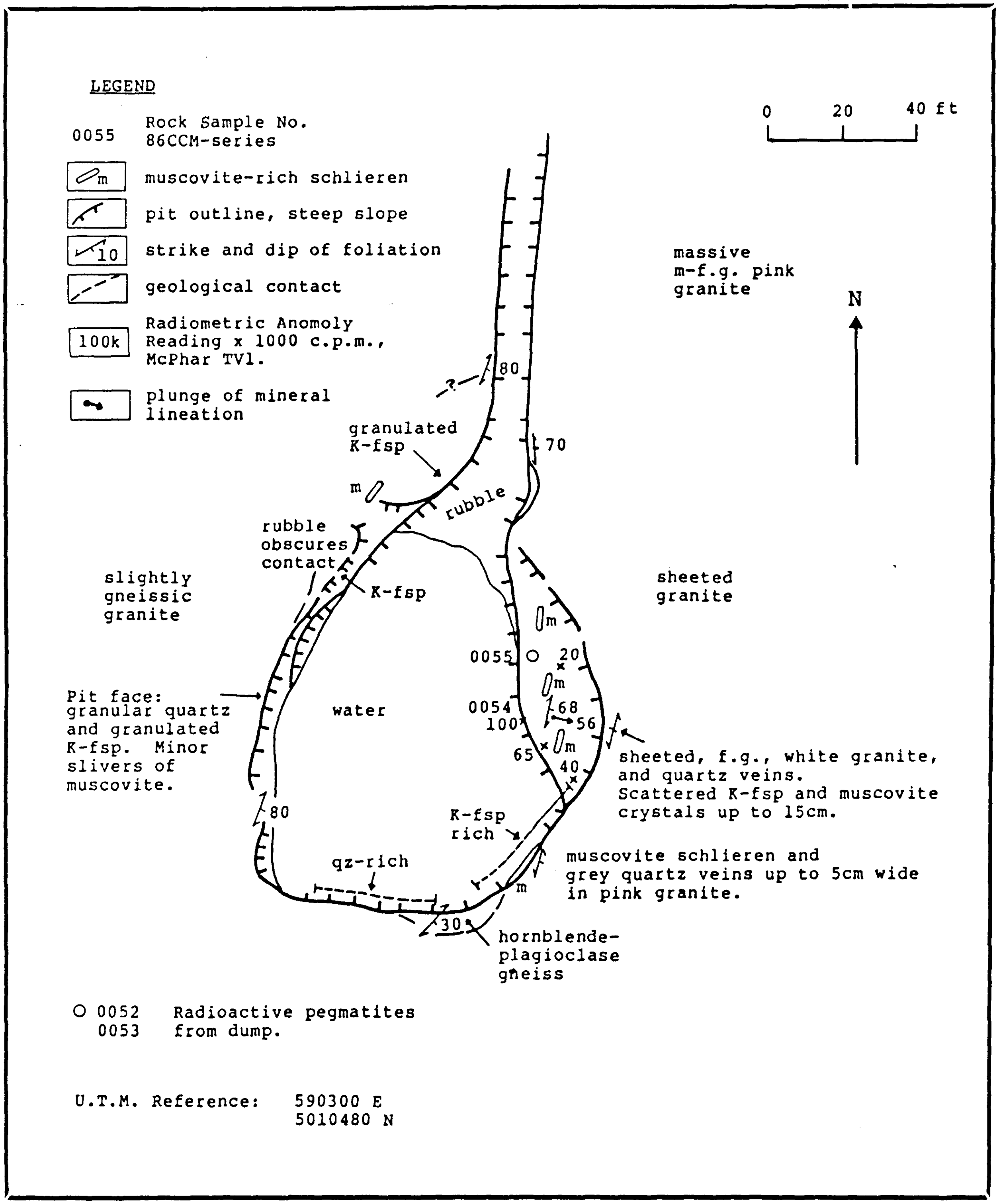


Figure 5.4: Geological sketch map of the Brignall Mine, Con. 10, Lot 7, Conger Township.

Table 5.2: Chemical Analyses, Quartz and Allanite in Pegmatite Deposits, Parry Sound Area.

Sample No.	SiO2	Al2o3	Fe2o3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	CO2	S	LOI	Total
Quartz:														
86CCM-0057	98.00	0.95	0.19	0.18	0.07	0	0.02	0.05	0.01	0.01	0.18	0.01	0.10	99.60
86CCM-0144	97.90	0.90	0.11	0.19	0.06	0.09	0.01	0.03	0.02	0.01	0.05	0.01	0.20	99.50
86CCM-0152	97.20	1.19	0.11	0.24	0.04	0.04	0.02	0.01	0	0.01	0.09	0.01	0.10	99.00
Allanite:														
86CCM-0135	39.60	23.30	11.70	0.46	22.00	0	0.05	0.15	0.01	0.13	0.67	0.01	2.30	99.70

Analyses by XRF, Ontario Geological Survey, Geoscience Laboratories, Toronto.

86CCM-0057 Quartz, Brignall Mine, Conger Tp., Con. 10, Lot 7.
86CCM-0144 Quartz, Oak Ridge Mine, McDougall Tp., Con. 12, Lot 8.
86CCM-0152 Quartz, McDougall Tp., Con. 12, Lot 12.
86CCM-0135 Allanite, McDougall Tp., Con. 11, Lot 3.

Table 5.3: Chemical Analyses, Feldspar in Pegmatite Deposits, Parry Sound Area.

Sample No.	SiO2	Al2o3	Fe2o3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	CO2	S	LOI	Total
86CCM-0056	63.40	19.50	0.35	0.26	0.24	2.16	11.90	0.06	0.03	0.01	0.35	0.01	0.30	98.20
86CCM-0130	63.90	19.80	0.19	0.26	0.13	1.73	13.00	0.01	0.01	0.01	0.15	0	0.10	99.10
86CCM-0134	64.20	19.80	0.19	0.12	0.14	1.78	12.90	0	0.01	0.01	0.10	0.01	0.20	99.30
86CCM-0141	64.20	19.20	0.17	0.32	0.18	2.18	12.60	0	0.01	0.01	0.15	0	0.20	99.10
86CCM-0149	64.50	19.70	0.12	0.12	0.10	1.54	13.00	0	0.02	0.01	0.10	0.01	0.10	99.20
86CCM-0136	62.80	22.20	0.43	0.41	4.01	8.07	1.01	0	0.03	0.01	0.17	0.01	0.40	99.40
86CCM-0142	63.30	22.00	0.21	0.20	3.30	9.05	0.73	0	0.01	0.01	0.16	0.01	0.30	99.10
86CCM-0143	63.70	22.20	0.29	0.29	2.62	9.20	0.88	0	0	0	0.15	0.01	0.60	99.80
86CCM-0147	65.60	21.30	0.22	0.39	2.39	8.96	0.86	0.02	0.01	0.01	0.08	0.01	0.30	100.00
86CCM-0153	59.50	24.50	0.31	0.27	5.53	7.90	0.93	0.03	0.01	0.01	0.24	0.01	0.50	99.50

Analyses by XRF, Ontario Geological Survey, Geoscience Laboratories, Toronto.

K-Feldspar:

86CCM-0056 Brignall Mine, Conger Tp., Con. 10, Lot 7.
86CCM-0130) West pit, McDougall Tp., Con. 11, Lot 3.
86CCM-0134) "
86CCM-0141 Oak Ridge Mine, McDougall Tp., Con 12, Lot 8.
86CCM-0149 Main pit, McDougall Tp., Con. 12, Lot 12.

Plagioclase:

86CCM-0136 East pit, McDougall Tp., Con. 11, Lot 3.
86CCM-0142) Oak Ridge Mine, McDougall Tp., Con. 12, Lot 8.
86CCM-0143) "
86CCM-0147 South pit, McDougall Tp., Con. 12, Lot 12.
86CCM-0153 Main pit, McDougall Tp., Con.12, Lot 12.

Table 5.4: Chemical Analyses, Rare Earth Elements in Pegmatite Deposits, Parry Sound Area.

	... Light		Rare	Earths ...		
Sample No.	La ppm	Ce ppm	Pr ppm	Nd ppm	Sm ppm	Eu ppm
86CCM-0020	16.00	35.00	4.50	16.00	3.60	0.65
86CCM-0023	180.00	390.00	53.00	200.00	54.00	8.70
86CCM-0030	1.80	4.70	0.80	3.90	3.80	0.25
86CCM-0133	8.10	12.00	0.97	3.30	0.50	2.00
86CCM-0135	2.60	6.00	0.80	3.80	1.40	0.91
86CCM-0331	230.00	470.00	57.00	185.00	31.00	6.00
86CCM-0342	45.00	105.00	15.00	57.00	16.00	2.80

	. . . . Heavy			Rare		Earths		
	Gd ppm	Tb ppm	Dy ppm	Ho ppm	Er ppm	Tm ppm	Yb ppm	Lu ppm
86CCM-0020	4.00	0.71	4.40	1.10	3.50	0.50	3.30	0.50
86CCM-0023	56.00	0.01	57.00	14.00	43.00	7.00	52.00	8.80
86CCM-0030	7.30	2.20	14.00	3.00	10.00	2.40	23.00	4.10
86CCM-0133	0.45	0.06	0.38	0.06	0.21	<0.05	0.18	<0.05
86CCM-0135	2.50	0.58	4.40	1.10	3.80	0.70	5.50	0.98
86CCM-0331	21.00	3.10	16.00	2.90	7.00	0.90	5.10	0.60
86CCM-0342	16.00	4.00	38.00	17.00	80.00	18.00	170.00	35.00

	Y ppm	Sc ppm	U ppm	Th ppm
86CCM-0020	30.00			
86CCM-0023	350.00			
86CCM-0030	69.00			
86CCM-0133	1.80	<1.00	1.00	10.00
86CCM-0135	29.00	16.00	23.00	<10.00
86CCM-0331	68.00			
86CCM-0342	535.00			

Analyses by ICP/MS, Ontario Geological Survey, Geoscience Laboratories, Toronto.

86CCM-0020	Quartz-K fsp- biotite-plagioclase migmatite, minor pyrite. (80,000 cpm McPhar TV1), Conger Tp., Con. 9, Lot 4.
86CCM-0023	K fsp-biotite-quartz gneiss; Conger Tp., Con 9, Lot 4.
86CCM-0030	K fsp-quartz-biotite-muscovite pegmatite; (80,000 cpm, McPhar TV1), Conger Tp., Con. 9, Lot 10.
86CCM-0133	Composite quartz-perthite pegmatite, McDougall Tp., Con. 11, Lot 5.
86CCM-0135	Allanite, east vein, McDougall Tp., Con. 11, Lot 5.
86CCM-0331	Plagioclase-quartz-garnet-magnetite-?allanite pegmatite Con. A, Lot 129, Lount Tp.
86CCM-0342	K fsp-quartz-plagioclase pegmatite, rich in garnet, biotite and muscovite; 10,000 cpm, McPhar TV1; Con. 3, Lot 10, Lount Tp.

there is a gradual change from massive granite to pegmatite over a width of ten metres or so, as scattered crystals of feldspar appear, increasing in size and abundance westwards, through a zone of sheeted quartz dikes and granite, into sheared pegmatite with scattered inclusions of granite (figure 5.5). In the northwestern part of the pit, large potassium feldspar masses are composed of granulated feldspar within which remnants of fresh crystalline feldspar up to 20 cm in diameter can be seen, further indicating the deformation to which the pegmatite has been subjected after its emplacement.

The pegmatite consists mainly of pink potassium feldspar and white quartz, but towards the margins of the vein, especially on the eastern side, are series of muscovite-rich pods, some of which contain local spots of high radioactivity. Allanite was recognized in one pod, and Ellsworth (1932, p.187) reported the presence of columbite-tantalite, and Lang et al. (1962, p.257) reported euxenite and monazite. The results of analyses of radioactive material, and of quartz and feldspar, are pending.

Red garnets up to 10 mm in diameter are locally abundant in feldspar and quartz in the eastern edge of the pegmatite.

Ojaipee Silica Felspar Company, Con. 9, Lot 4.

Figure 5.3 shows the location of this pegmatite body, and figure 5.6 is a geological sketch of the pit area. Martin (1983) reports that about 1500 tons of quartz and 100 tons of

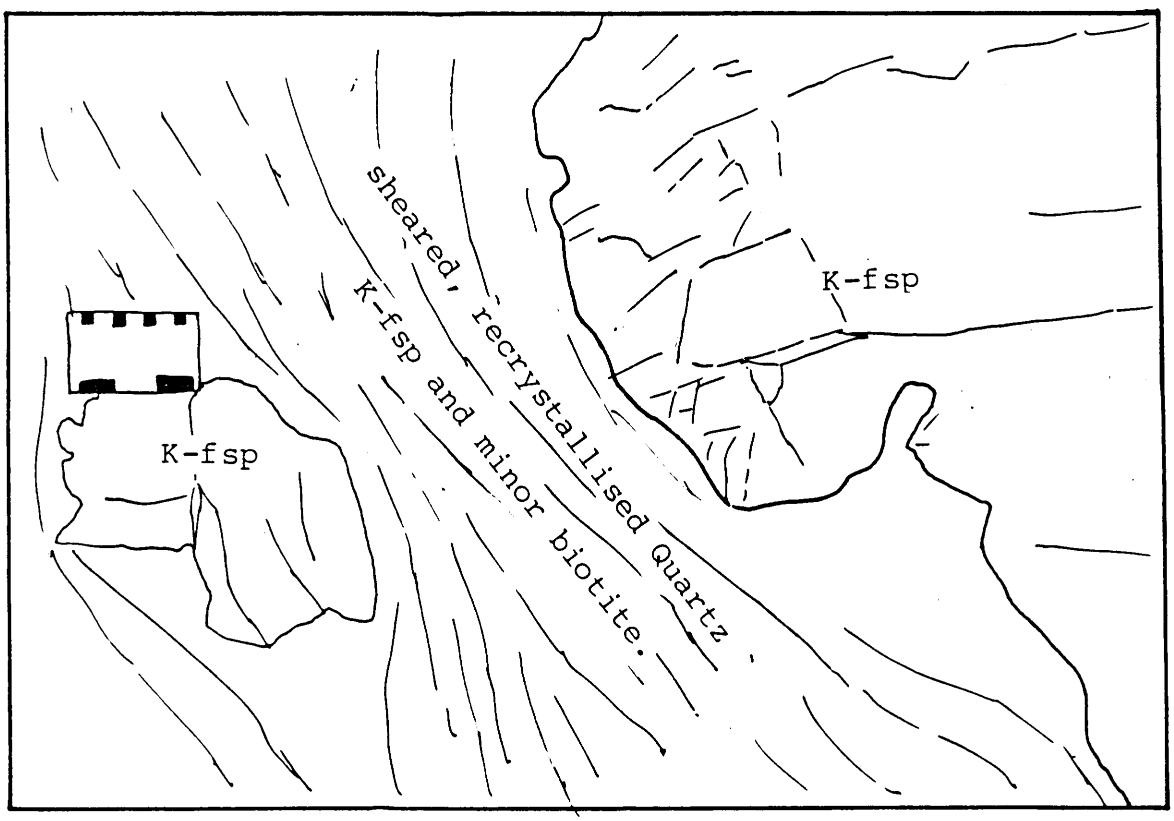


Figure 5.5: Sketch from a photograph showing the sheared marginal phase of the pegmatite at Brignall Mine. Note the presence of remnant large crystals of feldspar (K-fsp) within the sheared rocks.

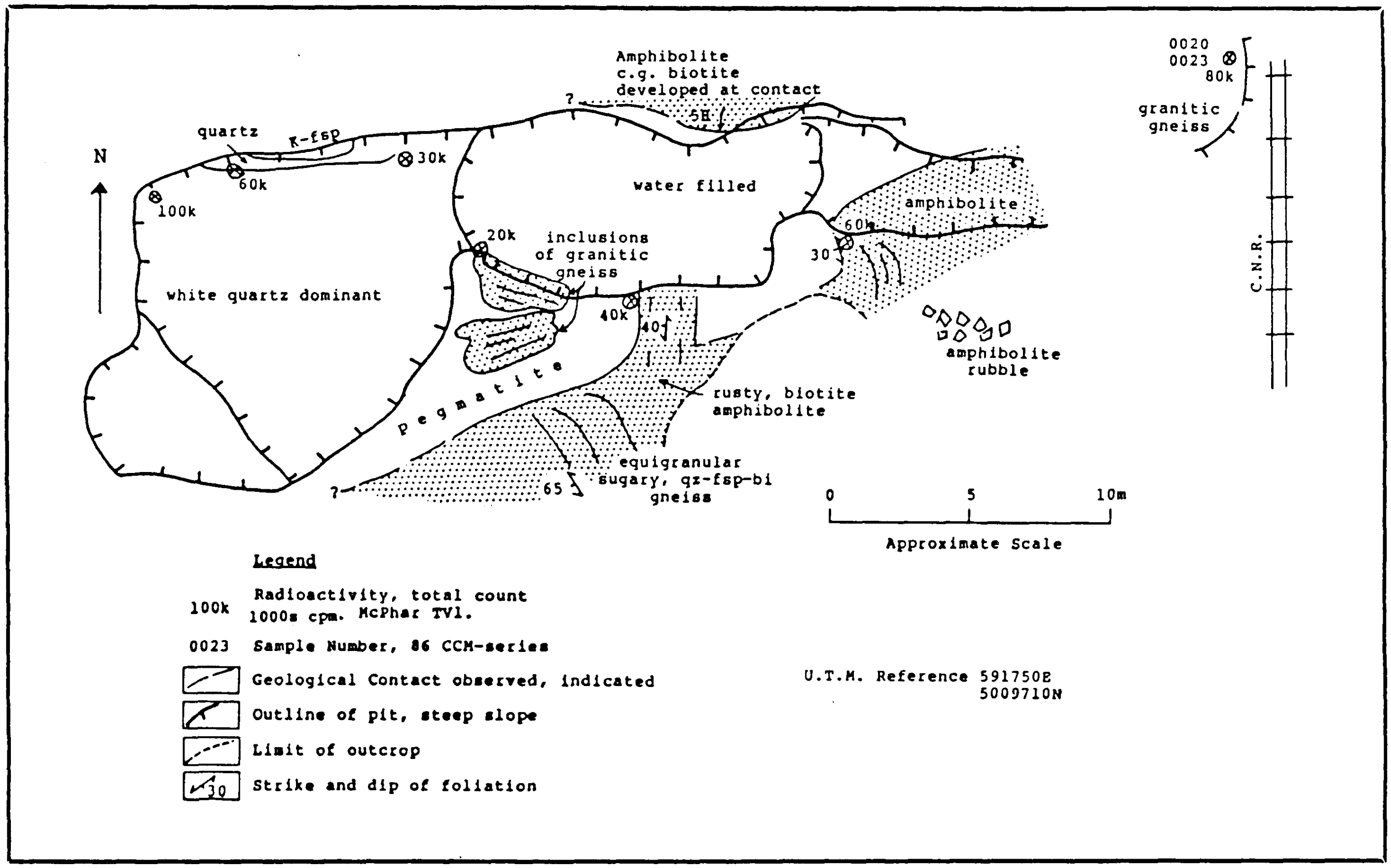


Figure 5.6: Geological sketch map of the Ojaipee Mine, Con. 9, Lot 4, Conger Township.

feldspar were extracted in 1910-1912. The property appears to have been active again in 1927 and 1928 (ODM Ann. Repts., Vols 37 and 38) and Hewitt (1967b) reports the total amount of material shipped as 3890 tons. Ellsworth (1932, p.187) noted the occurrence of slightly radioactive, altered allanite crystals.

The pit is about 30 metres long, from five to twelve metres wide, and up to five metres deep. The pegmatite strikes east - west and narrows eastward, dips moderately to steeply northward, and appears to rake northeastward. The pegmatite could not be traced further to the west. The country rocks are granitic gneiss and hornblende - biotite gneiss, some of which is included within the pegmatite. Biotite is abundant in the amphibolite at its contact with the pegmatite. Gabbro outcrops a few metres to the northwest of the pit, and narrow ultramafic layers occur within the granitic gneisses on the eastern side of the railway line a few metres east of the pit.

The pegmatite is composed predominantly of white quartz, with lesser pink potassium feldspar, minor plagioclase and biotite, and rare spots of radioactive minerals. On the western end of the north face of the pit, a potassium feldspar crystal 2.5 metres long in contact with a large mass of white quartz is visible. There is no clear pattern of zonation, except for the occurrence of biotite near the contact of the pegmatite with the enclosing gneiss.

Anomalous radioactivity was limited to isolated spots of less than 30 centimetres square in the pit (see figure 5.6). They are associated with fractures, smoky quartz and biotite, notably at the contact of the pegmatite and on the edges of inclusions. Local spots of radioactivity were also noted in the orange to pink granitic gneisses beside the CNR tracks. The anomalous areas are associated with pyrite in biotite-rich phases of the potassium feldspar-plagioclase-quartz-biotite gneiss. The results of analyses of grab samples of this radioactive material are presented in Table 5.4.

McQuire Mine; Con 9, Lots 9 & 10.

The location of this pegmatite occurrence is shown on figure 5.3, and figure 5.7 is a sketch of the outcropping dike. The property is reported to have produced 618 tons of feldspar in 1925 (Hewitt, 1967b), and to have been worked for radioactive minerals in 1922 (Satterly, 1942). Ellsworth (1932) describes uraninite, thucolite, calciosamarskite, cyrtolite and allanite from this occurrence.

The dike strikes east-northeasterly and appears to be sub - vertical. It is exposed for about 30 metres and is approximately ten metres wide. The dike could not be traced further to the southwest, but to the northeast a pink equigranular granitic rock is encountered which contains megacrysts of potassium feldspar. This association was noted by Ellsworth (1932) who referred to them as "augen pegmatites".

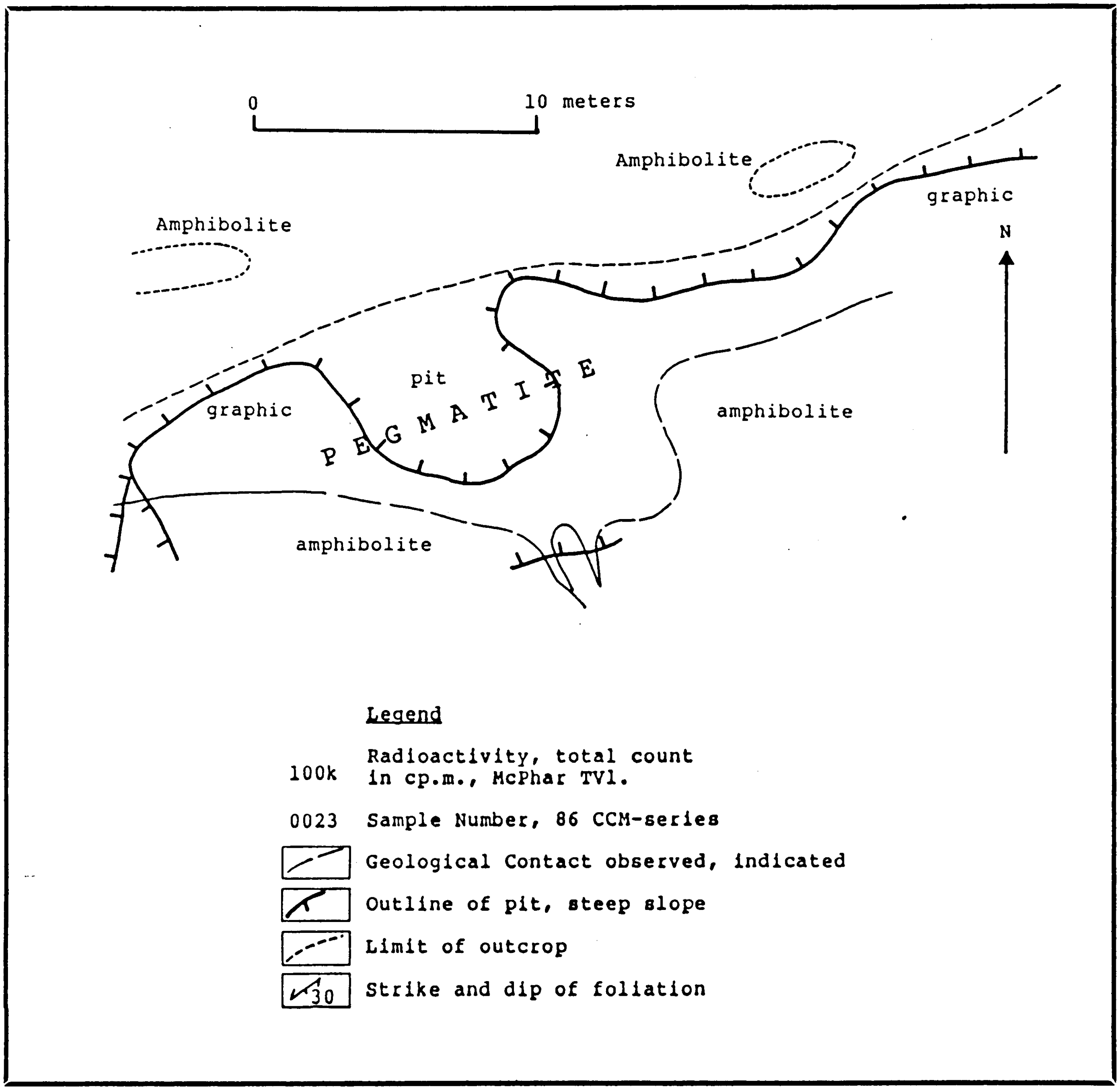


Figure 5.7: Geological sketch map of the McGuire Mine, Con. 9, Lot 10, Conger Township.

The material visible in 1986 was mainly white quartz, pink potassium feldspar crystals up to two metres in diameter, and graphic intergrowths of these two minerals, within a country rock of black hornblende gneiss.

Very local spots of radioactivity were noted, associated with smoky quartz and biotite in fractures and at contacts between large quartz and feldspar crystals.

The results of an analysis of radioactive, mica - rich material is shown on Table 5.4.

FERGUSON TOWNSHIP

McNeil Mine, Con. 1, Lot 11.

