Ministry of
Northern Development
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Ontario

Mines and
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ONTARIO GEOLOGICAL SURVEY

Open File Report 5714

Talc in Southeastern Ontario

by

P.S. LeBaron and Steven van Haaften

1989

LeBaron, P.S. and van Haaften, Steven 1989. Talc in Southeastern Ontario; Ontario Ministry of Northern Development and Mines, Open File Report 5714, 240p.

CANADA ONTARIO Mineral Development Exploitation Minérale

This project is part of the five-year Canada-Ontario 1985 Mineral Development Agreement (COMDA), a subsidiary agreement to the Economic and Regional Development Agreement (ERDA) signed by the governments of Canada and Ontario.

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V.G. Milne, Director
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ABSTRACT

Two of Canada's four talc producers are located in Ontario: Steetley Talc Inc. near Timmins in northern Ontario and Canada Talc Limited at Madoc in southeastern Ontario. Canada Talc products, used in the paint, plastics, roofing, and flooring industries, are produced from dolomite-hosted talc ore by dry milling and air classification. Steetley Talc produces a very high-purity talc product by flotation of ultramafic-hosted talc-magnesite ore for use in the paper, plastics, cosmetics, and paint industries. Numerous occurrences of talcose ultramafic rock and talcose carbonate rock in southeastern Ontario indicate good potential for additional discoveries of both types of talc ore.

Talc is the first mineral produced during progressive metamorphism of siliceous dolomitic limestone, followed by tremolite. Good potential for talc development exists close to the tremolite-calcite isograd in areas underlain by siliceous dolomitic marble. Stromatolites with alternating quartz-rich and dolomite-rich laminae, present at the Canada Talc mine, indicate a carbonate environment favourable for the formation of talc. In general, the carbonate-hosted talc occurrences in southeastern Ontario are associated with low-grade regional and contact metamorphism of siliceous dolomitic marbles, and with retrograde metamorphism of tremolitic dolomite associated with shear zones in more highly metamorphosed areas.

A narrow belt of talc occurrences associated with ultramafic rocks extends northward from the Tweed area for a distance of 50

km. These rocks are situated within a mafic metavolcanic sequence lying along the western margins of two granodioritic batholiths. Ultramafic rocks of komatiitic affinity within the thermal metamorphic aureoles of intrusions have been altered to various assemblages of talc, chlorite, serpentine, actinolite, anthophyllite, carbonates, and magnetite. They are locally talc-rich in zones up to 300 m long and 40 m wide, averaging from 20 to 40% talc. Beneficiation tests done on samples from three occurrences show that flotation processing produces a talc product suitable for use in the paper, paint and plastics industries.

The talc-bearing rocks of southeastern Ontario are well-situated with respect to industrial markets in Ontario and the northeastern United States and are close to excellent road, rail, and water transportation networks.

ACKNOWLEDGEMENTS

Numerous people provided assistance and information during the course of this study. The authors would like to thank Bob Kirkwood and Harold Sexsmith of Canada Talc Limited and Stephen Donaldson and Barry Woodrow of Steetley Talc Inc. for arranging informative tours of their mine and mill facilities.

Diamond drill core for beneficiation tests was provided by C. Roger Young, prospector, of Havelock, Tim Beesley, geological consultant for Gateford Resources, and W.T. Grant, MNDM drill core library geologist, Bancroft. C.R. Young, H.J. Abercrombie and W.T. Grant are gratefully acknowledged for bringing three previously undocumented talc occurrences to the attention of the authors.

Hugh de Souza of the Ontario Geological Survey Geoscience Laboratories performed thin section and x-ray diffraction studies on the beneficiation test samples.

A.F. Young of the Ministry of Natural Resources contributed research and field work in the early stages of the project. Vince Bernard provided assistance in the field in 1987. The authors also thank William Gowdy and Diane Burley for drafting the numerous figures in the report.

P.W. Kingston, Resident Geologist, Ministry of Northern Development and Mines, Tweed, critically reviewed the manuscript and made valuable editorial comments.

TALC IN SOUTHEASTERN ONTARIO

by: P.S. LeBaron[1] and Steven van Haaften[1]

This project is part 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.

INTRODUCTION

This report documents the results of a multi-year study of talc occurrences in southeastern Ontario. The study began with the cataloguing of all known talc occurrences and field examination of those prospects considered to have the highest potential for significant talc mineralization. During this phase of the study, carried out by Steven van Haaften, it was recognized that an extensive, undeveloped belt of ultramafic-hosted talc occurrences might contain talc deposits of similar grade and size to those currently being mined in Quebec and northern Ontario. This belt was subsequently mapped by P.S. LeBaron in 1987-88, and beneficiation tests were performed on samples from three talc occurrences.

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Manuscript approved for publication by V.G. Milne, Director, Ontario Geological Survey, 2 May, 1989.
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Part I of this report provides an introduction to talc as an industrial commodity, describes the geology and possible origins of the two main classes of talc deposits (carbonate-hosted and ultramafic-hosted) in southeastern Ontario, and documents the results of beneficiation tests on samples of ultramafic-hosted talc from the study area.

Part II contains descriptions of all known talc occurrences in southeastern Ontario. Location maps, geological and historical information and, in some cases, geological sketch maps are provided for a total of 54 occurrences.

PART I

LOCATION OF THE STUDY AREA

The study area covers most of the Central Metasedimentary Belt of the Grenville Province. It is bounded approximately by the towns of Arnprior and Brockville to the east, and Peterborough and Bancroft to the west (Fig. 1). Situated between the large population centers of Toronto and Ottawa, the area is well-developed with an extensive network of roads, railroads, and hydroelectric power lines. One of only two producing talc mines in Ontario is located near the town of Madoc, within the study area (Fig. 1).

PREVIOUS WORK

Descriptions of talc occurrences in southeastern Ontario have been published in reports by Spence (1922 and 1940), Wilson (1926), and Hewitt (1972). Many of the occurrences described in Part II of this report have also been previously documented in studies of selected occurrences and in various geological reports by the Ontario Geological Survey and the Geological Survey of Canada. References are listed in the property description reports (Part II).

TALC - PROPERTIES AND USES

Talc is a hydrous magnesium silicate, $Mg_3Si_4(OH)_2$, with the ideal composition of 65.5% SiO_2, 31.7% MgO, and 4.8% H_2O. It is one of the most versatile of the industrial minerals, with an extensive list of properties including extreme whiteness and softness, high lustre, slip and surface area, and the ability to absorb oil. It is chemically inert, has a high fusion point, low electrical and

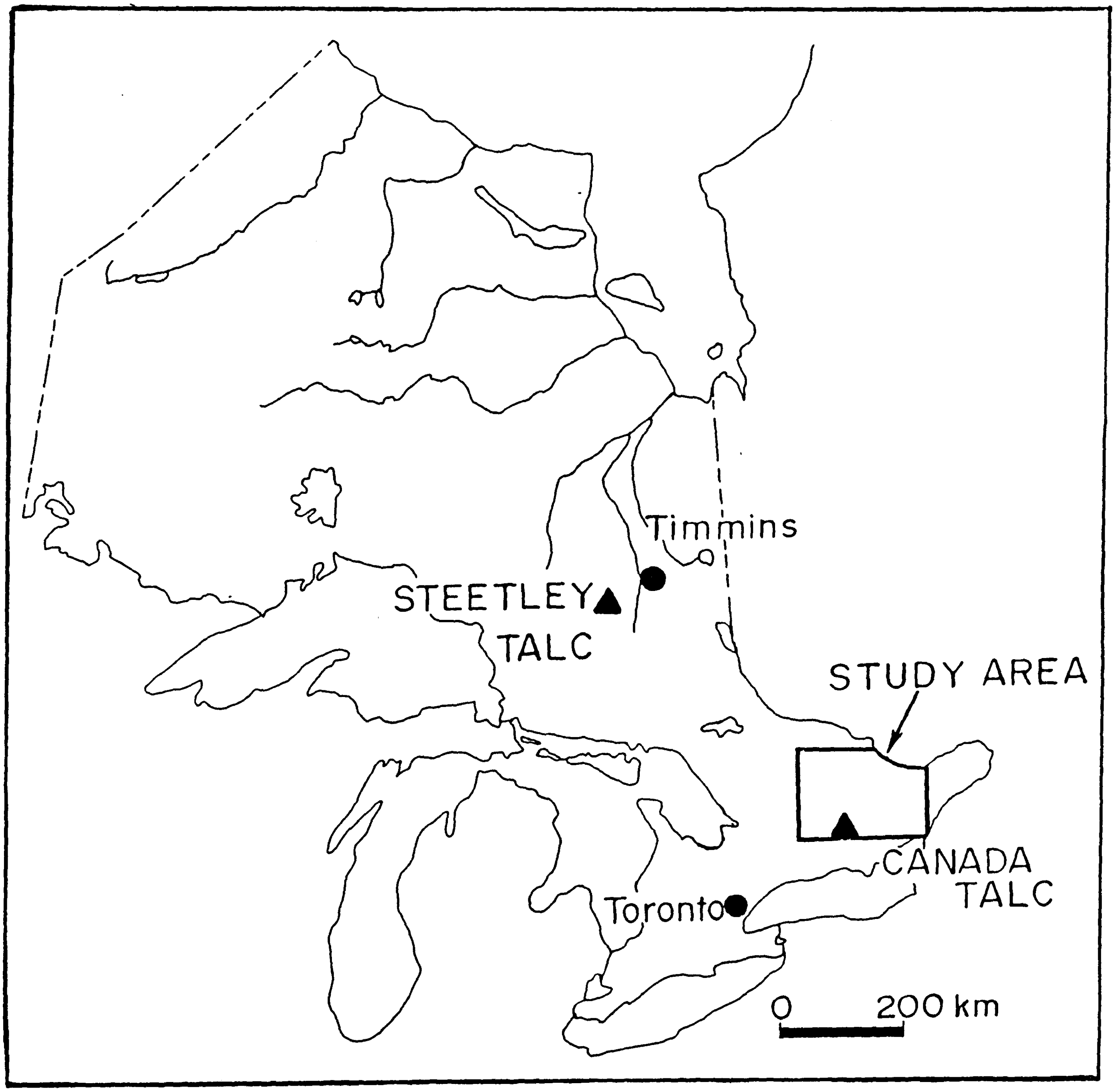


Figure 1: Location of the study area, showing currently producing talc mines in Ontario.

thermal conductivity, and low shrinkage. All of these properties are important in various commercial applications.

The major consumers of talc are the pulp and paper, roofing, and paint industries and, in the United States, the ceramics industry (Table 1). Other important markets are in plastics, cosmetics, and adhesives and sealants. There are also many miscellaneous uses of talc (Table 2) which account for a very small percentage of annual talc consumption.

TABLE 1: Talc Consumption by Industry, 1987

Application	Canada	United States
Pulp and Paper	37%	13%
Roofing	31%	11%
Paint	12%	17%
Ceramics	4%	35%
Plastics Cosmetics Adhesives and Sealants Others	16%	24%

Sources: 1. Canadian Minerals Yearbook 1987; Energy, Mines, and Resources, Canada

2. Mining Engineering, June, 1988

TABLE 2: <u>Miscellaneous Uses of Talc</u>

Textile sizing
Fillers in foam backing of carpets, rugs, parquet floor tiles
Upholstery fabric backing
Fire extinguisher powders
Bleaching agent
Cereal polishing (rice, corn, barley)
Odour absorption from foods
Floor wax
Water filtration
Leather treatment (oil absorption)
Joint fillers and grouts
Insecticide
Shoe polishes
Welding rod coatings
Printing inks
Coatings for iron ore pellets
Source of magnesium in plant foods

Source: Roe and Olson (1983)

High mineralogical purity is not necessary for all uses. In some cases, impurities in the talc product may be beneficial to the application. For example, the ceramics industry uses a mixture of platy talc and tremolite and most of the filler-grade talc used by the paper, plastics, and rubber industries is about 90% talc (Roe and Olson 1983). Common accessory minerals in talc ores and talc products are anthophyllite, tremolite, actinolite, chlorite, serpentine, calcite, dolomite, magnesite, diopside, and quartz. Many industrial talcs are obtained by simple dry-grinding and air classification of the impure talc ore. The production of high-purity talc, however, generally requires beneficiation of the ore, usually by a complex grinding and flotation process.

Specifications for talc products required for various applications are discussed in Roe and Olson (1983) and in Dillon and Barron (1985).

CANADIAN PRODUCTION AND IMPORTS, MARKET OUTLOOK

Table 3 shows recent statistics for Canadian production and imports of talc and pyrophyllite. Pyrophyllite, a hydrous aluminum silicate with properties similar to those of talc, accounts for less than 10% of the figures in table 3. Canadian production in 1987 was about 141,000 tonnes with a value of 16 million dollars, both figures representing an increase of about 14% from the previous year.

In 1986, Canada imported about 40,000 tonnes of talc, 99% of which was supplied by the United States, and exported about 30,000 tonnes to the U.S. (Shaw and Boucher, 1988).

TABLE 3: Talc and Pyrophyllite Production and Imports, Canada, 1986-87

	1986		1987	
	Tonnes	$	Tonnes	$
Production	123,037	14,182,284	141,223 (+14.8%)	16,190,460 (+13.7%)
Imports (Talc only)	39,369		36,680 (Jan.-Sept.)	

Source: Canadian Minerals Yearbook 1987; Energy, Mines, and Resources, Canada

Talc prices, which range from about $50/t to $200/t, depending on the quality of the product, increased steadily from 1985 to 1988, reflecting both greater demand and a trend toward use of higher-quality products (Shaw and Boucher, 1988).

Shaw and Boucher (1988, p.62.1) state, "The outlook for the talc industry is for prosperous growth. Talc consumption... should grow faster than the economy as a whole." One of the primary reasons for this expected growth is the use of talc in plastics as markets for filled and reinforced plastics in the construction, automotive, and domestic applicance industries continue to grow (Dickson, 1987). Recent developments, however, suggest that this outlook may be overly optimistic. Current North American talc production capacity of about 1.5 to 1.8 Mt exceeds the demand of 1.1 Mt. and the excess capacity situation is expected to remain into 1990 (Shaw and Boucher, 1988). This excess capacity has created increased competition among talc producers, and actual prices are currently considerably lower than recent list prices (B.N. Woodrow, Technical Services

Supervisor, Steetley Talc Inc., Timmins, personal communication, 1988).

Additional factors which may affect the market outlook are the trend toward consolidation of the industry by company mergers, and the continuing concern with talc ores and products containing tremolite.

In 1988, Cyprus Minerals Co. of the USA acquired Vermont Talc, Windsor Minerals (talc supplier to Johnson and Johnson), and a Spanish talc producer. Also in 1988, RTZ Corp. of the UK gained control of Talcs de Luzenac SA of France, the world's largest individual producer of talc (Industrial Minerals, No. 256, January 1989, p.7). Talcs de Luzenac is active in the North American talc market, with interest in two Canadian talc producers (LUZCAN and Steetley Talc Inc.) and a grinding plant in the USA. These examples illustrate the trend toward the acquisition of multiple talc-producing operations and multi-national supply and distribution networks in an attempt to gain a greater share of the market in a competitive environment.

Several talc producers may be affected by a forthcoming decision on the classification of tremolite as a health hazard. The US Occupational Safety and Health Administration (OSHA) has classified asbestos and asbestiform minerals as hazardous. Included in the OSHA definition of asbestiform minerals are tremolite, actinolite, and anthophyllite, as well as the common asbestos minerals chrysotile, amosite, and crocidolite. However, a more precise definition which will distinguish fibrous (asbestiform) from prismatic (non-asbestiform) amphiboles is expected in 1989. Tremolitic talc producers such as R.T. Vanderbilt Co. Inc. have already experienced increased problems in marketing their product due to perceived health risks (Grange 1989). Vanderbilt produces about 230,000 tpa of a product containing 30 to 40% non-asbestiform tremolite from the Gouverneur area in New York state (Grange 1989). If this product is withdrawn from the market due to health concerns, the excess capacity in the North American talc market will be greatly reduced.

CANADIAN TALC PRODUCERS

There are only four talc producers in Canada -- two in Quebec and two in Ontario.

Baker Talc Inc. of South Bolton, Quebec, produces high-quality talc by flotation of talc-magnesite ore hosted by altered ultramafic rocks, and low-grade talc by dry-milling.

LUZCAN Inc. of Broughton Station, Quebec, a subsidiary of Talcs de Luzenac SA of France produces soapstone blocks and crayons and low-quality talc from talc-serpentine-altered ultramafic rock. This is the former Broughton Soapstone Quarries property.

The two Ontario mines, Steetley Talc near Timmins and Canada Talc at Madoc (Fig. 1), account for 63% of Canada's talc production (Shaw and Boucher, 1988).

Steetley Talc Inc. operates an open pit mine in a talc-magnesite deposit derived from alteration of ultramafic rock. Flotation of the ore produces a high-quality talc which is micronized and sold to the paper, plastics, paint, and cosmetics industries. Production capacity is about 60,000 tpa.

Steetley Talc was purchased in 1988 by Talcs de Luzenac SA. Borax Francais SA, a subsidiary of RTZ Corp. PLC has since gained control of Talcs de Luzenac. Therefore, both LUZCAN Inc. and Steetley Talc Inc. are now controlled by RTZ Corp. (Industrial Minerals, No. 255, December 1988, p. 13).

Canada Talc Limited produces a variety of talc products from a carbonate-hosted deposit which has been in continuous operation since 1896. A very white ore, consisting of variable amounts of talc, tremolite, and dolomite, is mined by underground and open pit methods, dry-milled, air-classified, and sold to the plastics, paint, rubber, and roofing industries. About 70% of production goes to the plastics market, and about 70% is sold to markets in the United States (Harold Sexsmith, Mill Superintendent, Canada Talc Limited, Marmora, personal communication, 1988). Production capacity is 55,000 tpa. The Canada Talc deposit is described in detail in Part II of this report (occurrence HN1).

HISTORY OF SOUTHERN ONTARIO TALC PRODUCTION

Talc has been produced in southern Ontario since the 1880's, with most of the production coming from the Madoc area. The following past-producers are described in more detail in Part II of this report.

Between 1883 and 1929 small quantities of talc-dolomite schist were mined in Elzevir Township (ER3). The most recent operator of these deposits was the Actinolite Mining Company of Bloomfield, New Jersey, who erected a grinding plant at Actinolite, Ontario and produced roofing material (Spence 1940).

Between the years 1893 and 1901 the Sparham Roofing Company of Montreal mined small quantities of talcose rock for use in roofing products (Spence 1922, 1940). This material was mined on Grindstone Island in South Burgess Township (BS1) and in Pittsburgh Township (PH1).

Hewitt (1972) reported that talc was discovered at Madoc (HN1) in the 1880's, and in 1896 the first talc mine, the Henderson Mine, was opened. This mine was operated by several companies until 1937, when it was taken over by Canada Talc Limited.

The Conley Mine at Madoc is on the northeastward extension of the Henderson orebody. It was discovered in 1911 and production began in 1914 or 1915. The Asbestos Pulp Company operated the property from 1921 to 1929, when that company was reorganized as Canada Talc Company. On merger of the Henderson and Conley Properties in 1937, the company was again reorganized as Canada Talc Limited. In 1951 Canada Talc Limited was purchased by Canada Talc Industries Limited which was in turn purchased in 1981 by William R. Barnes Company Limited (Kingston et al 1982).

Significant quantities of talc were mined near Eldorado (MC1), in Madoc Township, between 1911 and 1920. The most recent operator of this deposit was the Eldorado Mining and Milling Company (Spence 1940).

RAM Petroleums Limited (PN1) processed up to 15,000 tpa of tremolite from its Palmerston Township open pit tremolite/talc mine from 1982 to 1986. The tremolite product was used primarily as an additive for asphalt road construction (Industrial Minerals, June 1986, p. 7).

Recent exploration activity for talc, with the exception of that on the Canada Talc mine property, has been concentrated in Madoc, Elzevir, and Cashel townships on occurrences of ultramafic-hosted talc. This work is noted in the property descriptions in Part II.

THE GEOLOGY OF TALC IN SOUTHEASTERN ONTARIO

REGIONAL GEOLOGY AND DISTRIBUTION OF TALC OCCURRENCES

The study area is underlain by Precambrian rocks of the Central Metasedimentary Belt of the Grenville Province. This belt is dominated by rocks of the Grenville Supergroup, a suite of metamorphic carbonates, calc-silicates, quartzites, paragneisses, amphibolites, and metavolcanic rocks. Deposition of the oldest rocks, mafic to ultramafic volcanics of the Tudor Formation (Hermon Group), began about 1,300 Ma ago. A varied suite of plutonic rocks was emplaced between about 1250 and 1100 Ma ago, and younger metasediments (Flinton Group) were deposited about 1050 Ma ago (Carter 1984). The Grenville Orogeny, which culminated about 1,000 Ma ago, superimposed a northeast structural trend over most of the Central Metasedimentary Belt and produced metamorphic grades ranging from greenschist facies near Madoc to granulite facies north of Kingston. The belt is bounded by older rocks of the Central Gneiss Belt to the north and west and by Paleozoic sedimentary rocks of the St. Lawrence Platform to the south and east.

Figure 2 is a simplified geological map of the Central Metasedimentary Belt showing the locations of all known talc occurrences and zones of low (greenschist facies), medium (lower amphibolite), medium-high (upper amphibolite), and high (granulite facies) metamorphic grade. The talc occurrences have been divided into two categories: a) those derived from the alteration of carbonate rock, and b) those derived from the alteration of ultramafic rock. Their distribution is controlled by a combination of metamorphic grade and presence of suitable host lithology.

Most of the occurrences lie within the zones of low and medium-grade metamorphism extending northeastward from the Madoc area, termed the Hastings Basin by Lumbers (1967). The most significant occurrences lie within the area of greenschist facies metamorphism.

The geology, economic potential, and possible origins of both types of talc occurrences are discussed in the following sections.

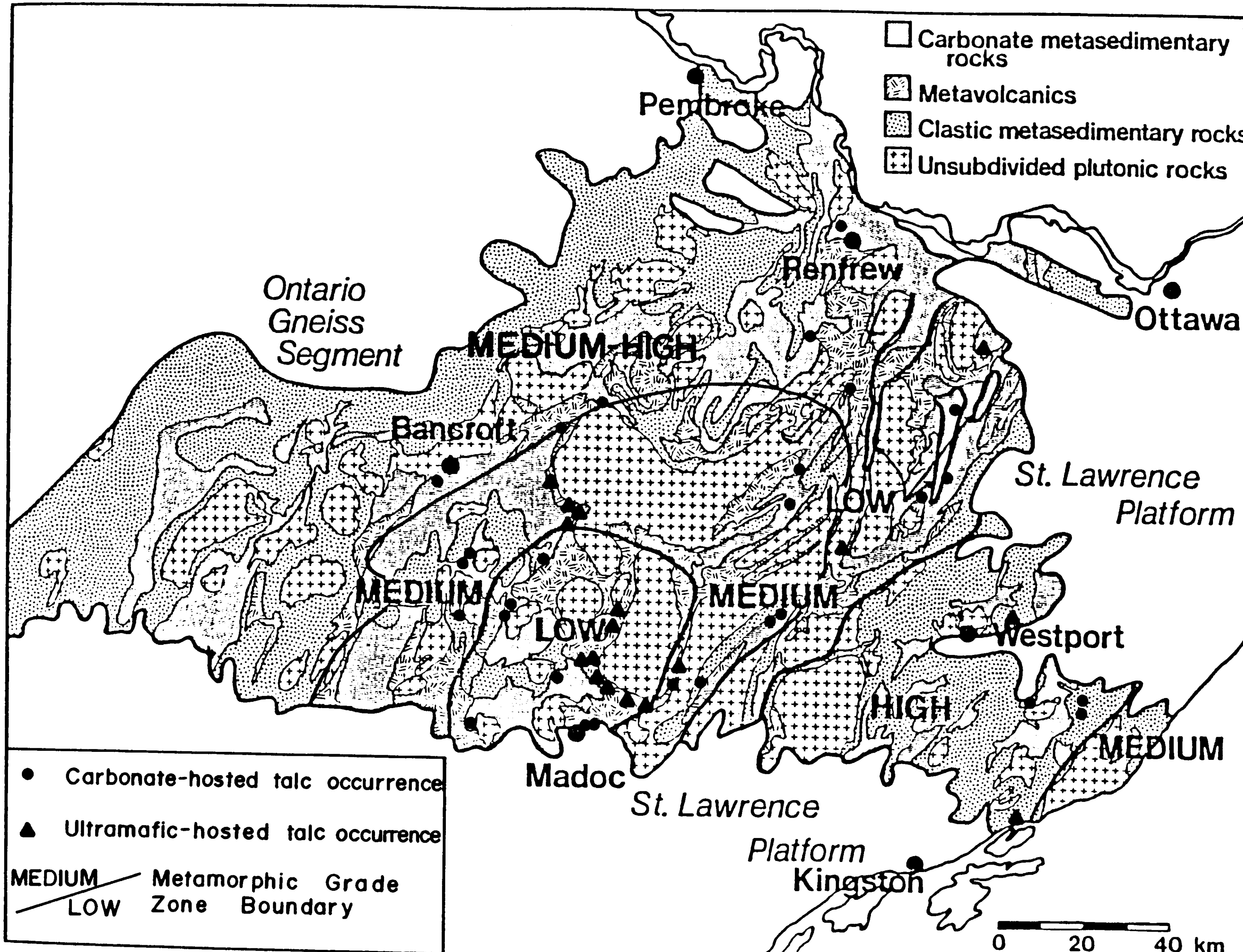


FIGURE 2 : GEOLOGY OF THE CENTRAL METASEDIMENTARY BELT, GRENVILLE PROVINCE, SHOWING LOCATIONS OF TALC OCCURRENCES. Geology after Carter (1984); Metamorphic grade boundaries after Sangster and Bourne (1982) and Carter (1984).

CARBONATE-HOSTED TALC

Origin of the Talc

The association of carbonate-hosted talc occurrences with low to medium-grade metamorphism reflects the fact that talc is the first mineral to form during progressive metamorphism of siliceous dolomitic limestone, according to the reaction:

3 dolomite + 4 quartz + 1 H_2O = 1 talc + 3 calcite + 3 CO_2

(Winkler 1979)

With increasing temperature, tremolite is formed from the talc-calcite assemblage by either of the following reactions:

5 talc + 6 calcite + 4 quartz = 3 tremolite + 6 CO_2 + $2H_2O$

2 talc + 3 calcite = 1 tremolite + 1 dolomite + 1 CO_2 + 1 H_2O

(Winkler 1979)

These reactions indicate that talc should be present near the tremolite isograd in areas underlain by siliceous dolomitic marble, a model which can be applied to the Canada Talc deposit at Madoc.

Geology of the Talc Occurrences

The Canada Talc mine lies at the southern edge of the Hastings Basin metamorphic low, in which quartz and dolomite coexist in carbonate rocks except in zones of higher metamorphic grade within thermal aureoles of intrusive bodies.

The deposit occurs in a zone of tremolitic marble bordering the Moira Granite (Fig. 3). The host rock dolomitic sequence includes thin quartzite beds and stromatolitic marble consisting of alternating quartz and dolomite laminae (Simandl and Ogden

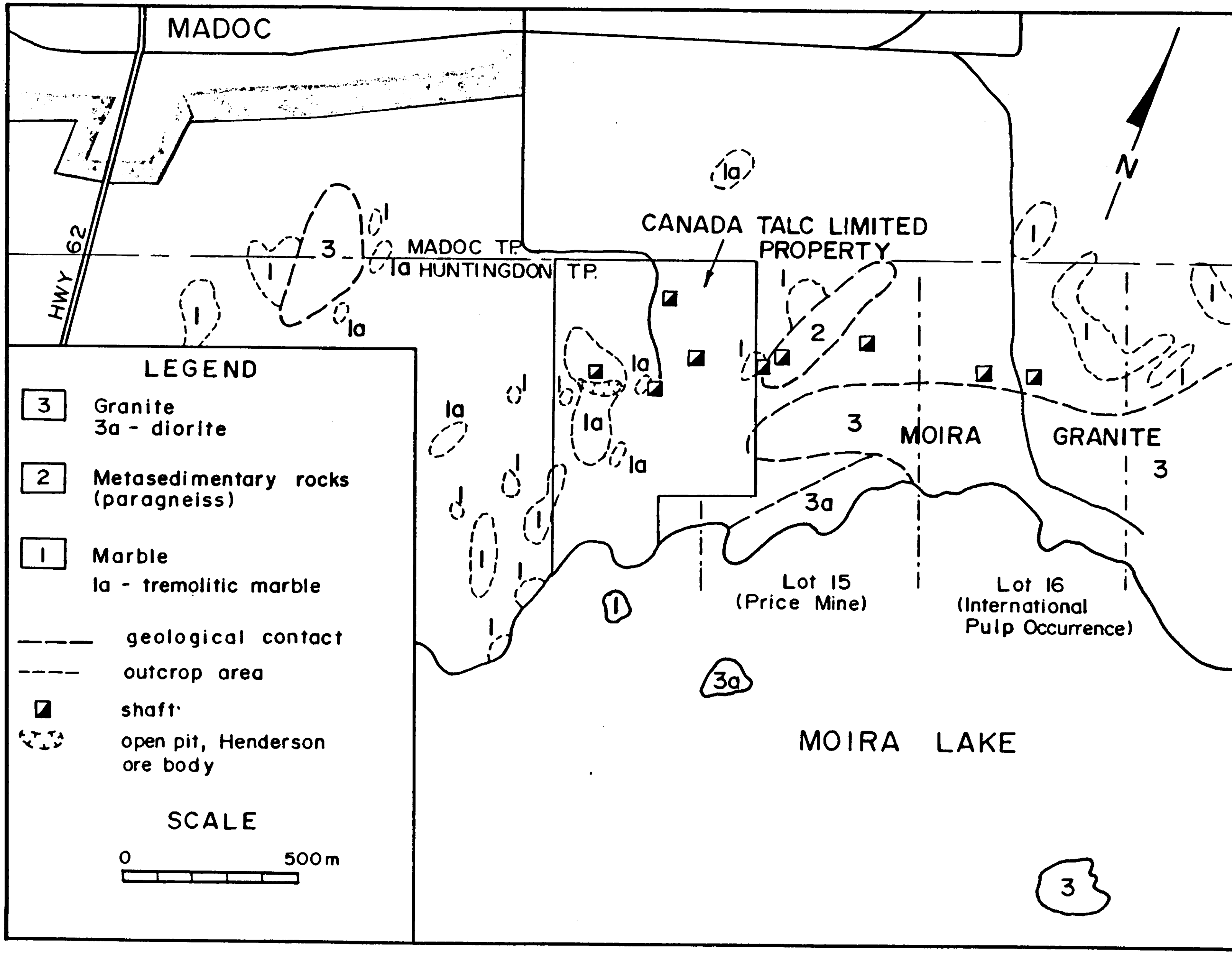


FIGURE 3: GENERAL GEOLOGICAL MAP, CANADA TALC DEPOSIT AREA, HUNTINGDON TP. (after Hewitt, 1968)

1982) -- evidence of a pre-metamorphism environment with the ingredients necessary for the formation of talc.