This white mica occurrence was explored in 1895-96. It could not be located in 1986.

Con. 1, Lot 13.

This occurrence appears to be simply a small prospect pit sunk on a pegmatite dike, reportedly some ten feet (three metres) wide (Satterly, 1943). It is currently poorly exposed in the front garden of Alex Harvey of Waubamik, and consists of quartz, white ribbon perthite, muscovite, garnet and (?) allanite. The location of this site is shown on Figure 5.8 and the results of an analysis of a composite sample of the pegmatite are pending.

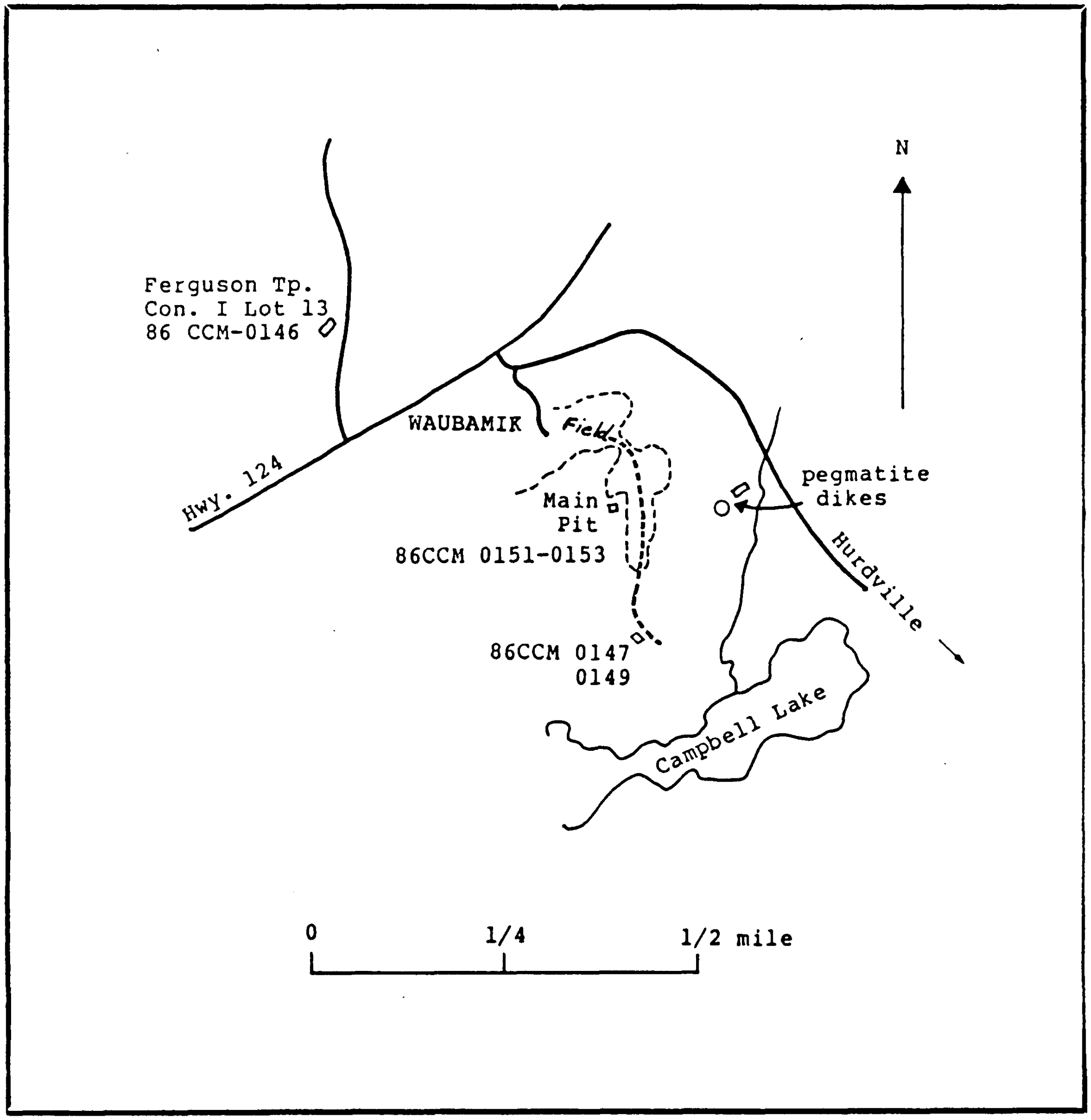


Figure 5.8: Location plan of pegmatites located in Con. 12, Lot 12 , McDougal Township and Con. 1, Lot 13, Ferguson Township. (Map traced from 1"=1/4 mile air photograph 77-4519, 46-29).

LAURIER TOWNSHIP

Comet Quartz, Con. 13, Lot 28.

A small quartz-rich pegmatite is exposed on the eastern side of a ridge, some 600 metres northwest of the forest access road (inset-figure 5.9). A small, but undetermined amount of quartz has been removed. The pit is partially flooded and filled with debris; trees growing in the bottom of the pit indicate it has been inactive for some time.

The pegmatite dike is approximately 8 metres wide and is exposed in a shallow pit and stripping which extends for about 30 metres. The dike strikes at 040 and dips about 55 to the northwest. The contact with the enclosing biotite-hornblende gneiss is exposed on the footwall; the hanging wall contact is not visible.

The pegmatite dike is crudely zoned from plagioclase +/- biotite at the margin to pure milky white quartz at the core (see figure 5.9). Magnetite and a small amount of pyrite were observed in material from the dump adjacent to the workings.

Two very shallow test pits have been made to the south of the main pit, apparently in an attempt to test the strike length of the dike. Neither of the pits appears to have encountered the dike.

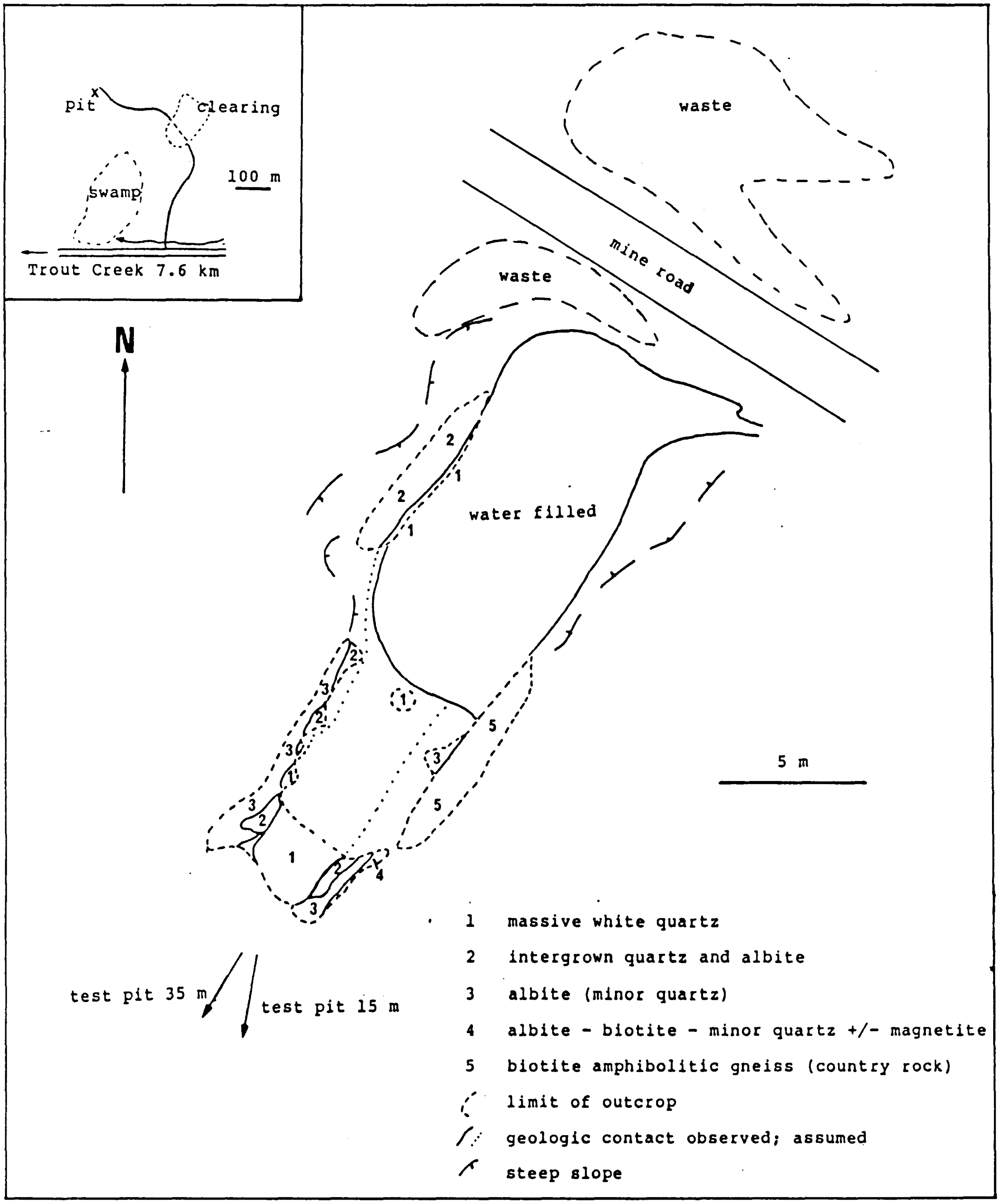


Figure 5.9: Geological sketch map and location plan (inset) of the Comet Quartz pegmatite, Con. 13, Lot 28, Laurier Township.

LOUNT TOWNSHIP

Two small pegmatite occurrences were visited in Lount Township; in Concession 5, Lot 3, and Concession 3, Lot 10. Both have been well described by Satterly (1955, p.41-42), and their location accurately shown on his map. The present exposure is such that no significant observations can be added to his.

A third pegmatite was observed at the site of a garnet occurrence in Con. A, Lot 129. It is composed of quartz, plagioclase, garnet, magnetite and, possibly, allanite. Samples of radioactive material were collected from all three pits and were analyzed for their REE content. The results are shown on table 5.4.

The site of a fourth pegmatite, also described by Satterly (1955, p.42), was not located with certainty. At the supposed site, in Concession B, Lot 137, there is evidence of some minor previous work, but no pegmatite was seen. A rusty, decomposed gneiss was visible within a country rock assemblage of granite gneiss, hornblende-plagioclase gneiss and marble. A mass of actinolite with chlorite and talc, several metres long, occurs in contact with the marble. Several minor pegmatite bodies occur to the northwest of this pit in Con B, Lot 138.

MCDOUGALL TOWNSHIP

Oak Ridge Mine, Con 12, Lot 8.

The Oak Ridge Mine's location is shown on Figure 5.10.

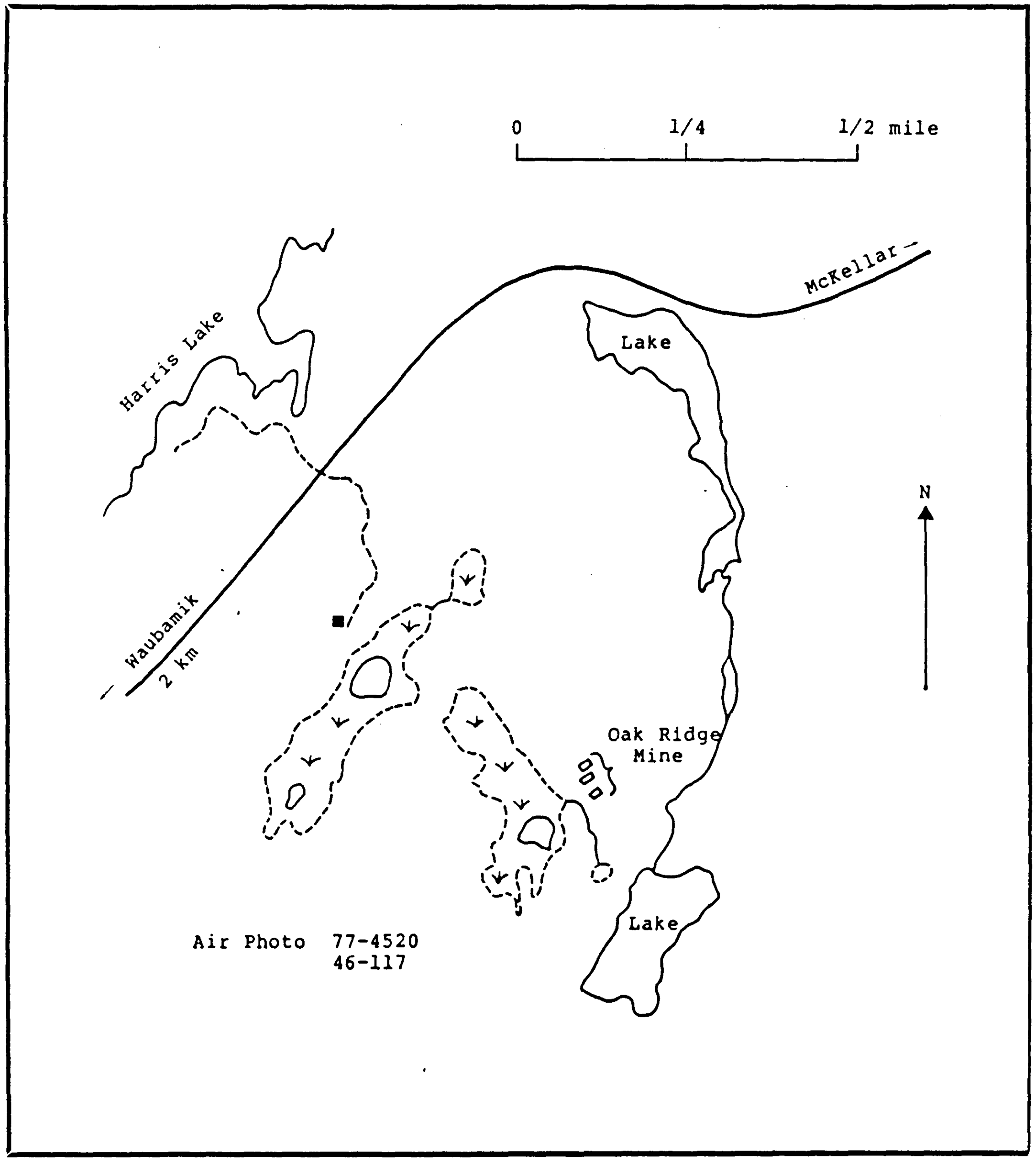


Figure 5.10: Location plan of the Oak Ridge Mica Mine, Con. 12, Lot 8, McDougall Township. (Map traced from 1"=1/4 mile air photograph, No. 77-4520, 46-118).

Satterly (1943) has described the property, which was mined in 1894. The occurrence comprises three parallel veins striking 030, and arranged en echelon from northwest to southeast. The main working is on the central vein, and consists of an open cut some 13 metres long, 3 metres deep and 2 metres wide.

The country rock is a black hornblende gneiss, from which the dike breaks cleanly. The pegmatite has a core of white quartz which is flanked by pink to greyish green plagioclase. Books of biotite up to 15 cm in diameter are scattered through the outer parts of the feldspathic zones (see figure 5.11, B). The quartz core appears to have been slightly boudinaged, and biotite is concentrated at this point.

Some 50 metres to the southeast of the main pit another pegmatite dike is exposed at the bottom of a small cliff. It displays the same zoning pattern as the main dike, but also contains an inclusion of amphibolite. It is almost 4 metres wide at the cliff face, but appears to narrow northward.

The western vein is exposed over a length of approximately 15 metres along the edge of the amphibolite outcrop, and appears to be less than two metres wide. It consists of a graphic intergrowth of potash feldspar and quartz, some potash feldspar megacrysts and scattered books of biotite.

Samples of quartz, plagioclase and biotite were analyzed; the results are shown in tables 5.2, 5.3, and 5.4. No anomalous radioactivity was detected.

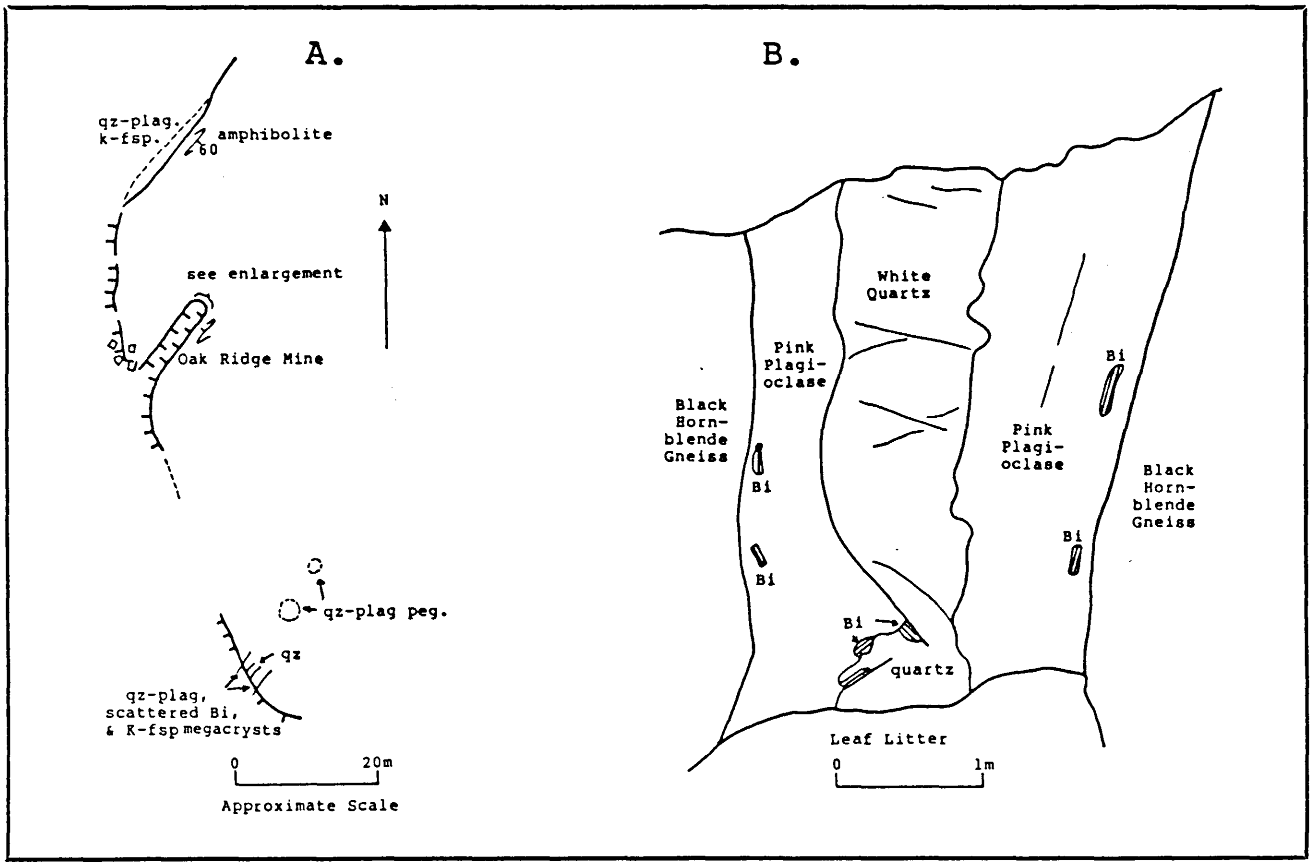


Figure 5.11: Oak Ridge Mine. (A) Sketch of the Oak Ridge Mine area. (B) Sketch from a photograph showing the headwall of the Oak Ridge Mine. Bi=biotite, qz=quartz, plag=plagioclase, K-fsp= potash feldspar.

Ascot Metals Corp. Ltd; Con. A, Lots 12 and 15.

These occurrences have been documented previously in SMDR 1081 (Source Mineral Deposit Record, MNR, Dept. Mines) and by Hewitt (1967a).

In the mid-1950s Trio Uranium Mines Ltd. performed an exploration program of geological and geophysical mapping, test pitting and drilled 23 diamond drill holes.

The best exposed bodies are in Con A, Lot 12, where they form three prominant ridges separated by flat open fields (Figure 5.12). The western-most body is the largest. It is a cataclastically deformed leucogranite, exposed over a length of 130 metres and a width of 15 - 20 metres. Remnant potassium feldspar crystals up to 50 cm in diameter occur within a mass of broken plagioclase, quartz and minor biotite. In a small trench on the southern side of the body the marginal part of the pegmatite has developed a foliation, with remnant feldspar reduced to augen and enveloped by quartz, which also penetrates along the cleavages of feldspar crystals. Radioactivity is generally low but one point source of five times background was noted (background = 3,000 to 4,000 cpm).

The middle pegmatite vein is located 30-40 metres east of the western body. It is 60 metres long and is up to 6 metres thick. For the most part it resembles the western body, but at its eastern end, an area of a square metre exhibits radioactivity of over ten times background (60,000 cpm) occurs in an iron-stained granitic pegmatite. Biotite is more

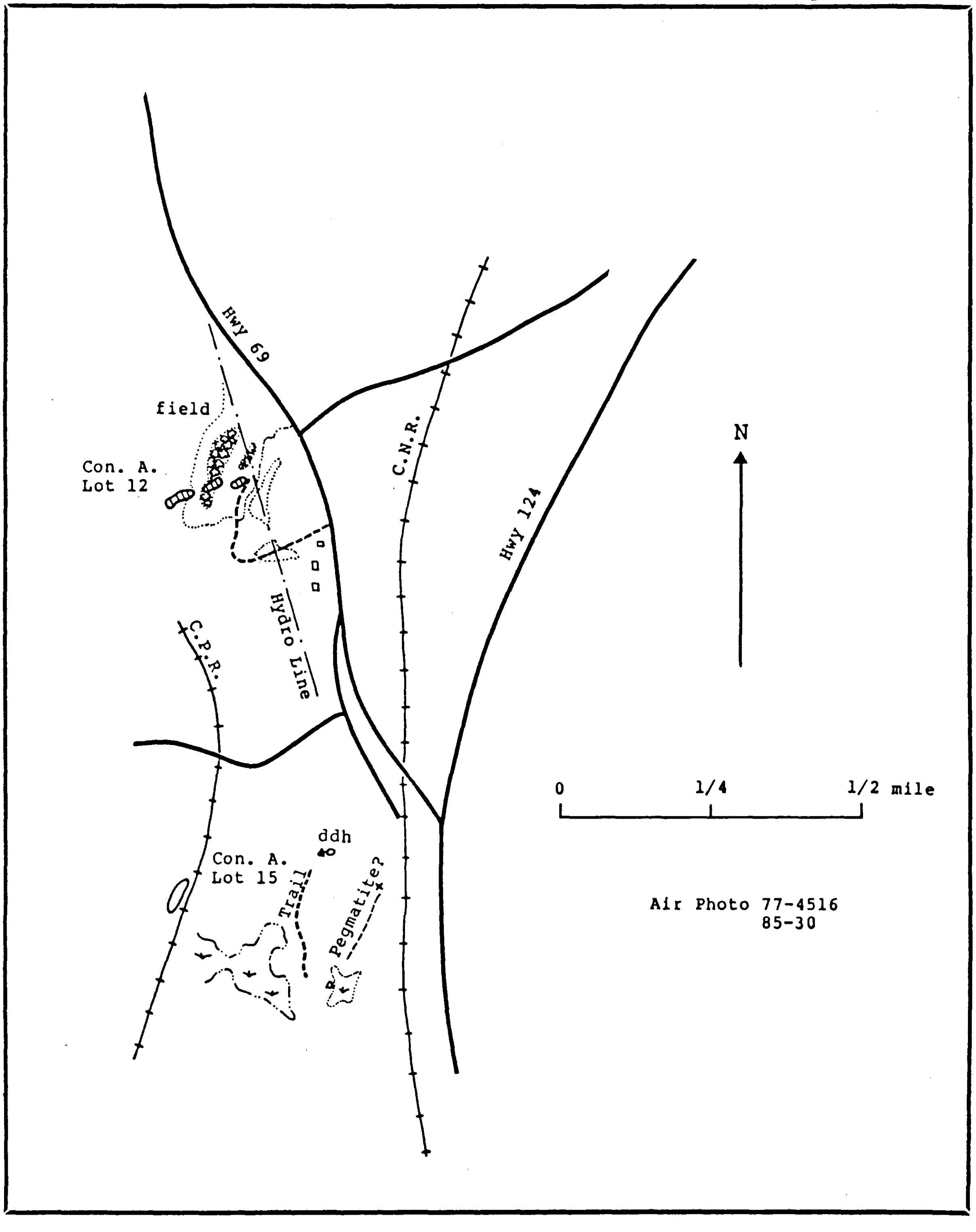


Figure 5.12: Location plan of pegmatites explored by the Ascot Metals Corp. Ltd. in Con. A, Lots 12 and 15, McDougall Township.

abundant in this area, which is also relatively quartz-rich, and contains 1% pyrite and trace chalcopyrite which appear to be related to late fractures.

The easternmost pegmatite is located some 30 metres from the central body, and is approximately 35 metres long and up to 5 metres wide. It is a cataclastic pegmatite composed of quartz, potassium feldspar, biotite and plagioclase and minor garnet. It contains several areas of anomalous radioactivity greater than 20,000 cpm. within which there are local concentrations of over 100,000 cpm. The highly anomalous areas are quartz-rich, and stained crimson and yellow, as a result of weathering of pyrite and secondary uranium minerals. Specks of uraninite were also noted. Results of analyses of the radioactive material from the central and eastern bodies are pending.

SMDR 1081 reports radiometric equivalent channel sample assays of 0.11% U3O8 over a length of 4 feet, and of 0.116% U3O8 over a length of 15 feet, but it is not clear whether these results were obtained from the showings in Lot 12 or Lot 15.

The 1200 foot-long (370 m) pegmatite body in Concession A, Lot 15 which is described by Hewitt (1967) and in SMDR 1081, was not located by the author. However, pegmatites were found at the locations denoted by an "x" on figure 5.12. A diamond drill hole site was also located and boulders of pegmatite found on the west side of a treed beaver swamp. The largest pegmatite body found occurs beside the CPR tracks, 300 metres south of the road leading to Bowers Bay. It is over 100 metres long, about eight metres thick and dips eastward, conformable with the enclosing quartz-feldspar-biotite schists. Local spots of radioactivity reach 80,000 cpm, but for the most part the sill is not anomalously radioactive. The spots of high radioactivity are quartz-rich, have rusty staining, yellow secondary uranium minerals, and small cubes of uraninite. Radioactivity tends to be higher near the margins of the body and in late fracture fillings. Analyses from this pegmatite are pending.

East of the CPR tracks small pegmatitic bodies occur conformable with the foliation of the easterly-dipping, quartz-feldspar-biotite +/- garnet schists.

What may be the trace of the body described by Satterly (1943) is represented by the dashed line on figure 5.12; and is inferred from a small outcrop of pegmatite at the northern end, and boulders west of a beaver swamp in the south. A small trench cut in schist was noted west of this line.

Con. 10, Lot 5.

The pegmatite dike occurring in Con. 10, Lot 5, described by Spence (1932), was not discovered. A shallow stripping has exposed another pegmatite in Con. 10, Lot 5 (figure 5.13). The stripped area is about 60 metres long and about five metres wide. It is largely filled with debris and

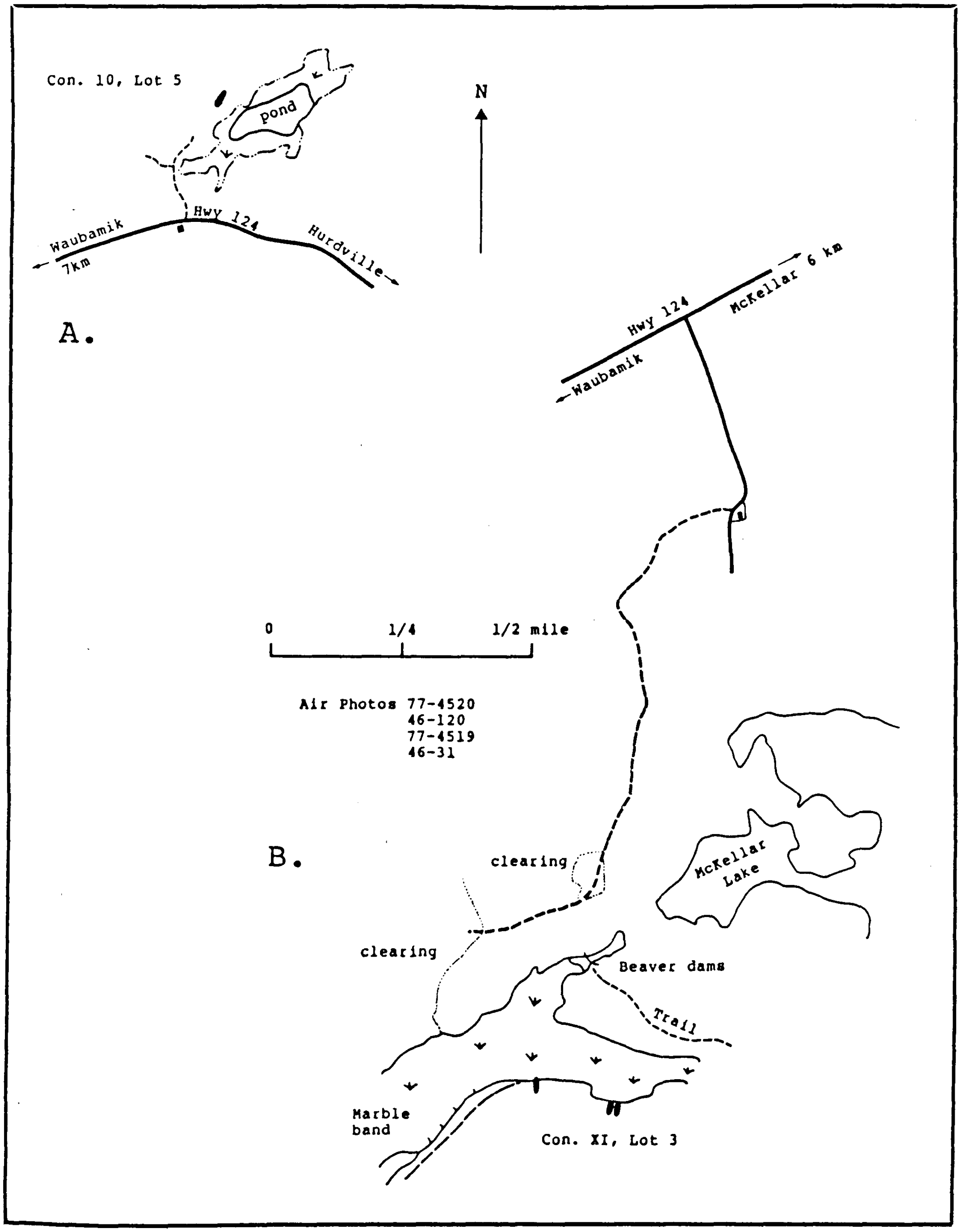


Figure 5.13: Location plan of pegmatites. A: Con. 10, Lot 5, and B: Con. 11, Lot 3, McDougall Township.

small trees.

The pegmatite dike consists predominantly of plagioclase and quartz. Relatively large (up to 30 cm) K-feldspar crystals occur sparingly in association with the quartz-rich portion of the dike (figure 5.14).

During the course of searching for the pit described by Spence (1932), numerous small pegmatite dikes were located; many show evidence of early exploration (shallow pits, strippings, etc.).

Con 11, Lot 3.

The two pegmatite dikes in Concession 11, Lot 3 in McDougall Township have previously been described by Satterly (1943, p.59). Figures 5.13, 5.15 and 5.16 show the location and geological maps of the veins. The country rocks are mainly easterly-striking granitic gneisses with interlayered bands of amphibolite. The western vein is relatively well-exposed, and exhibits a zoned pegmatite with a quartz core flanked by a microcline-rich zone, and a narrow, marginal, biotite-bearing zone. Plagioclase is also present, and graphic intergrowths of microcline and quartz occur in the outer parts of the microcline zone. Satterly (1943) observed allanite in this dike but this was not seen by the authors. The dike has a vertical dip, strikes 010 and attains a thickness of 8 metres at its northern end.

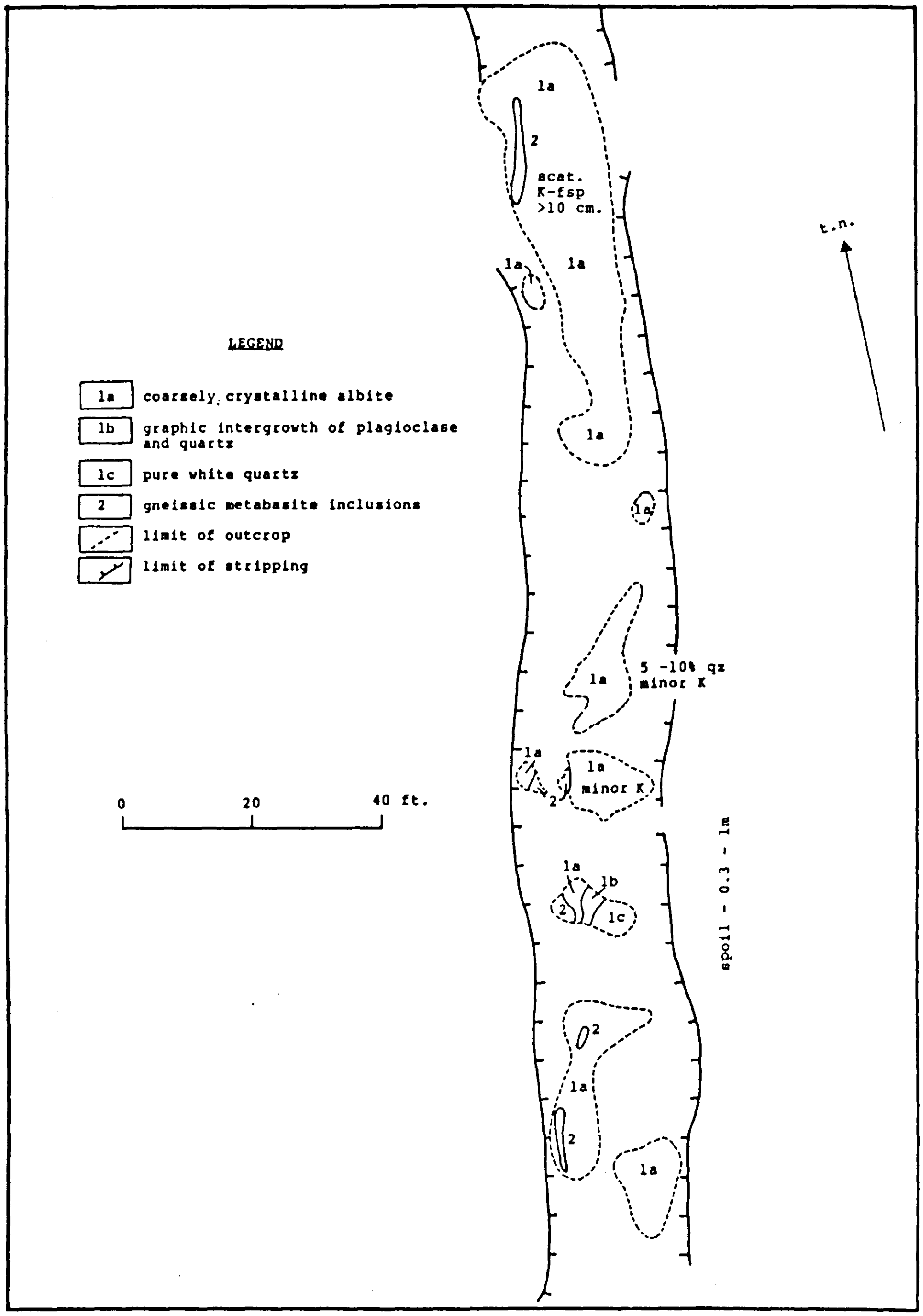


Figure 5.14: Geological sketch map of a narrow pegmatite, Con. 10, Lot 5, McDougall Township.

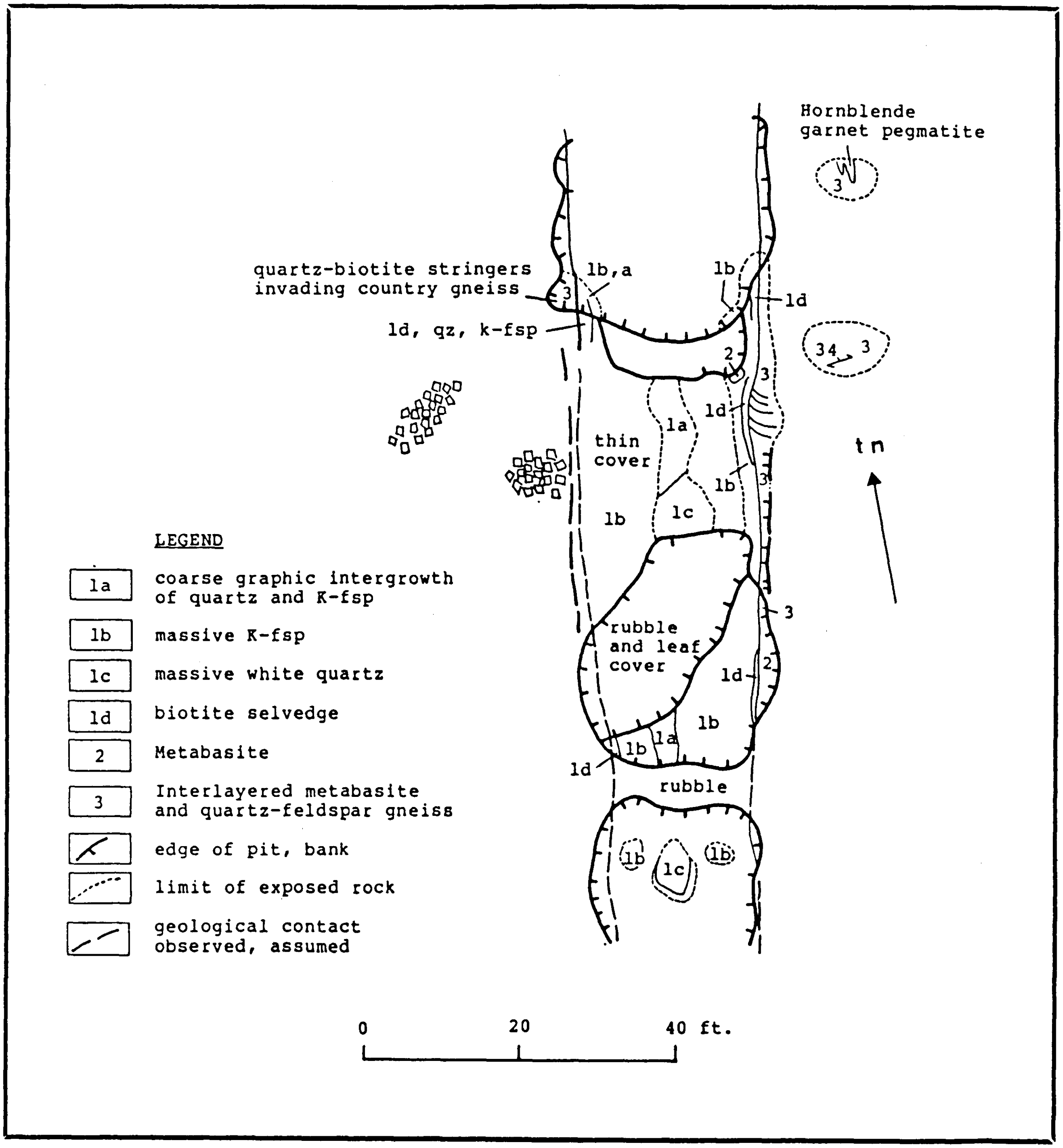


Figure 5.15: Geological plan of the western pegmatites, Con 11, Lot 3, McDougall Township.

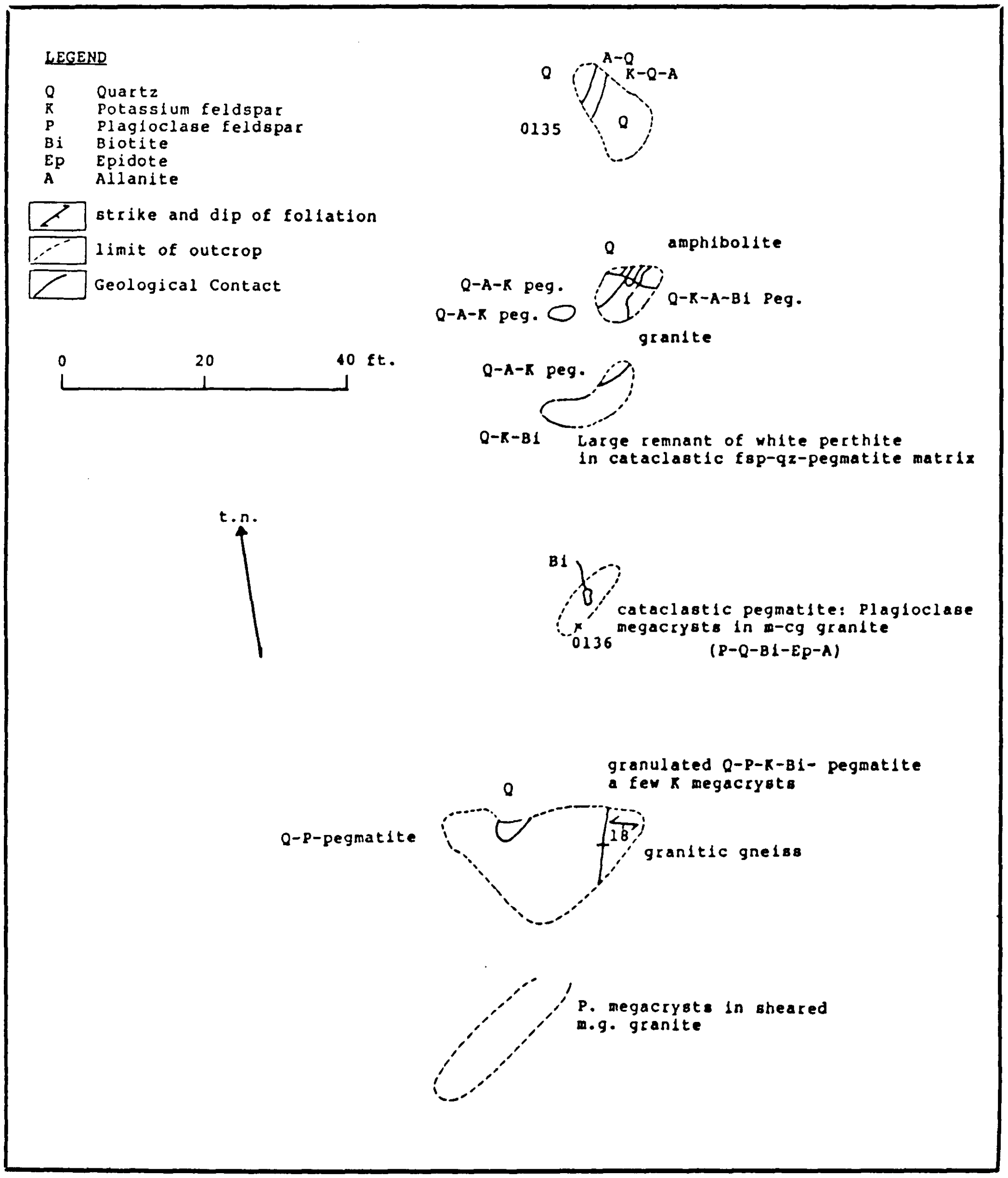


Figure 5.16: Geological plan of the eastern pegmatite, Con. 11, Lot 3, McDougall Township.

The eastern vein is less well exposed. It is mineralogically similar to the western vein, but contains more plagioclase, and has conspicuous allanite crystals up to 15 cm in length. It strikes parallel to the western vein, and is reported by Satterly (1943) to be 20 feet wide. At its southern end, its texture is noticeably cataclastic. The results of an analysis of allanite are shown in Table 5.4; and feldspars in Table 5.3.

Con 12, Lot 12.

Four small pegmatite bodies were located in the area immediately south of Waubamik but only one has been seriously tested (see figure 5.8). The main pit measures 6 metres by 5 metres, exposing a zoned pegmatite whose contacts with the enclosing hornblende gneiss strike 025 and dip 70 to the northwest, parallel to the strike of the gneiss. The pegmatite is at least three metres wide and on the northeast face of the pit is cored by white quartz. The quartz is flanked by an intergrowth of white plagioclase feldspar, pink antiperthitic feldspar, quartz and biotite. The quartz core is absent on the south face of the pit. An analysis of a composite sample rich in biotite is shown in Table 5.3.

Some 250 metres east of the main pit is another pegmatite dike. It is located on a ridge overlooking a culvert on the Hurdville road. It is 2.5 metres wide, and dips 80 degrees to the north and strikes east-west, parallel to the enclosing hornblende-plagioclase gneiss. The vein is not zoned and consists mainly of white quartz and pink potash feldspar, with books of muscovite up to 10 centimeters in diameter, and minor plagioclase. A composite sample was tested for its rare earth element content; analytical results are pending at the time of writing.

Three hundred metres south of the main pit, a small scraping has exposed a pegmatite composed of white quartz, pink plagioclase, white potash feldspar and biotite. Analyses of the feldspars are shown in table 5.3; that of the biotite is pending at the time of writing.

CONCLUSIONS

None of the pegmatites visited during 1986 appears to have much economic potential. All are small and are composed primarily of potassium feldspar, plagioclase and quartz, with lesser amounts of biotite or muscovite. Garnet occurs as an accessory mineral in some, and several contain minor amounts of radioactive minerals, the most common of which is allanite. Other minor minerals, notably in the Conger Township occurrences, are uraninite, euxenite, columbite-tantalite, monazite, cyrtolite, thucolite and calciosamarskite.

Several varieties of feldspar have been recorded in pegmatites in the area: peristerite, moonstone, and amazonite. The latter forms the basis of a rock-hounding and tourist operation at the Blue Star Mine in Chapman Township.

Beryl has been recorded from pegmatites in Butt and Henvey townships (Martin, 1983), tourmaline has been reported in McConkey Township (Friedman, 1957), and a magnetite and biotite-bearing pegmatite is reported by Hewitt (1967b) in Harrison Township.

GENESIS

Some preliminary observations can be made which have a bearing on the genesis of the pegmatites, which in turn has a bearing on their economic potential.

The pegmatites occur in a series of amphibolite to granulite facies gneisses. Many show signs of cataclasis and shearing, indicating that not all are post-tectonic, and must share some of the metamorphic history of the country rocks. Pegmatites are common in the ductile shear zones described by Davidson et al. (1981-86), where they also display evidence of being syntectonic. In the Mill Lake Quarry at Parry Sound, allanite grains occur in the mylonitic flagstones which are part of the Parry Sound shear zone. It is likely that the allanite is derived from a syn-tectonic (or possibly pre-tectonic) pegmatite, similar to other allanite-bearing pegmatites seen in the area, which has intruded along the shear zones during deformation. The development of pegmatites along the foliation planes of many gneisses and migmatites, for example at the Nickel Rim prospect in Conger Township, and the absence of any clear pattern of zoning or association with intrusive granites, suggest a metamorphic or partial melting origin for the pegmatitic fluids.

The mineralogy of the pegmatites is also consistent with their having formed at considerable depth under high grades of metamorphism (Cerny, 1982).

Future work will follow the same lines as the program instituted in 1986. However, the bodies seen to date, and the information available for others, suggest that their economic potential is limited, and their evaluation will receive a lower priority than some other aspects of the COMDA program.

6. BUILDING STONE

Introduction

There is currently only one stone quarry in the study area which approaches full-time production: the Mill Lake Quarry at Parry Sound (chart A - back pocket), which produces pink and grey flagstones from 1/2 inch to 4 inches thick. There are a number of other small quarries which supply flagstone "on demand". Martin (1983) has compiled an inventory of almost one hundred stone quarries in the project area. Most are in flagstone or gneiss and have sporadically supplied local markets, but stone from Mill Lake Quarry serves a wider market. Flagstone has not been studied in the course of the present program, but another COMDA project, the Mid-Ontario Building Stone Project, will investigate the value-added product potential of flagstone in the Parry Sound area, and of limestone on the Bruce Peninsula.

Most of the emphasis on building stone in the current project has been directed toward granitic and gabbroic rocks, following upon the recommendations of Verschuren et al. (1986), and A. Davidson (Geologist, Geological Survey of Canada, personal communication.,1986). Verschuren conducted a reconnaissance, largely restricted to roadside surveys, of potential building stones in central and eastern Ontario, and noted that the Powassan Batholith had the best potential in the Central Gneiss

Belt for homogeneous commercial granite. Davidson encountered many small bodies of gabbro (coronitic metagabbro) in the course of his regional reconnaissance programs (see Chapter 2, this report), and noticed that they were resistant and yielded a good finish upon polishing. Several of these bodies were also surveyed by Verschuren, who observed that closely-spaced joints and inconsistent texture and mineralogy mitigated against their exploitation as dimension stone.

The study area is renowned for its gneisses, which exhibit spectacular structures and textures in numerous roadcuts. Some effort will be made to evaluate the potential of such rocks in the coming season, since gneisses (notably from Brazil) with "marble-like" textures are currently making a significant impact upon the building stone industry.

The following sections describe the results of field investigations of the coronitic metagabbros and the Powassan Batholith during 1986.

CORONITIC OLIVINE METAGABBROS

Introduction

Examination of several clusters of coronitic olivine metagabbroic bodies was conducted during the 1986 field season. The primary aim of these examinations was to evaluate the dimension stone potential of these bodies. Aspects of the general geology of the coronitic metagabbroic bodies, combined with observations made at specific localities, are summarized.

Distribution

Coronitic metagabbroic bodies occur in all lithotectonic domains of the Central Gneiss Belt except the Parry Sound Domain. (The coronitic olivine metagabbroic bodies described herein should not be confused with the "coronitic amphibolites" described by Mummery (1973) - these do occur within the Parry Sound Domain). Their distribution is shown in figure 6.1 and on chart A (small open circle symbol). The coronitic gabbros are small, ranging from several meters to a maximum of 1 km. in greatest surface dimension, and commonly occur in clusters. Some clusters are spatially related to domain boundaries, while other clusters occur within lithotectonic domains (Grant, 1985, 1986).