There are two types of ore: a very pure, white talc zone 7 to 25 m wide, known as the Henderson orebody, and a zone of low-grade, talcose, tremolitic dolomite containing 20 to 60% talc. In both cases, there has been retrograde metamorphism of tremolite to talc (Hewitt 1972).

The lithological sequence from southeast to northwest through the Henderson orebody is (Fig. 4): (1) dark grey to black phyllite, (2) micaceous, tremolitic dolomite, (3) steatized dolomite, (4) high-grade talc ore, (5) laminated tremolitic dolomite (possibly altered stromatolitic dolomite), (6) siliceous, stromatolitic dolomite, (7) mottled grey-white dolomite, and (8) an undifferentiated thick dolomite sequence.

The presence of laminated tremolitic dolomite (unit 5) adjacent to stromatolitic dolomite (unit 6) consisting of coexisting quartz and dolomite laminae suggests that these units represent the outer limit of the thermal metamorphic aureole of the Moira Granite. The talc zone, therefore, has formed within siliceous dolomitic host rock close to the boundary between low and medium-grade metamorphic conditions at the margin of the thermal aureole of the Moira Granite, by prograde metamorphism to tremolite followed by retrograde metamorphism to talc. Previous explanations of the origin of the talc zone (Wilson 1926, Spence 1940, Hewitt 1972) involve siliceous hydrothermal fluids originating from the Moira Granite intrusion being introduced

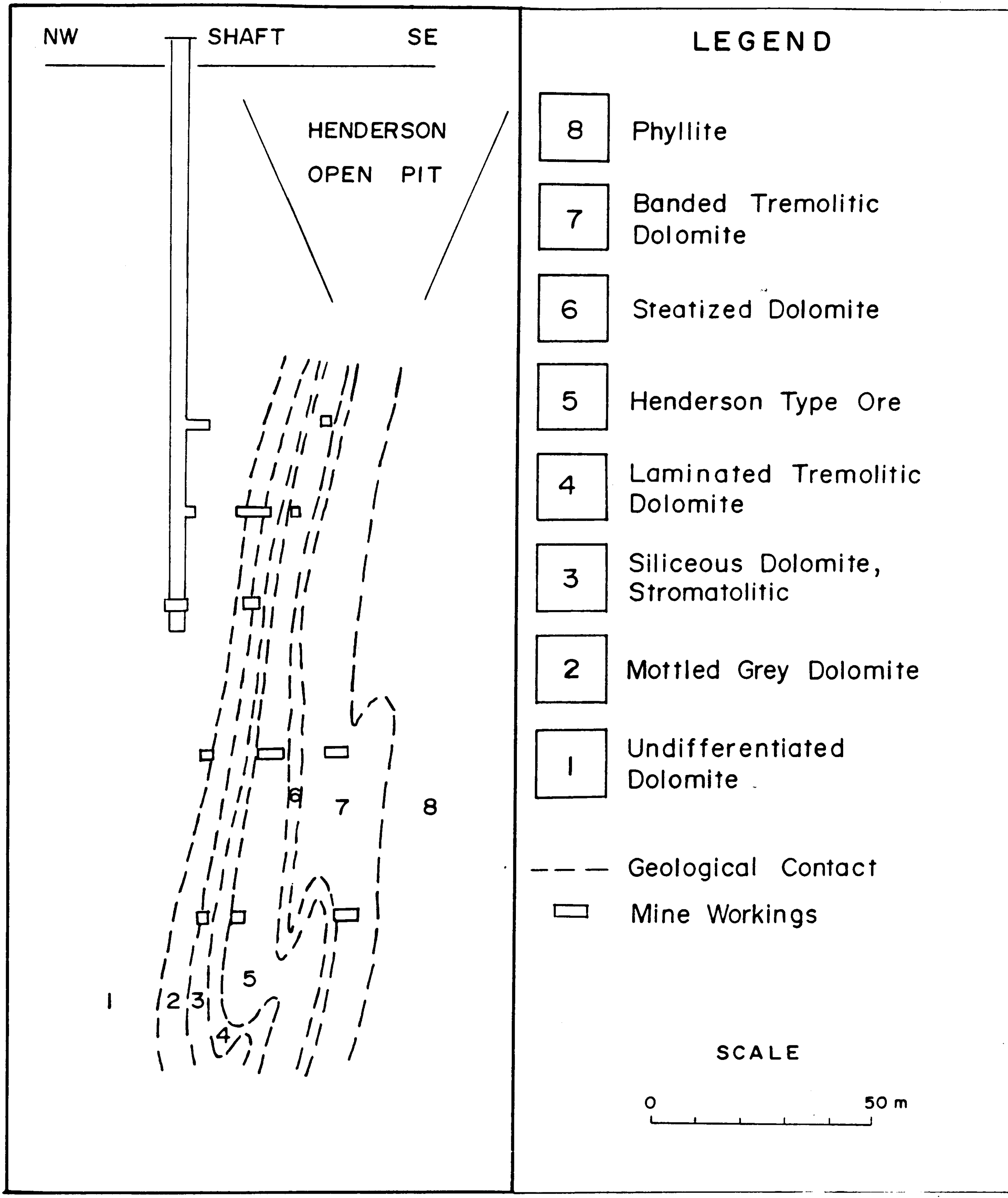


FIGURE 4: CROSS-SECTION THROUGH THE HENDERSON OREBODY, CANADA TALC DEPOSIT, HUNTINGDON TP. (after Simandl and Ogden 1982)

into the dolomite sequence along structural channels. However, although some structural control may have been involved in the circulation of fluids, it is not necessary to assume an external source of silica and water. The contribution of the Moira Granite to the formation of the talc deposit may have been only heat, in which case talc and tremolite alteration zones should be expected near the margin of the thermal aureole of any igneous intrusions, whether mafic or felsic, in areas of siliceous dolomitic marble of low regional metamorphic grade.

Another example of this type of talc occurrence is found in Belmont township (BT1), about 30 km west of Madoc, where a series of metamorphic zones has been mapped in stromatolitic dolomite within the thermal aureole of the Cordova Gabbro. DeKemp (1984) indentified metamorphic zones increasing in grade toward the gabbro with the assemblages: 1) dolomite-quartz-calcite, 2) talc-quartz-calcite, 3) tremolite-talc-calcite, and 4) diopside-tremolite- quartz (Fig. 5).

The talc occurrence, located near the line marking the first appearance of tremolite, consists of up to 80% talc pseudomorphic after tremolite. Marble adjacent to the talc zone displays relict stromatolitic structures and in the surrounding area, domal and columnar stromatolites consisting of quartz and dolomite laminae have been observed (de Kemp 1984). The similarity of the Belmont township talc mineralization and host rocks to those at the Canada Talc mine suggests good potential for talc in carbonates bordering the Cordova Gabbro. With the

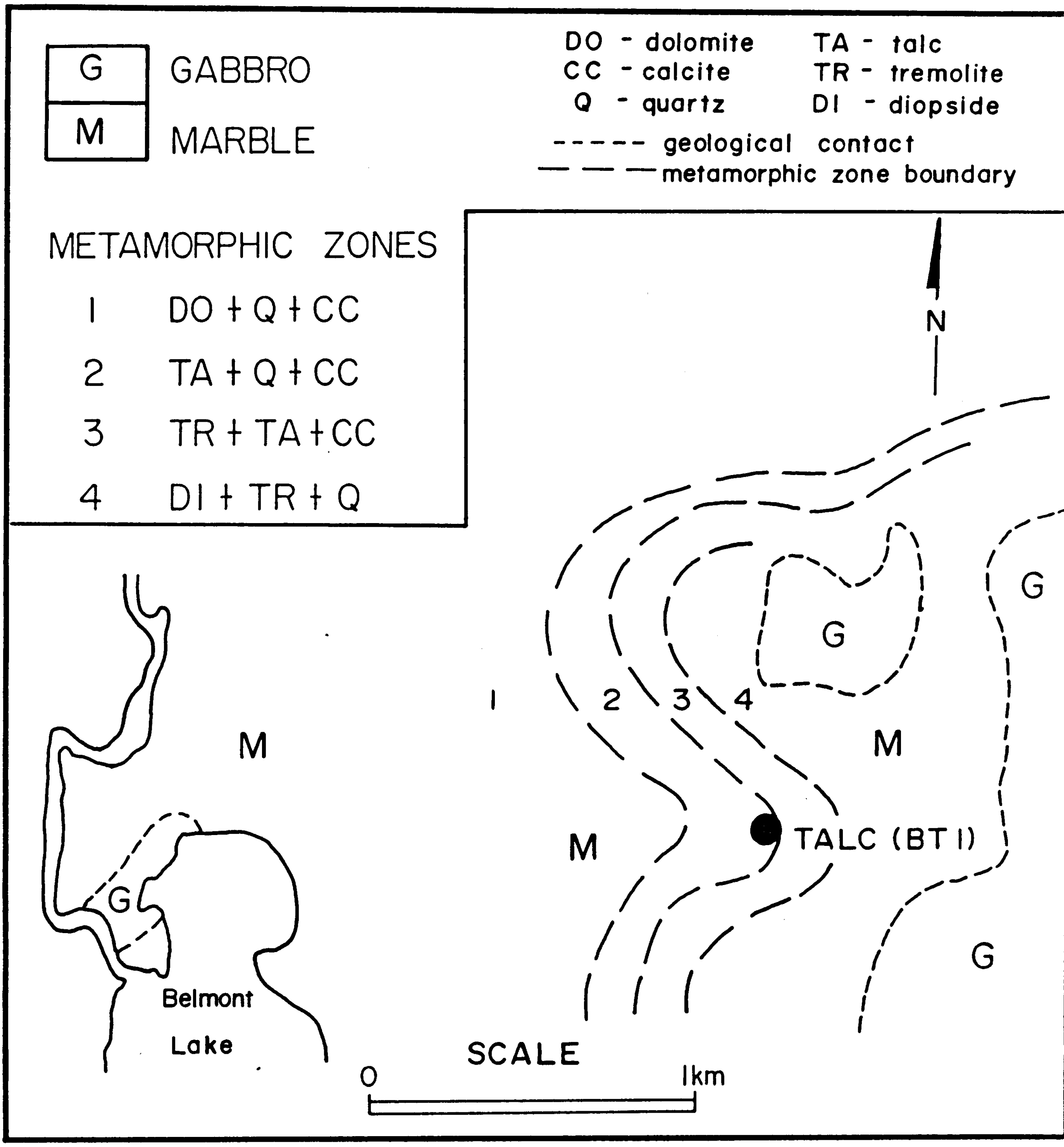


FIGURE 5: GENERAL GEOLOGY AND METAMORPHIC ZONES IN THE AREA OF THE BELMONT TOWNSHIP TALC OCCURRENCE (after deKemp 1984)

exception of one overgrown trench within the talc zone, there is no record of exploration for talc in this area.

The Dalhousie and Lanark township occurrences (DE1, DE2, and LNK1) are also examples of talc occurring near the tremolite isograd (Fig. 6), although in this case, the isograd is related to regional, rather than contact metamorphism. All three of these occurrences contain less than 10% talc, but indicate an environment favourable for talc formation. Figures 7, 8, and 9 show additional areas with good talc potential based on the association of minor talc occurrences with tremolitic marble in the Long Lake, Sharbot Lake, and Tudor township areas.

High grade metamorphism of siliceous, dolomitic marble can produce Ca-Mg silicate assemblages which represent favourable host rocks for talc-serpentine alteration under later, low-grade metamorphic conditions. Occurrences RLE1, BS1, and CY1, all in Leeds County north of Gananoque, are talc-serpentine bodies derived from alteration of pyroxenites which are the product of high-grade metamorphism of siliceous carbonate rocks. This appears to be the most common type of talc occurrence in the granulite facies terrain of the Frontenac Axis, although the pyroxenites, in some cases, may be of igneous origin (PH1, PM1). The talcose rock at these occurrences is similar to that of the ultramafic-hosted occurrences and would require flotation processing to produce a high-quality talc product.

In medium to high-grade metamorphic terrain, local concentrations of talc are associated with shear zones in tremolitic marble.

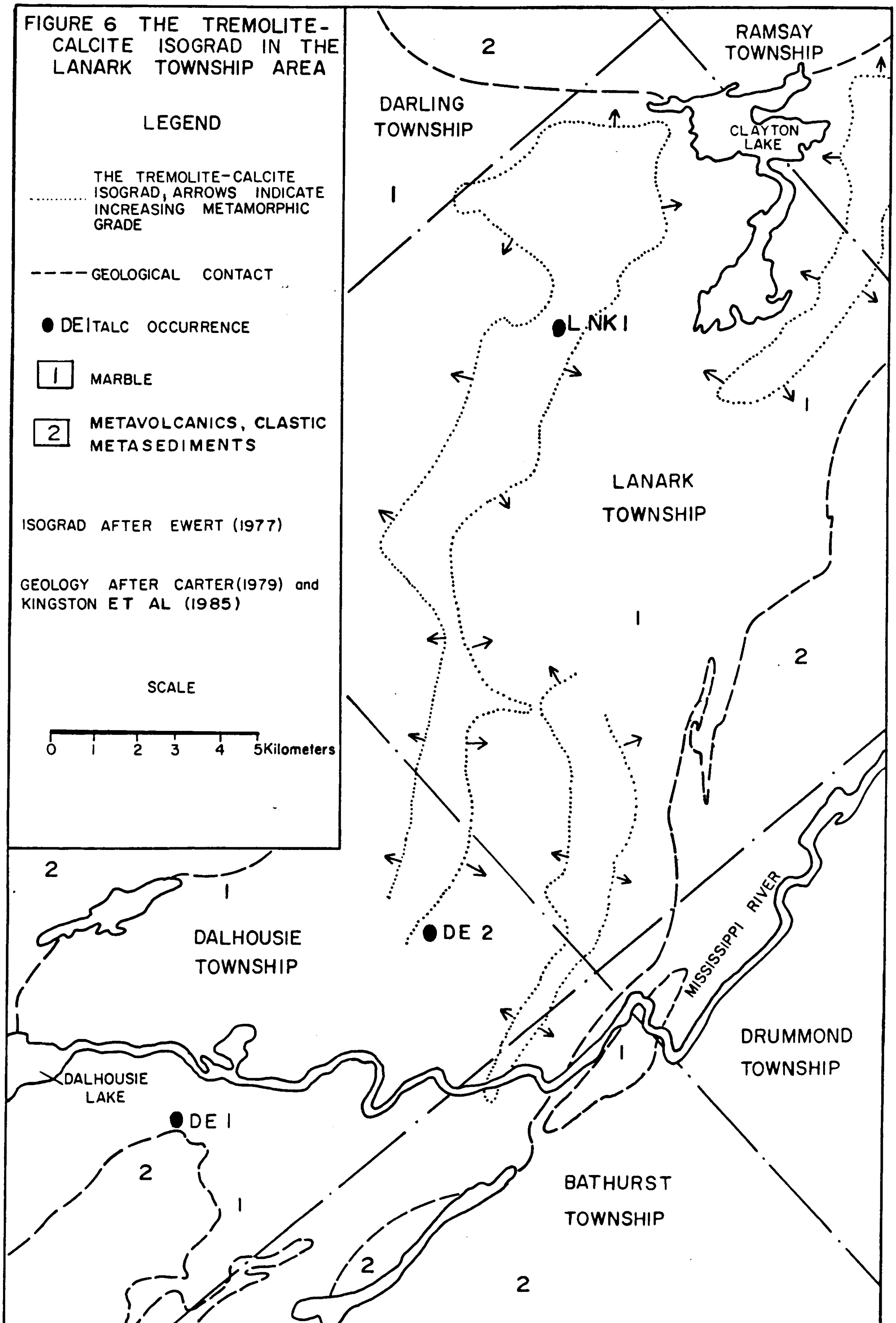


FIGURE 6 THE TREMOLITE-CALCITE ISOGRAD IN THE LANARK TOWNSHIP AREA
LEGEND
THE TREMOLITE-CALCITE ISOGRAD, ARROWS INDICATE INCREASING METAMORPHIC GRADE
GEOLOGICAL CONTACT
DE1 TALC OCCURRENCE
1 MARBLE
2 METAVOLCANICS, CLASTIC METASEDIMENTS
ISOGRAD AFTER EWERT (1977)
GEOLOGY AFTER CARTER (1979) and KINGSTON ET AL (1985)
SCALE
0 1 2 3 4 5 Kilometers
RAMSAY TOWNSHIP
DARLING TOWNSHIP
CLAYTON LAKE
LNK1
LANARK TOWNSHIP
DALHOUSIE TOWNSHIP
DE 2
MISSISSIPPI RIVER
DRUMMOND TOWNSHIP
DALHOUSIE LAKE
DE 1
BATHURST TOWNSHIP

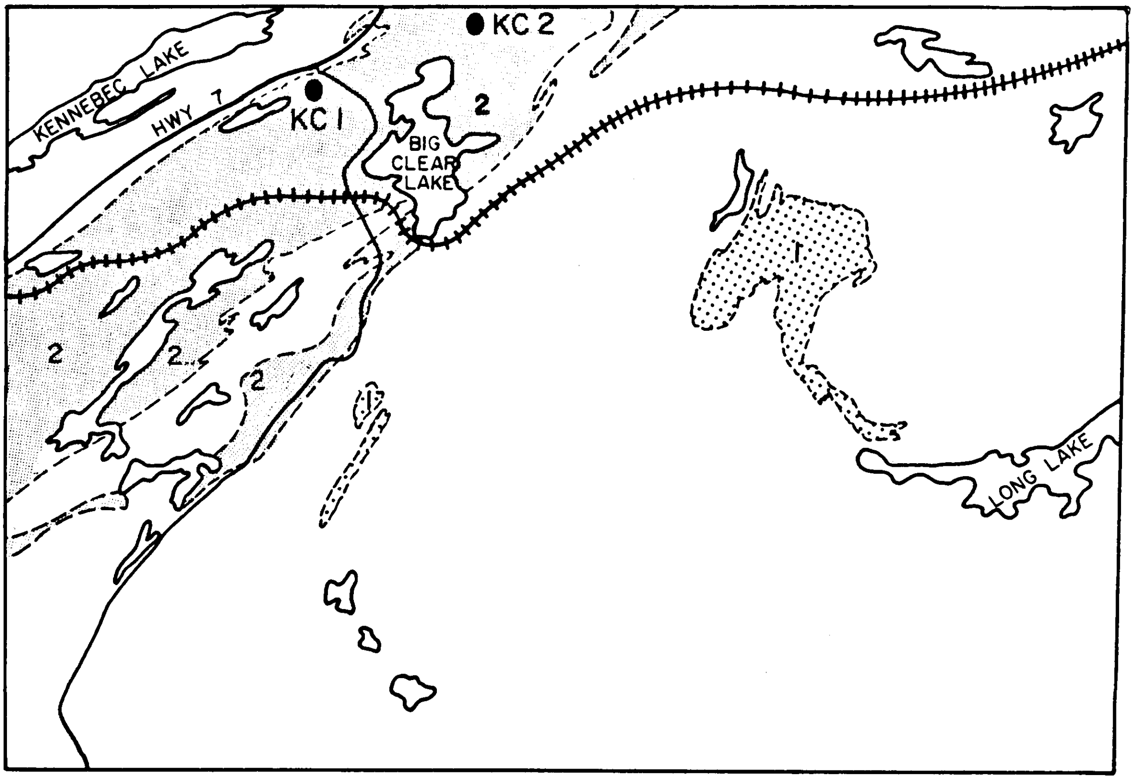


FIGURE 7 TALC - BEARING CALC-SILICATE ROCKS IN THE LONG LAKE AREA

LEGEND

2 AREAS IN WHICH CALC-SILICATE ASSEMBLAGES CONTAINING TREMOLITE ± SCAPOLITE ± DIOPSIDE ± TALC OCCUR

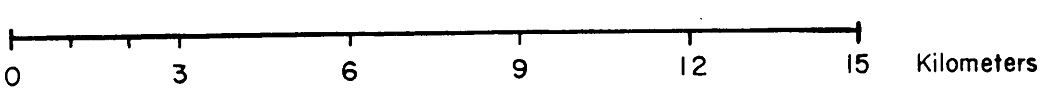
1 AREAS OF MARBLE

● OCCURRENCE OF CALCITE - TALC SCHIST

GEOLOGY AFTER KINGSTON ET AL (1985)

AREAS OF TREMOLITE ± SCAPOLITE ± DIOPSIDE ± TALC ROCKS AND CALCITE-TALC SCHIST AFTER WOLFF (1982b)

SCALE



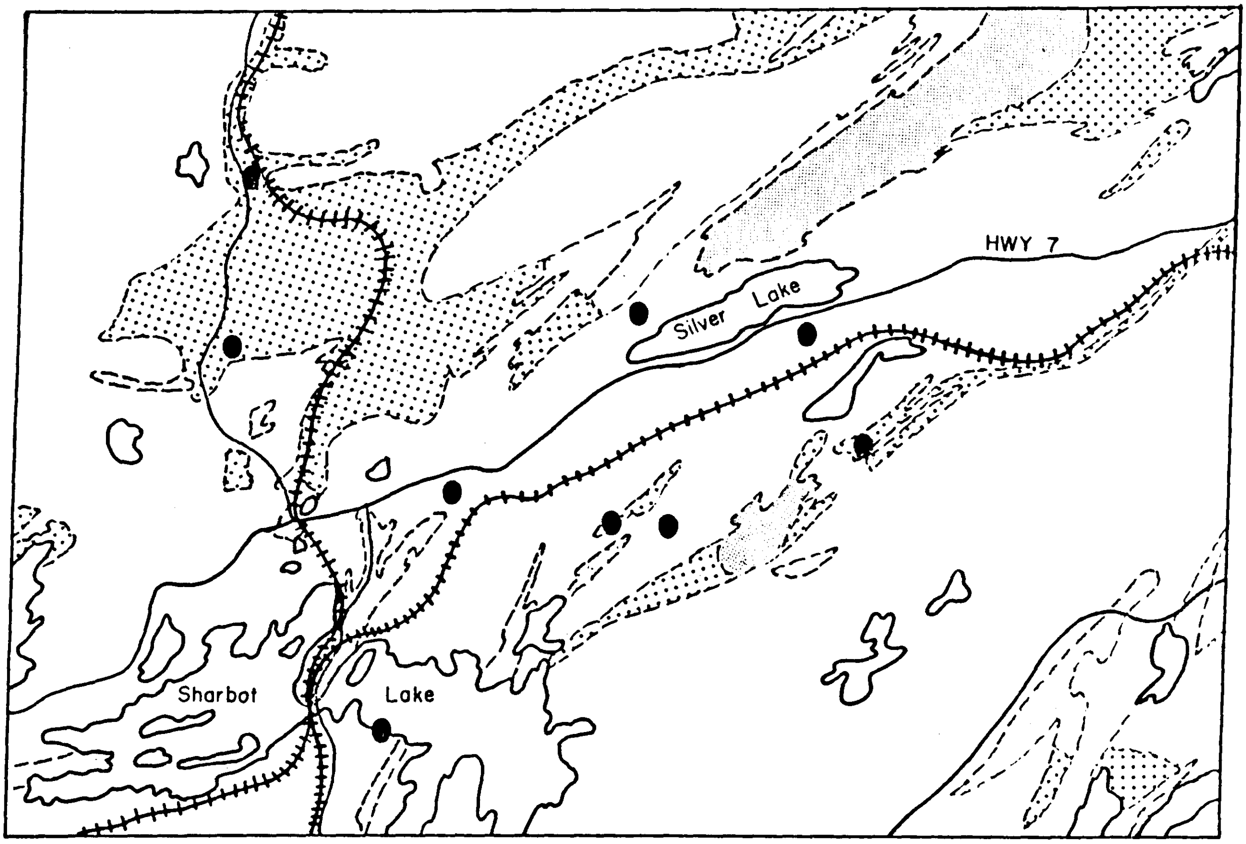


FIGURE 8 TALC-BEARING CALC-SILICATE ROCK IN THE SHARBOT LAKE AREA

LEGEND

2 — AREAS IN WHICH CALC-SILICATE ASSEMBLAGES CONTAINING TREMOLITE, DIOPSIDE AND TALC OCCUR

1 — AREAS OF MARBLE

● — DISCRETE OCCURRENCES OF CALC-SILICATE ASSEMBLAGES CONTAINING TREMOLITE, DIOPSIDE AND TALC

GEOLOGY AFTER KINGSTON ET AL (1985)

AREAS OF TREMOLITE, DIOPSIDE, TALC ROCK AFTER WOLFF (1985)

SCALE

0 1 2 3 6 9 12 15 Kilometers

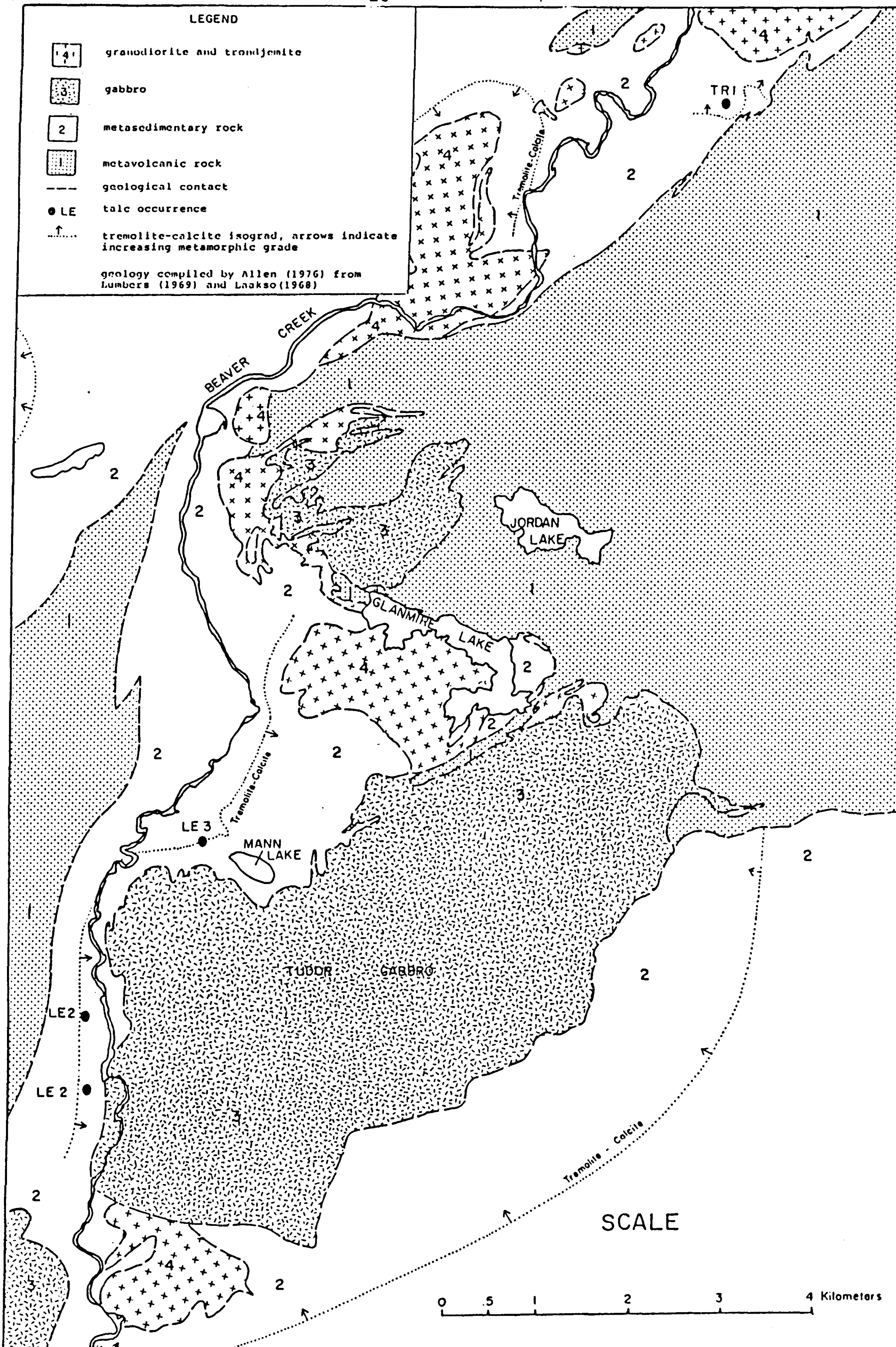


FIGURE 9: THE TREMOLITE—CALCITE ISOGRAD IN THE TUDOR TOWNSHIP AREA. AFTER ALLEN (1976)

However, in general, the greatest potential for carbonate-hosted talc is in areas of low regional metamorphic grade where siliceous dolomitic marble has been altered by igneous intrusions.

ULTRAMAFIC-HOSTED TALC

The Hastings Basin metamorphic low and adjacent medium-grade zones contain significant talc occurrences derived from the alteration of ultramafic rock (Fig. 2). They are exposed intermittently along the western margins of the Elzevir and Weslemkoon batholiths, within a belt of Tudor Formation mafic metavolcanics extending from southern Elzevir township to northern Cashel township.

Only two other areas show significant talc potential: the Kaladar township occurrences, described in this section, and the Pakenham township occurrence (PM 1), described in Part II of this report.

The Elzevir-Cashel Belt of Talc Occurrences

General Geology

Figures 10a and 10b show the general geology in the area of the Elzevir-Cashel belt of talc occurrences. Parts of the area have previously been mapped by Meen and Harding (1942), Hewitt and James (1955), Hewitt (1968), and Lumbers (1968).

A sequence of metavolcanic rocks dominated by mafic metavolcanics of the Tudor Formation lies along the western margins of the Elzevir and Weslemkoon granodiorite batholiths, striking roughly parallel to, and dipping steeply away from the batholiths.