General Geology

The term "coronitic" is applied to the olivine metagabbros to describe a texture consisting of concentric rims (coronas) of several minerals surrounding olivine and Fe-Ti oxide crystals. Coronas were developed by reactions between plagioclase and olivine, and between plagioclase and Fe-Ti oxide (Grant, 1986). Olivine crystals are rimmed by orthopyroxene, followed by clinopyroxene, and finally by garnet: rarely, a corona of brown aluminous amphibole occurs between the clinopyroxene and garnet coronas. Fe-Ti oxide grains are rimmed by biotite, followed by brown amphibole, followed by garnet. Typical examples of corona

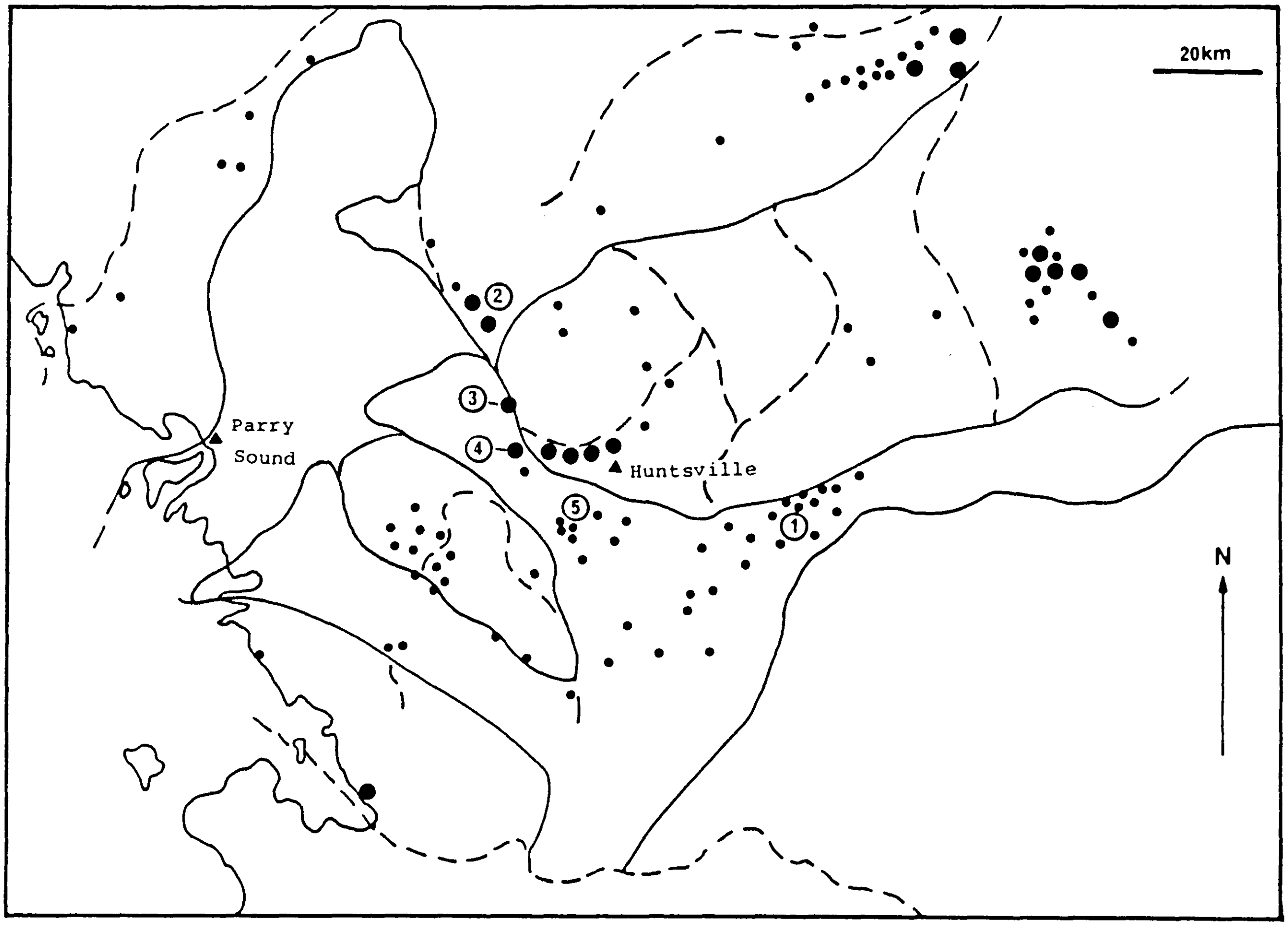
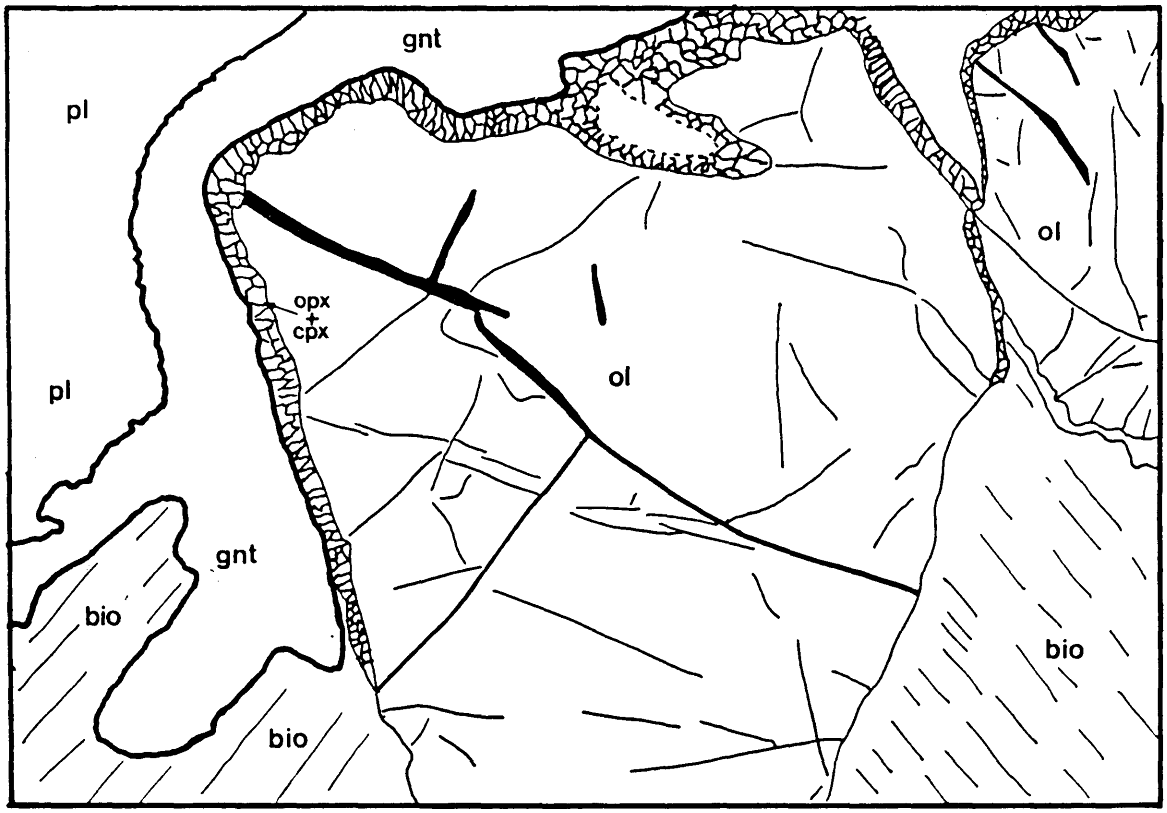


Figure 6.1: Distribution of coronitic olivine gabbro bodies within the Central Gneiss Belt (modified after Grant, 1986). Numbers refer to bodies or clusters described in the text. 1 Kawagama Lake, 2 Rainy Lake, 3 Haldane Hill, 4 Ashworth, 5 Mary Lake.

(A)


gnt
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pl
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+
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(B)

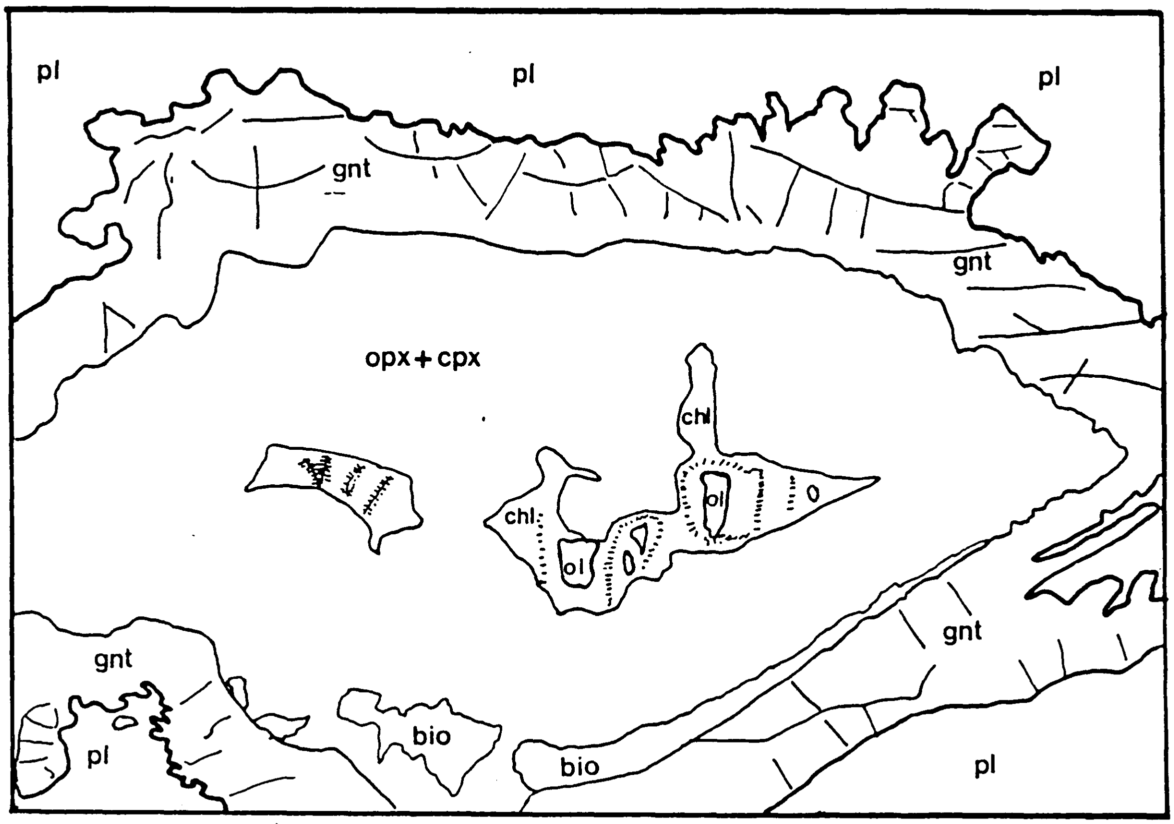

pl
pl
pl
gnt
gnt
opx + cpx
chl
chl
ol
ol
gnt
gnt
bio
pl
bio
pl

Figure 6.2: Sketches from photomicrographs showing representative examples of corona textures. (a) Corona developed between olivine and plagioclase. A large crystal of olivine (ol) rimmed by a narrow corona of orthopyroxene and clinopyroxene (opx + cpx) which is in turn rimmed by a corona of finely crystalline garnet (gnt). Note that coronas occur between olivine and plagioclase (pl) and not between olivine and biotite (bio). (b) Thick corona developed between olivine and plagioclase. Olivine crystal is almost completely replaced by a granular aggregate of orthopyroxene and clinopyroxene. Remnant olivine has suffered late stage alteration to chlorite. Field of view 3.5 x 2.5 mm.

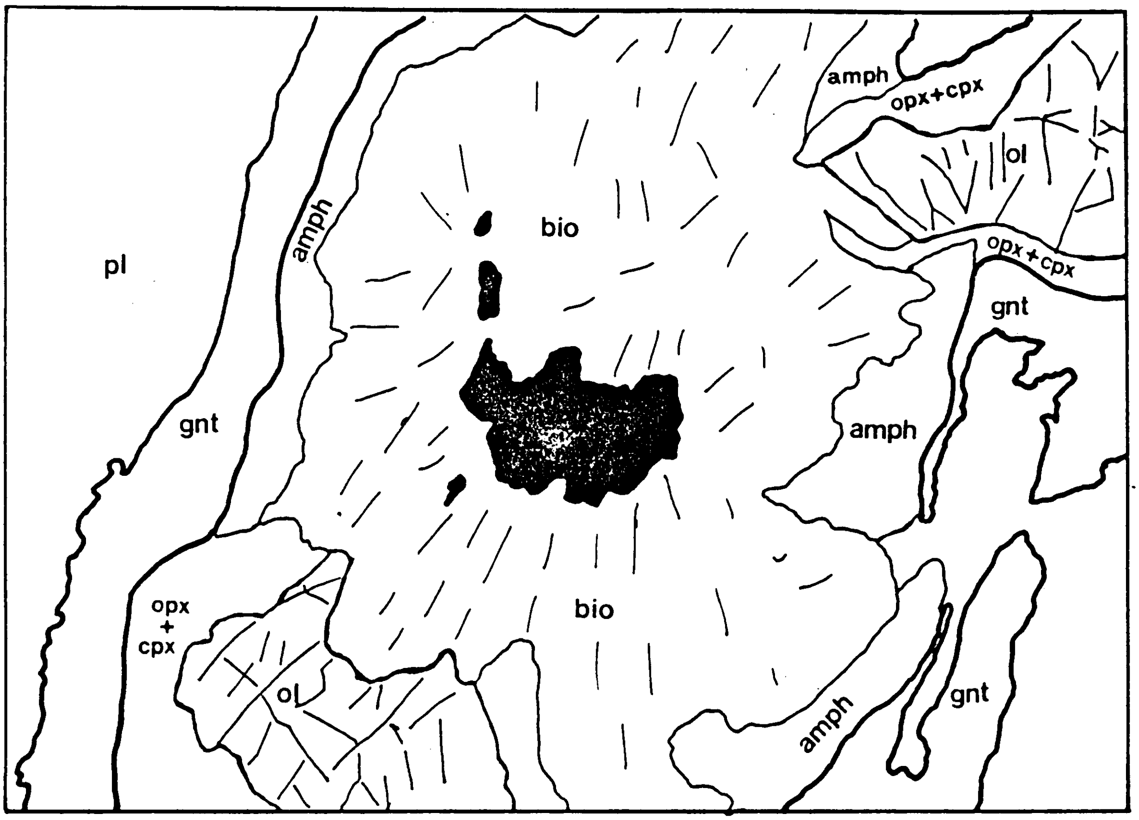


Figure 6.3: Sketch from a photomicrograph showing typical corona around Fe-Ti grains. The corona texture consists of coarsely crystalline biotite which is rimmed by finely crystalline brown amphibole (amph) and garnet. Note that the corona forms only between plagioclase and the opaque phase-olivine and biotite appear to be stable together. Field of view 3.5 x 2.5 mm.

textures exhibited by the olivine metagabbros are shown in figures 6.2 and 6.3. In addition to the corona minerals, the metagabbros contain large (2 - 20 mm) laths of plagioclase and large crystals of clinopyroxene. Unrecrystallized plagioclase is heavily charged with minute inclusions of green spinel. Large crystals of clinopyroxene subophitically enclose plagioclase and are rendered virtually opaque by an exsolved oxide phase.

The proportions of the constituent minerals and textures vary considerably within individual bodies and between adjacent bodies. In general, the proportion of olivine declines with increasing clinopyroxene content. Grant's (1986) preliminary data indicate a relatively wide variation in bulk composition between gabbros from different lithotectonic domains. This is reflected in the variable composition of individual mineral phases, and the proportions of constituent minerals.

The degree of preservation of primary textures and mineralogy is variable among the coronitic matagabbros. Recrystallization in response to strain (at high P and T) produces an assemblage consisting of plagioclase, hornblende, garnet and an opaque oxide +/- biotite and clinopyroxene. Clinopyroxene (augite) is commonly present in the recrystallized rocks: in some samples it is stable; in other instances it is clearly unstable and is rimmed and partially replaced by hornblende.

In most instances, the contact between the enclosing country rocks and the coronitic gabbros is tectonic. Recrystallization of the primary assemblage is most pronounced at the contacts with the country rocks.

Discussion

There are two main points which have to be addressed in considering the genesis of the coronitic olivine gabbros:

1. the origin and significance of the coronitic textures,
2. the common tendency of coronitic olivine gabbros to occur in clusters of small bodies.

The first aspect is largely of academic interest and is the subject of ongoing research (Grant, 1986; Davidson, 1986). Essentially there are two possible interpretations of the coronitic textures:

a) gabbroic liquids were intruded at deep crustal levels (country rocks at amphibolite and granulite grade) and the coronas were produced by subsolidus reactions between plagioclase and olivine and Fe-Ti oxide during slow cooling to ambient temperatures at high pressure,

b) crystallization of a gabbroic liquid at high crustal levels was followed by prograde metamorphism resulting in the development of the coronitic textures.

Uranium-lead age dating using zircons and baddeleyite (ZrO_2) from the coronitic metagabbros is currently being conducted (Davidson, Geologist, Geological Survey of Canada, personal communication, 1987) and should provide some clues concerning the development and significance of the coronitic textures.

The second aspect of the genesis of the coronitic gabbros is potentially significant in terms of their building stone potential. Grant (1986' attributes the clustering of small gabbroic bodies to boudinage of larger intrusions. She observed that the greatest concentration of the smaller bodies occurs in the Kawagama Tectonic Zone, which forms the boundary between the McClintock Subdomain and the Muskoka Domain: the Kawagama Tectonic Zone is the locus of strong deformation.

Grant (1986) noted that larger and less deformed bodies of coronitic gabbro occur within domains, although highly deformed equivalents also occur; implying that intrusion of gabbroic liquids may have occurred during "a protracted period of perhaps episodic deformation".

Based on Grant's (1986) tentative conclusions, the coronitic gabbros with the highest potential for building stone are those which occur within the domains rather than those which occur in the zones of strong deformation associated with domain boundaries; within-domain bodies should be the largest and the least deformed. If intrusion of gabbroic liquids occurred over a long period of time, it is possible that some intrusions were emplaced during the waning stages of tectonism and therefore may have escaped strong deformation.

Description of Occurrences

During 1986, coronitic gabbros were visited in the Rainy Lake area in Ryerson and McMurrich townships, at Kawagama Lake east of Dorset, and near Mary Lake, south of Huntsville (figure 6.1). The object of the visits was to gain an initial impression of the variability of mineralogy and texture within and between individual bodies and groups of bodies; to assess their structural characteristics; and to collect large samples for cutting, polishing, and petrographic study so that an evaluation could be made of their suitability for building stone purposes.

KAWAGAMA LAKE

A cluster of over two dozen coronitic metagabbroic bodies has been recognized in the Kawagama Lake area (Grant, 1986). Ten of these were visited in 1986 (see figure 6.4). They form topographic highs. The larger bodies are elongated in a northeasterly direction and dip moderately to the southeast, parallel to the foliation of the enclosing gneisses which fall within the Kawagama Lake Tectonic Zone, which separates the McLintock Subdomain of the Algonquin Domain to the northwest from the Muskoka Domain to the southeast.

As Grant (1986) has observed, there is a wide range of mineralogical composition and texture in the gabbros in this area; a result of variable deformation and recrystallization within the Kawagama Lake Tectonic Zone. Photograph 6.1 shows a very coarse-grained gabbro from body No. 7 (the largest in the group), which exhibits an undeformed primary igneous texture. In contrast, figure 6.5 shows strongly foliated, folded and net textured gabbro from the same body, some 100 metres to the west. The northern contact of this body is well-exposed on a north-facing cliff, where strongly foliated gabbro overlies leucogneiss, and is intruded by a late tectonic pegmatite, which itself has been slightly drawn into the plane of the gabbro's foliation. A mineral lineation is visible in the foliated gabbros, plunging east to southeast within the foliation plane.

Petrographic study of a sample collected from the core of the body, close to the site of photograph 6.1, reveals well-developed coronitic textures similar to those illustrated in figure 6.2. The rock contains an estimated 55% plagioclase, 10% olivine, 7% ilmenite and 4% primary augite. The balance is made up of minerals in the coronas: orthopyroxene 3%, clinopyroxene 3%, amphibole 2%, biotite 5-6%, and garnet 8%.

The marginal parts of the gabbroic bodies are recrystallized and essentially are amphibolites composed of hornblende, plagioclase and biotite. They are strongly weathered and it is difficult to obtain a fresh sample.

Undeformed gabbros were also noted within bodies 1, 3, 4, 5 and in an apparently separate body some 30 metres long between bodies 5 and 6.

Only one sample of massive gabbro from body No. 1 has been slabbed and polished to date. It takes a good polish, but it has been moderately recrystallized, with the result that it does not have the clear, sharp texture and large grain size

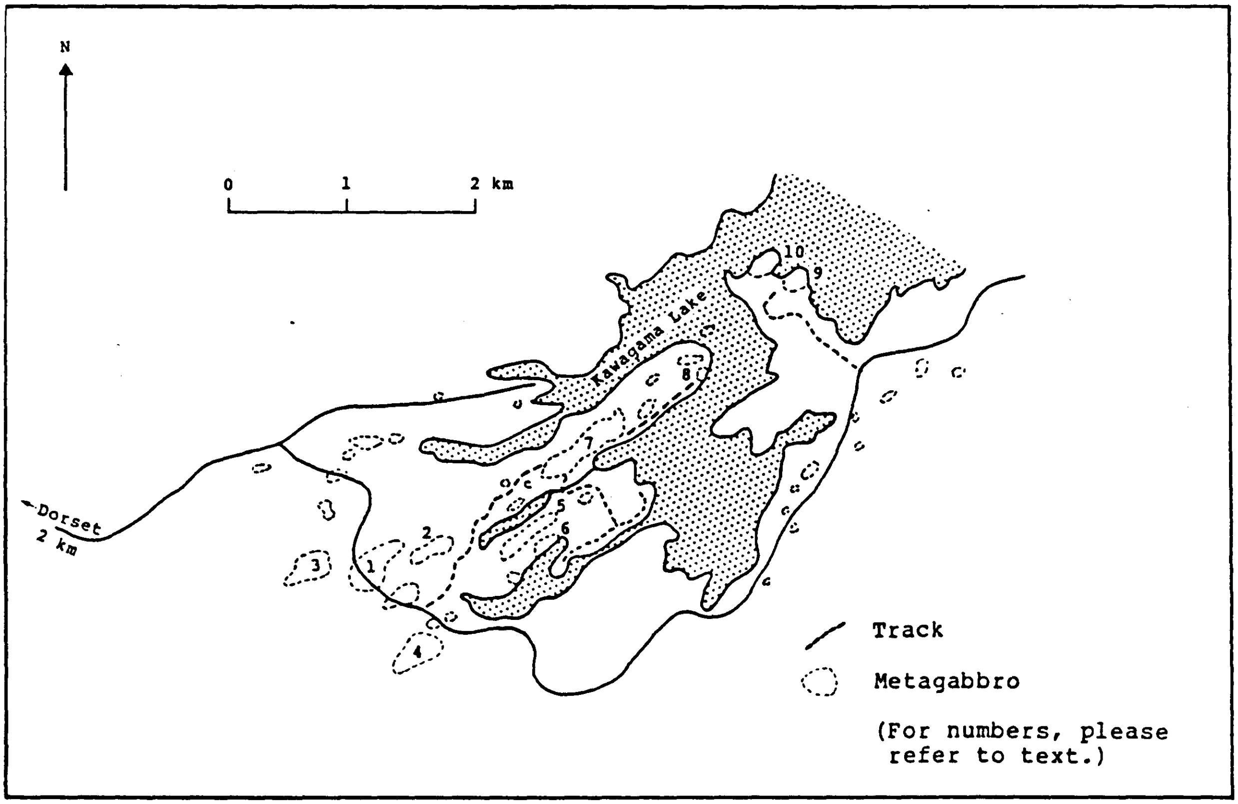


Figure 6.4: Geological plan of metagabbroic bodies in the Kawagama Lake area (Modified after Grant, 1986). Numbers refer to bodies examined by the authors.

Photo 6.1: Preserved primary texture of coarse grained coronitic gabbro from body No. 7, Kawagama Lake. Subhedral laths of plagioclase are subophitically enclosed by coarse crystals of clinopyroxene.

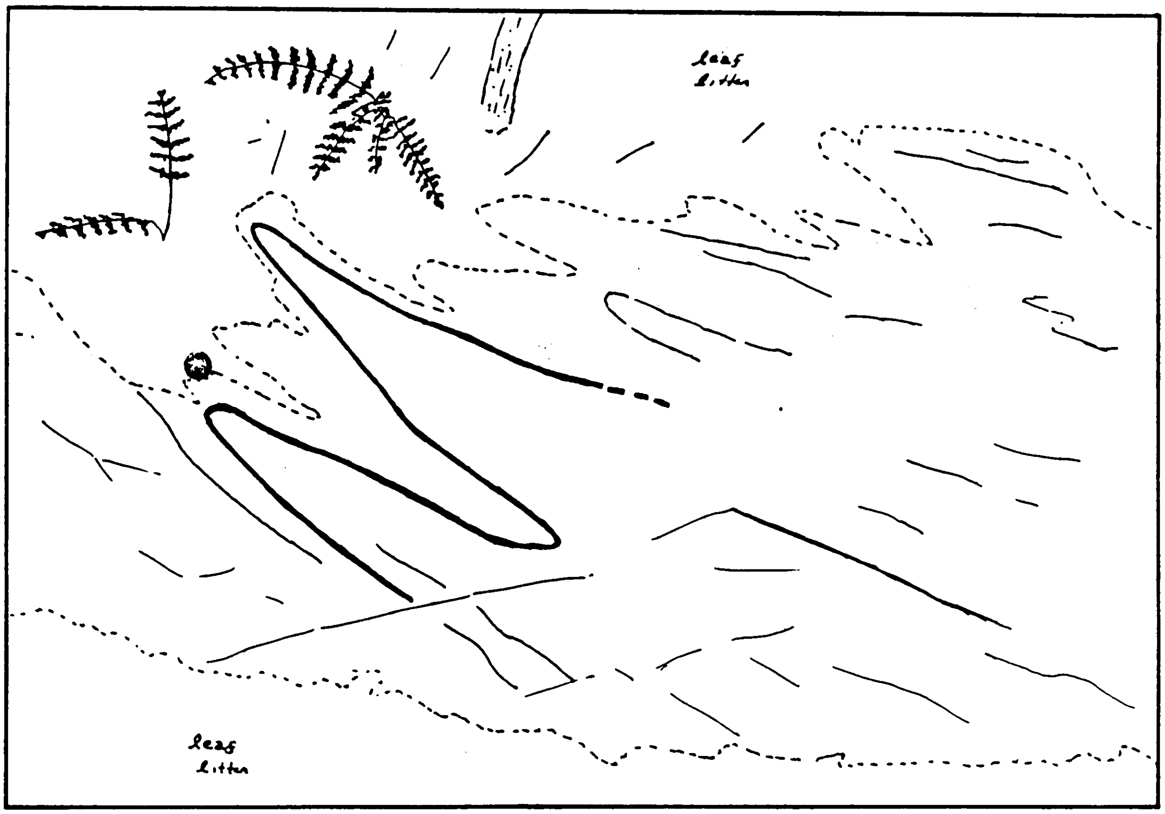


Figure 6.5: Sketch from a photograph showing strongly foliated, folded coronitic gabbro 100 meters to the west of photo 6.1, body No. 7, Kawagama Lake. Dark band is a folded pegmatite band with its axial plane parallel to the foliation. Black circle 5 cm.

which produce the attractive polished slabs such as those from Rainy Lake.