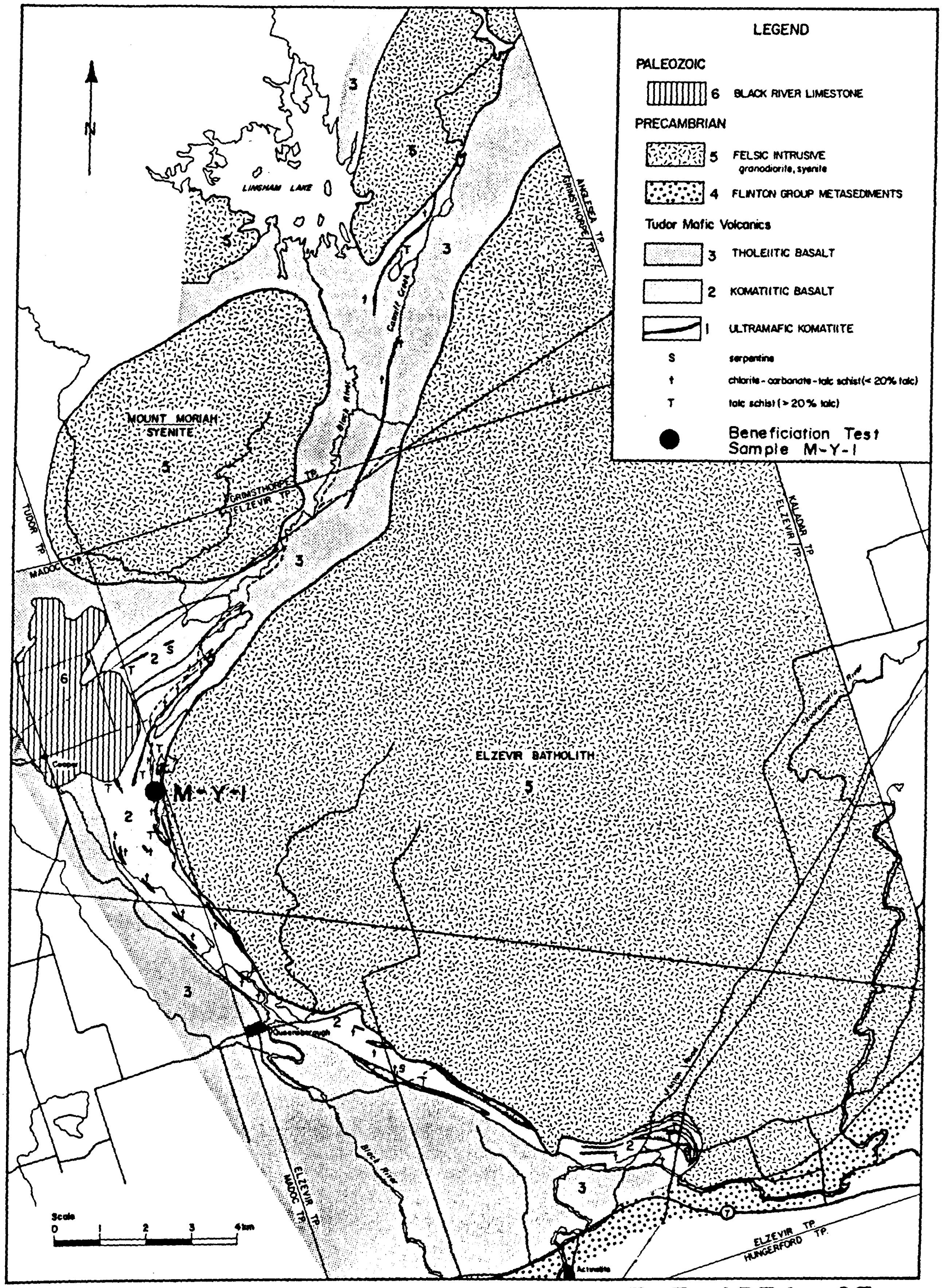


FIGURE 10a : GENERAL GEOLOGY IN THE AREA OF THE ELZEVIR-CASHEL BELT OF TALC OCCURRENCES (SOUTH SHEET) (after LeBaron et al 1987)

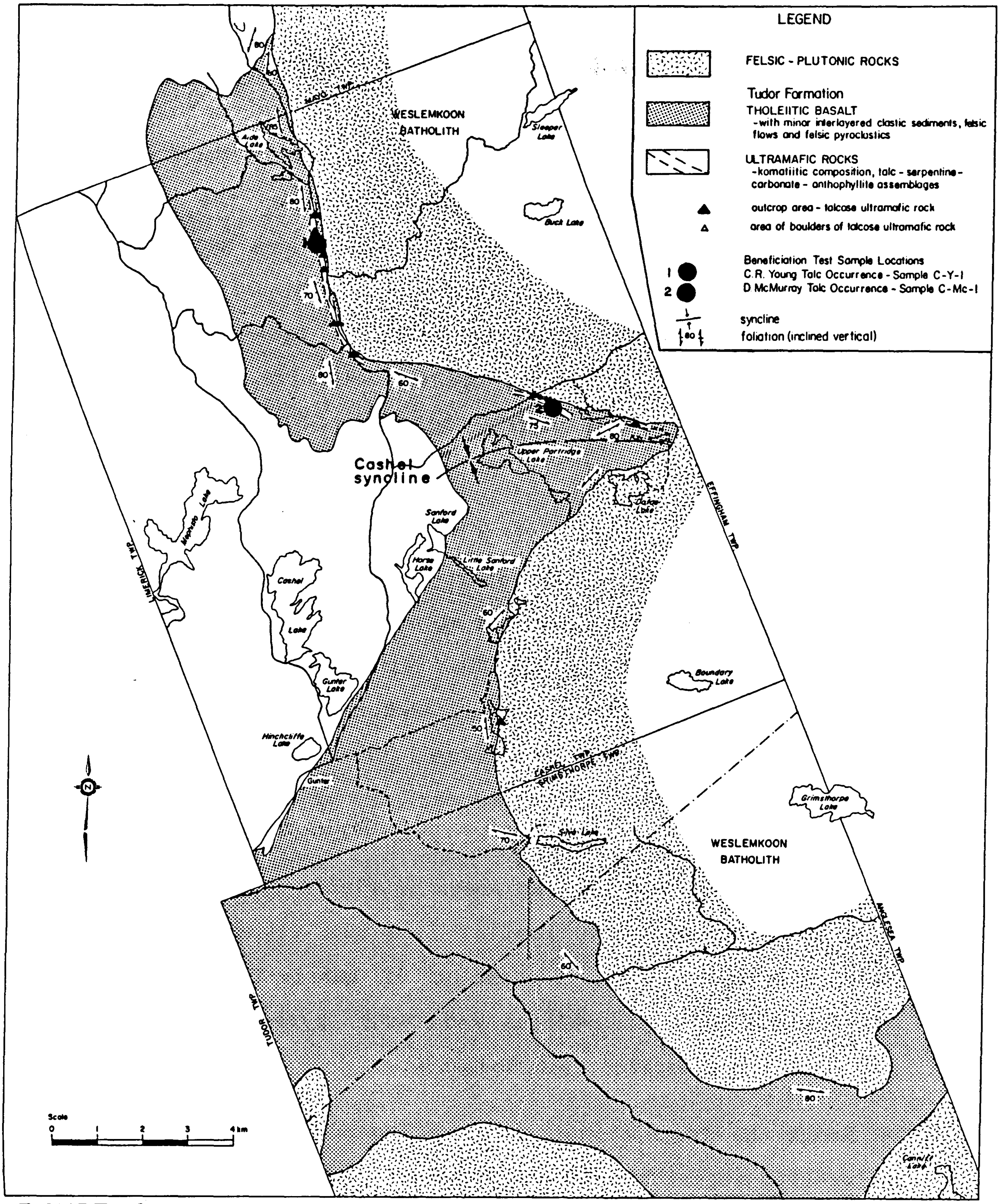


FIGURE 10b : GENERAL GEOLOGY IN THE AREA OF THE ELZEVIR-CASHEL BELT OF TALC OCCURRENCES (NORTH SHEET) (after LeBaron 1988)

Felsic flows and pyroclastics of the Oak Lake Formation are interlayered with the mafic metavolcanics toward the western edge of the volcanic sequence. Overlying the metavolcanics to the west are clastic and chemical metasediments of the Mayo Group, predominantly marbles and calcareous sandstones and siltstones. The metavolcanics have been intruded by the Canniff Lake granite, Mount Moriah syenite, and the mafic to felsic Lingham Lake intrusive complex. Overlying the metavolcanics, in northeastern Madoc township, is a small outlier of Paleozoic rock -- calcareous sandstone of the Shadow Lake Formation, Black River Group.

The area of interest with respect to talc is a zone up to 2 km wide within the Tudor Formation along the western margins of the Elzevir and Weslemkoon batholiths. Within this zone are numerous occurrences of ultramafic rock altered to various assemblages of talc, serpentine, anthophyllite, tremolite, chlorite, and carbonate. These rocks appear to represent part of a metavolcanic suite ranging in composition from ultramafic-komatiitic to tholeiitic, as shown in Figure 11, a Jensen Cation Plot of analyses of 90 samples from the Figure 10 map area. Metasedimentary rocks, consisting of quartz-feldspar-chlorite-biotite-amphibole assemblages and rusty, pyritic schists, occur throughout the metavolcanic sequence.

Although the areas shown in Figure 10a and the southern part of Figure 10b are within the regional greenschist facies metamorphic zone of the Hastings Basin, the rocks within the 2 km-wide belt of talc occurrences are within the amphibolite-grade thermal aureoles of the batholiths. In the northern part of Figure 10b, all rocks have undergone amphibolite grade regional metamorphism and the contact aureole is not identifiable.

Description of the Metavolcanic Rocks

The metavolcanics of the Tudor Formation were classified in the field as ultramafic komatiite, komatiitic basalt, and tholeiitic basalt based upon alteration mineralogy. Subsequent geochemical analyses of samples of each rock type supported the classifications, as shown on the Jensen Cation Plot (Fig. 11). Additional plots and discussion of the geochemistry of the metavolcanics are presented in Appendix 1.

Ultramafic Komatiites

The ultramafic rocks have been interpreted by previous workers (Lumbers 1968, Dillon and Barron 1985) as hydrothermal alteration products of mafic volcanic rocks. Verschuren (1982) noted the possibility that the volcanic-hosted talc occurrences in Elzevir township may be altered komatiitic flows or sills. The same hypothesis has been substantiated for talc, magnesite, and asbestos deposits in the Timmins-Kirkland Lake area by Kretschmar and Kretschmar (1986).

In this study, the ultramafic rocks have been included as a distinct member within the Tudor Formation sequence of mafic metavolcanics based upon the following features:

1) Preliminary analysis of the geochemistry of the ultramafic rocks indicates komatiitic affinity, distinguishable from

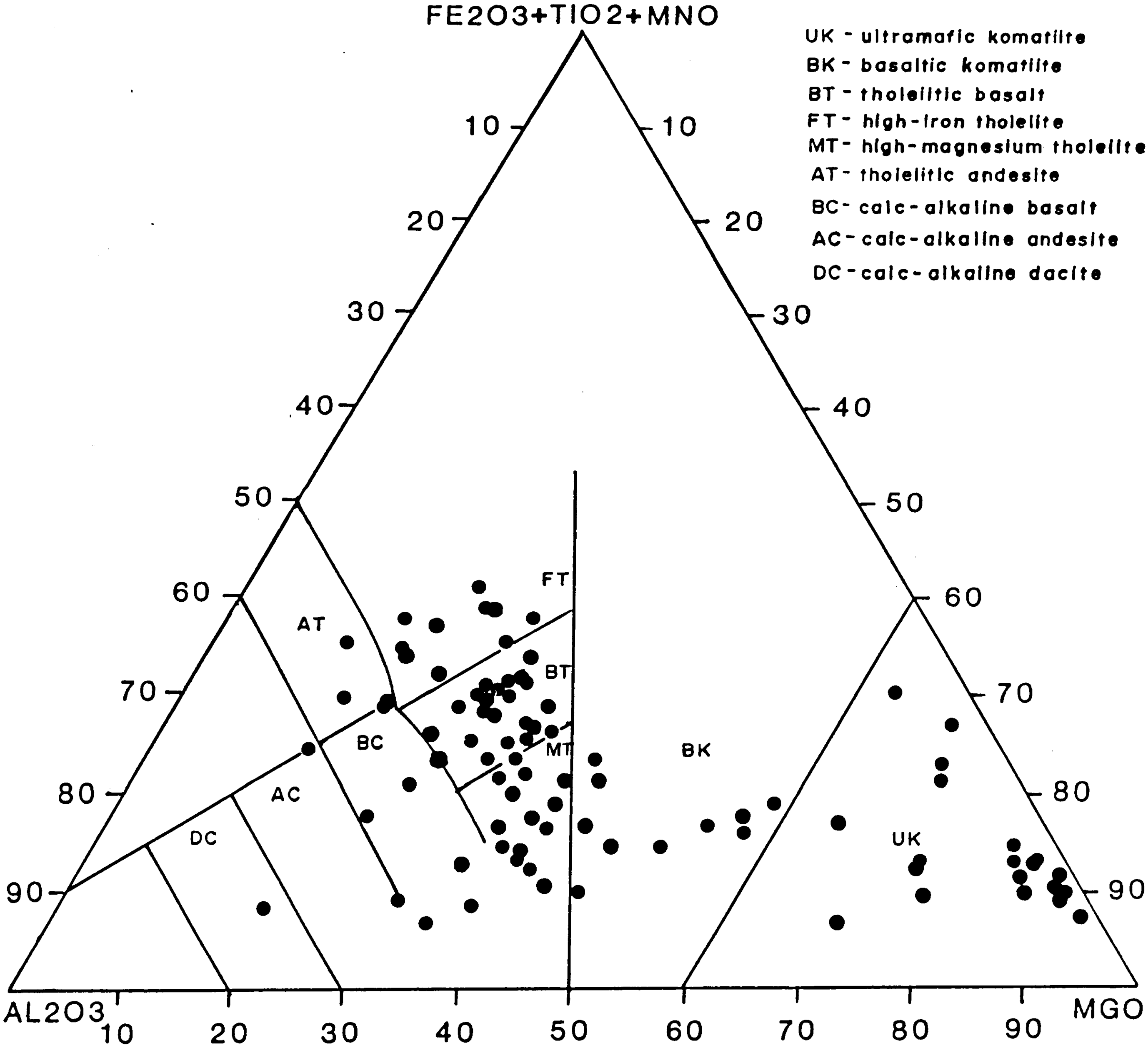


FIGURE II: JENSEN CATION PLOT OF 90 SAMPLES OF METAVOLCANIC ROCK FROM THE ELZEVIR-CASHEL BELT OF TALC OCCURRENCES that of the overlying tholeiitic basalts (Appendix 1).

2) Contacts between ultramafic and mafic rocks observed in outcrop and diamond drill core are conformable and sharp.

3) Thin (less than 2 m) layers of chlorite, biotite, and quartz-biotite schist occurring between ultramafic layers 2 to 10 m thick probably represent interflow metasediments between ultramafic flows.

4) Numerous occurrences of altered ultramafic rock of similar composition and thickness are present over a large lateral extent (60 km) within a limited stratigraphic interval.

It is acknowledged that there are several factors which may limit the validity of the above observations. These factors include: a) the limited outcrop exposure and limited geochemical database of the ultramafic rocks; b) the high degree of alteration, indicated by losses on ignition of up to 22%, which may have considerably changed the primary composition of the rocks; and c) the lack of primary textures and structures such as spinifex texture and polyhedral jointing. The last factor is not considered to be evidence against an extrusive origin for the ultramafic rocks because the primary textures have been replaced by coarse porphyroblastic to fine, schistose metamorphic textures. Jolly (1982, p.261) in reference to komatiites, states that, "Rocks of the amphibolite facies may be considered as completely recrystallized, as no relict minerals are observed and because most original textural features of the volcanic rocks have been obliterated."

The position of the komatiites in the volcanic sequence suggests that they represent a lower member of the Tudor Formation, overlain by a succession of tholeiitic volcanics, calc-alkalic volcanics, and shelf sediments. The older rocks (komatiites) are preserved locally along the margins of the batholiths due to a doming effect associated with the intrusions.

The ultramafic rocks are recognized primarily by their softness, due to high talc and/or serpentine content. In Elzevir, Madoc, and Grimsthorpe townships, the komatiites are generally schists consisting of variable amounts of talc, chlorite, serpentine, dolomite, anthophyllite, actinolite, and magnetite. Hematite is common in sheared, talc-rich zones, giving the rock a pink colour. Weathered surfaces are smooth, brown to green-grey where the rocks are serpentine and amphibole-rich, and pitted, rusty-red to grey where talc, carbonate, and hematite are present.

In Cashel township, the komatiites are more massive in texture, with coarse radial agregates of anthophyllite and talc (pseudomorphic after anthophyllite), coarse dolomite and calcite, and variable amounts of serpentine, chlorite, and magnetite.

Komatiitic Basalt

The komatiitic basalts form a band from 400 to 2,000 m wide along the western margin of the Elzevir Batholith in Elzevir and Madoc township. They are also locally present in Cashel township, but not as a continuous, traceable unit. They consist primarily of actinolite, with lesser amounts of hornblende, plagioclase, chlorite, and serpentine. They vary in texture from fine-grained and weakly schistose to coarse-grained porphyroblastic rocks with segregated bands of plagioclase and amphibole. The basaltic komatiites are locally altered to chlorite-carbonate schist with minor serpentine and traces of talc.

Tholeiitic Basalt

Tholeiitic basalts are the dominant rock type in the Tudor Formation. They are essentially hornblende amphibolites, fine to medium-grained, dark green to black, and massive to weakly foliated. Close to the Elzevir and Weslemkoon batholiths, they have been altered to a porphyroblastic, gneissic rock with segregated mafic and felsic bands. Pillows were observed north of Dafoe Lake, in Cashel township. Thick sections of mafic lapilli tuff and agglomerate (up to 20 m) occur within the tholeiitic sequence, as do thin units (1 to 5 m) of felsic tuff and rusty, pyritic schist.

Structural Geology

Deformation style varies with regional metamorphic grade, from predominantly brittle in Elzevir, Madoc, and Grimsthorpe townships to more ductile in Cashel and Mayo townships. Two prominent fault/shear systems are evident in the Figure 7a map area, described in LeBaron et al (1987) as follows:

"The first fault system strikes north-northeast to northeast, and is represented by the Black River and Caniff Creek in Grimsthorpe Tonwship, and by numerous smaller creeks within the Elzevir Batholith. The second system strikes northwest and is marked by parts of the Black River south of the Village of Cooper, and by numerous creeks and linear swamps in both metavolcanic and intrusive rocks throughout the map area.

Within the metavolcanic rocks, the most prominent shear zones occur along the fault system that parallels the strike of the metavolcanics. South of the Village of Cooper, the major shear zones strike northwesterly; north of Cooper, they strike northeasterly. These shear zones have developed within the less competent komatiitic rocks and exhibit varying degrees of talc, chlorite, serpentine, and carbonate alteration.

The junction of these two prominent shear directions within the metavolcanic rocks occurs where the komatiites are folded around the westernmost "nose" of the Elzevir Batholith, just east of the Village of Cooper. The occurrence of significant talc-bearing zones in this area (Cooper Area Talc Occurrence, described in Dillon and Barron 1985) may be related to the concentration of structural features in the komatiites east of the Village of Cooper.

Another area in which the occurrence of talc appears to be related to structure is the southeastern end of the komatiite band, between the Flinton Road and the Elzevir Batholith. Here, the metavolcanic rocks have been tightly folded within a horseshoe-shaped embayment in the batholith, and a wide zone of ultramafic komatiites has been extensively altered to talc and serpentine.

No large scale displacement of contacts was observed; the largest was a 70 to 100 m right-lateral offset of the batholith contact

400 m north of the Grimsthorpe-Elzevir township line."

Shearing of the metavolcanics in Cashel township is less evident, but folding is intense and complex. Most major and minor fold axes trend and plunge northeast to east (Lumbers 1968). The most prominent structure is the Cashel Syncline, which probably developed during intrusion of the northern and southern lobes of the Weslemkoon Batholith. Small scale drag folding, locally prominent near the intrusive contact, is also probably related to the intrusion.

Because the talcose rocks are poorly exposed, it is difficult to relate them to structural features. Although the zones are roughly linear, parallel to the regional foliation, thickening may occur at fold hinges. A concentration of talcose boulders adjacent to a swamp along the axis of the Cashel Syncline north of Dafoe Lake may indicate talc mineralization in bedrock below the swamp.

Description of the Talcose Zones

The ultramafic hosted talc occurrences in Elzevir, Madoc, Grimsthorpe, and Cashel townships are described individually in Part II of this report. Their general characteristics are as follows:

The talcose zones vary in width from 5 to 40 m, averaging 20 to 40% talc. Associated minerals include dolomite, serpentine, anthophyllite, chlorite, and magnetite. Less common are calcite, tremolite, and actinolite. Dimensions are difficult to determine because of poor exposure, but exposed widths of 15 m and lengths of 50 to 75 m are common. Both the McMurray occurrence (CL3) and the Cooper occurrence (MC6) are at least 40 m wide and over 300 m long. Many of the other occurrences may be considerably more extensive than is indicated in outcrop.

Examination of the McMurray occurrence in outcrop and in diamond drill core (stored at the Bancroft Drill Core Library) indicates that the zone consists of a series of talc-carbonate-anthophyllite altered ultramafic units from 2 to 10 m wide, separated by 20 to 40 cm - wide bands of chlorite schist, biotite schist, and quartz-biotite schist. Underlying the zone is a banded, quartz-biotite-hornblende schist containing some pyritic (rusty schist) bands. Overlying the talcose zone is a 3 to 5 m width of banded quartz-biotite-chlorite-hornblende schist, which is overlain by fine-grained, black amphibolite (tholeiitic basalt).

The McMurray occurrence apears to be representative of the general character of the Elzevir-Cashel talc occurrences. Similar descriptions of talcose zones as a series of ultramafic units separated by narrow bands of chlorite, biotite, or quartz-biotite schist are recorded in diamond drill logs from several other occurrences (Twin Buttes Exploration, Canada Talc Industries, and C. Roger Young; Assessment Files, Resident Geologist's Office, Ministry of Northern Development and Mines, Tweed).

Origin of the Talc

Talc-serpentine-carbonate assemblages are produced when ultramafic rocks react with water, silica, and a small amount of carbon dioxide under low grade metamorphic conditions. With higher temperatures and greater carbon dioxide content of the hydrothermal fluids, talc is converted to a anthophyllite by the reaction

$$7 \text{ talc} = 3 \text{ anthophyllite} + 4 \text{ quartz} + 4 \ H_2O$$

(Winkler 1979)

Ultramafic komatiites, representing one of the oldest members of the Tudor Formation metavolcanic sequence, were subjected to hydrothermal alteration associated with intrusion of the Elzevir and Weslemkoon batholiths. Higher metamorphic grades were attained in northern Cashel township (Lumbers, 1968), producing anthophyllite-rich rocks. Subsequent retrograde metamorphism has produced talc after anthophyllite in Cashel township, and talc-serpentine in the lower-grade rocks in Elzevir, Madoc, and Grimsthorpe townships.

Kaladar Township Talc

Three occurrences of talc-anthophyllite-carbonate altered ultramafic rock in Kaladar Township are very similar to those in Cashel Township. Figure 12 shows the geology in the area of Upper Flinton Road, Elzevir and Kaladar townships. The ultramafic rocks, exposed within a narrow belt of Flinton Group metasediments between the Elzevir and Northbook batholiths, are

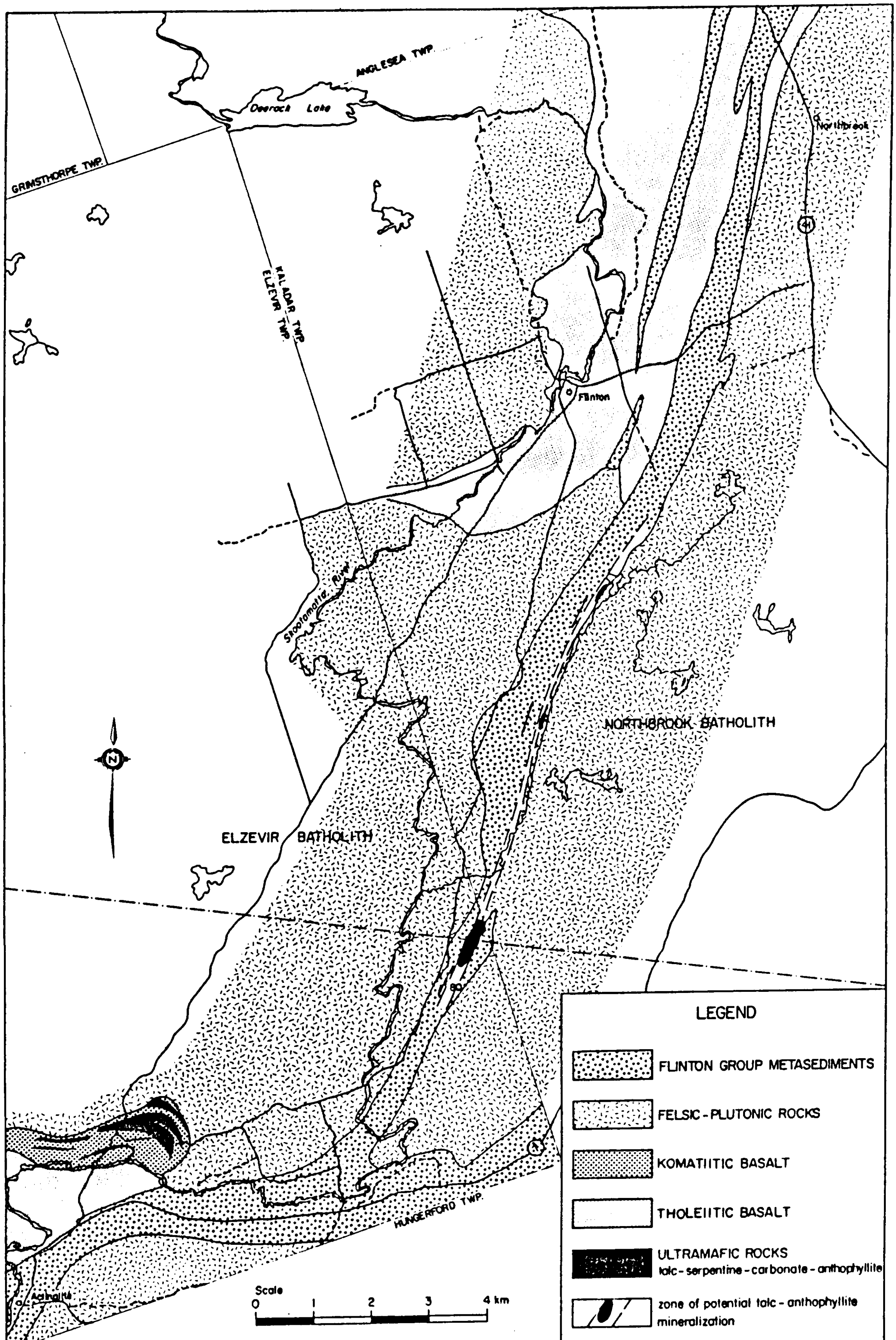


FIGURE 12: GENERAL GEOLOGY IN THE AREA OF THE KALADAR TOWNSHIP OCCURRENCES (after LeBaron 1988)

described by LeBaron (1988) as follows:

"These rocks show widespread alteration to talc-serpentine-carbonate-anthophyllite assemblages. The most common assemblage is anthophyllite-carbonate, in which 80 percent coarse rosettes of anthophyllite occur in a grey dolomite groundmass. Talc is pseudomorphic after anthophyllite, locally almost completely replacing the amphibole. Samples taken by Wolff (1982a) and Verschuren et al. (1986) contain 78 and 60 percent talc, respectively.

Wolff (1982a) correlates the ultramafic rocks with mafic volcanic rocks in the area, stating that the ultramafics may represent one of the oldest members of the Tudor Formation. They are similar in appearance and composition to ultramfic komatiites in Elzevir and Cashel townships. Diamond-drill core from a talc-anthophyllite-carbonate zone in lot 13, concession II, Kaladar Township (drilled by C.R. Young in 1981) shows that the zone consists of two ultramafic units about 7 m wide, separated by a 7 m wide section of chlorite-biotite and feldspar-biotite schist: a sequence similar to that observed at the McMurray Occurrence in Cashel Township.

The position of the ultramafic rocks within younger Flinton Group metasediments suggests tectonic emplacement. Thompson (1972) reports mylonite and strained quartz in adjacent metasediments as evidence of faulting along the margins of the ultramafic bodies. Linear swamps along the contact areas are additional evidence of possible faulting and should be considered as potential targets for talc mineralization within sheared margins of the ultramafics.

The ultramafic outcrop areas range in width from 5 m at the northernmost exposure (Figure 12) to 300 m near the Elzevir-Kaladar township line. The strike extent is obscured by overburden and may be more continuous than indicated on previous geological maps by Wolff (1982a) and Thompson (1972)."

BENEFICIATION OF ULTRAMAFIC-HOSTED TALC

Beneficiation tests on samples of talcose rock from three occurrences within the Elzevir-Cashel belt were done by I.M.D. Laboratories Ltd. in order to evaluate methods of extracting the talc and to assess the quality of the talc products.

The following is a summary of the test results, from LeBaron (1988). The complete report by I.M.D. Laboratories Ltd. is reproduced in Appendix 2.

SAMPLE DESCRIPTIONS

The locations of the samples, M-Y-1 (Cooper occurrence, MC6), C-Y-1 (occurrence CL4), and C-MC-1 (McMurray occurrence, CL3), are shown on figures 10a and 10b. Each sample consisted of about 11 kg. of split diamond drill core.

Sample C-Y-1 is from a 12.8 m talcose section, excluding 2.6 m of anthophyllite-rich rock with less than 5 percent talc. The zone is at least 200 m long, consisting primarily of talc, dolomite, and anthophyllite. Sample C-MC-1, from the McMurray Occurrence, is a composite sample from two diamond-drill holes 150 m apart on the same talc zone. The rock is a complex assemblage of talc, dolomite, calcite, serpentine, chlorite, and magnetite. Sample M-Y-1 is from an 8.5 m section of core, composed primarily of talc, dolomite, and serpentine, which represents a part of the "Cooper East Zone", estimated to contain 780 000 tonnes of 30 to 33 percent recoverable talc (Meillon 1985). About 350 m west is the "Cooper West Zone", estimated to contain 2.2 million tonnes of similar grade material. The Cooper Occurrence is described in detail by Meillon (1985) and by Dillon and Barron (1985).

Thin sections of representative samples from each test sample were studied to obtain mineral percentages, shown in Table 4. An X-ray diffraction scan was also run for each sample to check mineral identification and to estimate calcite/dolomite ratios.

TABLE 4: Mineralogy (Volume Percent) Of Beneficiation Test Samples, Determined By Thin Section Point Counts And X-Ray Diffraction

	M-Y-1	M-Y-1A	C-Y-1	C-Y-1A	C-MC-1	C-MC-1A	C-MC-1B
Talc	37	46	18	28	30	40	4
Dolomite	41	18	49	38	24	10	5
Calcite	-	-	-	-	24	20	1
Serpentine	19	29	11	9	16	11	33
Chlorite	1	5	-	1	3	13	1
Anthophyllite	-	-	21	23	-	1	3
Magnetite	2	2	1	1	3	5	15

TEST PROCEDURE

Each sample was subjected to a series of five or six tests involving grinding of the sample, followed by multi-stage froth flotation. The first three tests investigated the effect of varying particle size under constant flotation conditions, while the remaining tests were done to improve results by modification of the flotation process (i.e. varying pH and reagents). The flotation stages in each test consisted of a rougher float, a scavenger float, and three cleaner floats. All flotation products were treated by low and high intensity magnetic separation and a chemical analysis was done on the best product from each sample.

TEST RESULTS

The best results with respect to talc yield and dry brightness for each of the three samples are shown in Table 5. The dry brightness values for a sample of high-quality commercial talc and Johnson's Baby Powder, taken from Kriens (1985), are included for comparison.

A comparison of talc yield with the talc content of each sample, as indicated by thin section study (Table 4), suggests that talc recovery is in the 75 to 90 percent range. Dry brightness is improved at the expense of talc yield, except in the case of sample C-Y-1 which shows the highest percent yield and brightness from the same test sample. The dry brightness values of samples M-Y-1 and C-Y-1 equal that of the baby powder and are close to the value for a high-quality commercial talc. The brightness measurements were done on samples ground to -325 mesh, or about

40 microns. Micronizing can considerably increase the brightness as delamination of the talc flakes presents more fresh surfaces.

TABLE 5: Results Of Froth Flotation Tests On Samples Of Talcose Rocks From Madoc And Cashel Townships. Talc Yield Is The Weight Of Talc Product As A Percentage Of Original Sample Weight. Talc Recovery Is In The 75 To 90 Percent Range

Sample	Occurrence	Talc Yield (%)	Dry Brightness (%)	Acid Solubles (%)
C-Y-1-2	Occurrence CL4	23.6	90.2	11.70
C-MC-1-1	McMurray	29.2	88.7	5.73
C-MC-1-2	McMurray	30.3	88.3	6.19
M-Y-1-4	Cooper	46.8	88.0	9.92
M-Y-1-5	Cooper	35.9	90.4	3.54
Commercial Talc			91.2	
Johnson's Baby Powder			89.4	

The feed grades of about 30 to 47% talc for samples M-Y-1 and C-MC-1 are comparable to those of currently-producing mines. Steetley Talc Inc. operates at an average grade of 35 to 40% talc with 65 to 70% recovery, giving a talc yield of 28% (B.N. Woodrow, Technical Services Supervisor, Steetley Talc Inc., Timmins, personal communication 1988).

Samples of the talc products were analysed by X-ray diffraction to obtain estimates of mineral percentages, shown in Table 6.

Dolomite and serpentine as impurities in the talc product are acceptable in many industrial applications. Only anthophyllite, present in the C-Y-1 product, is considered as an undesirable component due to its possible classification as an asbestiform mineral by the United States Occupational Safety and Health Administration.

TABLE 6: Mineralogy of Talc Products From Madoc And Cashel Townships.

Sample	Talc	Dolomite	Serpentine/Chlorite	Anthophyllite
M-Y-1-5	88	3	9	--
C-Y-1-6	93	2	2	3
C-MC-1-6	86	4	10	--

POTENTIAL APPLICATIONS OF THE PRODUCTS

The talc products are of moderate quality. They are not suitable for cosmetic applications due to lack of purity, and the high iron content makes them unsuitable for use in ceramics. However, all three have potential application in the paint, plastics, and paper industries (J. Kriens, President, I.M.D. Laboratories Ltd., Concord, Ontario, personal communication, 1988). Additional testing of the products for qualities such as abrasion and absorption and testing in actual industrial applications is required to accurately determine their potential applications. The majority of industrial talcs are of moderate quality, consisting of about 90% talc (Roe and Olson 1983), therefore, the Elzevir-Cashel talcs appear to have good commercial potential.

SUMMARY AND RECOMMENDATIONS

The Precambrian rocks of southeastern Ontario represent a favourable exploration environment for talc deposits.

There is good potential for carbonate-hosted deposits of the Canada Talc type -- relatively pure talc bodies requiring little or no beneficiation, and large bodies of tremolitic talc which can be used as low-grade filler or up-graded to a pure talc product by flotation. The greatest potential is within areas of greenschist facies metamorphism where siliceous, dolomitic marble has been altered by igneous intrusion. More specifically, occurrences recommended for further exploration are HN2 and HN3 adjacent to the Canada Talc Limited mine in Huntingdon township; BT1 in Belmont township, which shows similarities to the Canada Talc deposit and is virtually untested; and MC1 in Madoc Township, a former producer with potential for a large talc deposit of low to moderate grade. There are numerous other occurrences of tremolite-talc mineralization which, although low-grade, represent favourable areas for additional exploration.

Several known ultramafic-hosted talc occurrences with dimensions and grades comparable to currently-producing deposits have been shown to yield a talc product by flotation which has potential application in the paint, plastics, and paper industries. The occurrences lie within a narrow belt of ultramafic rocks which represents a well-defined exploration target area extending through parts of Elzevir, Grimsthorpe, Madoc, and Cashel townships.

Other occurrences of ultramafic-hosted talc which warrant further investigation are the Pakenham township occurrence (PM1) and the Kaladar township talc-anthophyllite zone (KR3).

Because of the tendency of the talcose zones to form negative-relief features, topographic lows in areas of favourable host rock should be considered as potentially talc-bearing.

The best potential for both types of talc deposit is within the Hastings Basin, an area well-situated with respect to markets and transportation networks in southern Ontario and the northeastern United States.

PART II

DESCRIPTIONS OF SOUTHEASTERN ONTARIO TALC OCCURRENCES

This section contains descriptions of all known talc occurrences in southeastern Ontario, based on a literature search and geological field work.

The deposits are grouped in counties, and alphabetically by townships within counties. All the occurrences have been assigned alphanumeric names based on the first and last letters in the township names. For example, Kennebec Township contains talc occurrences KC1 and KC2.

Approximate locations of the occurrences are shown in Figure 13. Location maps at 1:250,000 scale are provided with the descriptions of occurrences by township.

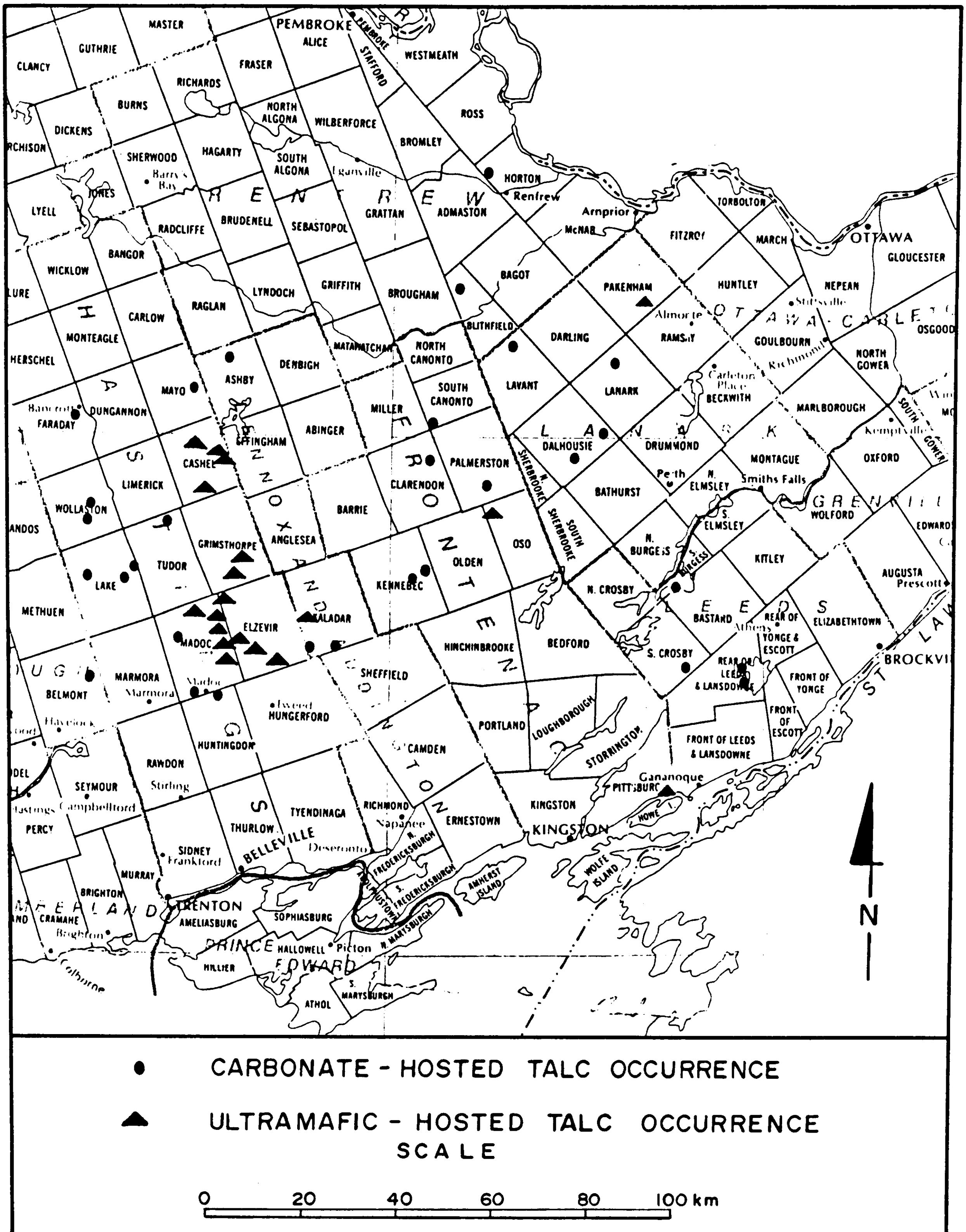


FIGURE 13: LOCATION MAP OF THE SOUTHEASTERN ONTARIO TALC OCCURRENCES.

TABLE 7: SUMMARY OF TALC OCCURRENCES IN SOUTHEASTERN ONTARIO

LOCATION	NAME	ROCK ASSOCIATION	FIELD CHECKED	COMMENTS
FRONTENAC COUNTY				
Clarendon Township Con II, Lot 34	CN1	Carbonate	No	Minor talc with tremolite and quartzite.
Kennebec Township Con VIII, Lot 17E 1/2	KC1	Carbonate	No	Poorly developed talc-carbonate schist with tremolite, calc-silicates, and quartzite.
Con XI, Lot 18	KC2	Carbonate	No	As for KC1
Oso Township Con II, Lot 25 or 26	OO1	Mafic volcanic	Yes	Low grade talc schist with large tonnage potential.
Palmerston Township Con VI, Lot 6	PN1 (RAM Petroleums Limited)	Carbonate	Yes	Tremolite schist with minor talc, recently mined for tremolite by RAM Petroleums Limited.
Pittsburgh Township Con III, Lot 35S 1/2	PH1	Ultramafic	No	Serpentine-talc; minor production for roofing material about the year 1900.
South Canonto Township Con 1, Lots 1, 2	CO1	Carbonate	Yes	Talc schist with siliceous and carbonate layers.
HASTINGS COUNTY				
Cashel Township Con II, Lot 16	CL1	Ultramafic	Yes	Talc-tremolite-chlorite-serpentine; limited tonnage potential.
Con VII, Lot 2	CL2 (Dubblestein)	Ultramafic	Yes	Diamond drilling by Canada Talc Limited in 1982 intersected several narrow talcose zones.
Con VIII, Lot 7	CL3 (McMurray)	Ultramafic	Yes	Low grade, large tonnage potential; flotation tests indicate that a talc product of good quality can be obtained.
Con XII, Lots 16, 17 Con XIII, Lot 16 Con XIV, Lots 15, 16	CL4 (Madoc Talc and Mining Company)	Ultramafic	Yes	Underground workings date to 1938. The zone was diamond drilled by Canada Talc in 1982. Flotation tests indicate that good quality talc can be obtained.
Elzevir Township Con I, Lot 27	ER1	Ultramafic	Yes	Extension of the zone of MC6 and MC7; low-grade, large tonnage potential talc-serpentine-chlorite-carbonate zones.
Elzevir Township Con II, Lots 10, 11 Con III, Lots 8-11 Con IV, Lots 6-9	ER2	Ultramafic	Yes	Low-grade, large tonnage potential; diamond drilling in 1982 by Steep Rock Iron Mines and Canada Talc Limited.
Con VI, Lot 5 Con VII, Lots 4, 5	ER3	Ultramafic	Yes	Low-grade, large tonnage potential; minor quarrying in early 1900's for roofing material.
Con I, II, Lots 14-18	ER4	Ultramafic	Yes	Multiple talc-bearing zones of low grade; large tonnage potential.
Con II, Lot 15	ER5	Ultramafic	Yes	As for ER4
Faraday Township Con X, Lot 11	FY1	Carbonate	Yes	Very minor amounts of talc in tremolitic marble.
Grimsthorpe Township Con IV, Lot 13S 1/2	GE1	Ultramafic	not found	Wide, low grade talc zone in serpentinized mafic volcanic.
Con V, Lot 10	GE2	Ultramafic	Yes	Low grade, large tonnage potential; includes narrow veins of coarse, pure talc.
Huntingdon Township Con XIV, Lots 14-15	HN1 (Canada Talc Industries Limited)	Carbonate	Yes	Current producer.
Con XIV, Lot 15 E 1/2	HN2 (Price Mine)	Carbonate	No	Low-grade talc-dolomite zone; narrow seams of high-grade talc.
Con XIV, Lot 16	HN3 (International Pulp)	Carbonate	No	Similar to HN2; three shafts sunk 1917-19.
Lake Township Con III, IV, Lots 18-20	LE1	Carbonate	No	Impure talc-actinolite rock with magnetite and minor chalcopyrite.
Con X, Lots 15-18	LE2	Carbonate	Yes	Talc-tremolite-carbonate associated with a fault zone.
Con XI, Lot 63	LE3	Carbonate	No	Minor talc and tremolite ir marble.
Limerick Township Con IV, Lot 7	LK1	Carbonate	No	Minor talc, iron oxides, and silicates in marble at granite contact.

TABLE 7 (Cont'd)

LOCATION	NAME	ROCK ASSOCIATION	FIELD CHECKED	COMMENTS
Madoc Township Con IV, V, Lots 20, 21	MC1 (Eldorado Mining and Milling Co.)	Carbonate	Yes	Low-grade talc-dolomite schist; minor production from 1911-1920.
Con V, Lot 2	MC2 (Seymour Iron Mine)	Carbonate	No	Former iron mine with minor talc occurrence.
Con X, Lot 24	MC3	Ultramafic	Yes	Low to moderate grade, large tonnage potential.
Con XI, Lot 15	MC4	Ultramafic	Yes	Impure talc-dolomite schist, very limited exposure.
Con XI, Lot 17W 1/2	MC5	Ultramafic	Yes	Narrow, high-grade talc-dolomite zone; limited exposure.
Con XI, Lots 22-24	MC6 (Cooper)	Ultramafic	Yes	Large tonnage of low-moderate grade talc ore outlined by diamond drilling; flotation tests gave good quality talc product.
Con X, XI, Lots 18-21	MC7	Ultramafic	Yes	Extensions of zones of MC6.
Con XI, Lot 28	MC8	Ultramafic	Yes	Probably northward extension of occurrence MC3.
Mayo Township Con X, Baker & Wanamaker Lots	MO1	Carbonate	No	Very narrow zone along diorite dike contact. Exact location unknown.
Tudor Township Con XVIII, Lots 8-10	TR1	Carbonate	No	Coarse talc reported in marble; very little previous work.
Wollaston Township Con IX, Lot 9	WN1	Carbonate	No	Minor talc in dolomitic marble.
Con X, XI, Lots 8, 9	WN2	Carbonate	Yes	Minor talc in tremolitic marble.
LANARK COUNTY				
Dalhousie Township Con VIII, Lot 6	DE1	Carbonate	Yes	Minor talc (3%) and tremolite in dolomitic marble.
Con II, Lots 5, 6	DE2	Carbonate	Yes	Minor talc in tremolitic bands within dolomitic marble.
Lanark Township Con VIII, Lot 20	LNK1	Carbonate	No	10% talc in tremolitic, calcitic marble.
Lavant Township Con III, Lot 24E 1/2	LT1	Carbonate	Yes	Traces of talc within serpentinized dolomitic marble; diamond drilling in 1981.
Pakenham Township Con VI, Lot 6	PM1	Ultramafic	Yes	Altered pyroxenite; moderate grades, large tonnage potential.
LEEDS COUNTY				
Rear of Leeds and Lansdowne Township Con IX, Lots A15, A16	RLE1	Carbonate	No	Minor talc-tremolite in quartzite-limestone transition beds.
Con X, Lots A15, A16	RLE2	Carbonate	No	Minor talc with phlogopite in an old mica prospect.
South Burgess Township Con I	BS1 (Grindstone Island)	Ultramafic	No	Serpentinized pyroxenite with minor talc; quarried for roofing material between 1893 and 1899.
South Crosby Township Con IV, Lots 5 and 6	CY1	Carbonate	No	Minor talc in serpentinized marble.
LENNOX AND ADDINGTON COUNTY				
Ashby Township Con XIV, Lot 17 (Subdivision annulled)	AY1	Carbonate	No	Narrow talc-rich and tremolite-rich bands in marble.
Kaladar Township Con I, Lot 5	KR1	Carbonate	No	Dolomitic marble-hosted talc occurrence; no additional information.
Con V, Lot 2	KR2	Carbonate	not found	60 cm-wide talc zone in tremolitic marble.
Con II, Lot 13	KR3	Ultramafic	Yes	Former stone quarry; potential for large tonnage of low-grade talc.
PETERBOROUGH COUNTY				
Belmont Township Con I, Lot 20	BT1	Carbonate	Yes	High-grade talc zone in siliceous dolomite; poor exposure; similar geology to that at Canada Talc Mine (MN1).
RENFREW COUNTY				
Blithfield Township Con IV, Lot 22	BD1	Carbonate	No	Serpentine-talc-tremolite shear zone in marble; minor quarrying in 1945-46 for "tremolite asbestos."
Horton Township Con I, Lot 21	HRN1	Carbonate	No	Former stone quarry in blue-white dolomitic marble with narrow zones containing talc and graphite.

FRONTENAC COUNTY

Clarendon Township

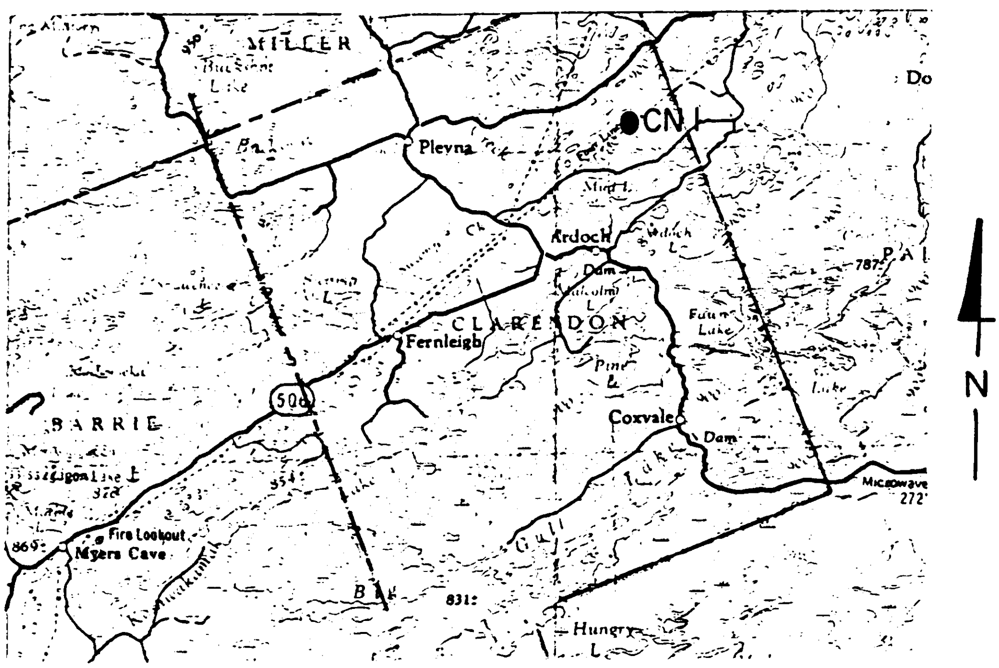


Figure 14: Location Map of the Clarendon Township Talc Occurrence.

(scale 1:250,000)

CN1: Clarendon Township, Concession II, Lot 34

Rock Association: Carbonate

Access: The occurrence lies to the north of Green Lake. The area of the occurrence can be reached by the dirt track that runs eastward from the Ardoch-Plevna Road, and via the hydro line which passes north of Green Lake.

Description: This occurrence was noted by Spence (1922, 1940), who stated that it "does not appear to be of economic importance".

The area of the occurrence is underlain by steeply-dipping, southwest-striking paragneiss, marble and schist (Pauk and Mannard, 1982).

Although this occurrence is apparently a minor one, the presence of tremolite and quartzite layers (Pauk and Mannard 1982), plus talc indicates that marbles in this vicinity are favourable host rocks for talc deposits.

Reference Map: Ontario Geological Survey Preliminary Map P. 2487, Ardoch Area by Pauk and Mannard, 1982.

Reference: Spence (1922, p.38; 1940, p.80).

Kennebec Township

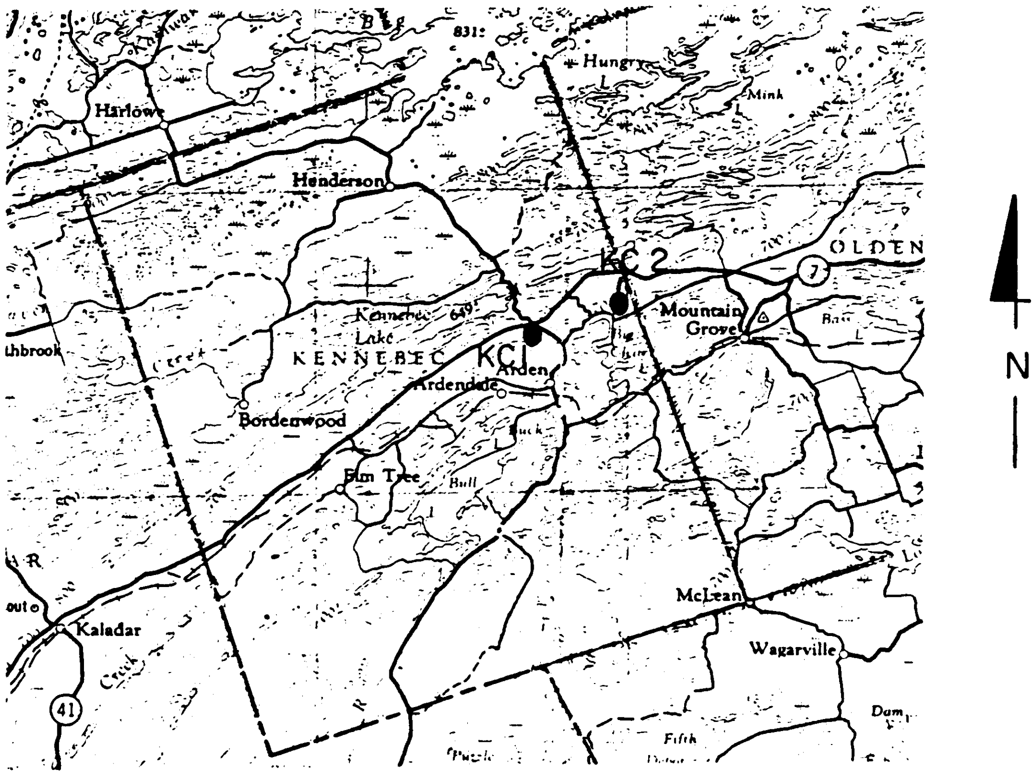


Figure 15: Location Map of the Kennebec Township Talc Occurrences. (scale 1:250,000)

KC1: Kennebec Township, Concession VIII, Lot 17, East Half

Rock Association: Carbonate

Access: This occurrence is immediately southeast of the junction of Highway 7 and the Arden Road. It may be reached on foot from the Arden Road.

Description: At this locality three outcrops of calcite-talc schist were mapped by Wolff and Smith (1979). These talc-bearing outcrops are located within a northeast-striking marble belt. The calcite-talc schist is interlayered with calcitic marble, dolomitic marble and quartzite, and tremolitic calc-silicate rock. According to Wolff (1982b), the talc schist is "poorly developed. A very friable and greasy-feeling rock, it weathers greenish streaky grey and has been pulverized during deformation."

Reference Map: Ontario Geological Survey Preliminary Map P.2246, Long Lake

Reference: Wolff (1982b, p.22)

Wolff and Smith (1979)

KC2: Kennebec Township, Concession XI, Lot 18

Rock Association: Carbonate

Access: The occurrence lies northeast of Arden, and its general area may be reached by road.

Description: At this locality Wolff (1982b) mapped one outcrop of calcite-talc schist within a northeast-striking marble belt. The calcite-talc schist is associated with dolomitic, tremolite-bearing marble.

Wolff (1982b) reported that the talc schist is "poorly developed. A very friable and greasy-feeling rock, it weathers greenish streaky grey and has been pulverized during deformation".

Reference Map: Ontario Geological Survey Map 2449, Long Lake

Reference: Wolff (1982b, p. 22)

Oso Township

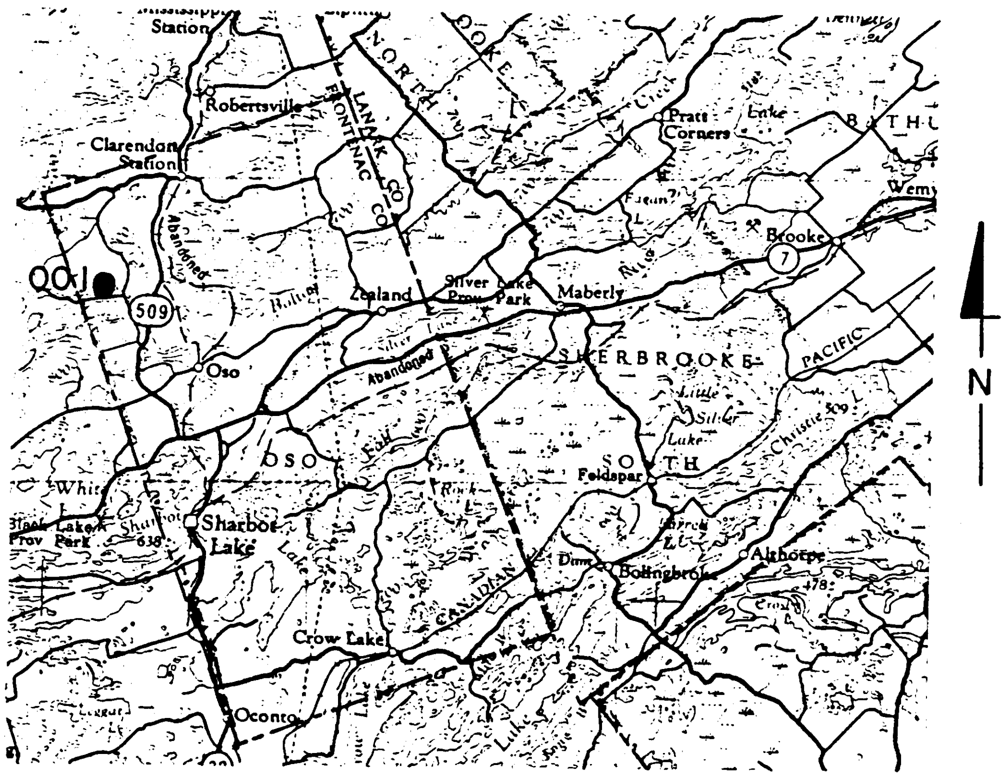


Figure 16: Location Map of The Oso Township Talc Occurrence. (scale 1:250,000)

001: Oso Township, Concession II, Lot 25 or 26

Rock Association: Mafic volcanic rock.

Access: An old wagon road leads northwest from the Pennick Lake Road to the occurrence.

Description: Wolff (1985) described this deposit as follows:

"[Talc showings occur] in the metavolcanics where they are immediately adjacent to the prominent shear zone just west of Pennick Lake.

...in outcrop the unit is composed of a north-striking talc-tremolite-serpentine-calcite schist enclosed by metavolcanics and minor amounts of carbonate metasediments. The outcrop itself is composed of a low ridge (maximum relief of 7 metres) which is some 100 metres wide and could be traced for 500 metres along strike. The ridge is intersected by several northwest-trending fractures which allow examination across strike of the lithologies.

...a thin section of one of the more talc-rich phases yielded 70 percent fine-grained (0.05 - 0.10 centimeters) talc bundles and sheaves with a ground mass of plagioclase (18 percent), tremolite (5 percent), iron oxide (5 percent), and opaques, pyrite (2 percent)."

Reference Map: Ontario Geological Survey Map 2471 Sharbot Lake Area.

Reference: Wolff (1985, p.61)

Palmerston Township

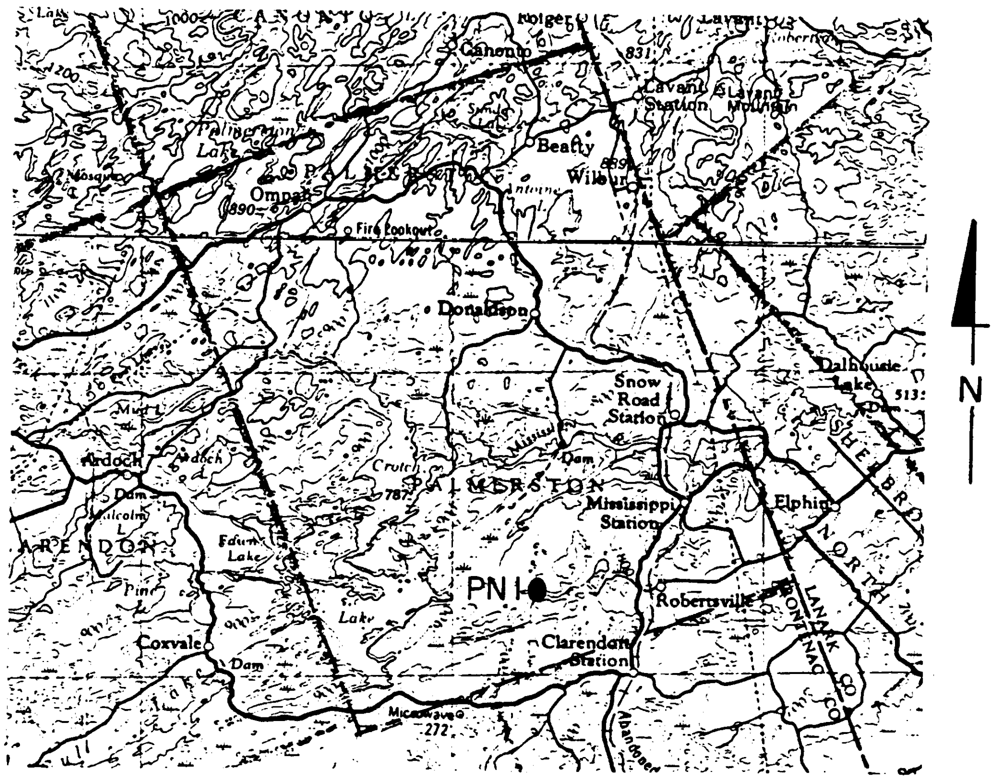


Figure 17: Location Map of the Palmerston Township Talc Occurrence.
(scale 1:250,00)

PN1: Palmerston Township, Concession VI, Lot 6
RAM Petroleums Limited

Rock Association: Carbonate

Access: The deposit is reached by approximately four kilometers of dirt road leading west from Ram Petroleums Limited's mill on Highway 509 near Robertsville.

Description: The deposit occurs in marble along its contact with mafic gneiss that lies to the south.

Hewitt (1972) visited the deposit and reported that:

"a zone of talc-tremolite schist 50 feet (15 m) wide was exposed intermittently over a length of 1000 feet (300 m). The strike is east-west and the dip of the schist is vertical. The band is strongly dragfolded."