RAINY LAKE

Grant (1986) has identified nine coronitic olivine metagabbroic bodies in the southwestern part of the Kiosk Domain, near Rainy Lake in Ryerson Township (Figure 6.6). The bodies are located close to the tectonite zones which define the contacts between four tectonic domains: the Novar and Kiosk Subdomains and the Parry Sound and Seguin Domains.

The two largest bodies were visited and sampled.

The body to the southeast of Rainy Lake is ellipsoidal in plan with its long axis oriented northwest-southeast. It is approximately 800 metres long, and 400-500 metres wide. This occurrence was previously reported by Verschuren et al. (1986) (RYE-02).

The gabbro forms a moderate topographic high within buff to grey coloured, fine to medium grained, equigranular, quartz-plagioclase-hornblende gneiss and migmatite. Within the gabbro body the outcrops occur as scattered, rounded, upstanding knobs. Some outcrops exhibit spheroidal weathering skins several centimetres thick, especially the coarser grained varieties, while some of the medium to fine grained varieties have a weathering rind of a millimetre or so thick. The latter are very tough, ring like a bell when hammered, and require considerable effort to break off large blocks suitable for

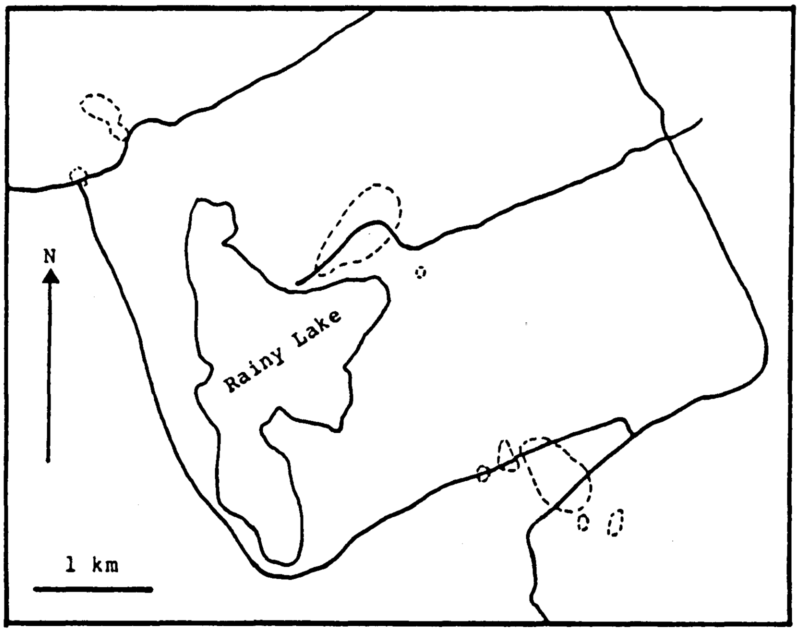


Figure 6.6: Location plan of coronitic olivine metagabbro bodies in the Rainy Lake area, Ryerson Township. (after Grant, 1986).

slabbing.

The gabbro is foliated and fine to medium grained for at least ten metres from its contact with the enclosing gneiss. Coarse grained and almost pegmatitic phases with well-defined coronas can be seen in outcrops in the central part of the body. The grain size of the coronitic gabbro is variable within and between outcrops. Ilmenite is prominent (up to 8%). Jointing is irregular and generally fairly closely spaced: few joint-free blocks greater than one cubic metre were seen.

The medium grained (2-5mm) varieties are attractive and yield a smooth, dark grey to black polish, highlighted by the metallic grey colour of the ilmenite. The biotite content ranges from 7 to 15%, most of which occurs as narrow rims around the ilmenite grains: it does not adversely affect the polish of the rock.

The body immediately north of Rainy Lake is very similar to the one just described (see also Verschuren et al., 1986, RYE 03). The scattered outcrops consist of prominent rounded knobs of medium to coarse grained gabbro (photograph 6.2). Again, the marginal phases are weakly foliated, but most of the body is massive and exhibits good coronitic textures. The finer grained varieties are tough, have a very thin weathering rind, and some outcrops display only weak to moderate jointing.

Only one thin section from each body has been studied and consequently an average mode or a range of modal compositions cannot be reliably estimated. The following modal

Photo 6.2: Typical outcrop of coronitic gabbro, north of Rainy Lake, Ryerson Township. Note the moderate joint and fracture density.

estimate from the northern body is provided only as an illustration of its mineralogy:

Primary minerals:		Secondary Minerals:	
		in coronas:-	
Plagioclase (clear)	10 vol. %	Opx	4-5 vol. %
Plagioclase (dusty)	20	Cpx	3
Cpx (very dusty)	15	Biotite	15
Olivine	10	Amphibole	5
Ilmenite	5	Garnet	5
Apatite	3-4	"alteration"	
		Chlorite	4
		spinel	3?

HALDANE HILL

Haldane Hill is eight miles south-southeast of Rainy Lake in McMurrich Township (figure 6.7). A coronitic metagabbro is exposed in a road-cut 600 metres west of Buck Lake (see Verschuren, 1986; site MCM-01).

This occurrence is the northernmost of a group of gabbroic bodies which occur along the tectonite zone which marks the southeastern edge of the Novar Subdomain. Other gabbros in this group, in the vicinity of Huntsville, have not yet been visited by the authors.

The Haldane Hill gabbro outcrops at the top of a

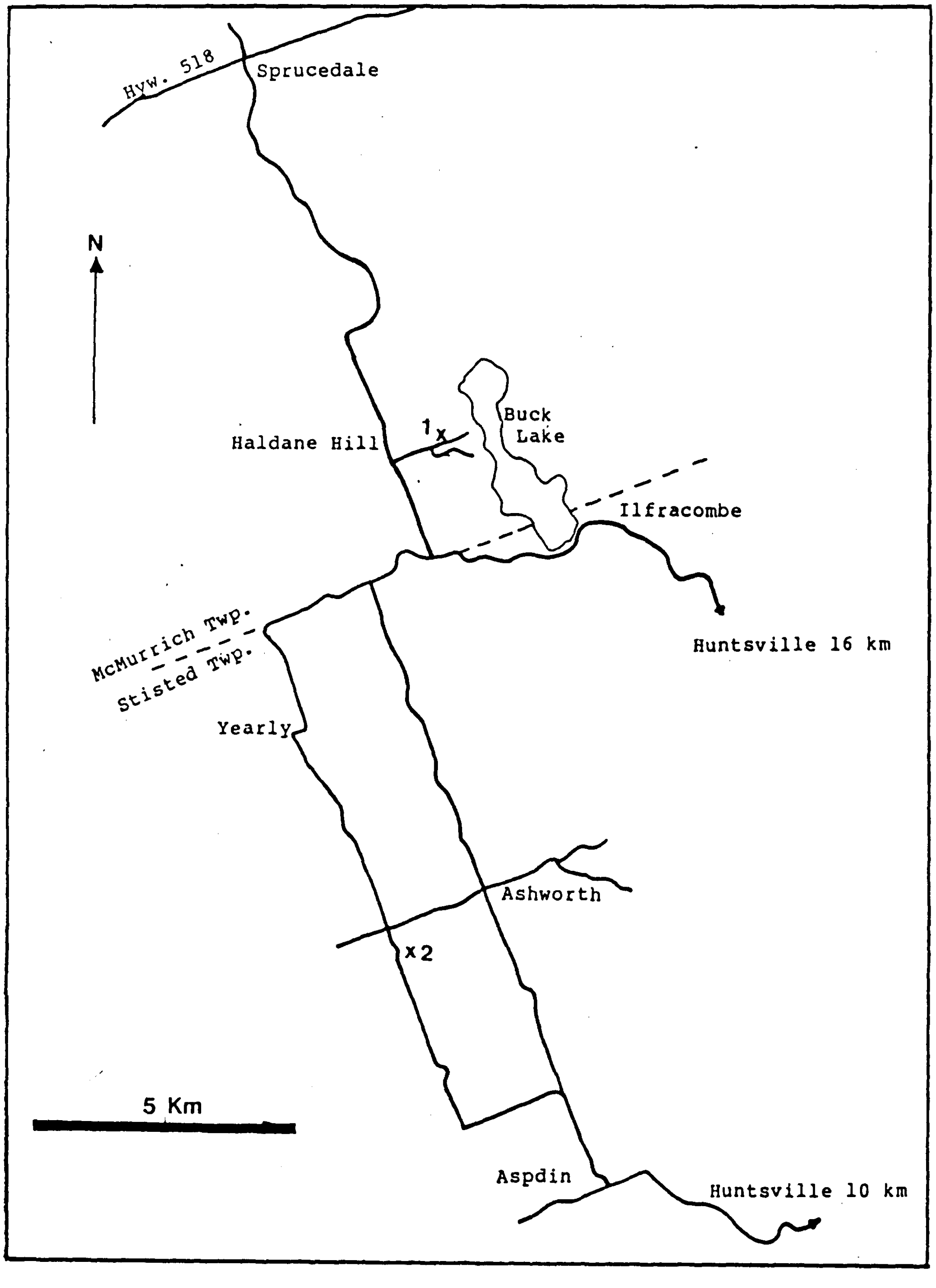


Figure 6.7: Location plan of the Haldane Hill (1) and Ashworth (2) metagabbroic bodies.

north-northwest-trending hill, where it is approximately 120 metres wide. Its length is not known as the body has not yet been examined in detail.

At the gabbro's western margin, a zone about eight metres wide consists of fine to medium grained, foliated gabbro. This is followed abruptly to the east by a very coarse grained gabbro which gradually becomes finer grained eastward, toward a shear zone which trends parallel to the ridge (a distance of some thirty metres). East of the shear, a fairly homogeneous, massive, medium-grained gabbro forms the balance (approximately 50 m) of the exposure.

The slabbing of samples from this location is in progress, and further field work is planned during 1987.

ASHWORTH

The Ashworth gabbro occurs in Stisted Township, some ten kilometres south of the Haldane Hill gabbro (figure 6.7). It is an isolated body located within the tectonite zone which separates the Seguin Subdomain from the underlying Huntsville Subdomain (Algonquin Domain). It appears to be one of the least sheared gabbroic bodies visited to date, and its internal mineralogy and texture are more consistent than in other bodies. The gabbro was briefly prospected and sampled.

Several prominent knobs of gabbro up to 5 metres high outcrop on a north facing slope. The outcrops occur over an area approximately 120 by 150 metres. The outcrops are obviously resistant, are barely weathered, tough and sound. Joint spacing is moderate (approx. 1-2 metres) and irregular: further investigation is required to quantify this aspect. The rock is consistently medium grained; plagioclase laths range up to 5 mm in length. Coronas are well developed. The rock is a dark green colour which is produced by the high plagioclase content.

One sample produced an attractive black polished slab.

The estimated modal composition of one sample from the Ashworth gabbro is given below:

Primary Minerals			Secondary Minerals	
			in coronas:	
Plagioclase	55	vol %	Opx	3 vol %
Dusty cpx	12		clear cpx	3
Olivine	7		amphibole	4
Ilmenite	4		garnet	5
			biotite	3
			"alteration"	
			spinel	5
			chlorite	1

MARY LAKE

A cluster of coronitic metagabbros is located near the intersection of Highways 11 and 141. The road-cut exposures of the two larger bodies were visited by the authors (see figure 6.8). These bodies are very strongly recrystallized and deformed, showing well-developed vein network texture and boudinage, with pegmatite development along the contacts of boudins (photos 6.3 and 6.4). Locally the vein network texture is folded. The deep red coloured "holes" of the net consist of plagioclase, biotite, amphibole and garnet, the latter sometimes being the predominant phase; while the anastomosing leucocratic net comprises plagioclase, hypersthene and augite. Locally within the western body there occur irregularly shaped, masses of rest pegmatite up to one metre in diameter within areas of undeformed gabbro. The margins of the pegmatitic areas are enriched in hornblende, while there is a garnet-rich rim around the pegmatite within the surrounding medium grained gabbro. The garnet content of the western body ranges up to 20%. It is cut by several sets of fairly closely spaced joints and pegmatites.

SUMMARY OF RESULTS

Of the gabbros visited to date, the one which appears to have the best potential for conventional building stone applications is the one at Ashworth, which exhibits the most consistent texture and mineralogy. This body will be mapped in detail, and representative samples collected for slabbing, polishing and petrographic study, with a view to quantifying the joint pattern, mineralogical and textural variation, and size of the body.

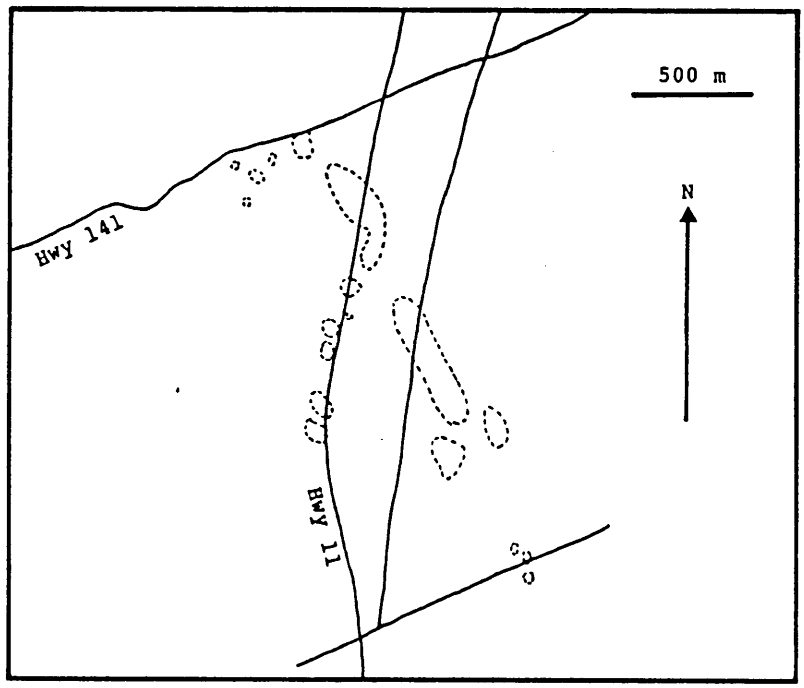


Figure 6.8: Location plan of coronitic metagabbros in the Mary Lake area (After Grant, 1986).

The coronitic olivine metagabbros at Rainy Lake and Haldane Hill are attractive rocks but exhibit more textural and mineralogical variation that at Ashworth. However, more detailed work is warranted at the northern Rainy Lake body and at Haldane Hill, with the same objectives as at Ashworth.

The coronitic olivine metagabbros at Kawagama Lake offer little potential as building stone. The massive bodies are too small for commercial exploitation and occur as isolated lozenges within sheared, foliated, soft, amphibolitic metagabbro. Furthermore, they occur in the midst of a popular cottage and recreational area.

Similarly, the gabbros at Mary Lake are too variable in mineralogy and texture, and too strongly jointed and veined to be of interest as conventional building stones. However, the high garnet content, which imparts a deep red hue to the rock, and the spectacular and complex gneissic textures, shown in photographs 6.3 and 6.4, suggest that they should be appraised with a view to exploiting those qualities.

CONCLUSIONS AND ECONOMIC CONSIDERATIONS

Reconnaissance of metagabbroic rocks in the study area performed during 1986 has indicated a wide variation in lithology, mineralogy and structure. Because of this variability each body must be treated in its own right and sweeping generalizations of the group as a whole cannot be made. Of the several dozen gabbroic bodies recognized by

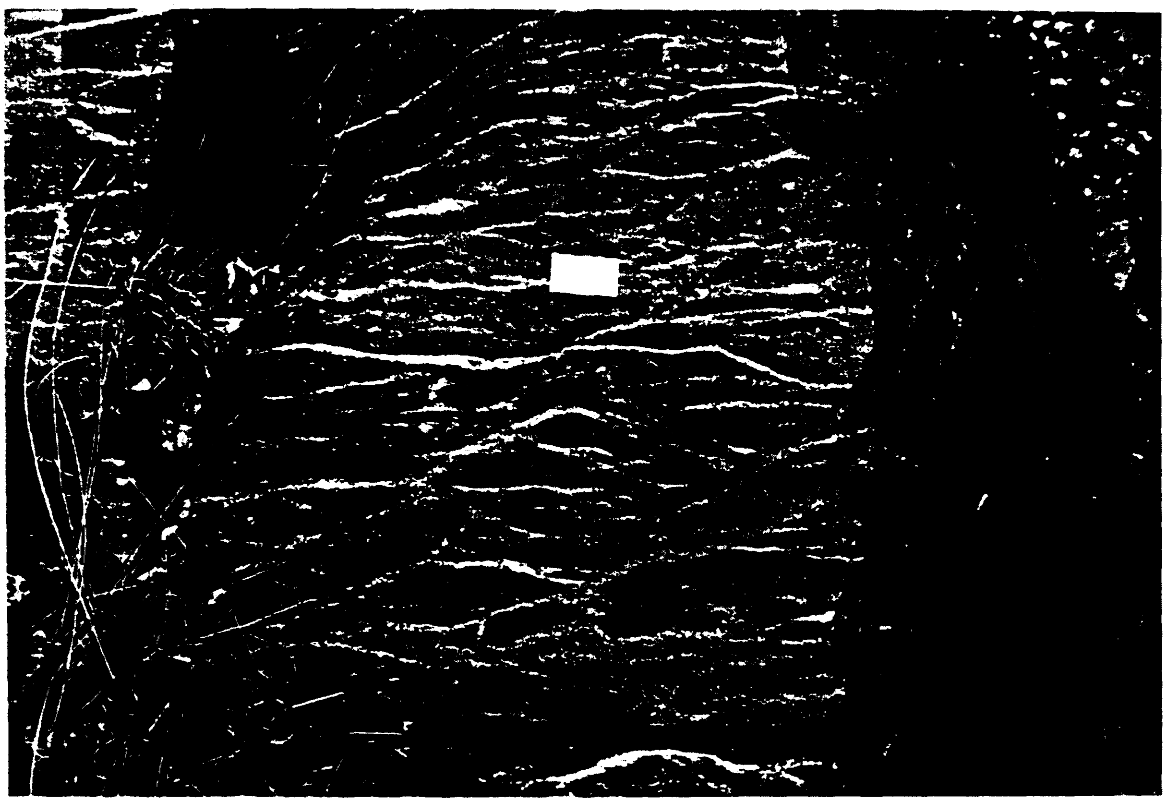


Photo 6.3: Net textured coronitic olivine gabbro, Mary Lake area.

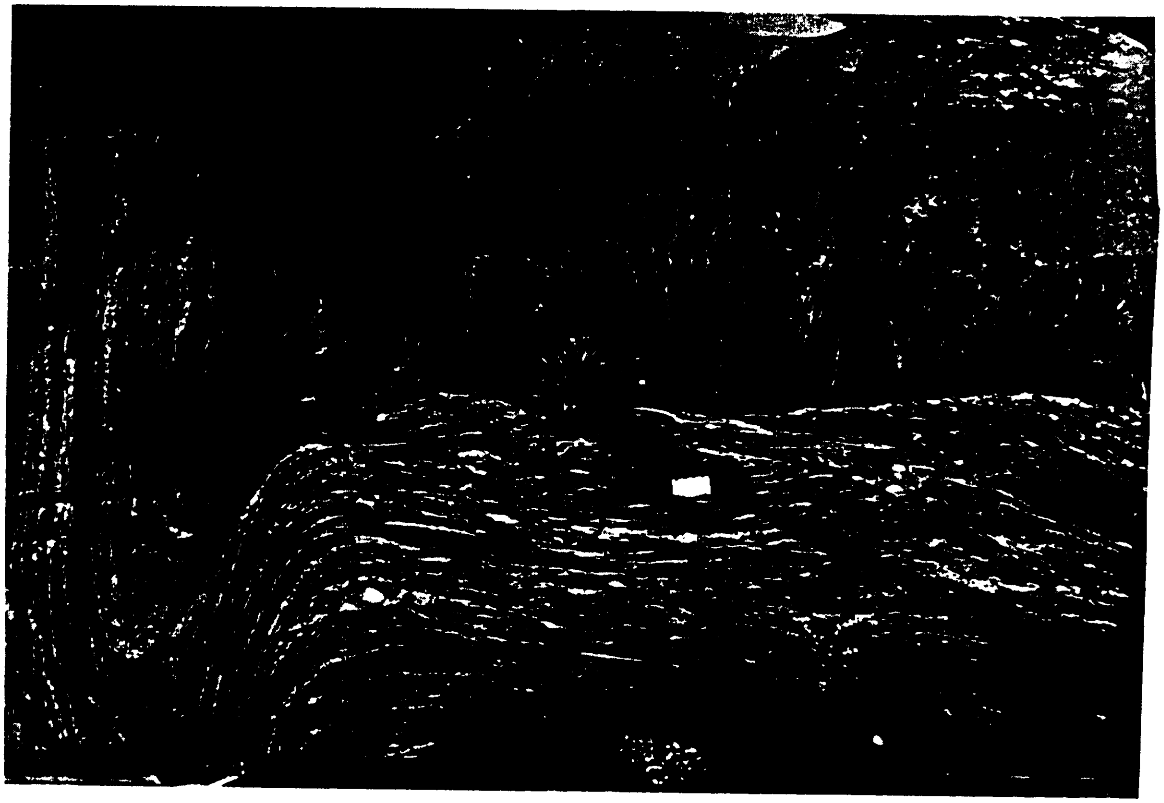


Photo 6.4: Net textured coronitic gabbro boudin in mafic gneiss. Note the occurrence a narrow pegmatite veinlet at the boudin contact (centre right) and the sigmoidal tails on feldspar porphyroclasts, indicating a left lateral sense of shearing.

Davidson and Grant (1986), the authors have visited but a few. Systematic evaluation of the larger remaining bodies will continue in order to define whether any has the makings of a quarriable deposit. The following factors must be weighed in evaluating the gabbros.

Durability and aesthetics: The gabbros are hard, resistant to weathering, and take a good polish to yield an attractive dark green to black colour, sometimes with a slight purple hue. Those containing several percent of ilmenite have a steel-grey metallic sheen.

Jointing: In many cases, joint spacing is too close and irregular to permit exploitation. However, many outcrops which exhibited limited jointing were seen a short distance off the road. More detailed work will be performed to quantify this factor.

Mineralogy: Mineralogy is variable, but deleterious minerals are insignificant. There are no sulphides; biotite is a minor constituent. Olivine (which can pose problems in flame finishing) and garnet (a hard mineral which could theoretically present problems in polishing due to resistance or plucking) are not considered deleterious: there are many commercial stones which contain either or both.

Texture: The texture and grain size of the gabbros vary between and within individual bodies to different degrees. The Ashworth body is fairly homogeneous, others are less so. As with other properties, texture must be treated on a case by case basis, and in any given body its homogeneity or its variability are qualities which could be exploited, provided that a degree of predictability can be acheived.

Size: None of the bodies appears to be very large. Areas of homogeneous mineralogy and texture may be limited to two or three hectares. This potential disadvantage is offset to some extent by the tendency of the bodies to occur in clusters, and their positive relief. Consequently, the development of several closely spaced deposits could be envisaged, each perhaps having its own unique character.

Development: None of the bodies is known to have been developed in the past. Any potential new development would be facilitated by the good road access, and the relief of the bodies, which permits development by means of quarries rather than pits.

Viability: It must be considered whether gabbroic bodies such as those under discussion constitute a target worth persuing as potential building stone. Whilst market studies and economic evaluations are beyond the scope of this study, the following "thumbnail" calculation provides an initial impression of the theoretical potential of small (geologically) bodies of rock:

A deposit with an area of two hectares and relief of 20 metres would provide 400,000 cubic metres of stone (14.28 million cubic feet) before the lowest bench dropped to below the level of the access point. With a 20% rate of recovery (2.85 million cubic feet) there would still remain a substantial value to the deposit, given an typical quarry price of, say, $10.00 per cubic foot for "black granites" currently on the market. Large quarries produce in excess of 100,000 cubic feet of rock per year. At such a rate of production an operation of the type discussed would have a significant life expectation.

The trend toward the use of smaller tiles and developments in equipment for handling smaller quarry blocks suggest avenues for further research into innovative extraction methods and the economics of exploiting attractive deposits which do not meet the traditionally accepted standards of deposit size, quarry block size or block shape. Some of these problems are to be addressed under two other COMDA projects: "Mid-Ontario Building Stone" and "Developments in Building Products", which are managed by the Industrial Minerals Section, Mineral Development and Lands Branch, Mines and Minerals Division of the Ontario Ministry of Northern Development and Mines.

POWASSAN BATHOLITH

A reconnaissance survey of building stones in Eastern Ontario by Verschuren et al. (1986) concluded that "Perhaps the best potential indicated so far in the Ontario Gneiss Segment is the North Bay-Powassan area". They indicated that the two sites within the Powassan Batholith had "good development potential". On the strength of this recommendation, a reconnaissance survey of the Powassan Batholith was conducted during the fall of 1986. The survey involved examination of all roadside exposures within the southern portions of the Powassan and Bonfield batholiths. This survey provides a general overview of the geology of the area and is being used as a basis for selecting areas for more detailed examination of their building stone potential.

Location and Access

The Powassan Batholith extends from North Bay southward almost to Burk's Falls; Highway 11 roughly bisects the batholith in a north-south direction. Road access to the northern and western portions of the batholith is provided by a regular pattern of concession roads. Access to the southern and eastern portions of the batholith is permitted by a few widely spaced lumber roads.

Most rock exposures occur on rounded knobs and along low ridges which stand 10 to 20 meters above the surrounding countryside. While it is premature to consider the location of potential quarry sites, it is worth noting that most of the area is readily accessible and the topography is generally favourable in terms of the development of quarry sites.

General Geology

The Powassan Batholith is a 65 x 25 km, elliptical pluton; its major axis trends northward. The northern portion of the pluton (north of Latitude. 46 00') was mapped by Lumbers (1971) at a scale of 1:126,720. The Bonfield Batholith consists of similar appearing rocks and is separated from the Powassan Batholith by a thin screen of paragneiss (Lumbers, 1971). Lumbers (ibid.) suggested that the two batholiths are joined at depth. For the purposes of this preliminary report, the Powassan and Bonfield Batholiths are described collectively.