A milled product consisting of 80 to 95% tremolite and 5 to 20% combined talc and mica has been produced by RAM Petroleums Ltd. Proven reserves are reported to be 1.55 Mt of tremolite, 220,00 t of mica, and 110,000 t of talc (Industrial Minerals, June 1986, p. 7).

History: Test pits were put down in 1946 by Montgomery and Scott of Havelock (Hewitt, 1972). RAM Petroleums Limited leased the property in 1979 (McKay and Young 1980) and erected a mill. From 1982 to 1986, up to 15,000 tpa of tremolite was produced for use in asphalt road construction (Industrial Minerals, June 1986, p. 7)

Reference Map: Ontario Geological Survey Map 1956-4, Clarendon/Dalhousie/Darling Area

Reference: Hewitt (1972, p. 23)

McKay and Young (1980, p. 123)

Smith (1958, p.45)

Pittsburgh Township

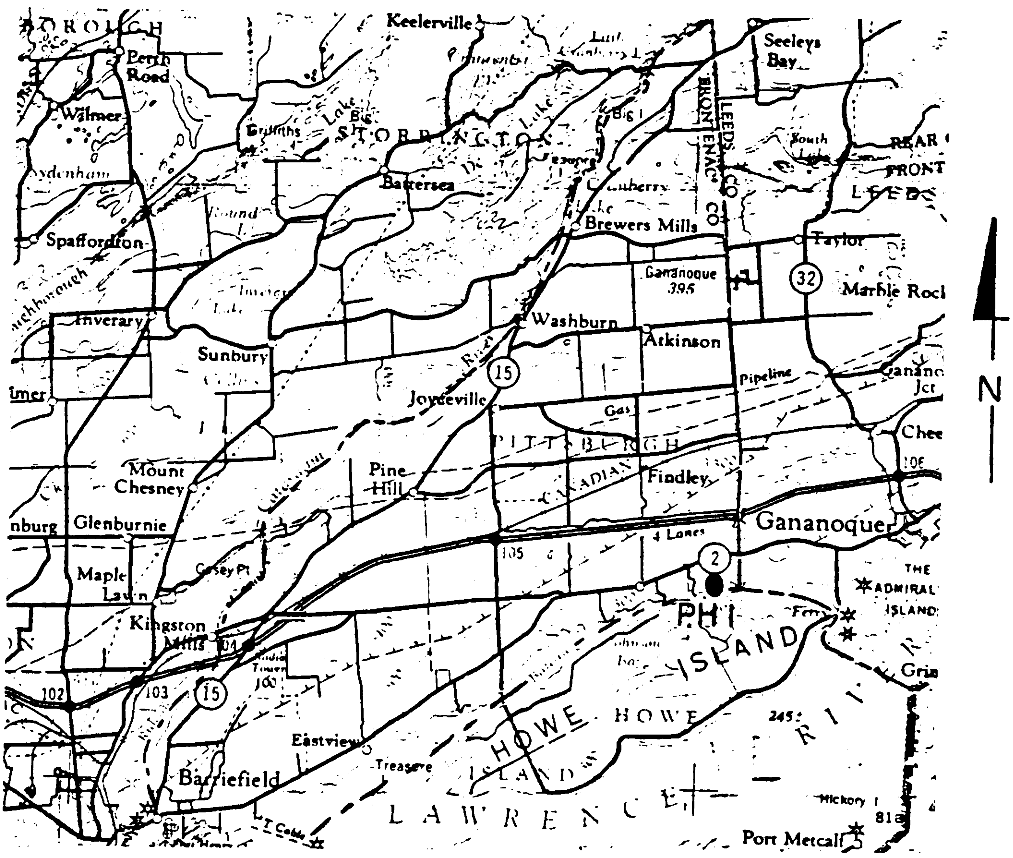


Figure 18: Location Map of the Pittsburgh Township Talc Occurrence (scale 1: 250,000)

PH1: Pittsburgh Township, Concession III, Lot 35, South Half

Rock Association: Mafic to ultramafic

Access: The prospect lies between the St. Lawrence River and Highway 2.

Description: Spence (1922) reported that:

"Dark, soft rock that appears to be partly altered pyroxenite occurs on this lot...There are a few small scattered pits on the property, which lies five miles (8 km) west of Gananoque, about one-fourth mile (0.40 km) south of the Gananoque-Kingston Road...From its general appearance the rock probably consists largely of rensselaerite or pyrallolite, which is pyroxene in various stages of alteration to steatite, or massive talc.

The rock is hardly to be classed as true talc, and it is probably mainly composed of mineral substance more closely allied to one of the serpentine group of minerals. The rock grinds to a grey powder possessing fair slip."

Mapping by Wynne-Edwards (1962) shows the area to be underlain by paragneiss and pegmatite that are cut by a diabase dyke, and by Cambro-Ordovician sandstone. It is possible that the "diabase" has been altered to talc-like rock.

History: Spence (1940) reported that this property was worked about the year 1900 by the Sparham Roofing Company of Montreal, who used the material in the maufacture of fireproof roofing.

Carter (1902), according to Spence (1922), reported that, "1800 tons of 'serpentine rock' were quarried from a locality two miles (3.2 km) west of Gananoque" between 1896 and 1901.

Reference Map: Geological Survey of Canada Map 27-1962, Gananoque, by Wynne-Edwards, 1962.

Reference: Carter (1902, p. 25)

Hewitt (1972, p. 23)

Spence (1922, p. 24-25; 1940, p. 77, 78)

South Canonto Township

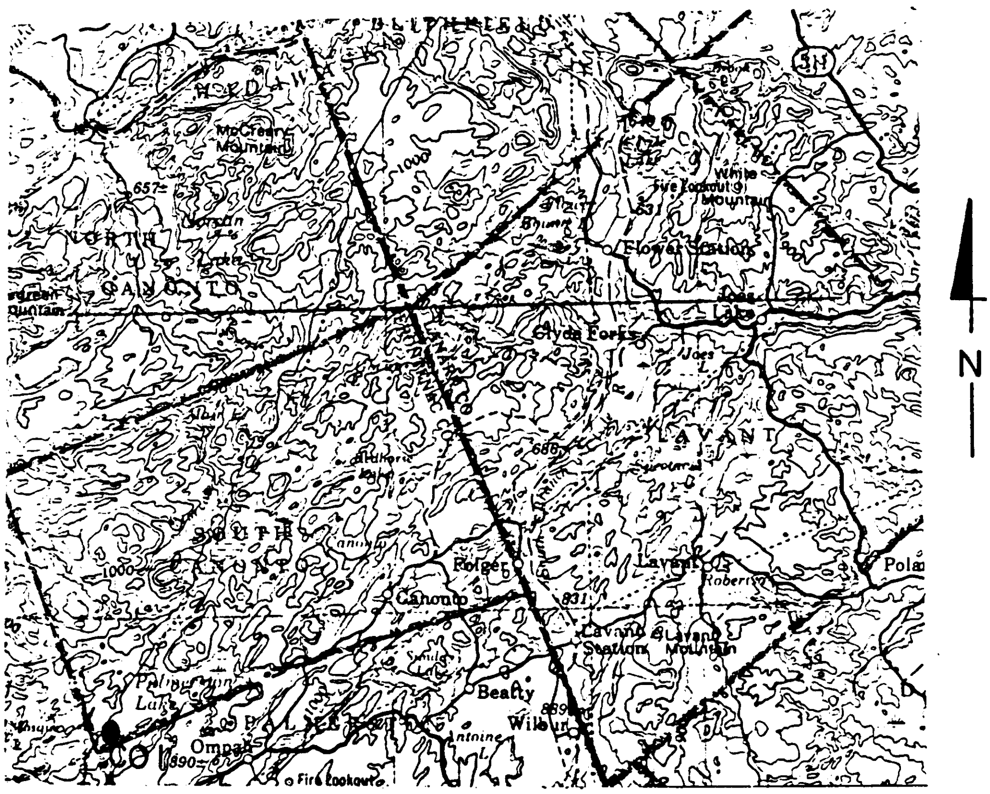


Figure 19: Location Map of the South Canonto Township Talc Occurrence. (scale 1:250,000)

CO1: South Canonto Township, Concession I, Lots 1 and 2

Rock Association: Carbonate

Access: The occurrence is reached via the Mosque Lake Road which leads north and east from Highway 509. The occurrence is adjacent to the road at the east end of Mosque Lake.

Description: Smith (1958) reported that:

"A band of talc schist about 50 feet (15 m) wide is exposed on the southeast shore of Mosque Lake, in the corner of Miller Township. About 500 feet (150 m) to the east, along the power line, there are some old workings on this schist consisting of two shafts, about 300 feet (90 m) apart along strike, and a small stripped area. The strike is N 60 E and the dip is about 55 S. Surface exposures are rare around the workings, and no dump was found to suggest the type of material mined, so that it is difficult to form an opinion of the deposit under present conditions. The shaft walls show pale-green, fine-textured, fibrous tremolitic rock with a slight development of talc. The material crushes to a fine white fibrous powder, which might have a commercial use, although some of the rock is quite siliceous and contains quartz stringers...On the shore of Mosque Lake the schist is coarser in texture, with some large flakes of talc, and contains carbonate. An old pit with a small dump of talcose material was found about 3/4 mile (1.2 km) east of the main workings approximately on the strike."

Spence (1940) stated that:

"There are reported to be extensive showings of (cream-coloured, compact, platy, steatite-like talc) on adjacent lots 2 and 3, Concession XIII and XIV, to the west (in Miller Township)."

A field examination revealed the following:

The talc occurs in a talc-carbonate pod within silicate metasediments (Figure 20).

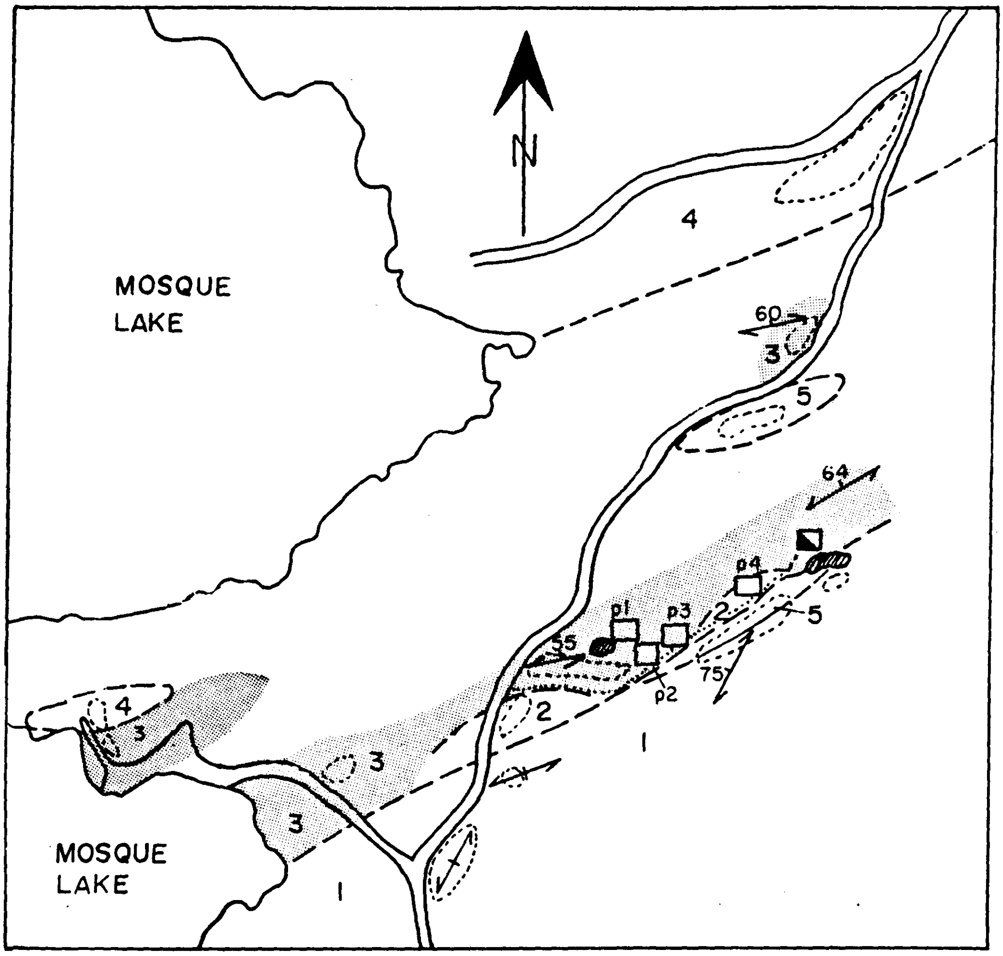
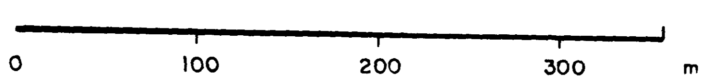


FIGURE 20 GEOLOGICAL MAP OF TALC OCCURRENCE ON SOUTH CANONTO TOWNSHIP, CON I, LOTS I AND 2 (CO I)

LEGEND

5	METADIABASE
4	PINK BIOTITE-QUARTZ-FELDSPAR GNEISS
3	TALC SCHIST
2	DOLOMITE
1	PARA-AMPHIBOLITE AND DARK GREY PARAGNEISS
75 (arrow)	STRIKE AND DIP OF FOLIATION
dotted line	CART TRACK
hatched	ROCK DUMP
half-filled square	SHAFT
open square	PIT
long dashes	INTERPRETED GEOLOGIC CONTACT
short dashes	OUTCROP

SCALE



The talc-bearing rocks are bounded to the south by interlayered para-amphibolite and dark-grey paragneiss. To the north the talcose rocks are in contact with pink biotite-quartz-feldspar gneiss. Massive amphibolite outcrops within the talcose pod along the southern boundary and in the north. These outcrops are probably metamorphosed mafic dyke rock.

The pits contain a very fissile rock that thin section examination showed to be composed entirely of irregularly-oriented, platy talc grains 0.5 to 1 mm long. A 6 m width of this talc rock, interbedded with siliceous and carbonate layers is exposed in the shaft area, and talc content over this width may be as much as 50 percent. Grey dolomite is exposed in some pits and in outcrop. The talc rock appears to have been sheared.

The material from the pits grinds to a grey or cream-white powder possessing moderate slip. Analysis (Spence, 1940) of samples submitted to the Federal Bureau of Mines showed:

silica	57.4%
iron + alumina	3.4%
lime	8.3%
magnesia	26.4%
Total	95.4%

History: Spence (1940) indicated that prospect pits were opened during or prior to 1939 by W.L. Peters of Maberly, Ontario.

Hewitt (1972) reported that W.R. Bonter, T. Hutchinson and C. Spry of Madoc operated this property in 1941.

Reference Map: Ontario Geological Survey Map 1956-4, Clarendon/Dalhousie/Darling Area.

Reference: Hewitt (1972, p. 24, 25)
Smith (1958, p. 45, 46)
Spence (1940, p. 77)
Storey and Vos (1981, p. 190, 191)

HASTINGS COUNTY

Cashel Township

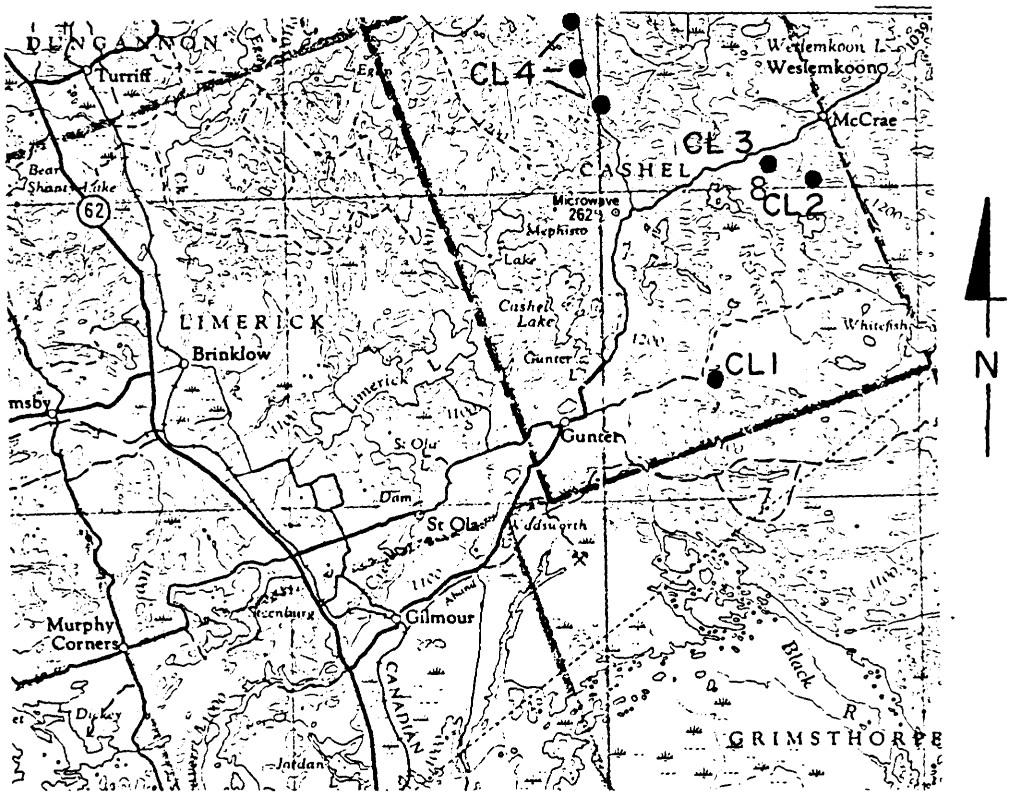


Figure 21: Location Map of the Cashel Township Talc Occurrences. (scale 1:250,000)

CL1: Cashel Township, Concession II, Lot 16

Rock Association: Ultramafic

Access: A dirt track leads eastward from Gunter to an unnamed lake on Potter Creek. The occurrence lies to the south of this lake, and is easily accessible on foot from the dirt track.

Description: Lumbers (1968) described the deposit as follows:

"Within a mafic metavolcanic inclusion in trondhjemite of the Weslemkoon batholith, talc-rich rocks are exposed over a length of about 150 feet (45 m) and a width of as much as 20 feet (6 m). The talc-rich rock, which is rusty on weathered surfaces, contains minor tremolite, chlorite, anthophyllite, and variable amounts of iron-titanium oxide minerals;...the talc of this zone is generally fine-grained and compact. In places the talc-rich rock grades into contact metamorphosed amphibolite through zones of chloritized and serpentinized amphibolite."

Figure 22 contains a sketch map based on a brief field examination. The grade of the zone is very variable. Two samples collected were found to consist mainly of serpentine and carbonate through thin-section examination, but one sample collected from a loose block adjacent to the outcrop was found to contain 38 percent talc.

Reference Map: Ontario Geological Survey Map 2142, Cashel Township

Reference: Lumbers (1968, p.44)

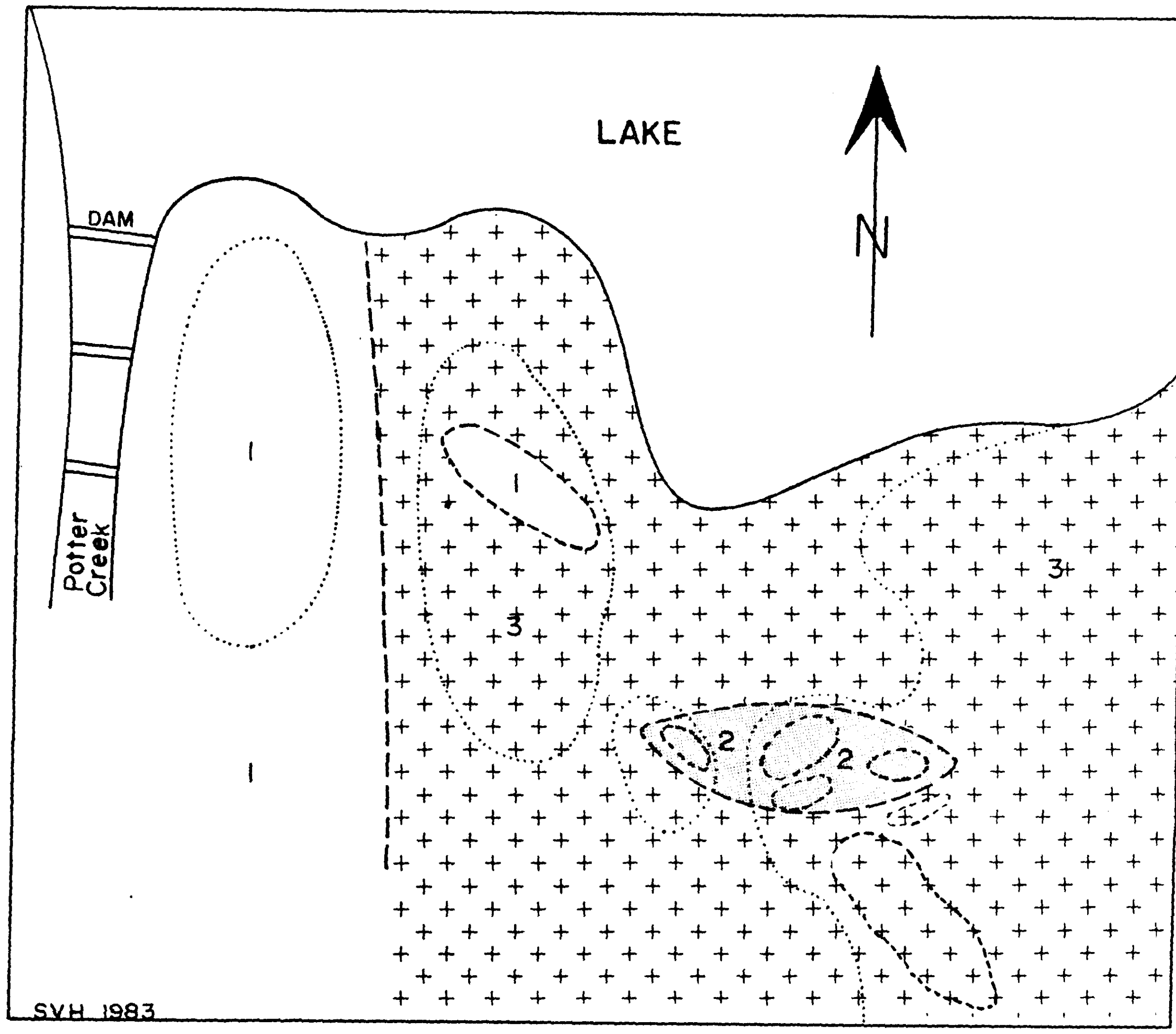


FIGURE 22 GEOLOGICAL SKETCH MAP OF TALC OCCURRENCE ON CON. II, LOT 16, CASHEL TOWNSHIP (CL 1)

LEGEND

+3 +	GRANODIORITE
2	TALCOSE ROCK
1	METAMORPHOSED MAFIC VOLCANIC ROCK
— — — —	INTERPRETED GEOLOGIC CONTACT
- - - - - - - - -	OUTCROP
....	HIGH RELIEF AREA: MAINLY OUTCROP

APPROXIMATE SCALE

0 15 30 45 60 75m

CL2: Cashel Township, Concession VII, Lot 2

Dubblestein Prospect

Rock Association: Ultramafic

Access: The occurrence is reached by a dirt track that leads south from the road to Weslemkoon Lake, about 1.6 km west of McCrae.

Description: Lumbers (1968) reported that:

"Talc-rich rocks of the zone in Lot 2, Concession VII contain 30 to 60 percent talc (mainly as fine-grained to medium-grained intergrown flakes), abundant tremolite, minor anthophyllite and dolomite, and as much as ten percent iron-titanium oxide minerals. The zone, which is poorly exposed about 80 feet (24 m) south of contaminated gabbro and diorite of the Weslemkoon batholith, can be traced along strike for about 130 feet (40 m) and to the south, the zone grades through an anthophyllite-tremolite-chlorite rock into contact metamorphosed amphibolite of the Tudor metavolcanics. The width of the talc-rich zone is unknown, but as much as 50 feet (15 m) of the talc-rich rocks is exposed across the strike."

Figure 23 shows a sketch map of the occurrence, based on a brief examination. Diamond drill hole C-82-4, put down by Canada Talc Industries Limited, intersected talcose rock from 188 to 194 feet (57.3 to 59.1 m), from 263 to 266 feet (80.2 to 81.1 m), and from 269 to 269.5 feet (82.0 to 82.1 m) (Assessment Files, Bancroft, Ontario). This zone is very similar to, and is probably a strike extension of, the McMurray Occurrence, CL3. This type of occurrence is discussed in more detail in Part I of this report in the section on ultramafic-hosted talc.

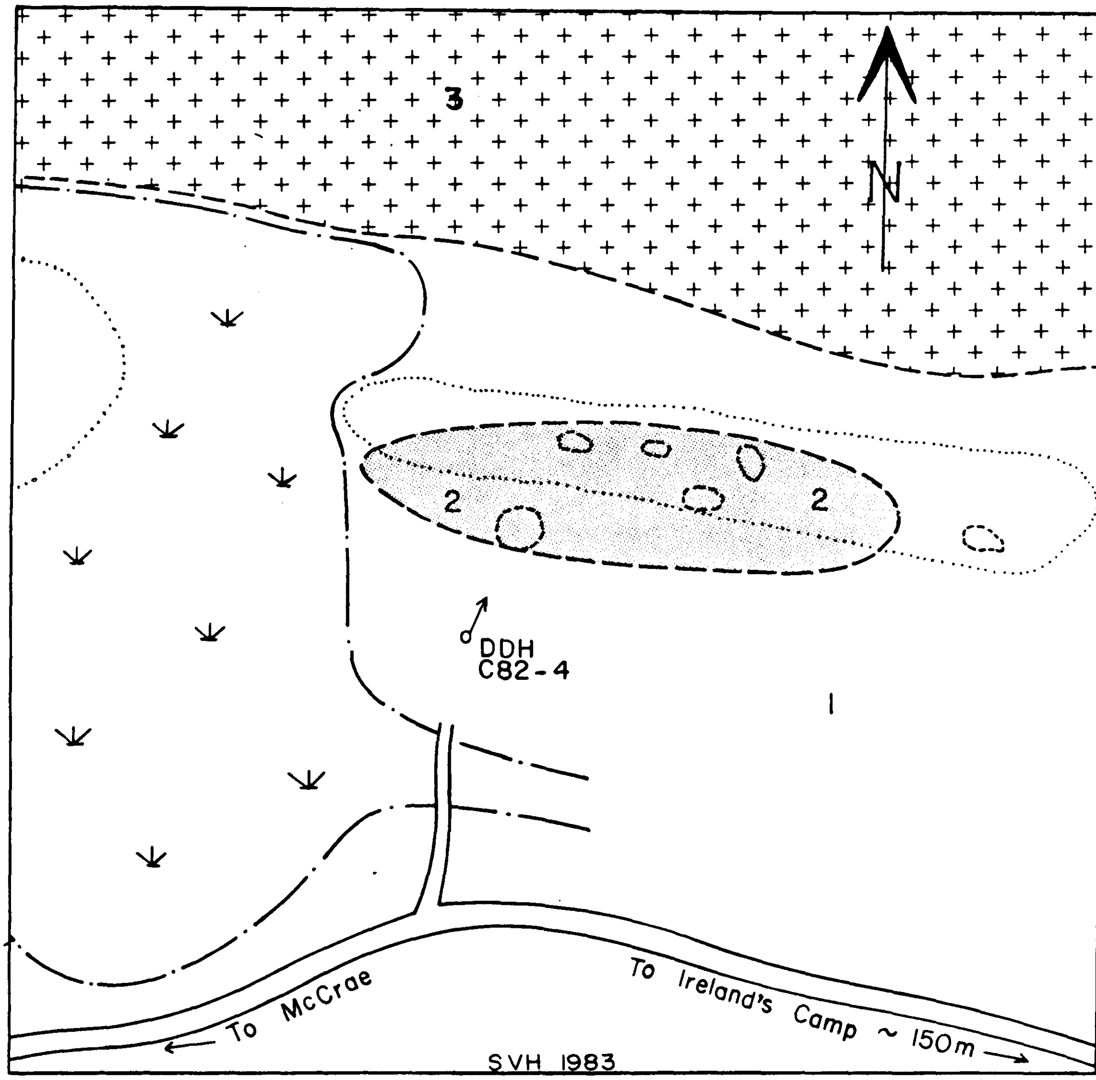


FIGURE 23 GEOLOGICAL SKETCH MAP OF DUBBLESTEIN TALC OCCURRENCE, CASHEL TOWNSHIP CON. VII, LOT 2 (CL 2)

LEGEND

+3+ GRANODIORITE
2 TALCOSE ROCK
1 METAMORPHOSED MAFIC VOLCANIC ROCK
INTERPRETED GEOLOGIC CONTACT
OUTCROP
OUTLINE OF GLACIAL DRIFT (HILL)
OUTLINE OF SWAMP
DDH DIAMOND DRILL HOLE

APPROXIMATE SCALE

0 25 50 75 100m

History: Four mining claims that include this occurrence were held by A. Dubblestein and M. Dubblestein during 1982. Under an option agreement Canada Talc Industries Limited drilled two diamond drill holes on the property, totalling 381 feet (116 m). (Assessment Files, Bancroft, Ontario). Hole C-82-4 apparently passed through the talc-bearing zone.

Reference Map: Ontario Geological Survey Map 2142, Cashel Township

Reference: Lumbers (1968, p. 41 - 44)

CL3: Cashel Township, Concession VIII, Lot 7

McMurray Occurrence

Rock Association: Ultramafic

Access: A bush road leads south to the occurrence from the Weslemkoon Lake Road, about 12 km east of the village of Gunter (or 1.0 km west of the road to CL2).

Description: An area about 25 m by 7 m has been stripped of overburden, exposing a zone of talc-carbonate-serpentine altered ultramafic rock. The zone strikes northwesterly, dipping steeply to the southwest, about 50 m from the western margin of the Weslemkoon batholith (Fig. 24). Between the talc zone and the batholith is banded, quartz-biotite-hornblende schist; to the southwest, the zone is overlain by black, amphibolitic metabasalt.

The talcose zone was traced along strike for a distance of 300 m and is indicated by diamond drilling to be about 40 m wide. Average talc content is 35 to 40%. The talc is present primarily as radial aggregates pseudomorphic after anthophyllite. This type of occurrence is discussed in more detail in Part I of this report in the section on ultramafic-hosted talc.

A sample of talcose rock from diamond drill core

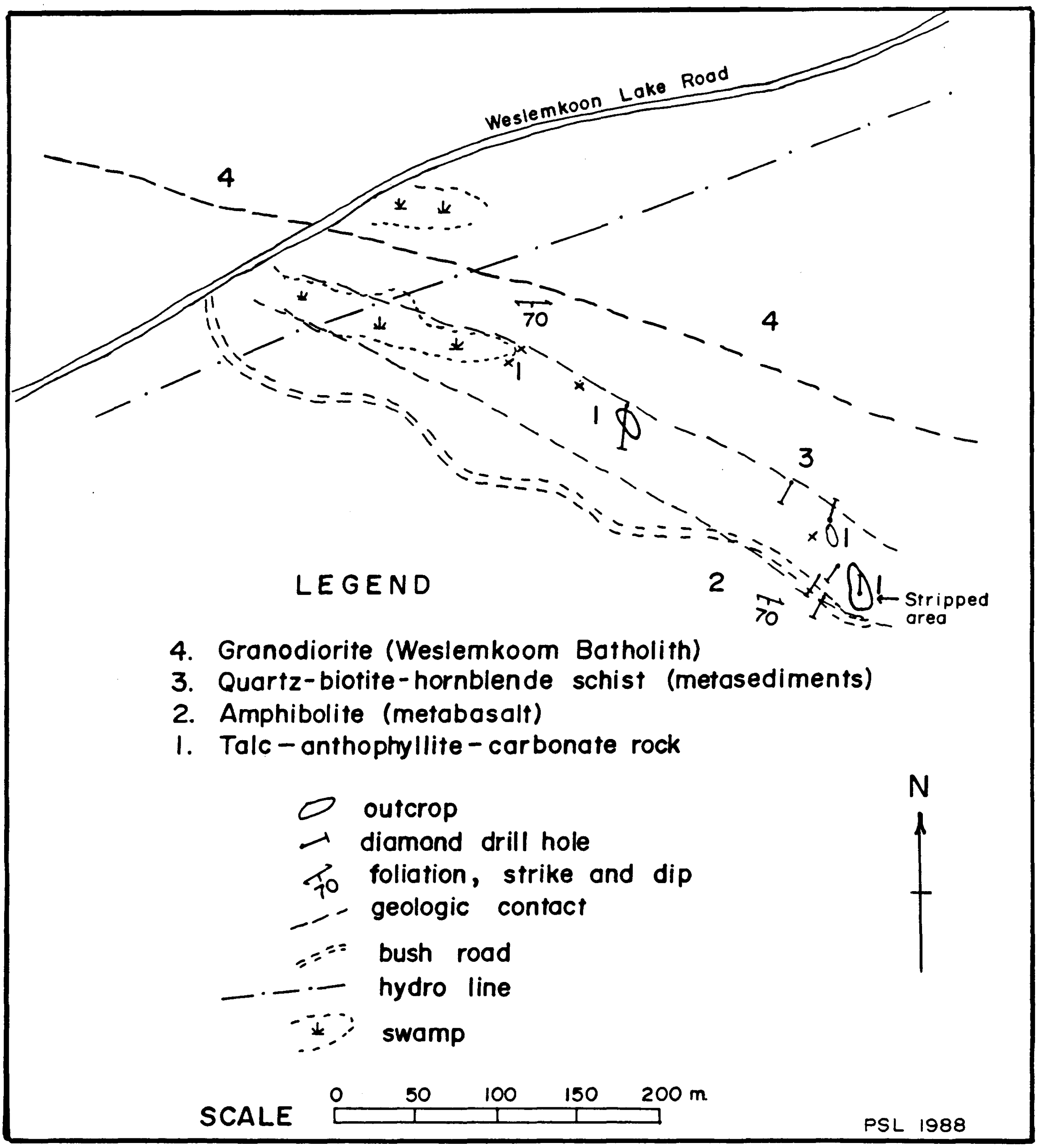


FIGURE 24 : GEOLOGICAL SKETCH MAP OF TALC OCCURRENCE ON CON. VIII, LOT 7, CASHEL TWP. (McMURRAY OCCURRENCE, CL3)

was subjected to beneficiation tests (grinding and flotation). The results, described in more detail in Part I of this report, indicate that flotation of this material can produce a good quality talc product suitable for use in the paint, plastics, and paper industries. The sample, composed of about 40% talc, 30% combined dolomite and calcite, 15% serpentine, and 15% combined chlorite, anthophyllite, and magnetite, gave a talc yield of 30% (75% recovery) at 88% brightness with 6% acid solubles.

History: 1982 -- stripping and diamond drilling (304 m in 17 holes) by David McMurray; the drill core is stored at the Ministry of Northern Development and Mines Drill Core Library, Bancroft.

Reference Map: Ontario Geological Survey Map 2142, Cashel Township

CL4: Cashel Township, Concession XII, Lots 16 and 17

Concession XIII, Lot 16,

Concession XIV, Lots 15 and 16

Madoc Talc and Mining Company and adjacent occurrences

Rock Association: Ultramafic

Access: The occurrences are adjacent to the forest access road in north-central Cashel Township.

Description: Lumbers (1968) reported that:

> "The largest concentrations of talc exposed (in Cashel Township) are along the forest access road in the northern part of the township (Figure 25). There, within 600 feet (180 m) of contaminated gabbro and diorite of the northern lobe (of the Weslemkoon batholith) talc-rich zones, which are concordant generally with the foliation in the host metavolcanics, range in width from 4 inches (10 cm) to 100 feet (30 m).
>
> Along the forest access road most of the talc-bearing zones are either in mafic metavolcanics containing thin felsic metavolcanic units, or at the contact between mafic and felsic metavolcanics. Quartz and quartz-carbonate veins are common in the talc-bearing zones which appear to dip subvertically and pinch and swell along the strike...Mafic metavolcanics adjacent to the zones are extensively chloritized, biotitized and carbonatized; locally the mafic metavolcanics were converted to rusty-weathering schists."

At the Madoc Talc and Mining Company shaft in Lot 17, Concession XII, the talc-rich zone may be 20 m wide, with most of the talc lying under the forest access road. At this locality the talc rocks grade eastward into tremolite-dolomite schist which is in contact with gabbro of the Weslemkoon batholith 80 m to the east of the shaft. To the west of the shaft the talc rock is in sharp

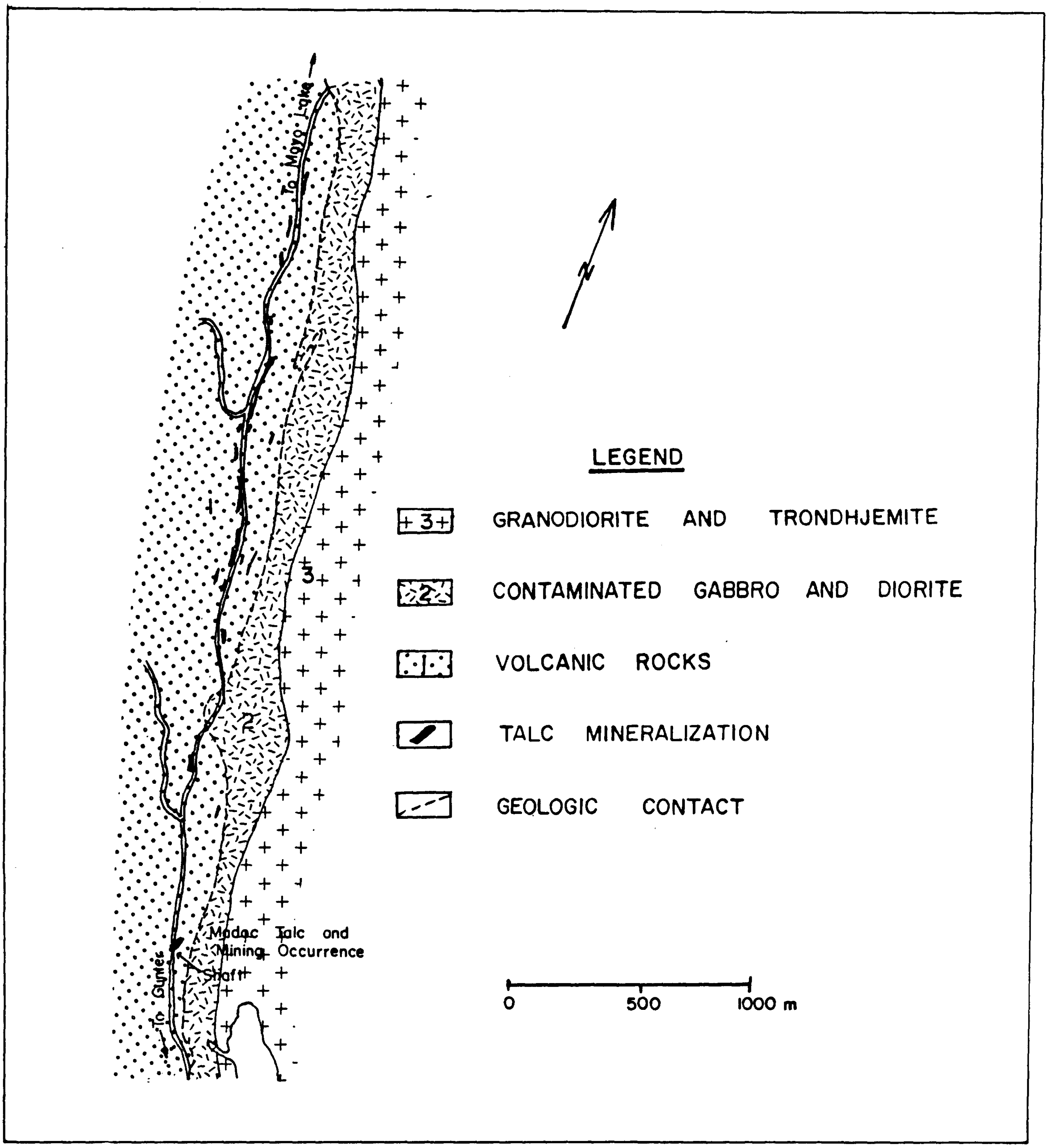


FIGURE 25 TALC OCCURRENCES ON CON XII, LOT 16, 17, CON XIII, LOT 16, CON XIV, LOT 15, 16, CASHEL TOWNSHIP; MADOC TALC AND MINING CO. AND NEARBY OCCURRENCES (CL4).

AFTER LUMBERS(1968)

contact with para-amphibolite. The occurrences are shown in Figure 25. Thin section examination of samples indicated a maximum grade of 75 percent talc. Talc-bearing zones in this area are intermittently exposed over a strike length of 3 km. The zones were found to range from 3 to 20 m in width.

Lumbers (1968) reported the following laboratory results:

	samples collected about 2400 m north of shaft PERCENT	samples collected near shaft PERCENT
SiO	55.86%	41.49%
Fe O	5.82%	6.05%
Al O	2.23%	2.38%
CaO	2.43%	4.20%
MgO	26.74%	28.36%
loss on ignition	5.71%	16.00%

These occurrences are similar to CL3, and appear to be altered ultramafic rocks as discussed in Part I of this report in the section on ultramafic-hosted talc.

The results of beneficiation tests on talcose rock from a diamond drill hole on the property of C.R. Young (Con XIII, Lot 16) are also described in Part I. This rock consists of about 25% talc, 22% anthophyllite, 40% dolomite, and minor amounts of chlorite and magnetite. The flotation tests gave a talc yield of 24% (90% recovery) with a brightness of 90% and 11.7% acid solubles -- a product suitable for use in the paint, plastics, and paper industries.

It should be noted that this sample is from an exploratory drill hole and does not represent the best grade of talcose rock available in the area.

History: Spence (1940) reported that this area was prospected in 1937 by L.S. Reeves. In 1938 the Madoc Talc and Mining Company of Trenton was incorporated to proceed with development. A shaft was sunk to 90 feet (27 m) with a 50 foot (15 m) cross-cut at the 85 foot (26 m) level and 125 feet (38 m) of drifting on the orebody.

During 1981 and 1982 mining claims covering this large area were held by Canada Talc Industries Limited of Madoc and by Roger Young of Havelock. Canada Talc Limited (Resident Geologist's Files, Bancroft, Ontario) put down two diamond drill holes on their own claims and three on R. Young's claims under an option agreement for a total of 1005 feet (360 m).

Reference Map: Ontario Geological Survey Map 2142, Cashel Township

References: Hewitt (1972, p. 25-28)

Lumbers (1968, p. 41-44)

Spence (1940, p. 75-76)

Elzevir Township

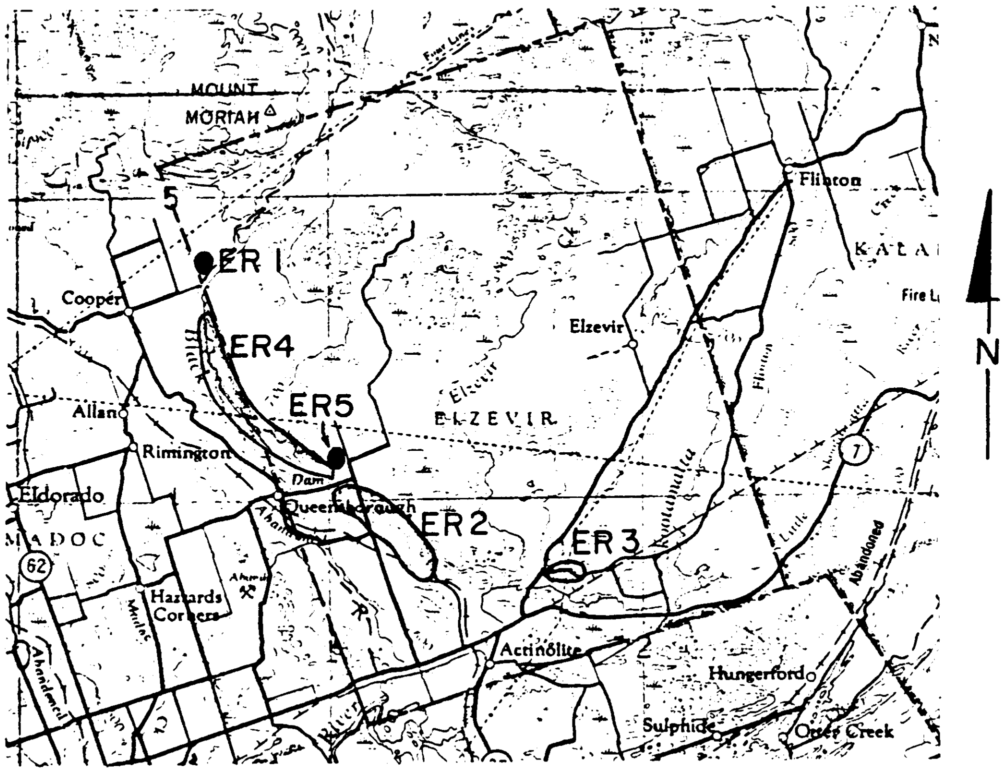


Figure 26: Location Map of the Elzevir Township Talc Occurrences. (scale 1:250,000)

ER1: Elzevir Township, Concession I, Lot 27

Rock Association: Ultramafic

Access: The area of this occurrence can be reached by the road that leads eastward from Cooper.

Description: This occurrence is located along the Black River within metavolcanic rocks in close proximity to the Elzevir batholith (Fig. 45). The mineralogy (primarily talc-serpentine-dolomite with lesser tremolite, chlorite, anthophyllite, and magnetite) is similar to that of other volcanic-hosted talc occurrences in Elzevir Township and eastern Madoc Township, as described in Part I of this report in the section on ultramafic-hosted talc. This occurrence represents the northeastward extension of occurrence MC6 which lies immediately to the west of ER1.

Reference Map: Ontario Geological Survey Map 51d, Grimsthorpe-Kennebec Area.

References Geological Survey of Canada (1863, p. 469)
Wilson (1926, p. 91)

ER2: Elzevir Township, Concession II, Lots 10 and 11

Concession III, Lots 8, 9, 10 and 11

Concession IV, Lots 6, 7, 8 and 9

Rock Association: Ultramafic

Access: This area is accessed by Hastings County Road 20, which runs from Highway 7 northward to Queensborough.

Description: This area was mapped in detail by Verschuren (1982). Verschuren mapped two large stratabound units of talc-serpentine-carbonate schist (Figure 27) and reported:

"One zone lies in contact with...mafic metavolcanics...and...actinolite schist...and is designated as the west zone. The east zone outcrops between the Elzevir batholith...and the actinolite schist...Both zones are approximately 100 to 200 metres wide, and appear to extend beyond the northern and southern boundaries of the map area."

"Map unit four is composed of serpentine-rich and talc-rich schists. both of which are composed of talc, serpentine, dolomite, and magnetite in varying proportions. The highest concentrations of magnetite correspond to dolomite-rich zones which contain little talc, and conversely, talc-rich zones contain less magnetite.

The serpentine-rich rock is the more common and constitutes the major part of map unit four.

The talc-rich schist is wholly enclosed within the serpentine-rich zones as relatively small lenticular bodies that...grade into the enclosing serpentine-rich schist. The largest talc-rich zones are approximately 30 m wide and less than 100 m in length, and are visually estimated to be composed of 25 to 50 percent talc. Within these lenses, veins up to 15 cm wide are composed of almost pure talc."

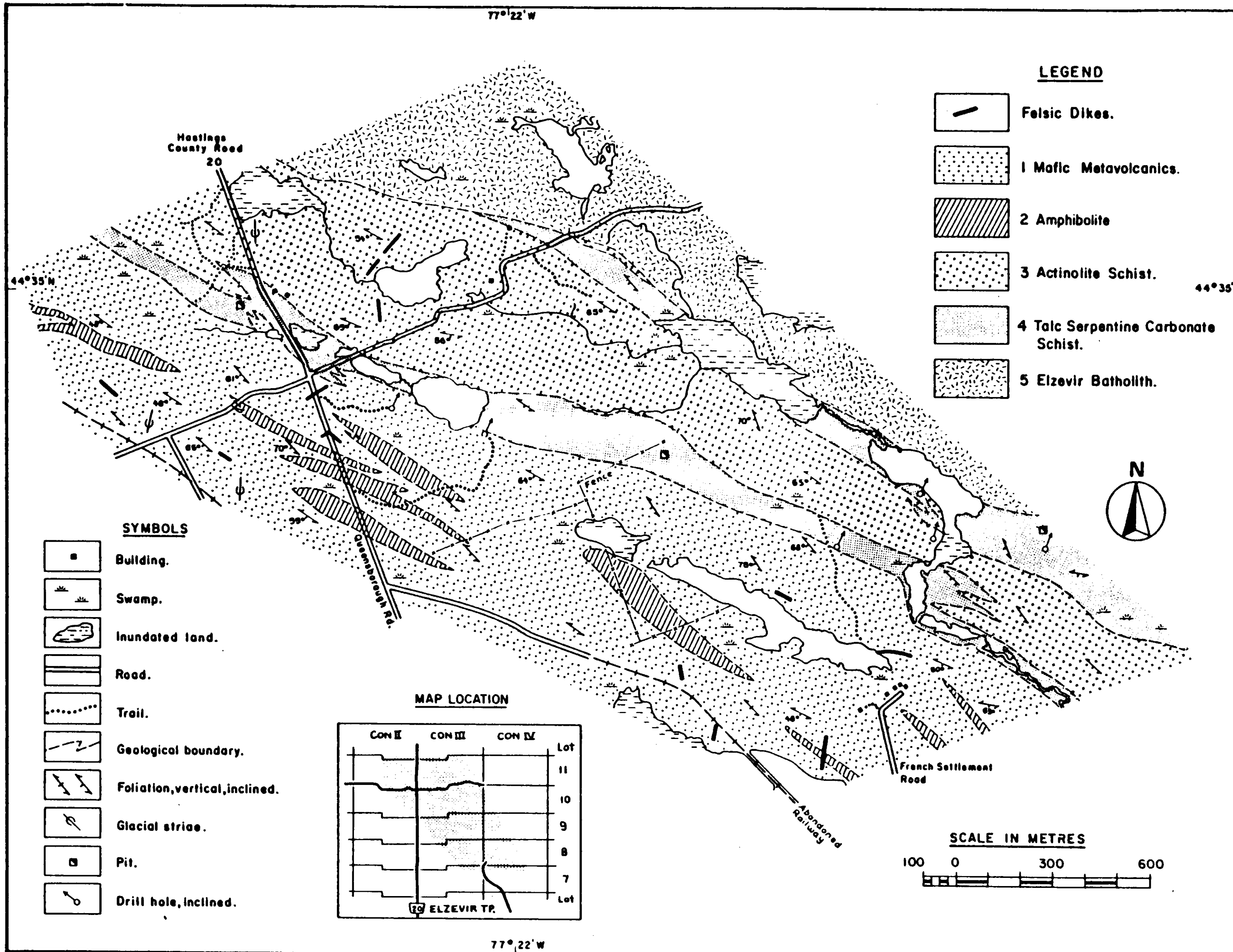


FIGURE 27 GEOLOGICAL MAP OF TALC OCCURRENCES, CON. II, LOT 10,11, CON. III, LOT 8-11, CON IV, LOT 8,9, ELZEVIR TOWNSHIP, ER 2 (AFTER VERSCHUREN, 1982)

History: Some early exploration pits were put down, and at least one of these pits existed in 1926 (Wilson, 1926). An exploration trench was put down on Concession III, Lot 9 during the 1940's (Hewitt, 1972).

In 1982 Steep Rock Iron Mines Limited and Canada Talc Industries Limited carried out mapping, sampling, diamond drilling and limited bench-scale testing of these talc zones (Verschuren, 1982).

Reference Map: Ontario Geological Survey Map 51d Grimsthorpe/ Kennebec Area.

References: Hewitt (1972, p. 28, 29)

Verschuren (1982, p. 92-96)

Wilson (1929, p. 91, 92)

ER3: Elzevir Township, Concession VI, Lot 5

Concession VII, Lots 4 and 5

Rock Association: Ultramafic

Access: This occurrence lies along the Flinton Road at the "Hayloft" campground.

Description: Wilson (1926) stated:

> "The deposits in these lots...lie near one another, are similar in character and origin, and can therefore be described together. They consist chiefly of zones of talc-dolomite schist in altered basic lava flows."

Spence (1940) wrote:

> "The workings...consist of seven small scattered pits opened variously in a rusty talc-dolomite schist or a similar rock mixed with greenstone (serpentine). The latter rock has been highly sheared and jointed, with the development along the cracks of a harsh-fibred, asbestos-like actinolite. The amount of such mineral is relatively subordinate, and the main mass of the rock consists of a heterogeneous mixture of dolomite, talc, serpentine and actinolite, with talcose greenstone the dominant material."

The deposits lie within an area of mafic to ultramafic volcanic rock that is in contact with granodiorite of the Elzevir batholith to the north, east and southeast.

This area (Figure 28) is underlain by much talc-actinolite-dolomite schist. Outcrop is sparse, so the extent of the talcose zones is difficult to determine.

The talc-bearing rock is interlayered with grey to black amphibolite (metabasalt) and with serpentinized rock. The talcose and serpentinized

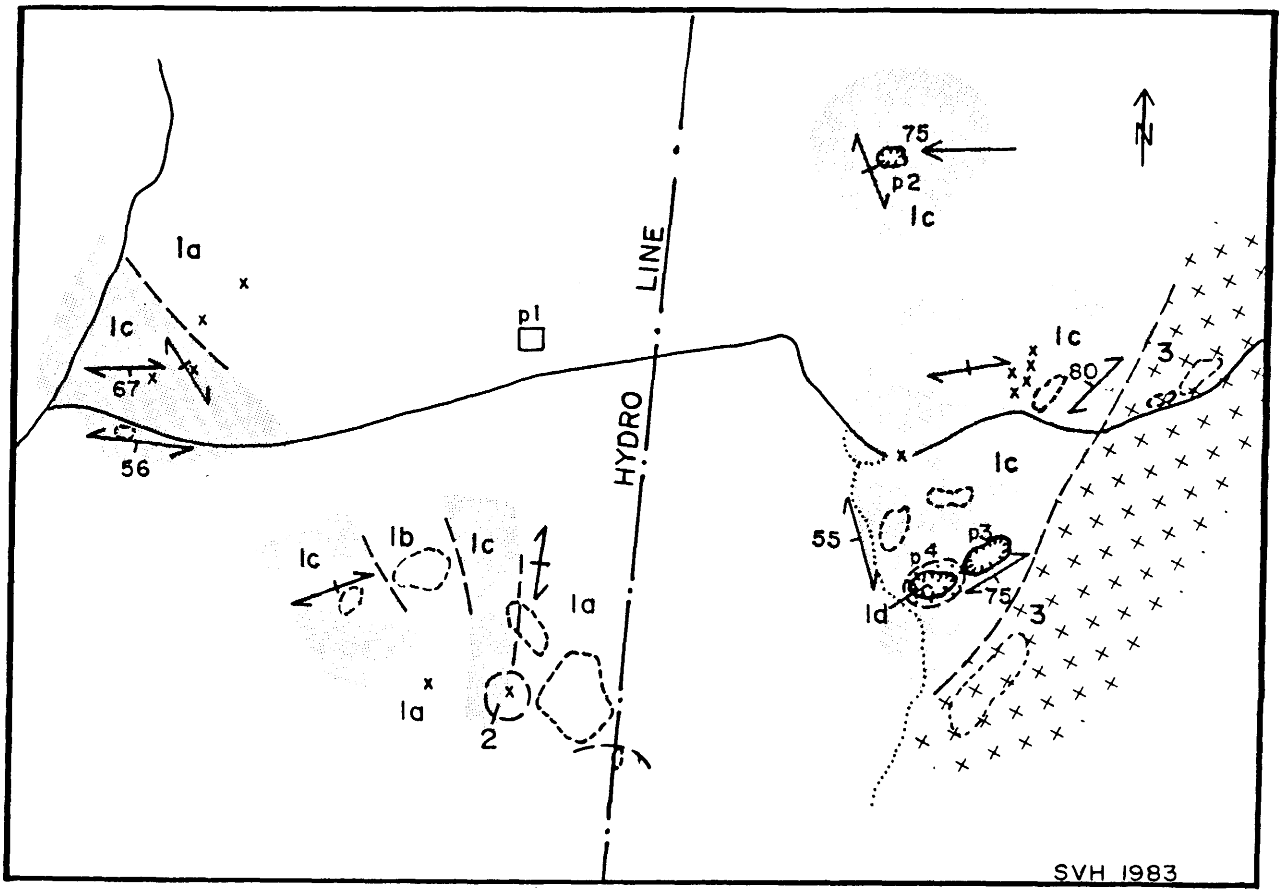


FIGURE 28: GEOLOGICAL MAP OF TALC OCCURRENCES, CON. VI, LOT 5 AND CON. VII, LOT 4,5, ELZEVIR TOWNSHIP (ER 3)

LEGEND

- +3+ GRANITE
- 2 GABBRO
- Id SERPENTINE ROCK
- Ic TALC-ACTINOLITE-DOLOMITE SCHIST
- Ib INTERLAYERED AMPHIBOLITE, TALC-DOLOMITE SCHIST
- Ia MASSIVE AMPHIBOLITE
- ----- x OUTCROP
- 67 STRIKE AND DIP OF FOLIATION
- ——>75 TREND, PLUNGE OF MINERAL LINEATION
- – – – – ASSUMED GEOLOGICAL CONTACT
- .... TRAIL
- p1 □ p2 PIT

SCALE

0 100 200 300 400 500 m

rocks represent the most altered portions of an ultramafic volcanic rock unit. Rocks in this area were mapped as ultramafic by Thompson (1972) and by LeBaron (1987).

The talc-actinolite-dolomite schist exposed in pits and outcrops may be classified as a soapstone. This rock unit was visually estimated to grade from five to 15 percent talc overall, but a thin section made from a sample collected in pit 2 contains 40 percent talc.

History: Spence (1940) reported that:

"Several small quarry openings have been made at various times between 1883 and 1908 on these lots for the production of a class of mineral reported as "actinolite". The deposits were first worked by J. James of the Village of Actinolite.., who ground and shipped the output for roofing purposes. Later, in 1908, the properties were acquired by the Actinolite Mining Company of Bloomfield, New Jersey, who erected a grinding plant at Actinolite and continued to produce a small tonnage annually of ground roofing material until 1929, since then there has been no further work."

Reference Map: Ontario Geological Survey Map 51d, Grimsthorpe-Kennebec Area.

References: Hewitt (1972, p. 29,30)

LeBaron et al (1987)

Spence (1940, p. 74,75)

Thompson (1972)

Wilson (1926, p. 92-94)

ER 4: Elzevir Township, Concession I, II, Lots 14-18

Rock Association: Ultramafic

Access: This area of multiple talc occurrences is accessible by Hastings County Road No. 20, but individual occurrences must be reached on foot.

Description: This area was explored for talc by the Ontario Geological Survey in 1983 (Dillon and Barron, 1985). This reconnaissance survey identified a number of talc bodies in Elzevir and Madoc Townships (occurrence MC7, Madoc Township). The locations of these talc deposits are shown in Figure 29.

The talc bodies are hosted by mafic to ultramafic volcanic rocks near the western margin of the Elzevir granodiorite batholith, and also occur as lenses of talcose rock within the granodiorite. Dillon and Barron (1985) stated:

"Talc zones occur as discontinuous lenses 2-15 m thick and up to 60 m in strike length. They are very soft, massive to poorly foliated rocks with weathered surfaces that are often pitted and irregular. The light greenish-grey to pinkish grey surface shows fine discordant carbonate veinlets 0.5 to 10 mm wide which weather a tannish brown.

In thin section the talcose material consists of fine to medium-grained (0.1 to 3 mm) platy aggregates of talc (20 to 80%) with intergrowths of fine platy chlorite and/or serpentine. Carbonate comprises up to 30% of these rocks as medium to coarse grains and grain aggregates (1.0 to 5.0 mm) disseminated throughout the talc chlorite rock. Carbonate also occurs in discordant fractures which cut the talcose rocks.