The Powassan Batholith consists of a diverse collection of dioritic, quartz monzonitic, and granitic rocks. All the rocks of the Powassan Batholith have been metamorphosed to upper amphibolite or granulite grade. The term "batholithic complex" is appropriate since the relationships (comagmatic?, intrusive?) between the different lithologic units (described below) are unknown. Broad shear zones transect the batholithic complex and there exists the possibility that several unrelated plutonic bodies have been tectonically juxtaposed.

Lithology

Three major lithologic units were identified during the reconnaissance survey:

a) quartz monzonitic augen gneiss.

b) garnet-hornblende porphyroblastic quartz monzonite.

c) biotite-hornblende granitic gneiss.

The general distribution of the three lithologies is illustrated in figure 6.9. The reconnaissance nature of the survey is emphasized; figure 6.9 is a broad generalization of very complex geology and should be regarded as such.

The quartz monzonitic augen gneisses occupy the north-central and western portion of the Powassan batholithic complex. These rocks range in colour from pink to white (less commonly dark green). They consist of 20 to 40 percent K-feldspar phenocrysts (chiefly perthitic orthoclase, less commonly perthitic microcline) in a fine to medium grained matrix of plagioclase, orthoclase (or microcline), hornblende, garnet, biotite (+/- clinopyroxene) and sphene. Apatite, zircon and magnetite are common accessories. These rocks have been derived from a feldspar porphyritic protolith by recrystallization in response to mechanical strain under conditions of high pressure and temperature. The degree of recrystallization is variable, ranging from formation of very narrow rims of anhedral feldspar grains around relict phenocrysts, to near-complete destruction of feldspar phenocrysts, producing lenses of finely crystalline anhedral grains aligned parallel to the foliation.

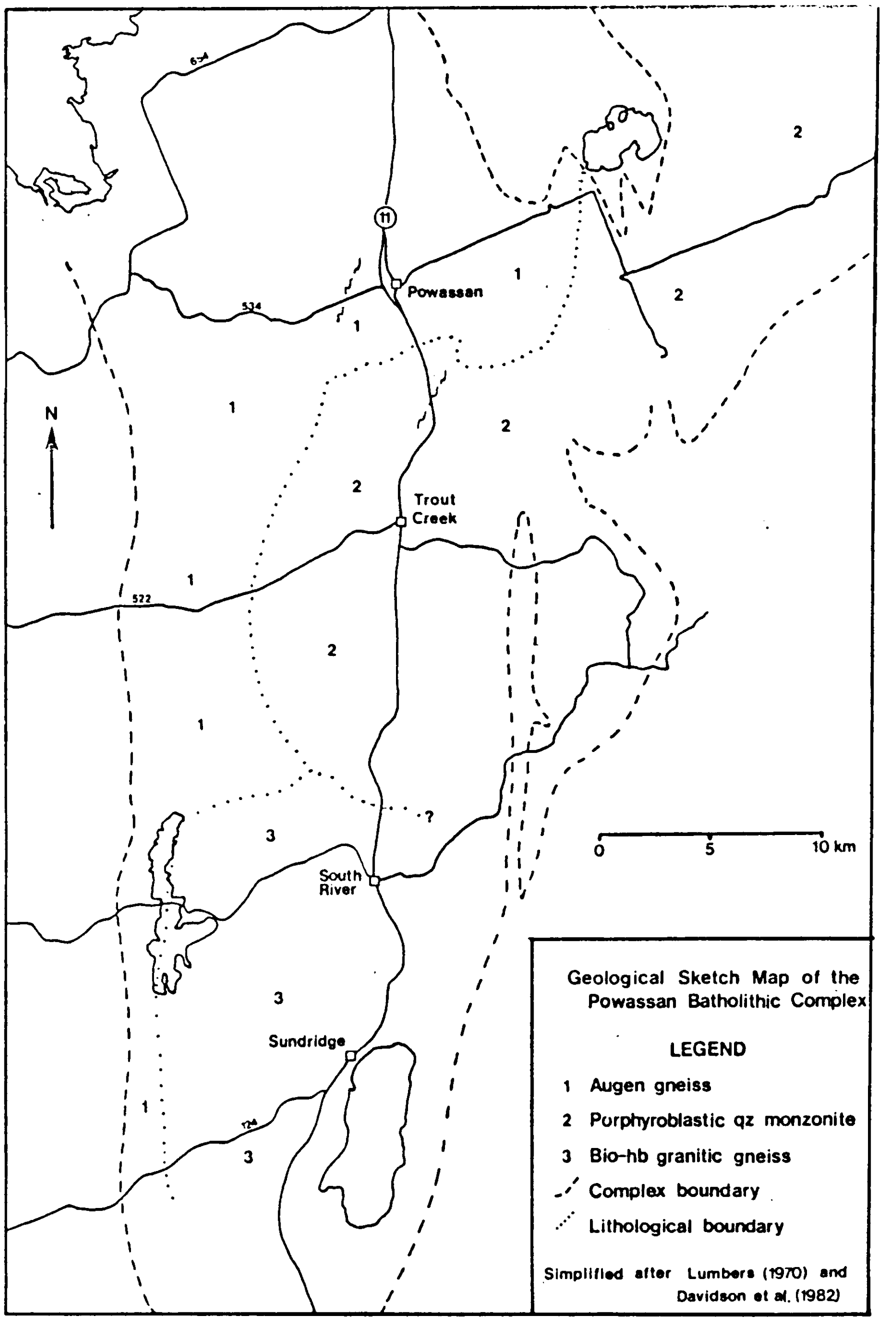


Figure 6.9: Sketch map of the Powassan Batholith showing the distribution of the three major lithologies.

The garnet-hornblende quartz monzonitic rocks dominate the northeastern and central portion of the batholithic complex. They are mineralogically similar to the augen gneisses but are texturally distinct. The rocks are white to pale pink on fresh surfaces. Garnet and hornblende occur as composite porphyroblasts which are evenly distributed throughout, and which impart a readily recognizable spotted texture to the rock.

The biotite-hornblende granitic gneisses are restricted to the southern portion of the batholithic complex. They are distinguished from the monzonitic rocks by their greater modal abundance of quartz (> 20 percent). A crude foliation, resulting from parallel alignment of biotite, is generally recognizable. The granitic rocks commonly contain between 1 and 5 percent garnet, although garnet-free assemblages are not uncommon.

Several less widely distributed rock types, including migmatite and quartz diorite, occur within the Powassan batholithic complex. They were encountered in only a few locations during the reconnaissance and it is not possible to comment on their overall distribution at this time.

Metamorphism and Structure

The mineral assemblages observed during the reconnaissance, and those recorded by Lumbers (1971), leave no doubt that the Powassan batholithic complex has been completely metamorphosed to upper amphibolite and granulite grade. Rocks containing an assemblage diagnostic of granulite facies (clinopyroxene + garnet + hornblende) are apparently restricted to a relatively small area east of the village of Powassan (these are readily recognizable in the field by a distinctive greenish hue). The remainder of the rocks of the Powassan batholithic complex contain assemblages diagnostic of upper amphibolite facies (hornblende + biotite + K-feldspar +/- garnet).

Retrograde metamorphism has affected only a small proportion of the samples studied. In a few localities chlorite replaces hornblende, and muscovite occurs at the grain boundaries of microcline crystals.

During the course of the reconnaissance mapping, several broad northerly trending zones of strong deformation were recognized (see Figure 6.9). These deformation zones have numerous features in common with the ductile shear zones which transect the Central Gneiss Belt (CGB). Features observed in the shear zones within the Powassan Batholithic Complex include: straight gneisses, steeply plunging tight isoclinal folds, complete recrystallization of feldspar augen, and disruption of late pegmatitic dikes (including the formation of feldspar porphyroclasts). Lumbers (1971) observed that a southeast-plunging stretching lineation predominates in the North Bay area. Structural measurements recorded during the reconnaissance survey indicate that stretching lineations within the Powassan Batholith plunge gently toward the northwest. Davidson et al. (1982) attributed the development of southeast-plunging lineations in other parts of the CGB to tectonic transport toward the northwest. Based on these observations, it is probable that the Powassan batholithic complex is allochthonous: it certainly appears to have endured the same structural and metamorphic history as most of the enveloping gneisses and is neither post-tectonic nor post-metamorphic. The change in plunge of the stretching lineations (ie. from southeast to northwest) probably represents either late flexing of the complex, or primary undulations in the plane of thrusting.

Building Stone Potential

Assessing the building stone potential of the Powassan Batholithic Complex is a difficult problem owing to its large size, lithological diversity, and structural complexity. The following general observations concerning its potential can be made:

a) Fabric: There is considerable textural diversity within the Powassan batholithic complex. Weak to moderate foliations and partially recrystallized K-feldspar augen produce attractive and distinctive textures. Foliations and lineations produced by preferred orientation of minerals impart anisotropic strength characteristics to rocks. These strength characteristics may have to be evaluated depending upon the intended use of the stone.

b) Mineralogy: The predominant mineral assemblage in the rocks of the Powassan Batholith is K-feldspar, plagioclase, hornblende, biotite, garnet and quartz. Undesirable minerals (iron sulphides, carbonates) are uncommon. The modal proportion of biotite is generally less than 10 percent and therefore it is not likely to pose problems during polishing.

c) A variety of joints, fractures, veinlets, etc. are present in all rock types. The joint and fracture density varies considerably over comparatively small areas (tens of meters). Some large outcrops have very low joint/fracture densities but no systematic distribution of either joints or fractures could be discerned during the reconnaissance survey. High densities of joints and fractures prevent extraction of large (20 ton) blocks which are currently required by the dimension stone industry. Veinlets and other textural irregularities generally detract from the value of the finished product.

Based on the limited data collected, none of the three lithologic units should be eliminated from future study. Initial indications are that the garnet-hornblende porphyroblastic quartz monzonite has the lowest potential for use as dimension stone. This tentative conclusion is based on:

a) its apparent instability in the weathering environment, manifested by differential weathering (pitting) and by the ubiquitous presence of a rusty weathering rind that penetrates outcrops to a depth in excess of 10 cm. (this stone is probably unsuitable for exterior uses).

b) its poor polishing characteristics (inferred from the sieve texture and fractured nature of the garnets, plucking of garnets during thin section preparation (figure 6.10), and from a single attempt to make a small polished slab which proved far less attractive than the original rough stone.

c) its common tendency to break easily along curved fractures.

The augen gneisses do not suffer from the problems described above. Since this rock type contains between 1 and 15 percent garnet, it may present problems in cutting and polishing. However, the number of garnetiferous products currently on the market suggests that this is not a severe problem. Furthermore, the low quartz content of these rocks compensates in part for the presence of garnet.

Most of the granitic rocks have a moderate to strong foliation produced by aligned crystals of biotite and by elongate crystals (and crystal aggregates) of quartz. These features are certain to result in anisotropic strength characteristics which may have to be evaluated depending of the intended end use of the product.

Recently a variety of gneisses have made an impression on the dimension stone industry. It is possible that some of the contorted gneisses, which occur in the shear zones described

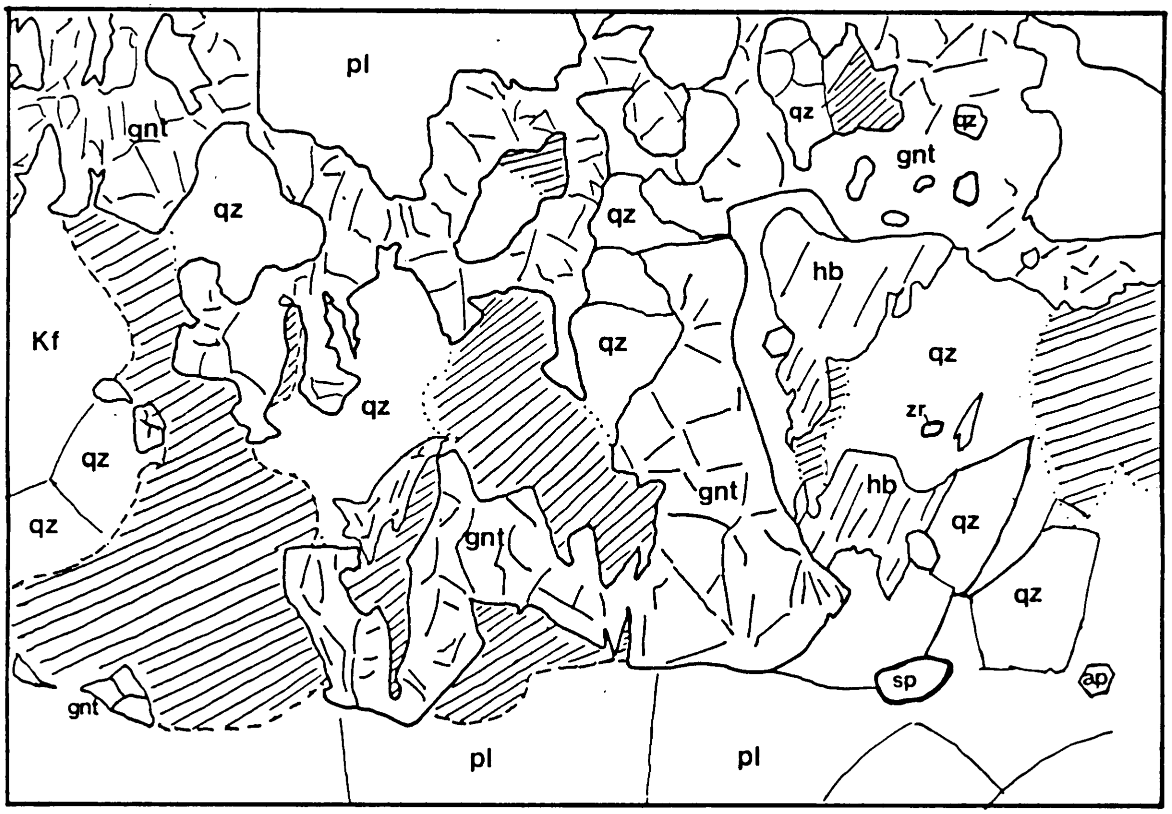


Figure 6.10: Sketch from a photomicrograph showing areas where garnet has been plucked during thin section preparation (diagonal shading). Abbreviations: gnt - garnet, qz - quartz, pl - plagioclase, Kf - K-feldspar, hb - hornblende, ap-apatite, sp - titanite (sphene), zr - zircon. Field of view 3.5 x 2.5 mm.

previously, also have potential applications as building stones.

Further investigation of the building stone potential of the Powassan Batholith is planned for the 1987 field season. Most of the effort will be focussed on the augen gneisses since these rocks are substantially different from most of the commercial stones currently on the market. The field investigation will involve more detailed mapping in the area east of Powassan.

A preliminary study of structural elements and joint and fracture patterns will be conducted. The aim of this study will be to determine whether a predictive model of joint and fracture density can be developed.

Given the structural, textural and mineralogical complexity of the Powassan Batholith, there appears to be no a priori reason why it should be more propective than other felsic-intermediate plutons and orthogneisses; ie. the PowassanBatholith is not a post-tectonic intrusion.

It is planned to reconnoitre other potentially prospective units, particularly those in the Britt Domain, in 1987.

7. SKARNS

Introduction

Lount Township is notable for the large number of mineral occurrences recorded within its boundaries. Most are described by Satterly (1956), who mapped the township during 1953 and 1954. They include copper sulphide, marble and pegmatite occurrences, and magnetite and garnet "skarn" deposits. A number of these were visited by the authors during 1986 in an attempt to make a preliminary assessment of the mineral potential of the area.

Previous Work

Magnetite ore was extracted from a pit in Concession 3, Lot 17 in 1901, when 6,000 tons were shipped. There was only limited geological and exploration work in the area until 1941 when Satterly (1942) mapped the township in the course of his reconnaissance of mineral occurrences in the Parry Sound District. In 1953 an airborne magnetic survey was made of an 800 square mile area, which included Lount Township, to test for the presence of additional magnetite iron deposits. The same year, Satterly conducted a program of geological mapping in order to follow-up on the airborne survey and evaluate the iron occurrences (Satterly, 1956).

Geology

Most of Lount Township, with the exception of the eastern and southeastern margins, is underlain by amphibolitic rocks (Satterly's Unit 2a, Map No. 1955-4), which are likely orthogneisses, but which are difficult to differentiate in the field and form no distinct, readily mappable units. Units of tectonic marble breccia (unit 3) are intercalated with the amphibolite. Mafic (unit 4) and granitic (unit 8) plutonic rocks intrude the amphibolites. This assemblage forms a part of the Parry Sound Domain (Davidson and Morgan, 1981).

The southeastern part of the Township consists largely of granite and granitic gneiss and mappable units of paragneiss: (biotite paragneiss, unit 2p; garnet - biotite gneiss, unit 2pg) and quartzite (unit 2q), which fall within the Kiosk Domain and the ductile shear zone which separates the Kiosk Domain from the Parry Sound Domain.

Magnetite Occurrences

The magnetite occurrences in Lount Township all lie within amphibolites of the Parry Sound Domain, clustered along the old Nipissing Road. Satterly (1956) divided the iron occurrences into three groups:

"1) Garnet hornblende gneiss or garnet amphibolite with disseminated magnetite or narrow seams of massive magnetite.

2) Amphibolite or hornblende gneiss with disseminated magnetite or narrow seams of massive magnetite.

3) Amphibolite with masses of deep red garnet rock and with or without lenses of crystalline limestone or skarns of coarse calcite, epidote and garnet".

Satterly (1956) suggested that magnetite deposits of type 3 formed by the replacement of limestone inclusions in the amphibolite and that types 1 and 2 are higher grade equivalents of these.

Petrographic examination of magnetite-garnet samples collected in 1986 indicate a granulite facies mineral assemblage. Further work would be required to determine whether these rocks are really skarns (ie., the products of contact metamorphism), or simply high grade equivalents of mafic rocks interlayered with calcareous sediments and carbonates, or a combination of both - namely, regionally metamorphosed skarns.

Analyses of grab samples of magnetite reported by Satterly (1956) revealed only traces of vanadium, nickel and chromium. He also concluded that the deposits were too small to be of economic importance either as sources of iron or these other associated elements.

During 1986 the authors visited eight "skarn" occurrences: Con 3, Lot 17; Con 8, Lot 22; Con A, Lot 126; Con A, Lot 129; Con A, Lot 136; Con A, Lot 133; Con B, Lot 129; Con B, Lot 145. Most of the pits are poorly exposed, and at some distance from the nearest outcrops. Consequently it is not possible to obtain a good impression of the geological setting of the iron showings and the reader is referred to Satterly (1956) for descriptions of the iron and garnet occurrences, which were better exposed at the time of his mapping. Several samples were collected and analyzed during 1986, and the results are presented in table 7.1.

Anomalous levels of vanadium appear to be associated with titanium in samples from Con B, Lot 145, whence Satterly also reported comparable titanium values. High vanadium values were also obtained from a magnetite-bearing sheared gabbro from near the northern contact of the Whitestone Anorthosite (E.G. Bright, Geologist, Ontario Geological Survey, personal communication, 1987).

Copper-Gold Occurrences

In addition to the magnetite occurrences, there are also a few minor base metal showings in Lount Township. One of these was visited in Concession 5, Lot 14, on the farm of Carmen Maeck. Slightly anomalous values of gold had previously been reported from this location (Villard et al., 1984), and higher values were obtained by the authors' sampling in 1986 (Table 7.1). The anomalous gold values occur in irregular narrow stringers of chalcopyrite, pyrite and pyrrhotite which lie sub-parallel to the foliation of the enclosing gneisses. The host rocks are amphibolite to granulite grade gneisses composed of variable proportions of clinopyroxene, orthopyroxene, hornblende, garnet, plagioclase, microcline, epidote, calcite and quartz. Reaction rims between clinopyroxene and plagioclase consist of hornblende, followed by an epidote-quartz symplectic intergrowth, garnet and calcite.

The skarn-type magnetite and garnet (and minor metallic mineral) occurrences seen in Lount Township are an enigma. Their genesis and geological setting are poorly understood, and while the cluster of showings invites interest, previous results suggest that the deposits are very small. A geological breakthrough in understanding the area (or a mineral discovery) is needed to provide the stimulus for further work. The problem will be reviewed in the course of investigations of marble in the area.

Table 7.1 Chemical Analyses, Skarn-type Magnetite - Garnet Deposits of the Parry Sound Domain.

Sample No.	SiO2	Al2o3	Fe2o3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	CO2	S	LOI	Total
86CCM-0273	27.70	5.01	36.50	7.61	7.09	0.34	0.35	13.90	0.01	0.28	0.07	0.32	-1.00	97.80
86CCM-0275	22.40	5.57	43.40	4.62	5.68	0.67	0.38	16.90	0.02	0.30	0.16	0.05	-0.90	99.00
86CCM-0276	25.60	3.39	41.80	7.42	6.74	0.33	0.04	15.70	0.02	0.29	0.11	0.12	-1.40	99.90
86CCM-0313	45.20	8.40	24.20	0.79	18.60	0.12	0.02	0.12	0.07	0.27	0.11	0.70	1.70	99.50
86CCM-0315	14.50	1.41	78.40	1.12	4.34	0.60	0.01	0.35	0.07	0.10	0.10	0.10	-2.20	98.70
86CCM-0361	38.40	5.01	32.10	8.03	10.30	1.01	0.13	5.22	0.05	0.28	0.23	0.03	-1.00	99.80
86CCM-0321	31.20	3.77	27.80	4.10	15.70	0.08	0.21	0.28	0.02	0.25	5.68	8.37	4.40	97.80

	Co	Cr	Cu	Ni	Pb	Zn	V	Au	Pt	Pd
86CCM-0273	60.00	14.00	22.00	14.00	-10	155.00	1354.00	-2	-1	-1
86CCM-0275	54.00	12.00	9.00	15.00	-10	135.00	1017.00	-2	-1	-1
86CCM-0276	44.00	12.00	10.00	6.00	-10	135.00	1402.00	-2	-1	-1
86CCM-0313	41.00	21.00	220.00	60.00	-10	36.00	129.00	-2	5.00	5.00
86CCM-0315	66.00	18.00	9.00	148.00	-10	78.00	306.00	5.00	-1	-1
86CCM-0361	70.00	73.00	36.00	16.00	-10	215.00	1495.00	-2	-1	-1
86CCM-0321	76.00	16.00	3.58P	106.00	-10	420.00	not ass	210.00	-1	-1

P=percent

Co, Cr, Cu, Ni, Pb, Zn by AA; V by ICP; Results in ppm.
Au, Pt, Pd by AA; Results in ppb.

Ontario Geological Survey, Geoscience Laboratories, Toronto.

86CCM-0273 Lount Tp., Con. B, Lot 145; 2-pyroxene-hornblende-magnetite/ ilmenite skarn, north pit.

86CCM-0275 as above, south pit.

86CCM-0276 as above, south pit.

86CCM-0313 Lount Tp., Con. B, Lot 136., garnet-quartz-epidote-cpx-magnetite "skarn"; minor pyrite and titanite.

86CCM-0315 Lount Tp., Con. B, Lot 136., semi-massive magnetite-epidote-cpx/hornblende skarn.

86CCM-0361 McKenzie Tp., Con.1, Lot 13; magnetite-rich pod of gabbro at sheared contact of Whitestone anorthosite.

86CCM-0321 Lount Tp., Con. 5, Lot 14; cpx/hornblende-garnet-plagioclase--epidote and quartz symplectite-magnetite gneiss-with stringers of pyrite and chalcopyrite.

8. CONCLUSIONS

This report presents the results of the first year's work in a three year program to evaluate the mineral potential of the Huntsville-Parry Sound-Powassan area. The emphasis is on industrial minerals, but all potentially economic commodities are being considered, including rare earth elements and precious metals. While it is recognized that marketing is a critical aspect of the industrial minerals business, the current program will focus on the geological aspects: because the geology of the area is so poorly known, it is appropriate to first define whether there is anything in the area worth marketing.

Because the geology, particularly the structure, is very complex, it is to be expected that mineral deposits will also be complex. This has been clearly demonstrated in the case of the calcitic marble deposits northeast of Parry Sound. However, an understanding of the structure and mineralogy has the potential to turn a less than ideal deposit into a mine, since the structures, though complex, are predictable. The texture and mineralogy suggest that the marble should be amenable to beneficiation to produce fairly high quality products. Although previous attempts to develop these deposits were unsuccessful, the mill circuits employed were fairly simple, and it is possible that the addition of, for example, a wet grinding circuit or electromagnetic separators, could make all the difference. There are a number of marble or limestone operations in the world which make money by producing high quality products from impure raw materials, using such technology. Consequently, investigation of milling processes which could be applied to mineral deposits in the study area will be an integral part of the project.

Hence, the objective of the study is initially to identify potentially economic resources, define their extent and grade, and then to demonstrate how they might be successfully exploited.

The marketing aspects will be considered in the future. Suffice it to say here that the study area is located some 200 to 300 km from Toronto, and that the area is well serviced by road and rail, by hydro electricity, and has access to Lake Huron. Consequently, it is favourably located to take advantage of major markets in southern Ontario and the northern United States.

While various conclusions have been drawn in the respective sections of this report, the following notes serve to put things in perspective.

Of the commodities investigated during 1986, the most promising appear to be to be the anorthosites, followed by the marbles. Some of the anorthosites contain less than 5% mafic minerals. Such material (as well as some of the more mafic anorthosite) is likely to be amenable to beneficiation, and produce a white plagioclase (+/- scapolite) product suitable for use in the insulation industry and, potentially, the glass and filler industries. Future work will attempt to define strategically located areas of an appropriate and consistent composition. (Geological constraints similar to those which apply to the marbles also apply to the anorthosites). Another COMDA program will investigate the potential industrial applications of such material and research available information on its processing.

The marbles have been discussed, in part, above. Future work will attempt to define their compositional and structural variations, in order to identify the areas most likely to contain calcitic and/or dolomitic marble with a minimum of waste material.