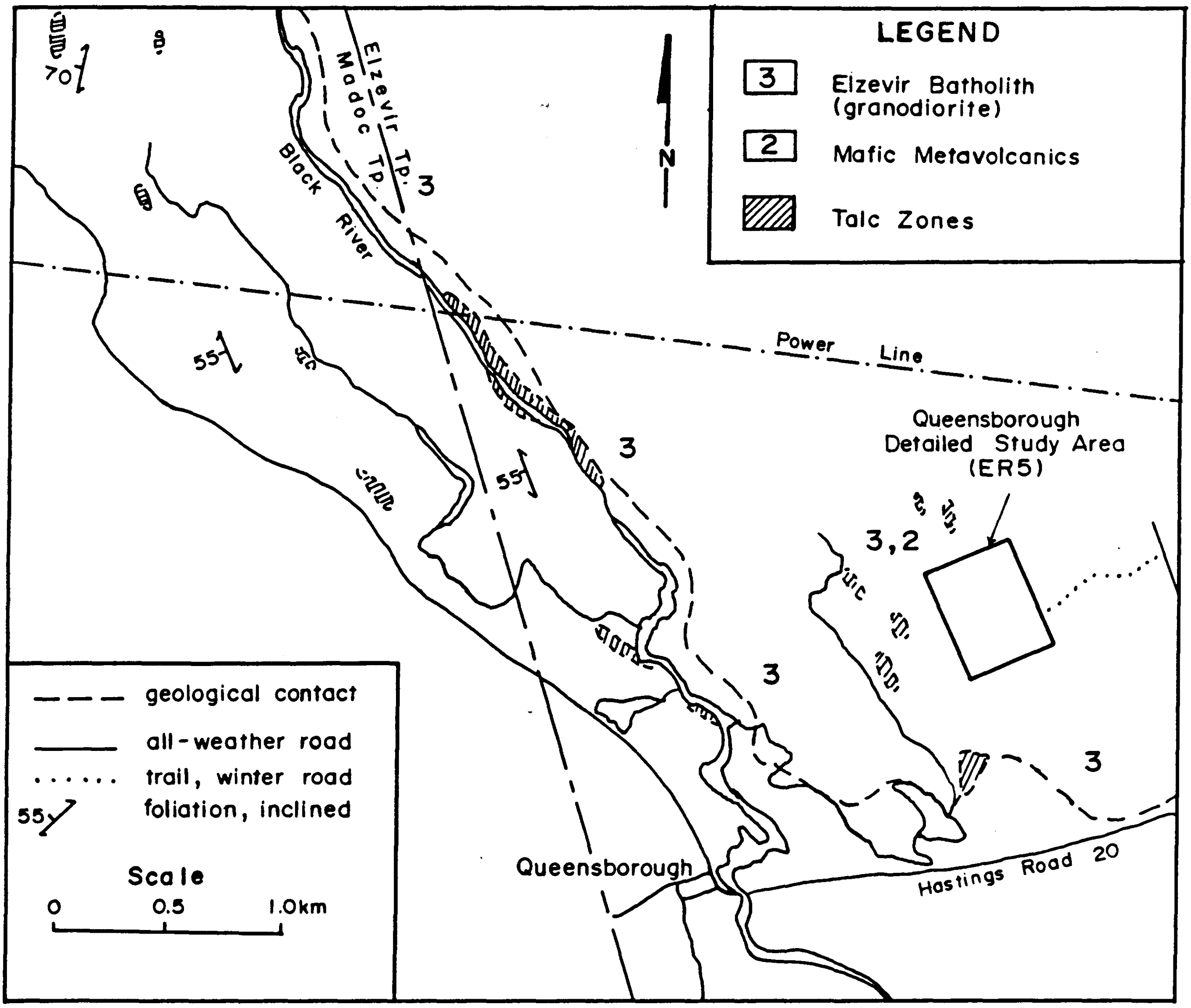


FIGURE 29: GEOLOGY OF THE COOPER-QUEENSBOROUGH RECONNAISSANCE STUDY AREA (ER4, MC7) (after Dillon and Barron 1985).

These fractures vary from 0.5 to 10 mm wide and commonly contain minor chlorite and magnetite.

Magnetite occurs as fine to medium (0.5 to 3 mm) subhedral to anhedral grains disseminated with coarse chlorite and carbonate grain aggregates. Rarely it occurs along the margins of carbonate chlorite veins."

References: Dillon and Barron (1985, p. 32-3)

Verschuren (1982, p. 92-96)

ER5: Elzevir Township, Concession II, Lot 15

Rock Association: Ultramafic

Access: This property is accessible by a trail leading west from a concession road north of Hastings Road 20 (Fig. 29)

Description: This area of talc mineralization was discovered by C.R. Young of Havelock. The area was mapped in detail by the Ontario Geological Survey (Dillon and Barron 1985). The location of the property is shown in Figure 29, and the detailed geology in Figure 30.

The talc occurs in an area of mafic to ultramafic volcanic rock that lies within the Elzevir granodiorite batholith. "Approximately 60% of the 500 X 500 m block is talcose rocks and the remainder small plugs of intrusive material and lenses of altered mafic metavolcanic rocks." (Dillon and Barron 1985, p. 41). Rock types within the altered mafic to ultramafic rocks at this site were classified as amphibolite schist, amphibolite, chlorite-magnetite schist, and talc-chlorite-carbonate-magnetite schist.

Dillon and Barron (1985, p. 44-45) stated that the talc rock "is a soft talc-chlorite-carbonate-magnetite schist, fine to medium grained, massive to poorly foliated which weathers medium greenish grey. The weathered surface is irregular and

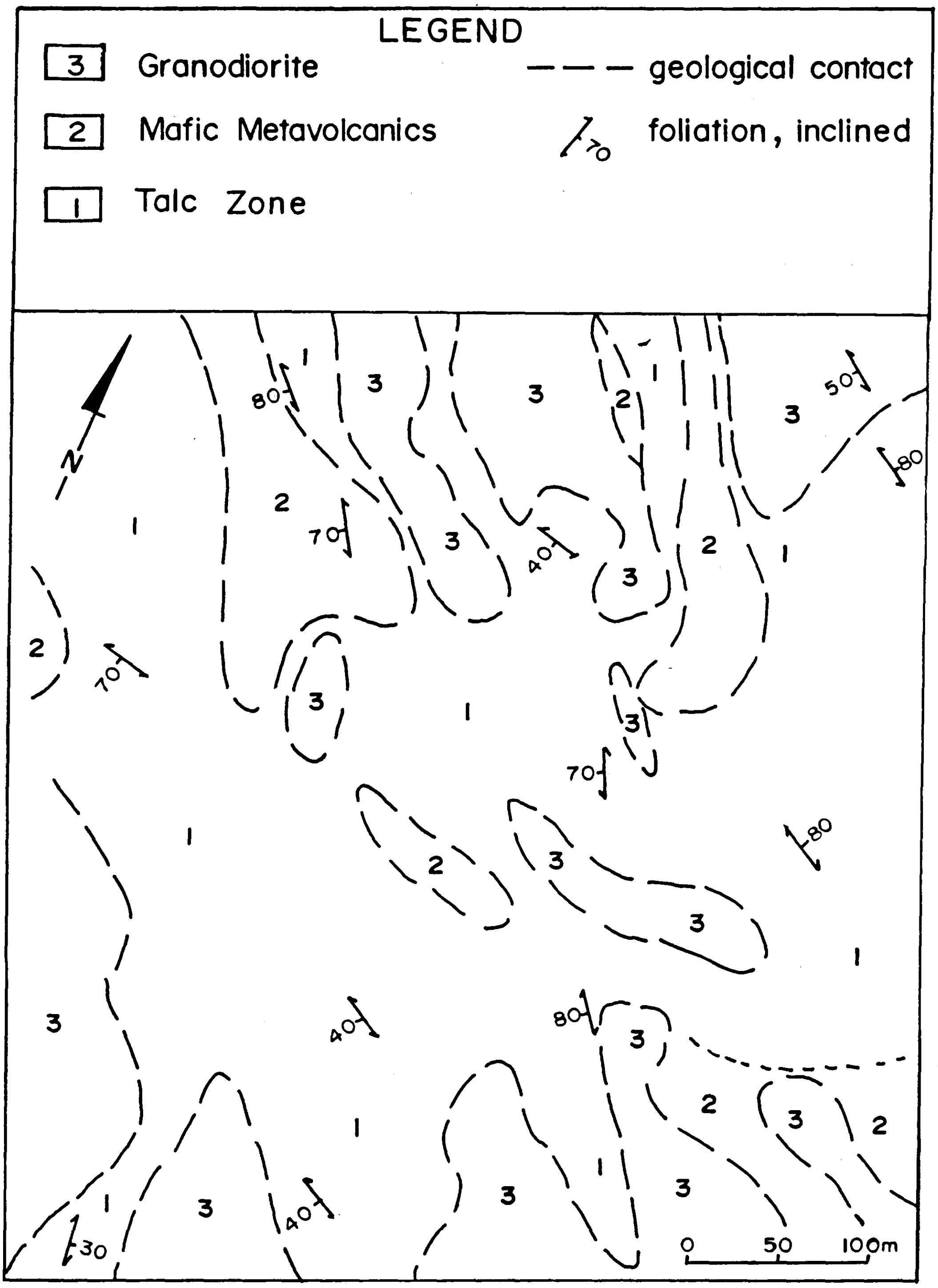


FIGURE 30: GEOLOGY OF THE QUEENSBOROUGH DETAILED STUDY AREA, ELZEVIR TP. (ER5) (after Dillon and Barron 1985). Location of the map area is shown on Figure 29.

pitted with a slight pinkish cast from weathered magnetite.

Thin sections show 30 to 80% fine to medium-grained platy talc (0.5 to 2 mm), 20 to 50% finely foliated masses of chlorite, 5 to 15% dolomite as medium to coarse subhedral to anhedral disseminated grains and grain aggregates and 2-5% fine to medium-grained disseminated subhedral magnetite which is commonly enclosed in platy flakes of chlorite. Minor cross-fractures filled with carbonate and magnetite occur.

These rocks vary from talc-chorite to chlorite-serpentine-talc to talc-carbonate in composition. Average talc content within the sections studied is 50%. Only the coarser talc appears to contain intergrowths of chlorite, mostly along cleavage traces."

Talc mineralization extends beyong the area mapped in detail by Dillon and Barron (1985).

Reference: Dillon and Barron (1985, p.41-47)

Faraday Township

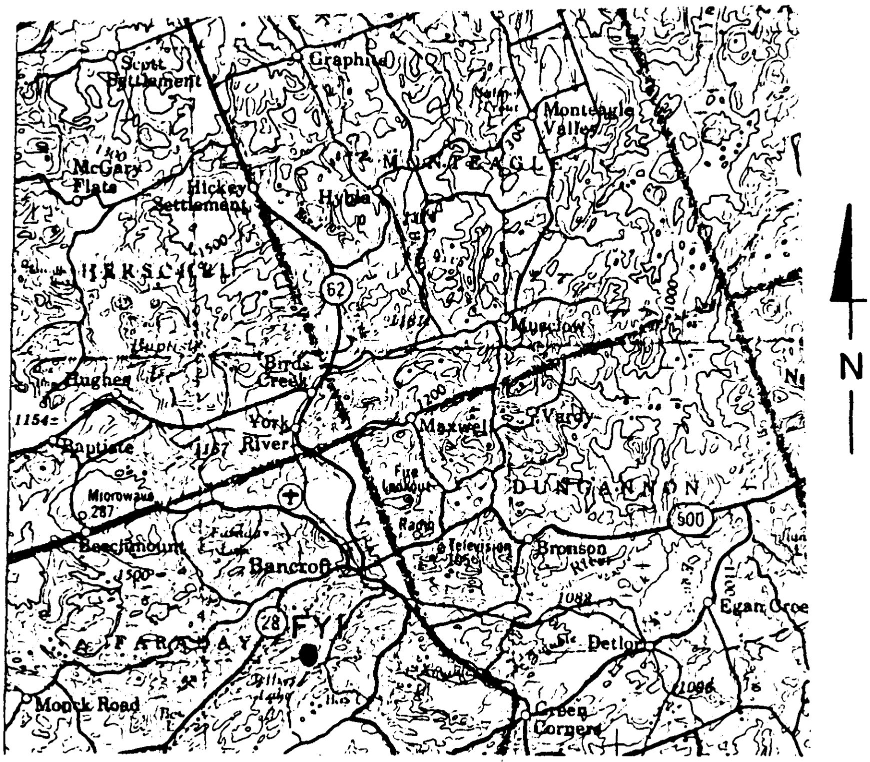


Figure 31: Location Map of the Faraday Township Talc Occurrence. (Scale 1:250,000)

FY1: Faraday Township, Concession X, Lot 11

Rock Association: Carbonate

Access: The occurrence is reached by a dirt road which leads west from Highway 62 about one km south of the centre of Bancroft.

Description: Thomson (1943) reported:

"Talc and soapstone occur near the shore of a small lake in the western part of Lot 11, Concession X, Faraday Township...Near the lake there are exposures showing talc developed along slip planes in the limestone and amphibolite.

Samples submitted to the writer from these developments included much soapstone composed of massive amphibolite with local development of talc along slip planes.

Field investigation revealed two slightly talcose rock units (Figure 32). North of the lake tremolitic rock contains three percent talc. Tremolitic zones in marble south of the lake contain very small amounts of talc.

History: Hewitt (1972) reported:

On the northern side of the lake a little blasting has been done in a 5 to 15 foot (1.5 to 4.5 m) wide band of white to buff quartzite containing rare 1/8 inch (3 mm) streaks of actinolite.

Reference Map: Ontario Geological Survey Map 1957-1, Cardiff and Faraday Township.

References: Hewitt (1959, p. 50: 1972, p. 30)

Storey and Vos (1981, p. 192)

Thomson (1943, p. 71)

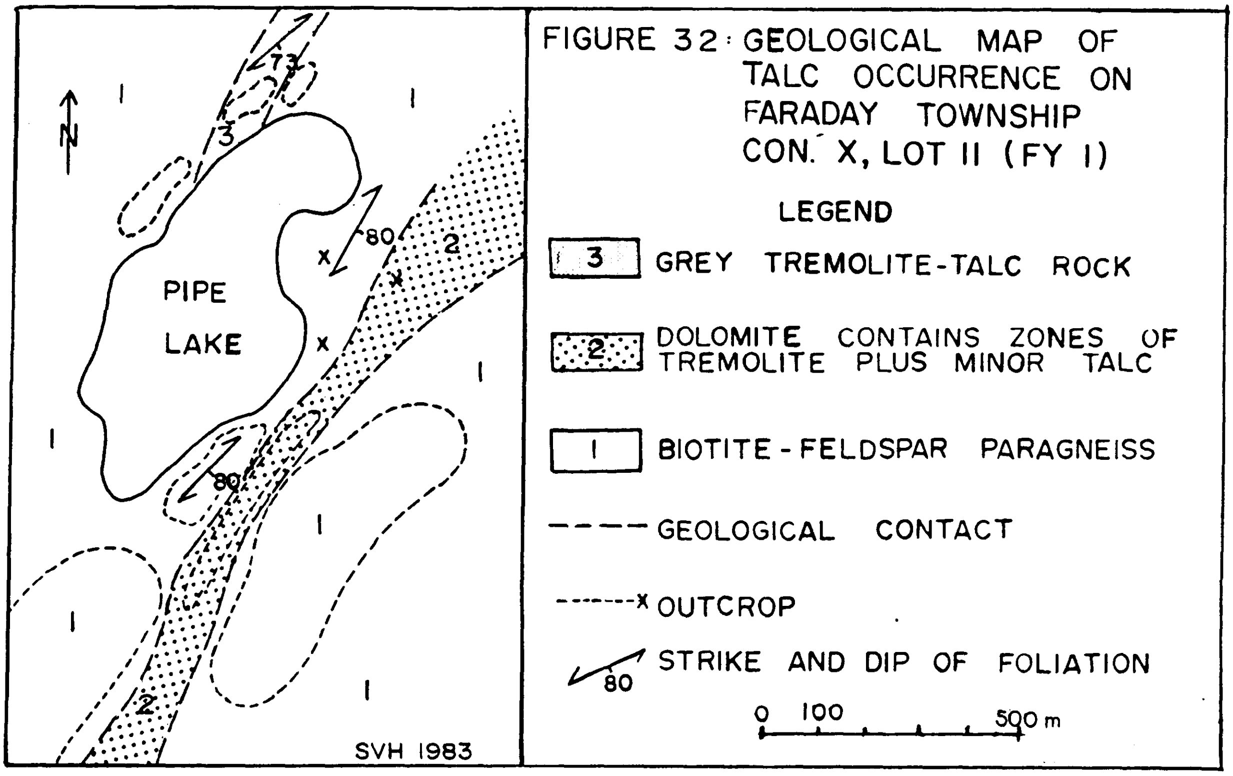


FIGURE 32: GEOLOGICAL MAP OF TALC OCCURRENCE ON FARADAY TOWNSHIP CON. X, LOT II (FY I)

Grimsthorpe Township

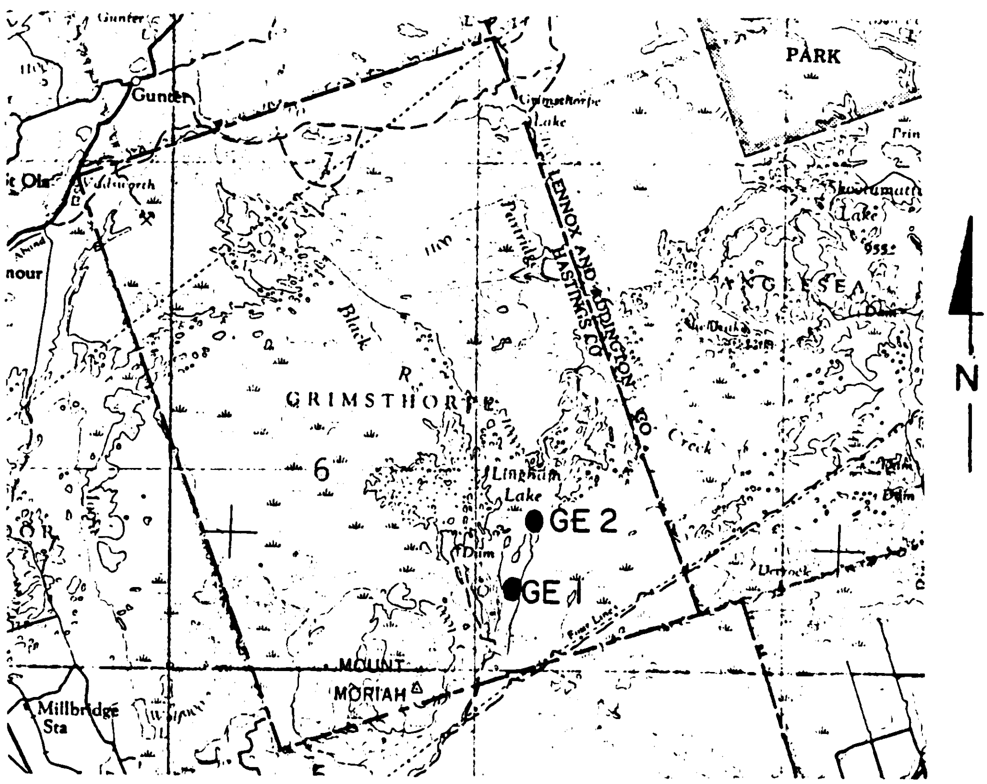


Figure 33: Location Map of the Grimsthorpe Township Talc Occurrences.

(Scale 1:250,000)

GE1: Grimsthorpe Township, Concession IV, Lot 13, South Half

Rock Association: Ultramafic

Access: This southern part of Grimsthorpe Township is accessed from the driveable road that follows the power line in northern Elzevir Township.

Three kilometers northeast of Lingham Lodge on the power line, a forest track follows the east shore of Canniff Creek to the Black River where a trail goes north to the occurrence area. The track must be followed on foot from the power line.

Description: Hewitt (1972) reported:

"The talc-bearing zone is in serpentinized greenstone. All holes cut talcose rock with a section of about 60 feet (18 m) of talc and talcose rock in hole five."

Talc was noted in this lot on Ontario Geological Survey Map 51d, but was not mentioned in the accompanying report (Meen, 1942).

An unsuccessful attempt was made to locate this occurrence in the field. A one meter wide shear zone in serpentinized mafic volcanics, containing 5 to 10% talc, was located on the east side of a creek near the center of lot 13, con IV, but there is no evidence of previous diamond drilling.

History: In 1948, five diamond drill holes were put down on this showing by Active Exploration Sydincate (Hewitt, 1972).

Reference Map: Ontario Geological Survey Map 51d, Grimsthorpe-Barrie Area.

Reference: Hewitt (1972, p. 31)

GE2: Grimsthorpe Township, Concession V, Lot 10

Rock Association: Ultramafic

Access: This southern part of Grimsthorpe Township is accessed from the driveable road that follows the power line in northern Elzevir Township. Three kilometers northeast of Lingham Lodge on the power line, a forest track follows the east shore of Canniff Creek to the occurrence.

Description: Spence (1940) reported:

"A very pure foliated talc, of a pale apple-green shade, is found in a narrow 14-to-18 inch (35-to-45 cm) vein on this lot. A couple of small surface pits have been opened on the deposit in a search for mineralogical specimens, but no attempt at development has been made...The talc is in the form of aggregates of very large flakes, some of which extend across the entire width of the vein, and is associated with coarsely crystalline dolomite in a serpentine band that is probably an alteration product of amphibolite. Although the talc is of high purity and grinds to a snow-white powder, the deposit is probably too small to be of any commercial importance. An analysis, made in the laboratory of the Geological Survey, showed:

	Percent
Silica	60.45
Iron oxide	2.82
Alumina	0.27
Lime	0.16
Magnesia	29.84
Water above 105 C	5.42
Total	98.96

A field examination located the talc vein in an area of serpentinized to talc-carbonate altered rock up to 10 m wide along the northeast side of a swamp (Figure 34). The zone may extend below the swamp and has potential as a low-grade, large tonnage prospect.

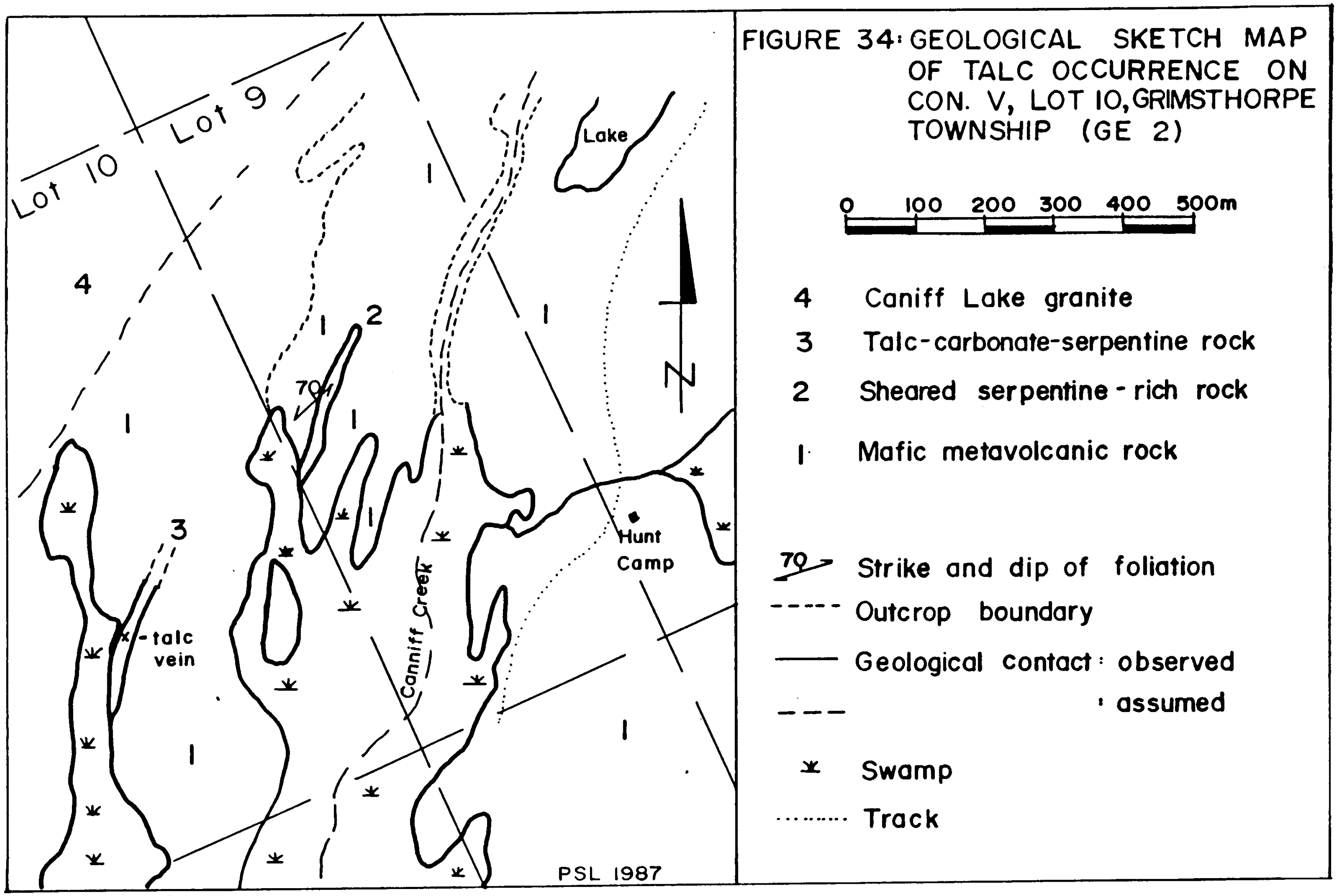


FIGURE 34: GEOLOGICAL SKETCH MAP OF TALC OCCURRENCE ON CON. V, LOT 10, GRIMSTHORPE TOWNSHIP (GE 2)

History: Wilson (1926) stated that a very small prospect pit had exposed a pure talc vein 25 to 35 centimeters wide.

Reference Maps: Ontario Geological Survey Map 51d, Grimsthorpe-Barrie Area

Ontario Geological Survey Map 52b, North Hastings Area

References: Hewitt (1972, p. 31,32)

Spence (1922, p. 25; 1940, p. 75)

Wilson (1926, p. 90,91)

Huntingdon Township

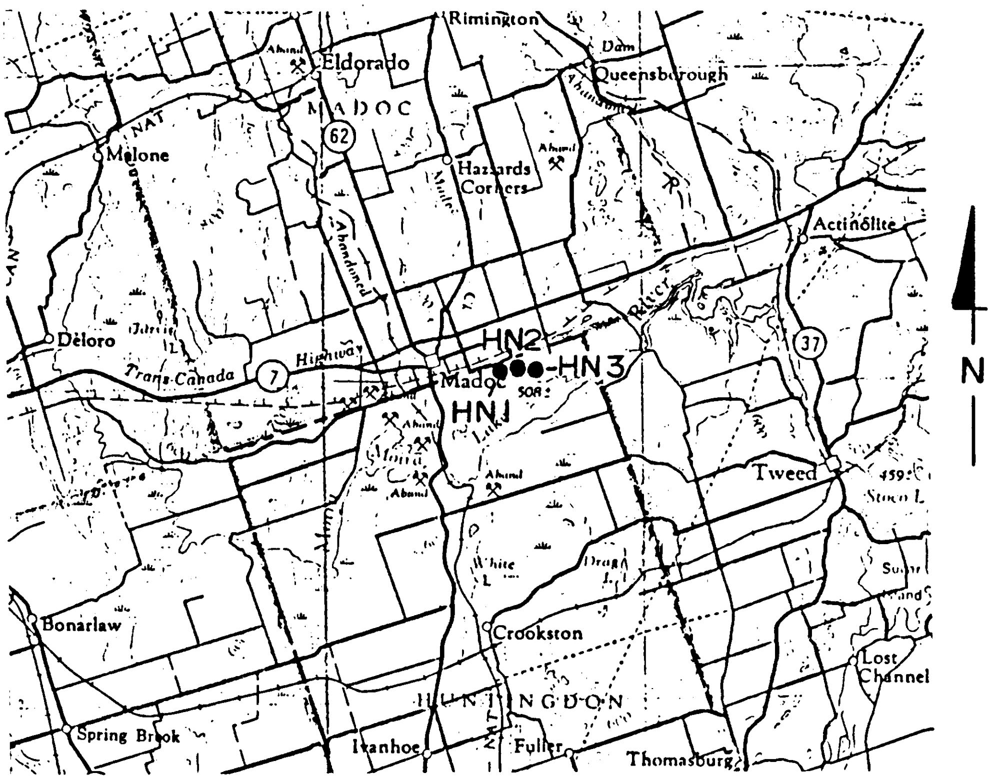


Figure 35: Location Map of the Huntingdon Township Canada Talc Industries Mine (HN1), Price Mine (HN2), and International Pulp Co. Occurrence (HN 3). (Scale 1:250,000)

HN1: Huntingdon Township, Concession XIV, Lots 14E1/2, 15NW1/4
Canada Talc Limited

Rock Association: Carbonate

Access: This operating mine is located on the southeast edge of Madoc and is accessible by road.

Description:

Introduction

On this property, strata-conformable talc orebodies hosted by dolomitic-tremolitic marble have been mined since 1896. Presently, talc, talcose dolomite and dolomite are being produced.

History

Talc was discovered at Madoc in the 1880's, and in 1896 the Henderson Mine was opened. The Conley Mine, which was originally comprised of the northeastward extension of the Henderson orebody, was discovered in 1911, and production began in 1914 or 1915. Hewitt (1972) detailed the complex operating and ownership history of the Henderson and Conley Mines up to 1972. Major events, plus recent developments, are noted below.

The Henderson and Conley properties were merged in 1937, and subsequently have been operated as one mine. From 1951 to 1983 this mine was operated by Canada Talc Industries Limited. In May, 1981, W.R. Barnes Company Limited took control of Canada Talc Industries Limited, and in October, 1983, the company was reorganized as Canada Talc Limited, with W.R. Barnes Company Limited retaining a controlling interest.

Old Mine Workings

The Henderson Mine had three shafts, but No. 1 and No. 2 shafts were put down in the talc orebody and were eventually abandoned due to caving. The Henderson No. 3 shaft, located immediately north of the Henderson orebody, became known as the No. 4 shaft of the combined Conley-Henderson property. This No. 4 shaft is still used as an escapeway, and for pumping and ventilation. The Henderson Mine had seven levels, with the deepest being at 133 m. None of these old workings are presently being mined; the Henderson orebody is today accessed by the modern No. 3 level at about 195 m and the "ramp level" at 250 m.

The early Conley Mine had two shafts. The No. 1 shaft, located in wallrock south of the Henderson-Conley main orebody, was used for most of the mining. The Conley Mine had eight levels, with the deepest being at 143 m. These old Conley Mine workings are no longer used and the No. 1 and No. 2 shafts are sealed off.

Presently - used Mine Workings

The present production shaft is known as the Conley No. 3 shaft. This shaft was sunk in 1935 near a newly-discovered ore body. This No. 3 shaft now accesses three levels: No. 1 level at 82 m, No. 2 level at 98 m and No. 3 level at about 198 m.

Talc has been mined in the past on the 82 m deep No. 1 level. No. 2 level is virtually undeveloped; it contains some exploratory workings. No. 3 level has been extensively developed for talc and talcose dolomite mining. In addition to talc and talcose dolomite orebodies near the No. 3 shaft, the No. 3 level accesses the Henderson talc orebody. Talcose dolomite is being mined on No. 3 level and some talc was mined in 1983 from No. 3 level orebodies near the production shaft. The Henderson talc orebody has not recently been mined on the present No. 3 level. A decline extends from No. 3 level to the 250 m deep ramp level of the Henderson orebody. Presently all high-purity talc production comes from this level.

Underground Mining

Talc in the Henderson orebody is mined by the "block caving" technique. Drawpoints are established on the ramp level, undercutting the talc. The talc then caves into the drawpoints, where large blocks are broken up by the use of explosives. The talc ore is conveyed by rubber-tired vehicles up the decline to the shaft on No. 3 level.

The talcose dolomite is mined on No. 3 level from "shrinkage stopes" about 12 m wide. Because the talcose dolomite is much more competent than Henderson talc ore, the shrinkage stopes have to be advanced by blasting. Mining on No. 3 level is carried out using steel rail equipment.

There are two grizzlies on No. 3 level near the shaft. One grizzly is used to pass talc ore, the other for talcose dolomite. The ore is carried to surface in a one-ton skip. The shaft has three compartments, with a five-man cage and a manway in addition to the ore skip.

General Geology

The talc orebodies lie within an area of dolomitic marble. The No. 3 shaft area is about 800 m northwest of outcrops of the Moira Granite, a granite stock that in part underlies Moira Lake (Fig. 3). The dolomite is tremolitic in part, and is interlayered with quartzite, amphibolite, and phyllite.