It would be premature to dismiss the pegmatites as potential sources of REE, silica, feldspar, mica or rare elements. However, the ones investigated to date appear to be too small to warrant further exploration. It should be noted, however, that some commodities, for example high purity silica, command a very high price, and consequently a deposit containing such material need not be very large. The deposits not visited during 1986 will be investigated as a matter of routine in concert with other aspects of the program.

The building stone component of the program has both specific and general aspects. The specific targets are the coronitic metagabbros, which have a limited size and whose locations are known. They are thus relatively simple to evaluate. The general component of the program includes the Powassan Batholithic Complex, and other large and small plutonic bodies distributed throughout the study area. These are potential sources of conventional dimension stone, but their very size presents a problem in evaluation. However, they have been subjected to complex metamorphism and tectonism. Consequently their mineralogy and texture are highly variable, and some parts of the bodies have been converted to strongly foliated and contorted gneisses. A more general regional overview of the "granites" is required before concentrating on specific areas. Investigation of the "marble-like" gneisses with interesting textures will begin in the 1987 field season. Additional investigations of flagstone and gneisses will be undertaken within the framework of the COMDA "Mid-Ontario Building Stone Project".

The skarn-type magnetite and garnet (and minor metallic mineral) occurrences seen in Lount Township are an enigma. Their genesis and geological setting are poorly understood; and while the cluster of showings invites interest, previous results suggest that the deposits are very small. A geological breakthrough in understanding the area is needed to provide the stimulus for further work. The problem will be reviewed in the course of investigations of marble in the area.

The commodities studied in 1986, as discussed above, were selected partly because they had known potential industrial applications, and partly because they had been identified and their locations were known: much of the area remains poorly understood. Consequently, in addition to following up on some of the 1986 work, some effort will be spent in 1987 in attempting to identify new targets. These will include ultramafic and mafic intrusions (potential for Pt-Pd, Au, olivine, talc, tremolite, Cr); possible alkaline intrusive rocks along strike from the Pickerel Lake Complex and Bigwood Township Nepheline Syenite (Lumbers, 1976) which have potential for rare earth elements and the glass, ceramic and filler industries; quartzites (silica); pelitic gneisses (graphite, garnet, aluminosilicates); and various potential building stones, with an emphasis on gneisses.

APPENDICES

APPENDIX 1

An annotated list of research currently in progress in the Ontario Segment of the Central Gneiss Belt south of French River and Lake Nipissing.

L. Tremblay and G. MacRoberts of the OGS will map an FRI sheet in the Parry Sound Domain during 1987.

A. Davidson of the GSC is studying the structure and lithology along a traverse across the Central Gneiss Belt along the coast of Georgian Bay. In 1987 he will start at the northern part of the Bay, and his area of study will extend as far east as Highway 69.

H. Koral and J. Starkey, of the University of Western Ontario, are conducting studies in the Whitestone Anorthosite.

M. Van Kranendonk of the University of Toronto is studying the controls of anorthosite emplacement in the Moon River Synform.

W.G.W. Maitland and J.C. White of the University of New Brunswick are studying subsolidus phenomena in pyroxenes from granulite facies gneisses in the McKellar area.

T.W. Needham of Queens University in Kingston is studying gabbroic bodies in the Britt Domain.

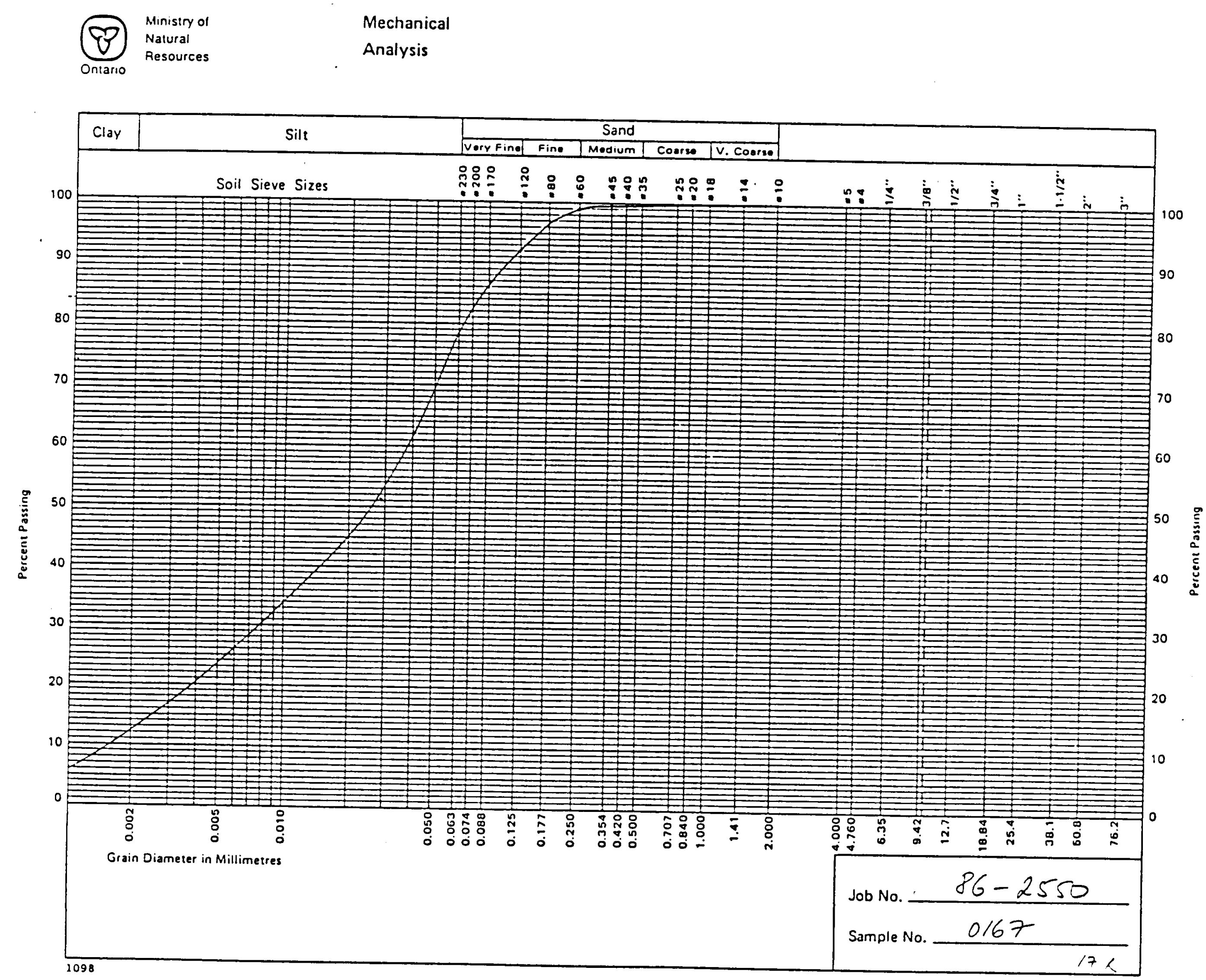
W.M. Schwerdtner of The University of Toronto is studying decollement and fold structures in several parts of the Central Gneiss Belt west of Algonquin Park.

R.M. Stesky, University of Toronto, Erindale Campus, has conducted an analysis of lineaments and faults in the Ontario Grenville Province from a series of LANDSAT photographs.

J.C. White, C.K. Mawer and M.L. Tremblay (M. Sc. Thesis) of the University of New Brunswick are studying recrystallization and associated exsolution textures in perthites associated with deep crustal thrusting along the Parry Sound shear zone.

APPENDIX 2

Size fraction analysis of pulverized marble, Cononaco Mines Limited, Waubamik Mill Site.



* Note that there is likely to have been contamination of the pulverized material in the period since it was processed, but the data is included here in order to provide a qualitative impression of the product. Analysis by Ontario Geological Survey, Geoscience Laboratories, Toronto.

APPENDIX 3.

Summary of Results of Metallurgical Tests performed on drill core samples of Marble from Lount Township, Con. 1, Lot 26.

A composite marble sample submitted by Pominex Ltd. to Lakefield Research (Report LR 2355) assayed as follows:-

$CaCO_3$	76.3
MgO	0.72
SiO_2	16.64
Al_2O_3	3.45
Fe_2O_3	1.4
Undetermined	1.49

The marble was crushed. Microscopic examination of the calcite concentrate showed the presence of the diluent minerals feldspar, quartz, actinolite, sphene, possibly anhydrite, opaque inclusions in the silicate minerals, and two or three unidentified species. Liberation appeared to be complete at minus 100 mesh.

Flotation and high intensity magnetic separation yielded a product containing 81.9% calcite, 0.42% Fe_2O_3 and 10.8% SiO_2, the balance of 6.88% undetermined. Most of the impurities were concentrated in the coarse fraction. Lakefield recommended further testing to evaluate the effects of grinding on the upgrading efficiency as well as alternative flotation schemes.

The concentration of impurities in the coarse fraction has also been observed at Steep Rock's Tatlock mine, and consequently much beneficiation is achieved simply through grinding and screening.

APPENDIX 4.

Summary of Analytical Results of Pulverized Marble, McKellar Township.

The following table lists the chemical analyses and physical qualities of milled material from the McKellar marble occurrence (assays of the core before processing are not available).

	"10 Micron Grade"	"-325 Mesh Grade"
$CaCO_3$	97.40 %	97.45 %
$MgCO_3$	0.24	0.20
Fe_2O_3	0.39	0.29
Al_2O_3	0.26	0.17
SiO_2	1.38	1.51
Cu	0.0014	0.0014
MnO	0.0112	0.0105
LOI	0.3	0.13
Water Soluble salts as Na_2CO_3	0.41	0.41

		"10 Micron Grade"	"-325 Mesh Grade"
Brightness, green filter		83.5	84.5
Fineness, Hegman		4	2
Loose Bulk Density 20 gm	(cc)	27.5	19.1
Apparent Density	(lb/cu ft)	45.4	65.3
Oil Absorption Rub Out	(lb/100lb)	27	22
Specific gravity		2.73	2.73
Specific resistance		9.0	9.1

General Particle Shape: irregular, rectangular, rhomboid.

Particle Size Distribution:

	"10 Micron Grade"	"-325 Mesh Grade"
% less than 44 microns	100	85
30	98	74
20	96	61
15	92	50
10	86	39
5	55	23
1	13	11

Analyses performed by J.T. Donald Inspection Laboratory, Toronto.

APPENDIX 5.

Marble Analysis, Spence Township, Con. 14, Lot 18.

The results of analyses made by Lakefield Research of Canada Limited in 1975 of three marble samples collected from Burcal Mining Limited's pit in Spence Township by Consolidated Canadian Faraday Ltd. are summarized below:-

HEAD ASSAYS:

	Sample"L"	"Impure S"	"Pure S"
CaO acid soluble	46.3	37.7	48.2
CaO total	48.1		-
MgO total	0.78		1.26
CO2	36.4		-
Acid Insoluble	14.2		11.5
C elemental	0.76		"low"
Fe total	0.55		0.5

The sample contained calcite as the major constituent, with microcline, orthoclase, graphite, diopside, quartz, actinolite, sphene and a trace of chlorite.

Different tests were performed on the recovery of calcite from these samples, including crushing, pulverising, flotation, screening, magnetic separation and electrostatic separation.

Using only flotation and grinding, sample "Pure S" produced a concentrate with the following composition:

Total carbonates (Bidtel method)	98.13%
Total carbonates (CO_2 method)	98.52
$CaCO_3$	96.68
$MgCO_3$	1.80
Fe_2O_3	0.40
Al_2O_3	0.18
SiO_2	0.48

Recovery was 85.7%, with 99.2 % passing 325 mesh (44 microns). The particle size distribution was:

Finer than 44 microns	-	99.2 %
30	-	95.8
25	-	91.2
20	-	82.0
12	-	59.0
10	-	52.0

The physical characteristics of the ground product were as follows:

Specific Gravity	2.74
pH of Saturated Sol.	8.75
Oil Absorption, lb/100lb	23.1
Dry Brightness cpw $MgCO_3$	89%
Bulk Density (loose) lb/cu.ft.	30.6
Bulk Density (compacted) lb/cu. ft.	84.9
Specific Surface area (sq cm/g)	5318

Flotation of sample "impure S" yielded a product containing 91.6% calcite with a recovery of 92.7%, while a product containing 96.8% calcite at a recovery of 89.7 % was made from sample "L".

Lakefield noted that graphite was detrimental to the brightness of the final calcite product, although graphite was readily separated from the calcite by the electrostatic method in the +150 mesh fraction. Flotation was also effective in separating the graphite from the calcite, but the graphite was slow floating, and 7-8% calcite was lost in this flotation product.

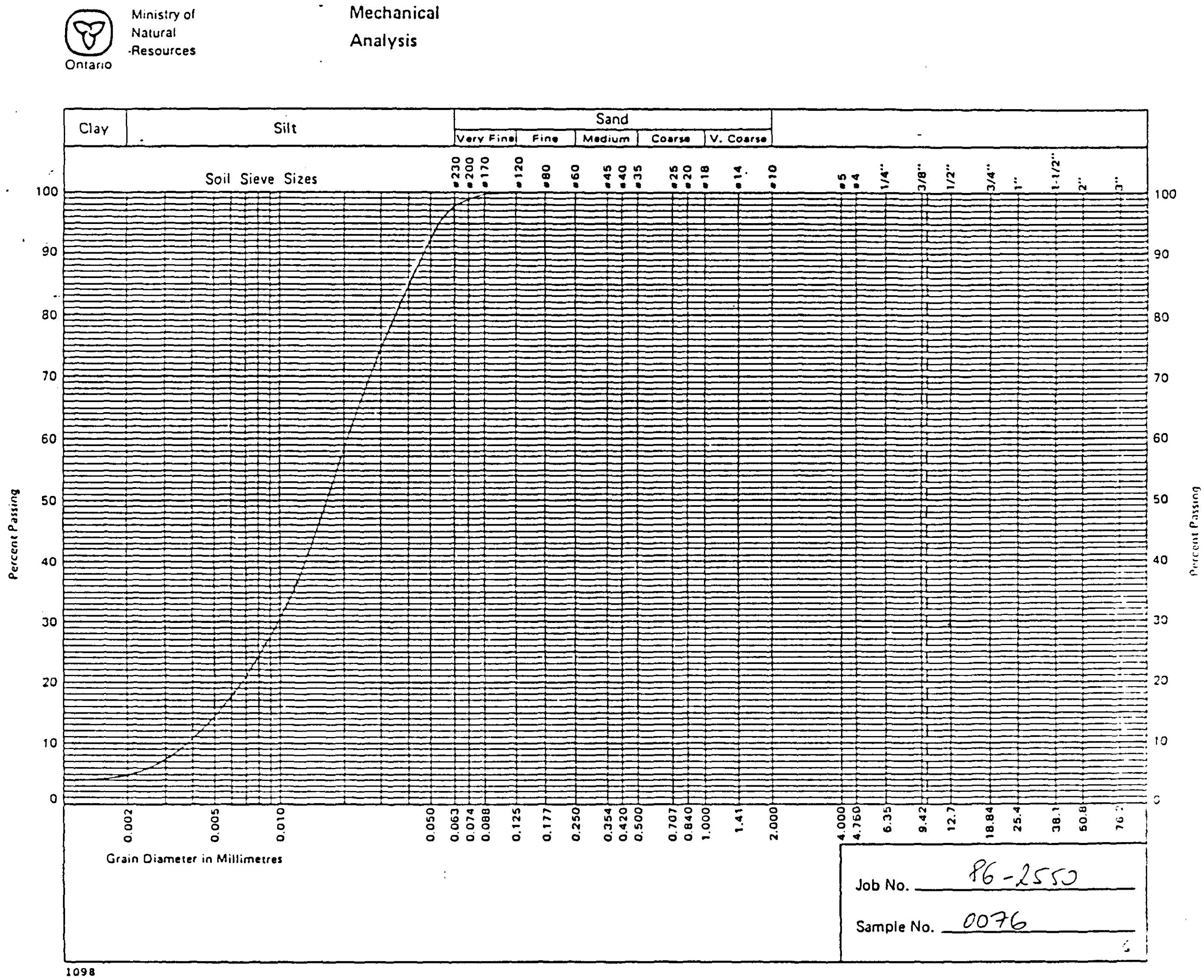
Diopside, actinolite and chlorite were readily separated from the calcite by high intensity magnetic separation.

Brightness values obtained should be considered as minimum values owing to the small sample size and contamination from equipment used.

APPENDIX 6.

Size fraction Analysis of Pulverized Marble,

Burcal Mines Limited, Mill Site, Burk's Falls.



* Note that there is likely to have been contamination of the pulverized material in the period since it was processed, but the data is included here to give a qualitative impression of the product. Analysis by Ontario Geological Survey, Geoscience Laboratories, Toronto.

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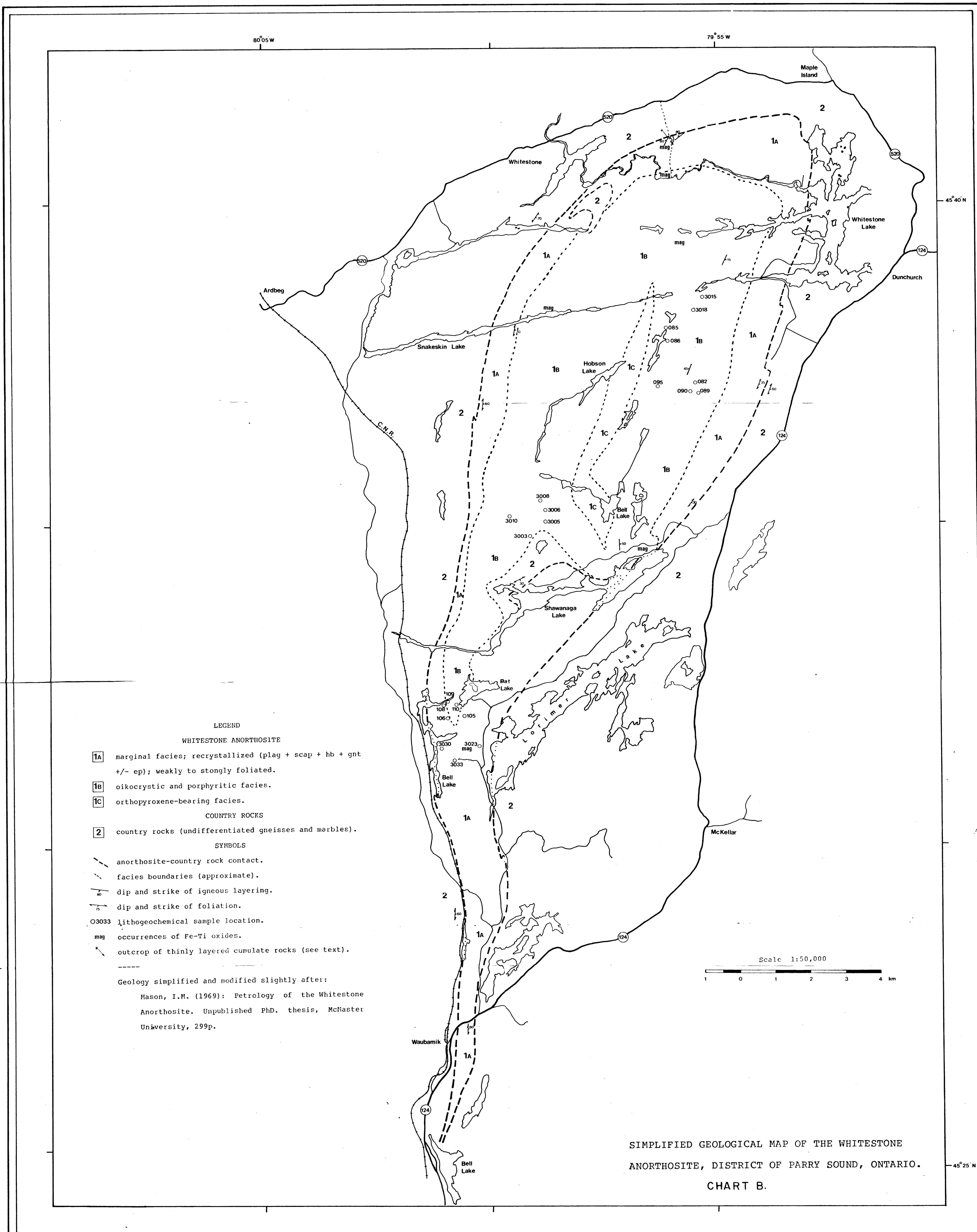
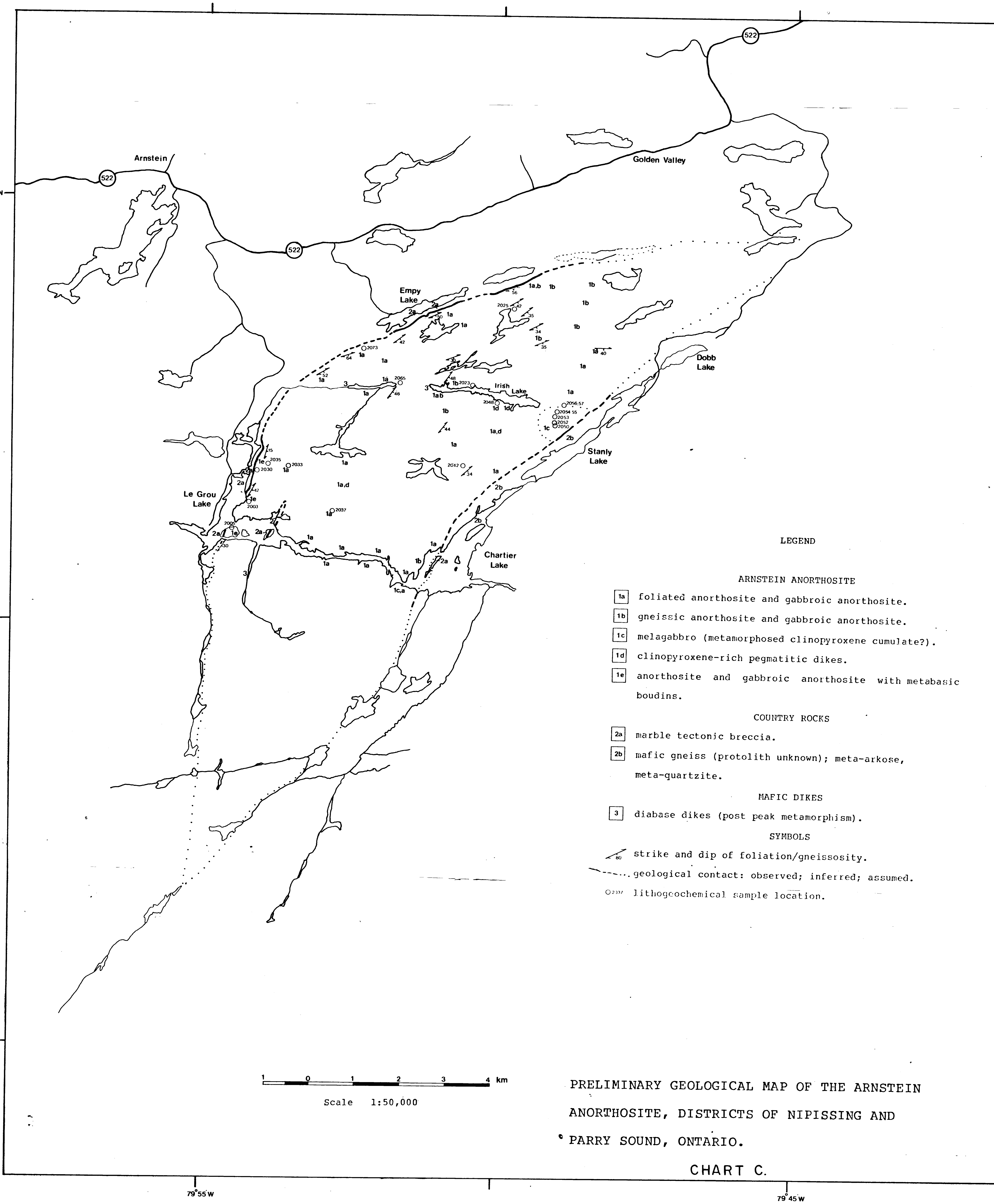


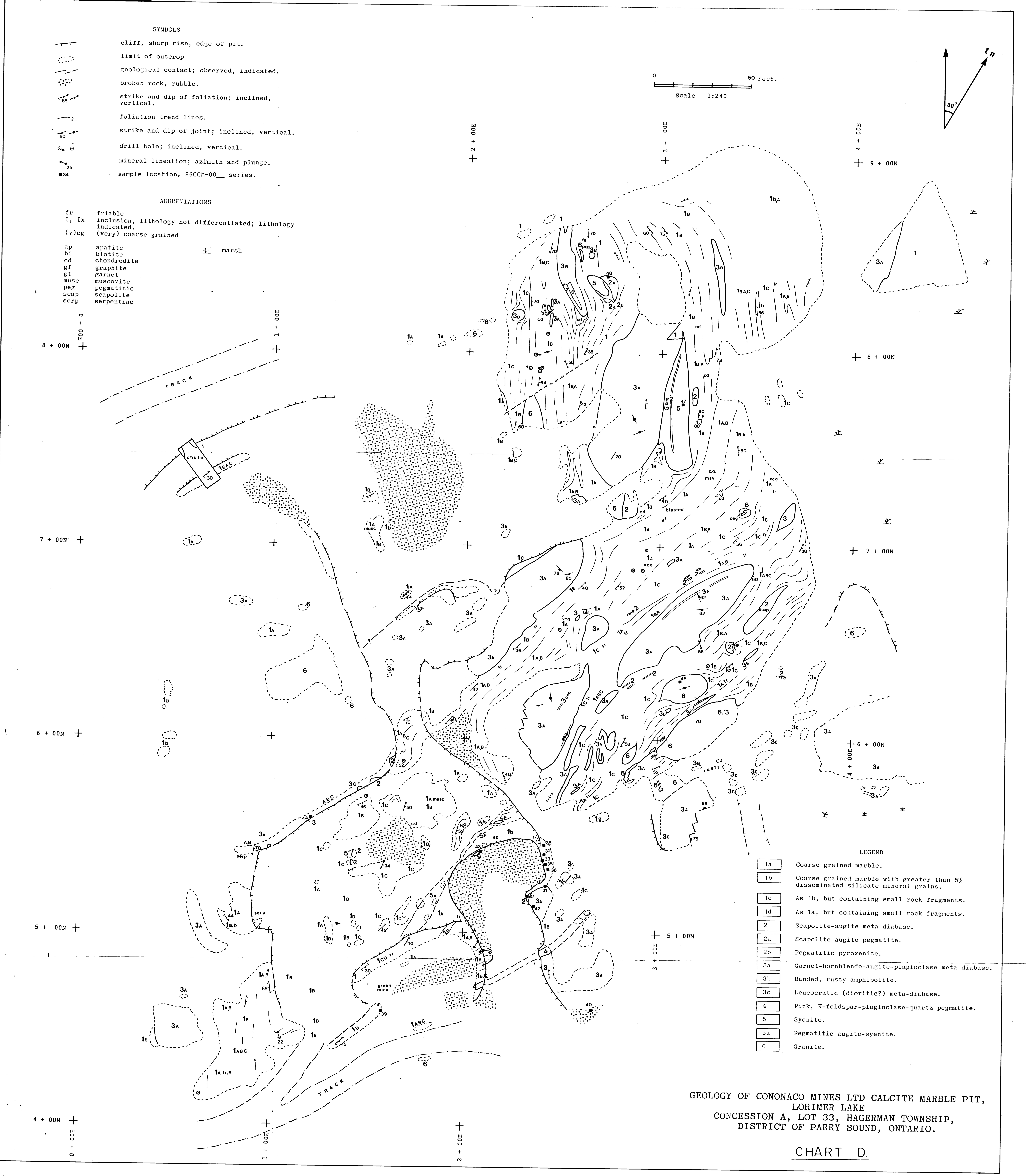
SIMPLIFIED GEOLOGICAL MAP OF THE WHITESTONE ANORTHOSITE, DISTRICT OF PARRY SOUND, ONTARIO.

CHART B.



PRELIMINARY GEOLOGICAL MAP OF THE ARNSTEIN ANORTHOSITE, DISTRICTS OF NIPISSING AND PARRY SOUND, ONTARIO.

CHART C.



GEOLOGY OF CONONACO MINES LTD CALCITE MARBLE PIT,
LORIMER LAKE
CONCESSION A, LOT 33, HAGERMAN TOWNSHIP,
DISTRICT OF PARRY SOUND, ONTARIO.

CHART D.

0 50 ft

SCALE
1:240

LEGEND

1a	Coarse grained marble.
1b	Coarse grained marble with greater than 5% disseminated silicate mineral grains.
1aIx	As 1a, but containing small rock fragments of type indicated by subscript.
1bIx	As 1b, but containing small rock fragments of type indicated by subscript.
2	Augite amphibolite: meta diabase.
3b	Banded, rusty amphibolite.
7	quartzite.
8	augite granite.
9	diopsidic granite.
10	biotite syenite.

SYMBOLS

- cliff, sharp rise, edge of pit.
- limit of outcrop
- geological contact; observed, indicated.
- broken rock, rubble.
- 65 strike and dip of foliation; inclined, vertical.
- foliation trend lines.
- 80 strike and dip of joint; inclined, vertical.
- drill hole; inclined, vertical.
- 25 mineral lineation; azimuth and plunge.

ABBREVIATIONS

fr	friable
I, Ix	inclusion, lithology not differentiated; lithology indicated.
(v)cg	(very) coarse grained
ap	apatite
bi	biotite
cd	chondrodite
gf	graphite
gt	garnet
musc	muscovite
peg	pegmatitic
scap	scapolite
serp	serpentine

marsh

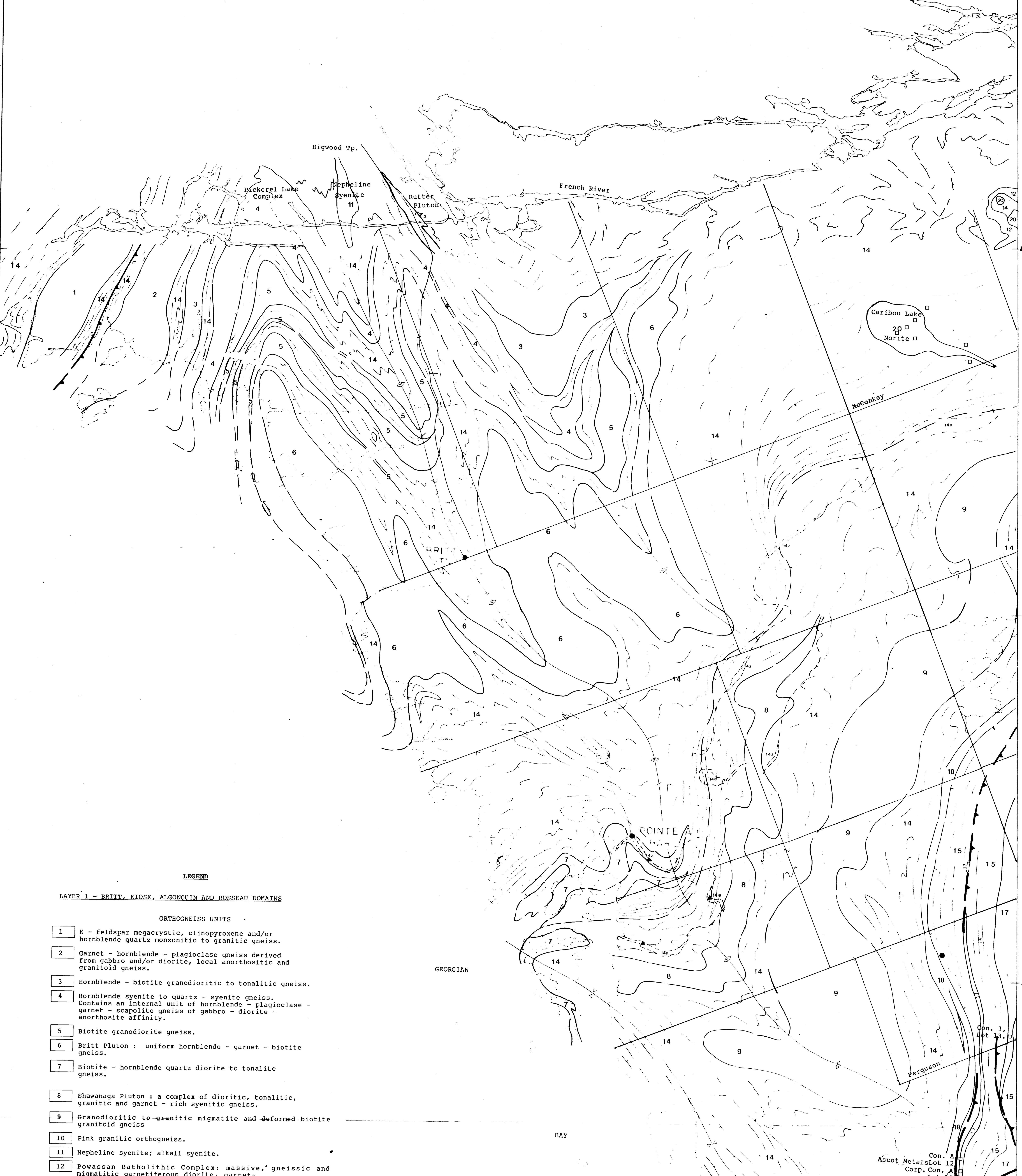
PRELIMINARY GEOLOGICAL MAP
OF
BURCAL MINES LTD CALCITE MARBLE PIT,
ORANMORE,
CONCESSION 14, LOT 18, SPENCE TOWNSHIP
DISTRICT OF PARRY SOUND, ONTARIO.

CHART E.

1 point
00 pen

SIMPLIFIED GEOLOGY AND STRUCTURE, AND SELECTED MINERAL OCCURRENCES OF THE PARRY SOUND-HUNTSVILLE-POWASSAN AREA

Chart A, east half.



LEGEND

LAYER 1 - BRITT, KIOSK, ALGONQUIN AND ROSSEAU DOMAINS

ORTHOGNEISS UNITS

1	K - feldspar megacrystic, clinopyroxene and/or hornblende quartz monzonitic to granitic gneiss.
2	Garnet - hornblende - plagioclase gneiss derived from gabbro and/or diorite, local anorthositic and granitoid gneiss.
3	Hornblende - biotite granodioritic to tonalitic gneiss.
4	Hornblende syenite to quartz - syenite gneiss. Contains an internal unit of hornblende - plagioclase - garnet - scapolite gneiss of gabbro - diorite - anorthosite affinity.
5	Biotite granodiorite gneiss.
6	Britt Pluton : uniform hornblende - garnet - biotite gneiss.
7	Biotite - hornblende quartz diorite to tonalite gneiss.
8	Shawanaga Pluton : a complex of dioritic, tonalitic, granitic and garnet - rich syenitic gneiss.
9	Granodioritic to ~~granitic~~ migmatite and ~~deformed~~ biotite granitoid gneiss
10	Pink granitic orthogneiss.
11	Nepheline syenite; alkali syenite.
12	Powassan Batholithic Complex: massive, gneissic and migmatitic garnetiferous diorite, garnet-hornblende monzonite, quartz monzonite and biotite leucogranite (Kiosk Domain).
13	Granitoid orthogneiss: hypersthene-bearing granodiorite to quartz monzonite (Rosseau Domain).

PARAGNEISS COUNTRY ROCKS

14	Quartzo-feldspathic gneiss, including "meta-arkose".
14a	Semi-pelitic gneiss (hornblende - biotite - plagioclase - quartz with red garnet); quartzite; pelitic gneiss (containing sillimanite and/or kyanite, biotite, **graphite**, pyrite, violet - pink garnet, and lacking hornblende).
14b	Undifferentiated orthogneiss and paragneiss of Huntsville and Novar subdomains (see Davidson et al. 1985).

LAYER 2 - PARRY SOUND DOMAIN

15	Paragneiss, amphibolite. Mafic gneisses of volcanic and/or plutonic parentage; minor quartzo-felspathic gneiss, quartzite and alumino-silicate-bearing gneiss.
16	Marble tectonic breccia.
17	Anorthosite, gabbroic anorthosite, leucogabbro.
18	Metagabbro, metadiorite, metatonalite (enderbite), granodiorite, granite.

LAYER 3 - SEGUIN AND MOON RIVER DOMAINS

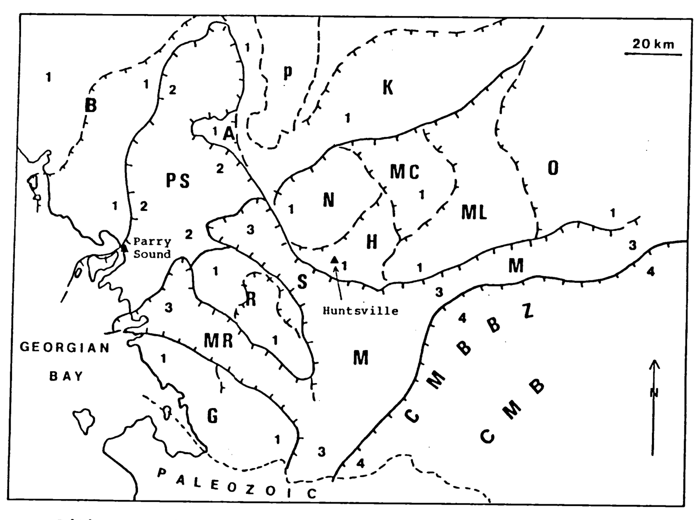
19	Migmatitic, felsic and intermediate orthogneiss, quartz syenite, anorthosite and gabbro; migmatitic paragneiss including marble, calc-silicate rocks, pelites and meta-arenite.

MAFIC INTRUSIVE ROCKS

20	Syn-tectonic to late-tectonic mafic intrusive rocks.
21	Diabase dikes, east-west trending (not shown).

PALAEOZOIC

22	CAMBRIAN: nepheline syenite, carbonatite.
23	ORDOVICIAN: dolomite.



Lithotectonic domains and subdomains of the Central Gneiss Belt (after Davidson and Grant, 1986). CMBBZ - Central Metasedimentary Belt Boundary Zone. Numbers refer to stacking order.

Stack 1:	DOMAINS: B - Britt, K - Kiosk, A - Ahmic, Subdomains of the Algonquin Domain: Huntsville (H), McCraney (MC), McClintock (ML), Opeongo (O) and Novar (N) subdomains) Subdomains of the Muskoka Domain: R - Rosseau and G - Go Home. p - Powassan Batholithic Complex
Stack 2:	Parry Sound Domain.
Stack 3:	M - Muskoka Domain (including the Moon River (MR) and Seguin (S) subdomains, but excluding the Go Home and Rosseau subdomains).
Stack 4:	Central Metasedimentary Belt (CMB), including the CMB Boundary Zone.

MINERAL OCCURRENCES AND AREAS OF MINERAL POTENTIAL

17	Anorthosite Suite - (High - Al ceramics, Building stone, PGE?)
16	Marble - (Lime, Cement, Filler)
□	Pegmatite - (REE, U, Th, Silica, Feldspar)
O 20	Syn-tectonic and late tectonic mafic intrusions including coronitic metagabbro (Building stone; Au - PGE - Base metals).
12	Powassan Batholithic Complex - (Building Stone)
	Ductile Shear Zones - (Flagstone)
14a	Graphitic and/or pelitic and/or semi-pelitic units- (garnet, aluminosilicates). Triangles indicate occurrences containing notable concentrations of graphite.
●	Ultramafic Intrusions - (PGE, Base metals, Olivine)
⊕ 15	Mafic Gneisses of the Parry Sound Domain - (Base metals, Precious metals, PGE)

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EXPLANATION

That portion of Chart A, east half and west half, which lies south of latitude 46°00′N, is derived largely from the results of reconnaissance mapping by Davidson and co-workers, and is enlarged from data at a scale of 1:250,000. Consequently some geological contacts may not be accurately located. Furthermore some lines are schematic, notably the boundaries of the domains and sub-domains, since these are tectonite zones with widths ranging up to several kilometers.

The geology north of latitude 46°00′N is simplified from Lumbers (1971, 1975), who mapped at a scale of 1:126,720.

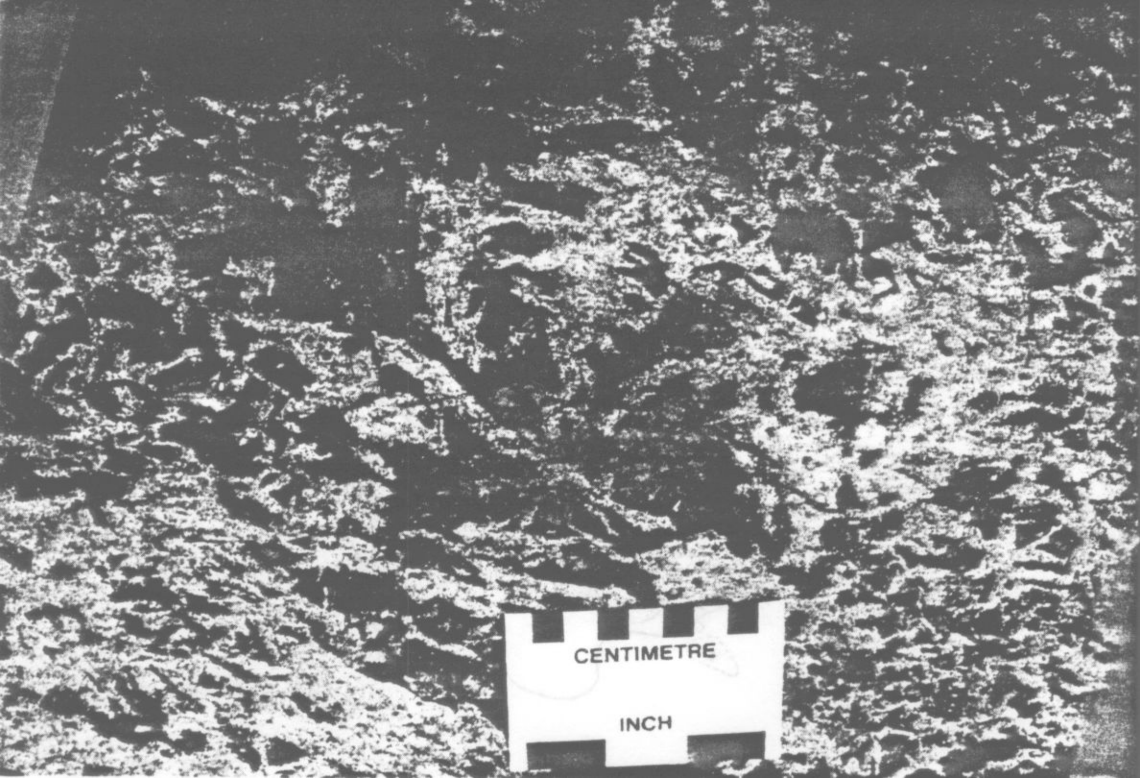
Refer to text for detailed references and a summary of geology.

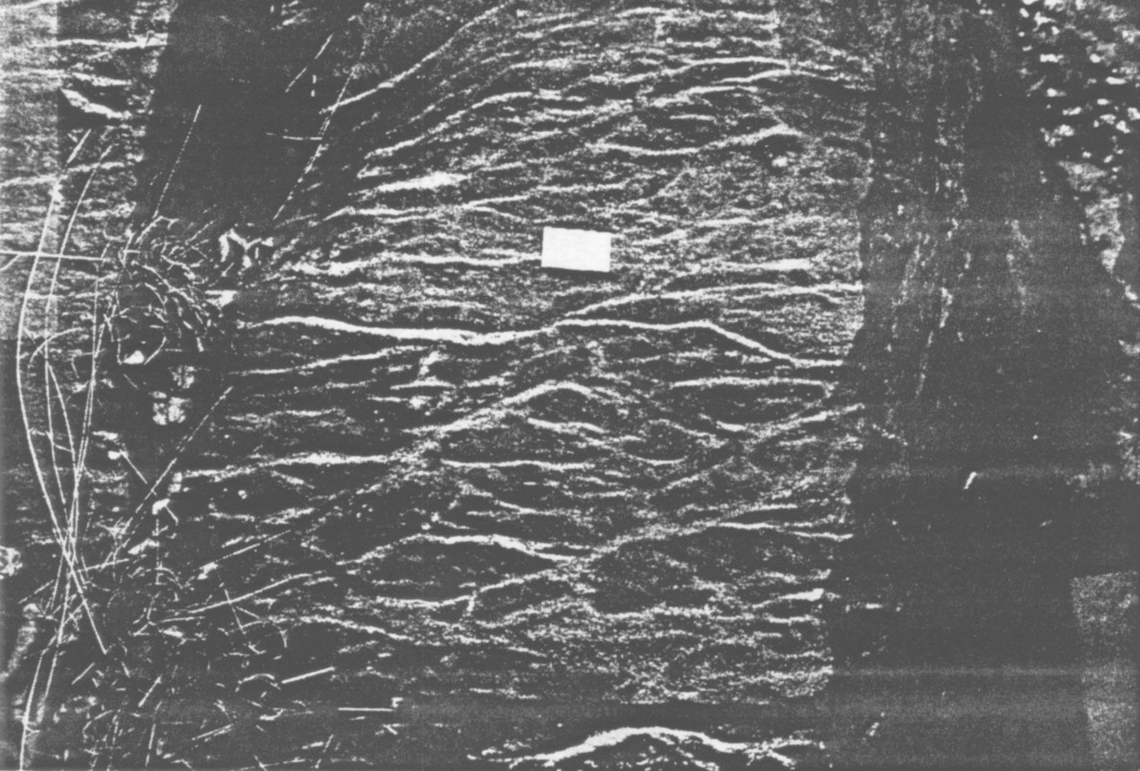
0 5 10 km

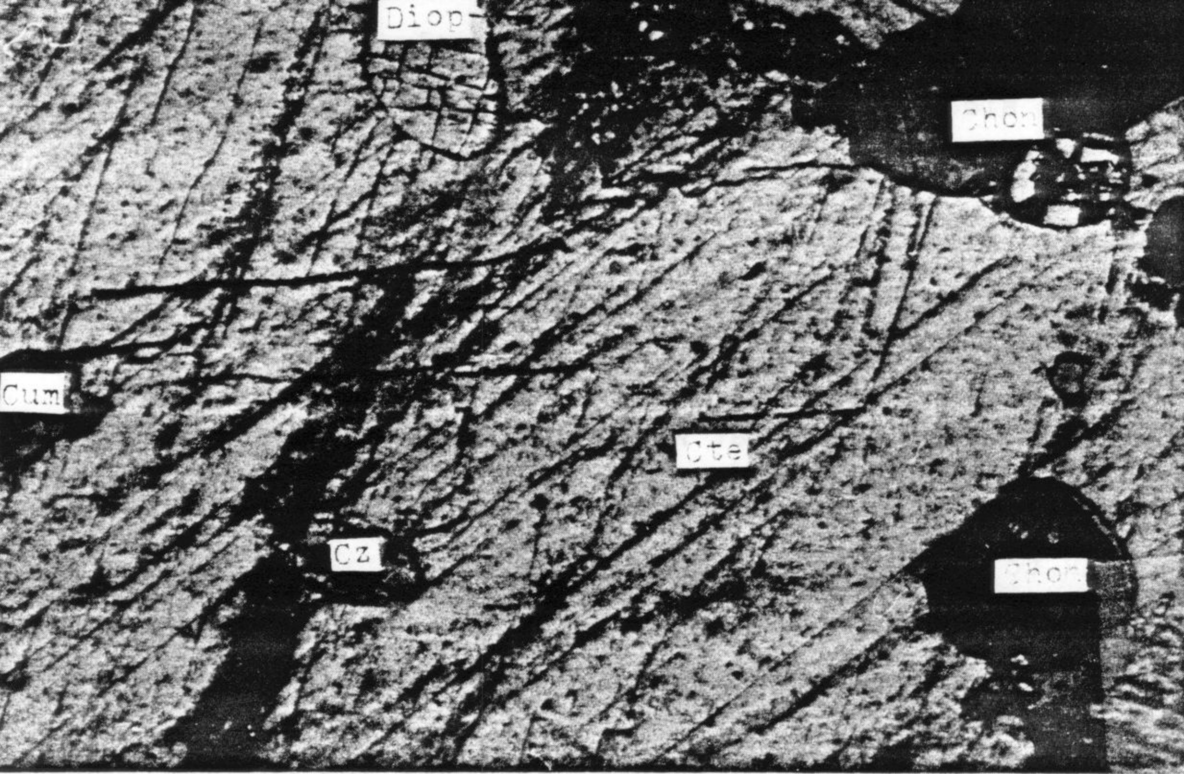
Scale: 1:125,000.

SIMPLIFIED GEOLOGY AND STRUCTURE, AND SELECTED MINERAL OCCURRENCES OF THE PARRY SOUND-HUNTSVILLE-POWASSAN AREA

Chart A, west half.


CENTIMETRE
INCH




Diop
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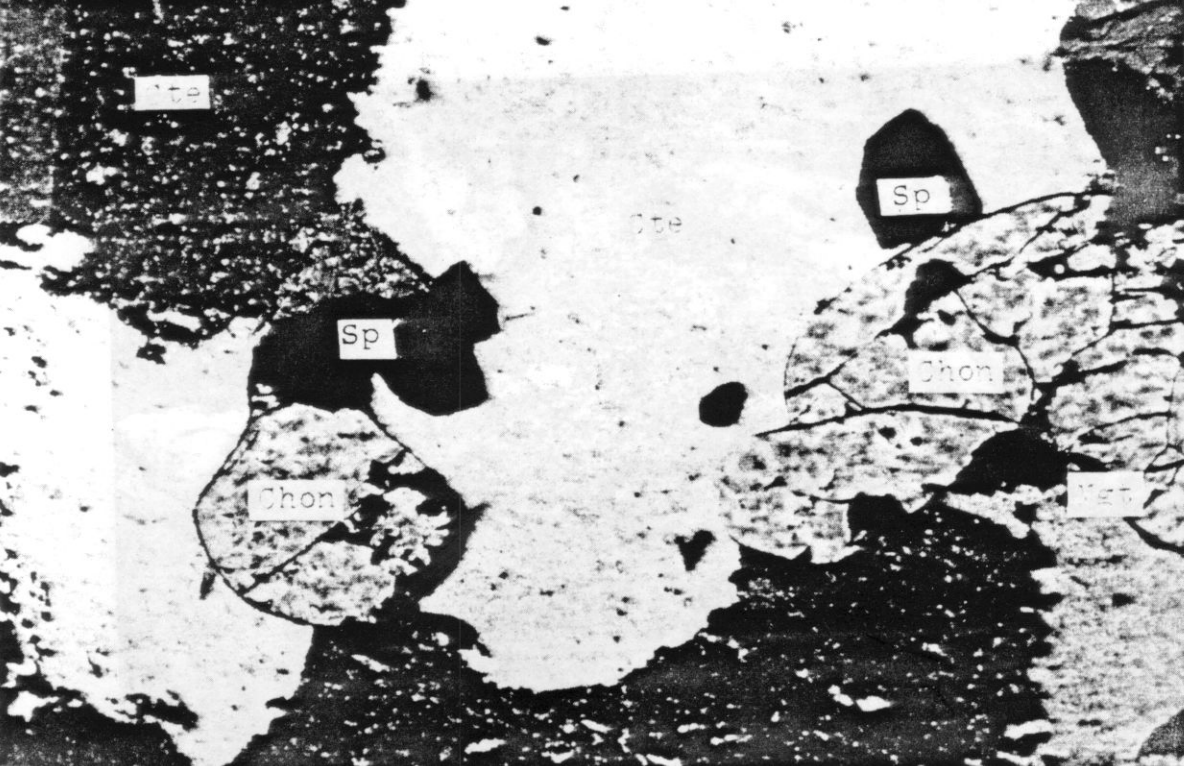
Cz
Chon


Sp
Sp
Chon
Chon