Layering in the country rocks dips subvertically and stikes roughly northeast. Drag folds occur in the country rocks and the orebodies, and

Sandomirsky (1954) reported that the main geological structure appears to be an anticline, with the closure lying just west of the Henderson open pit (Fig. 36). There are probably a number of faults on the property. Sandomirsky, and Wilson (1926) reported that a major fault cuts the Henderson workings at the 60 m level, with a lateral displacement of 15 m on this level.

The metasediments are cut by dark-coloured dikes which were named "madocite" by Wilson (1926). These dikes consist mainly of black tourmaline, amber mica, tremolite and plagioclase feldspar, with minor amounts of pyrite, arsenopyrite, quartz, actinolite, sphene, apatite and zircon.

Some Paleozoic age sandstone, conglomerate and limestone of the Shadow Lake Formation cap the Precambrian rocks in parts of the mine property. This unconformity is well-exposed in the northeastern wall of the east orebody open pit.

Geology of the Orebodies

Four types of ore can be identified. Henderson talc ore, a high-purity talc, and Conley low-talc ore, a talcose dolomite ore, are mined on an ongoing basis. Conley high-grade talc ore is mined intermittently. East orebody talc, a green-coloured high-grade talc, was produced from an

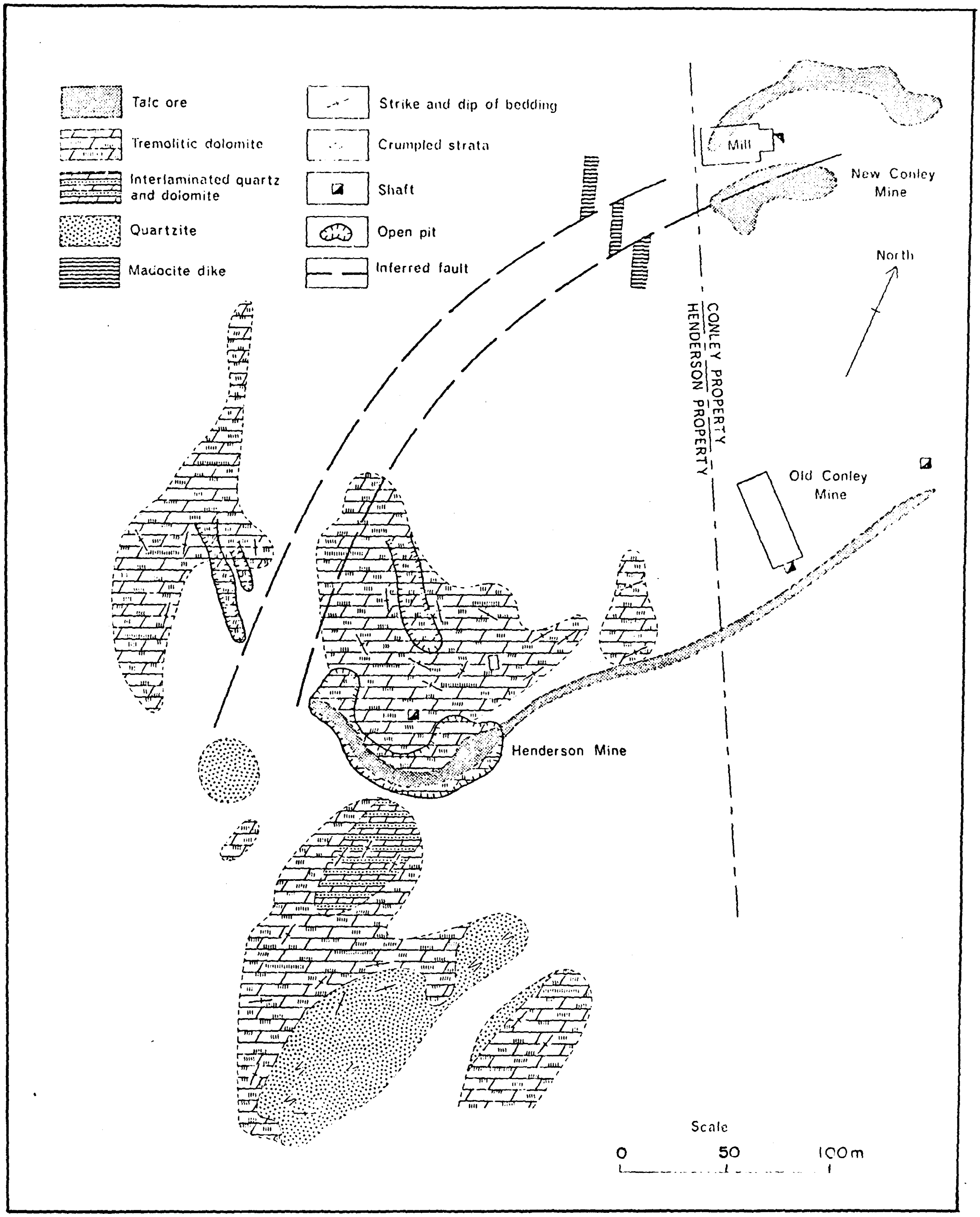


FIGURE 36: GENERAL GEOLOGY, CANADA TALC MINE PROPERTY (HNI)
(from Hewitt, 1972)

open pit located east of the mine office from 1982 to 1986.

The Henderson type talc ore was at one time also mined in the Henderson orebody's eastward extension on the Conley mine property. This very white, extremely pure talc is used to manufacture all of the mine's high-purity talc products. The orebody is a tabular sheet of pure, white, foliated talc. It is 7 to 25 m wide, 250 m long and has been mined to a depth of 250 m. Diamond drilling in 1987 intersected a 3 to 4 m width of high-grade talc up to 120 m below the 250 m level. The orebody also contains compact, massive steatite which ranges from green to white in colour. The steatite is found in large masses or "plums" in the Henderson orebody (Sandomirsky, 1954). Near the walls of the orebody, Henderson talc may contain impurities such as sulphide minerals, amber mica and tremolite.

A geological plan of the Henderson orebody on the No. 3 level is shown in Figure 37. The south side of the orebody is regarded as the footwall. Simandl and Ogden (1982, p.8) described the host rocks and orebody as follows:

"The footwall of the deposit consists of dark gray to black phyllite overlain by irregularly banded micaceous dolomite containing coarse prismatic

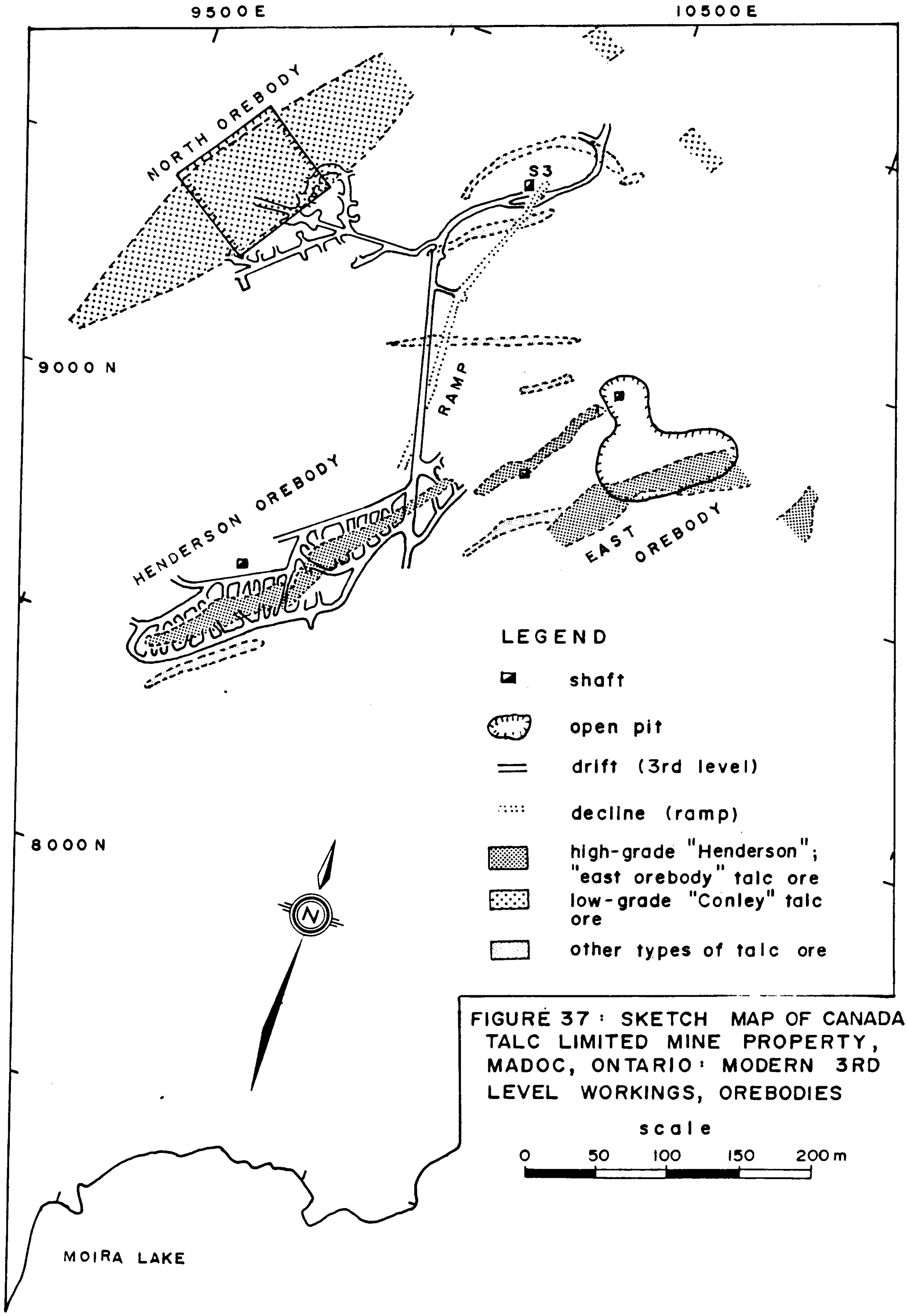


FIGURE 37: SKETCH MAP OF CANADA TALC LIMITED MINE PROPERTY, MADOC, ONTARIO: MODERN 3RD LEVEL WORKINGS, OREBODIES

tremolite. The micaceous dolomite is partly steatized near the contact with the talc body.

The hanging wall consists of regularly banded micaceous and tremolitic dolomite, containing some gray siliceous bands. Next to this banded micaceous and tremolitic dolomite is a discontinuous tourmaline-bearing layer overlain successively by quartz-bearing beds displaying a stromatolitic texture, "mottled blue" dolomite (dark gray and white with irregular patchy texture) and a thick dolomitic sequence. The dolomitic sequence contains some siliceous, pyrite-bearing beds (probably of exhalative origin) and amphibolite beds (metavolcanics).

The geology is further complicated by the sets of steeply dipping dykes, crosscutting both the host rock and the orebody. The dykes are of four main types:

a) fine-grained siliceous, sulphide-bearing;
b) coarse tourmaline sulphide type;
c) amphibolites; and
d) quartz-calcite pegmatite (youngest, least abundant and thinnest).

The thickness of the dykes varies from 0.1 to 7 metres. Sandomirsky (1954) noted that tremolite crystals increase in size near the dyke contacts."

Figure 4 shows a geological cross section through the Henderson orebody.

<u>Conley</u> <u>low-talc</u> <u>ore</u> is a fine-grained dolomitic marble that contains talc on slip surfaces and as disseminations, plus some tremolite. This low-talc ore contains up to 20% talc and it is pale gray to white in colour. This ore type is being mined underground, and from an open pit located west of the mill. Conley low-talc ore is used to manufacture filler products and terazzo chips.

Conley high-grade talc ore has been produced from the first and third underground levels near the No. 3 shaft. Mine staff reported that this ore type is a dolomite-talc schist that contains some amber mica, and that it grades up to 60% talc. Hewitt (1972) reported that on the first level this ore is a talcose tremolitic dolomite, in many places containing less than 30% talc.

The east orebody was outlined by diamond drilling in 1981 and 1982 and was mined by open pit from 1982 to 1986. The orebody is up to 30 m thick and it has been traced along strike for 140 m.

The east orebody talc is high-grade, and quite similar to the Henderson type ore, but in the open pit it is pale green in colour. Diamond drilling has shown that the talc is whiter at depth. A visit to the pit showed that the orebody contains zones of dolomite and green amphibole. A mafic "madocite" dike was exposed in the southwest wall of the pit. This dike is irregularly-shaped and appears to have been folded with the country rocks.

Milling

Since 1984, most of the ore has been milled at the Marmora mill. Ore is crushed at the minesite in Madoc and trucked to Marmora where it is passed through a tumble drier and fed by conveyor into the mill. The ores coming into the mill are placed into two bins. High-grade talc ores are stored in a 55-tonne bin, low-talc or dolomite ore is stored in a 90-tonne bin. The mill is fed from one bin at a time to produce the desired product.

From the storage bins, the crushed ore is fed into a Raymond mill which produces a -325 mesh product (98% 40microns or less). This product is blown into storage tanks and packed in 20 kg. bags for shipment by truck.

Mill capacity is 50,000 tonnes per year, but actual production is limited by the ore supply to about 33,000 tonnes per year.

Products Available (as of Nov., 1988):

Five talc products are manufactured from Henderson-type ore. These are:

a) Cantal MM- 45- 95 (-40 microns, 95% brightness)

b) Cantal MM- 45- 90 (-40 microns, 90% brightness)

c) Cantal MM- 45- 85 (-40 microns, 82-85% brightness)

d) Cantal MM- 45- 80 (-40 microns, 75-81% brightness)

e) Talfil 40- 200 (-60 microns, 75% brightness)

Conley low-talc ore is used to produce the following products:

a) Dolfill MM 50- 90 (-40 microns, 84-88%

brightness)

b) Dolfil Fieldstripe

Dolomite terazzo chips are also produced.

The Cantal products are marketed as fillers for the paint, plastics, rubber and related industries. The Talfil product is marketed as lower- cost general purpose talc. The Dolfil product is also marketed as a filler. Dolfil Fieldstripe is sold as a line marking for track and field athletic facilities.

In 1988, about 70% of production was sold to the plastics industry, to be used mainly in the manufacturing of dark polypropylene. About 70% of Canada Talc's production is sold in the United States. (Harold Sexsmith, Mill Superintendent, Canada Talc Limited, Marmora, personal communication, 1988).

Reference Map: Ontario Geological Survey Map 2154, Madoc Township and Part of Huntingdon Township.

References: Hewitt (1972, p. 9 - 23, 33 - 34)
Sandomirsky (1954)
Simandl and Ogden (1982)
Spence (1922, p. 25 - 31; 1940, p. 68 - 70)
Wilson (1926, p. 78 - 90)

HN2: Huntingdon Township, Concession XIV, Lot 15 E 1/2

Price Mine

Rock Association: Carbonate

Access: The property is located less than 200 m east of the Canada Talc Industries Mine (HN1) and is accessible by foot from the Canada Talc Mine road. (Fig. 3).

Description: Talc mineralization similar to that at Canada Talc Limited (HN1) has been reported from this half lot. Early work on the property was described by Wilson (1926, p.89) who reported the following:

"This half-lot adjoins the Connolly property on the east and is owned by the Asbestos Pulp Company, to which the Connolly now belongs. There are two openings in the property, an old pit lying 40 feet (12 m) northeast of the No. 2 pit on the Connolly and a new shaft 45 feet (14 m) deep sunk in 1922 by the Asbestos Pulp Company. The first pit is 15 feet (4.5 m) long by 10 feet (3 m) wide and 25 feet (8 m) deep, in which a zone of cream-white to grey talc schist 2 to 5 feet (0.6 to 1.5 m) wide is exposed along the southeast wall. The schist zone trends north 40 degrees east magnetic and dips 75 degrees northwest. The wall-rock is dolomite similar to that seen on the Henderson and Connolly properties. The cream-white phase of the schist zone, except for small lenses of dolomite, is composed of high-grade flake talc, but this constitutes a very small part of the deposits, the greater part of the zone consisting of grey, hard, impure talc with flake talc developed only on the foliation planes.

The new shaft is situated about 140 feet east of the west boundary of the lot and 100 feet east of the old pit. It has been put down on a zone or zones of talc schist which lie about 15 feet (4.5 m) southeast of and parallel to, the talc schist zone in the old pit. This deposit consists chiefly of alternating zones of white, flaky, micaceous talc and white or grey dolomite. A few thin zones of grey to green talc schists are also present. The zones of white talc range from a few inches to 2 (0.6 m) or even 3 feet (0.9 m) in width, but contain numerous inclusions of dolomite up to a foot (0.3 m) or more in diameter. The most persistent zone lies along the southeast wall of the shaft. The dolomite is traversed by numerous seams of talc. A northwesterly trending vertical fissure in which grey or smoke-coloured crystals of calcite encrusted with pyrite were observed extends diagonally down the north and south walls of the shaft. The talc zone as exposed in the shaft is too much broken and contains too many inclusions to be workable. The presence of high-grade talc similar to that composing the main deposits on the Henderson and Connolly properties indicates, however, that a more extensive deposit free from inclusions may be present on the continuation of the zone or nearby."

Later work was described by Hewitt (1972, p. 33)

as follows:

"In 1941 and 1942, the Trent Mining Syndicate Limited sunk two shafts on the northeast quarter of lot 15, concession XIV, Huntingdon Township. The property is known as the Price Mine. The principal shaft is 90 feet (27 m) deep with levels at 40 and 80 feet (12 and 24 m). The dolomite strikes N10E and dips 55W. The shaft was dewatered when the property was visited by the author in August, 1949. On the 40-foot level, a drift goes 140 feet (43 m) north along a narrow sericite-talc schist zone. The talc zone exposed in the drift is 2 to 5 feet (0.6 to 1.5 m) wide and cuts siliceous dolomitic marble. The drift runs N10E parallel to the strike of the dolomitic marble band. A crosscut running east for 15 feet (4.5 m) from the station cuts into a green serpentinized schist footwall. A crosscut running west for 85 feet from the station exposed a hanging wall of black graphitic schist and amphibolite. On the 80-foot level, 108 feet (33 m) of drifting is reported.

A pit 15 feet (4.5 m) long, 12 feet (3.6 m) wide, and 4 feet (1.2 m) deep, was put down in fine-grained buff to white marble 150 feet (4.6 m) northwest of the shaft. Pits east of the shaft expose foliated sericite carbonate schist, which is green in colour due to chlorite and serpentine."

Reference Map: Ontario Geological Survey Map 2154, Madoc Township and part of Huntingdon Township

References: Hewitt (1972), Wilson (1926)

HN3: Huntingdon Township, Concession XIV, Lot 16

International Pulp Company

Rock Association: Carbonate

Access: Located about 1 km east of the Canada Talc Industries Mine (HN1), the property is accessible by road leading east 1.5 km from Madoc, then south to Moira Lake (Fig. 3).

Description: Wilson (1926, p.89-90) described this talc occurrence as follows:

"Prospecting operations were carried on in this lot by the International Pulp Company, of Gouverneur, New York, from August, 1917, to July, 1919. Three shafts were sunk, No. 1, a few hundred feet south of the buildings on the Arthur Pitt farm, No. 2 close to the west boundary of the lot and about 700 feet (213 m) from its northwest corner, and No. 3 on the Chesley Pitt farm about 70 feet (21 m) northeast of shaft No. 1. There are no rock outcrops near any of these shafts and they are now, with the exception of No. 3, completely filled with water, so that the writer's observations consisted chiefly in examining the materials on the rock dumps adjoining the shafts.

Shaft No. 1 is inclined about 70 degrees to the west and is 50 feet (15 m) deep. A drift extends 80 feet (24 m) northeast from the bottom of the shaft and a crosscut 50 feet (15 m) southeast from a point in the drift 30 feet (9 m) from the shaft. The rock on the dump consists of grey to rusty brown mica schist, dolomite, limestone, massive talc, and siliceous talc schist. The mica schist occurred in the shaft, the dolomite and limestone in the drift, and the talc and talc schist in the crosscut.

Shaft No. 2 is said to be 60 feet (18 m) deep. From its bottom a crosscut extends 100 feet (30 m) north and drifts for about 10 feet (3 m) to the east and west. The rocks on the dump consist chiefly of fine, dark grey, talcose, tremolitic schist and a light grey, tremolitic dolomite. The minerals observed were arsenopyrite in numerous, fine, rod-like crystals embedded in tremolitic schist and a coarse, micaceous porphyry, pyrrhotite, pyrite, fine phlogopite (amber mica), quartz, and tremolite in radial aggregates. Fragments of coarse, white to grey, talc schist, some of which is similar to that in the main zone in the Henderson and Connolly properties, were seen in the dumps, but the amount of this material is small.

Shaft No. 3 is about 25 feet (75 m) deep, with a drift 5 feet (1.5 m) towards the northeast at its bottom. The material exposed in the shaft and on the dump is a grey to white talc schist containing lenticular inclusions of quartz. It resembles the talc schist seen on the dump of shaft No. 1 and is presumably the continuation of the same zone. It strikes north 70 degrees east magnetic. According to Mr. Chesley Pitt, two diamond drill holes, one 70 feet deep (21 m) and inclined 60 degrees to the north, and the other 60 feet (18 m) deep, and inclined 60 degrees to the south, were put down from a point about 35 feet (10 m) south of shaft No. 3. The writer has no information regarding the material cut in these holes."

Reference Map: Ontario Geological Survey Map 2154, Madoc Township

and part of Huntingdon Township

References: Hewitt (1972)

Spence (1922, 1940)

Wilson (1926)

Lake Township

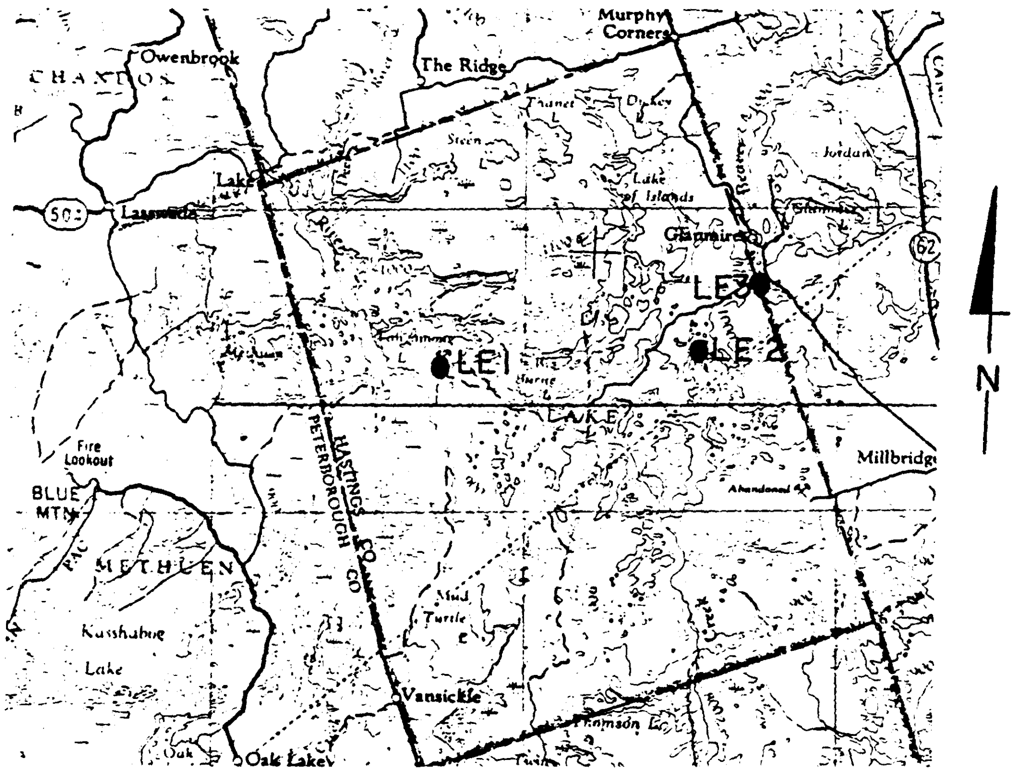


Figure 38: Location Map of the Lake Township Talc Occurrences. (Scale 1:250,000)

LE1: Lake Township, Concessions III, IV, Lots 18,19 and 20

Rock Association: Carbonate

Access: This occurrence on the east side of Whetstone Lake is reached by a dirt road that enters the township from the east.

Description: Thomson (1943) described this iron, talc and minor copper prospect as follows:

"On the principal showing small patches of magnetite are exposed in amphibolite and a talc-actinolite rock in the general vicinity of a granite contact."

Mapping by Laakso (1968) suggested that the talc-actinolite rock is a calc-silicate paragneiss that is interlayered with "orthoamphibolite".

History: This prospect has been explored for iron over many years. Tomahawk Iron Mines Limited carried out stripping, trenching and diamond drilling in 1942 (Thomson, 1943).

Laakso (1968) reported:

"In 1946 a 20 ton mill was constructed...In 1947 the mill was tested with magnetite bearing rock in the stockpile; 150 tons had been treated by the end of the year."

Laakso also reported that in 1950 Mag-Iron Mining and Milling Company Limited began operations, and in 1955 Clarkden Development Company began to operate the pit and mill. Mining operations ceased in 1958. Between 1950 and 1958 modest quantities of iron concentrate were produced.

Some surface exploration work was carried out in 1959.

Reference Map: Ontario Geological Survey Map 2106, Lake Township.

References: Laakso (1968, p. 25, 26)

Thomson (1943, p. 39, 40)

LE2: Lake Township, Concession X, Lots 15,16,17, and 18

Rock Association: Carbonate

Access: South of Glanmire in Tudor Township, a driveable road heads west and crosses Beaver Creek. From the bridge over the creek, the occurrence must be reached on foot.

Description: Laakso (1968) reported:

"A low-grade talc-bearing band, in lots 15,16,17,18, Concession X, parallels the west bank of Beaver Creek.

The talc occurs in a talc-tremolite-carbonate band enclosed in dolomite, and along what appears to be a fault zone. The strike of the narrow talc-bearing band is N 10 E and its dip is vertical. Lenses of bluish quartzite are also found in the dolomite. The Tudor gabbro is about 300 yards (275 m) east of the talc band; a fine-grained bluish calcareous marble is present toward the west."

During a field examination, talc was observed in three areas (Figure 39). On the hydro line, tremolitic rock contains talc on shear planes. In the centre of the mapped area, talc-dolomite schist grades up to five percent talc. The most pure talc was observed in fault breccia adjacent to the talc-dolomite schist. Veins of pure, white, foliated talc up to five cm thick occur in the fault breccia, between blocks of dolomite and quartzite.

Reference Map: Ontario Geological Survey Map 2106, Lake Township

References: Allen (1976, p. 101)

Hewitt (1972, p. 34)

Laakso (1968, p. 19, 28,29)

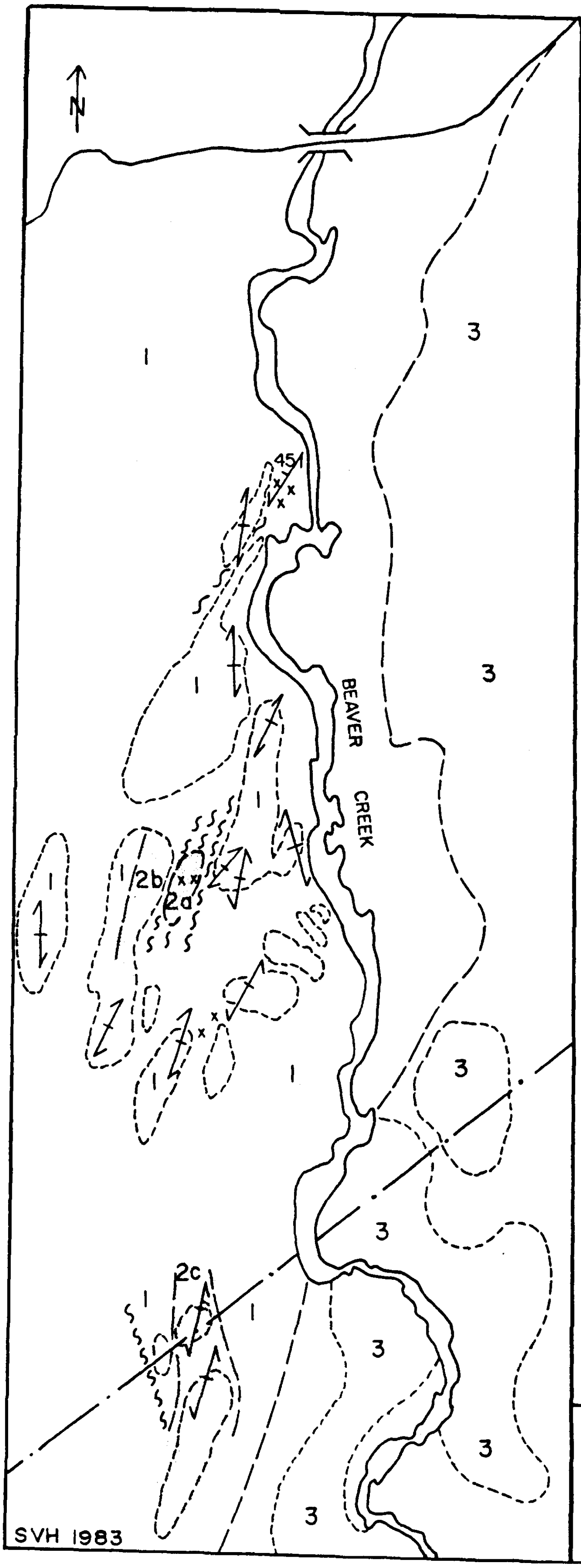


FIGURE 39: GEOLOGICAL MAP OF TALC OCCURRENCES ON CON X, LOTS 15,16,17,18, LAKE TOWNSHIP (LE 2)

LEGEND

- 3 — metagabbro, metadiorite interpreted after Laakso (1968)
- 2c — grey and white dolomite interlayered with lenses of tremolitic rock; talc on shear planes
- 2b — dolomite-talc schist, contains some talc reaction rims 5 cm thick around quartz lenses
- 2a — fault breccia: jumbled blocks of quartzite and dolomite-talc schist; talc seams up to 5 cm thick occur between blocks
- 1 — grey and white siliceous dolomite. Contains quartz tremolite layers, quartzite and grey schistose dolomite
- geologic contact
- fault
- area of outcrop
- small outcrop
- strike of foliation, dip vertical, inclined (45)
- hydro line

SCALE

0 100 200 300 400 500 m

LE3: Lake Township, Concession XI, Lot 63

Rock Association: Carbonate

Access: These occurrences straddle the road which enters Lake Township south of Glanmire.

Description: Allen (1976) noted that fine-grained talc was present in minor amounts in samples of marble collected north and south of the road in this lot. The marble in this area contains calcite, dolomite, tremolite and talc.

Reference Maps: Ontario Geological Survey Map 52b, Hastings Area.

Ontario Geological Survey Map 2106, Lake Township

Reference: Allen (1976, p. 101, 106)

Limerick Township

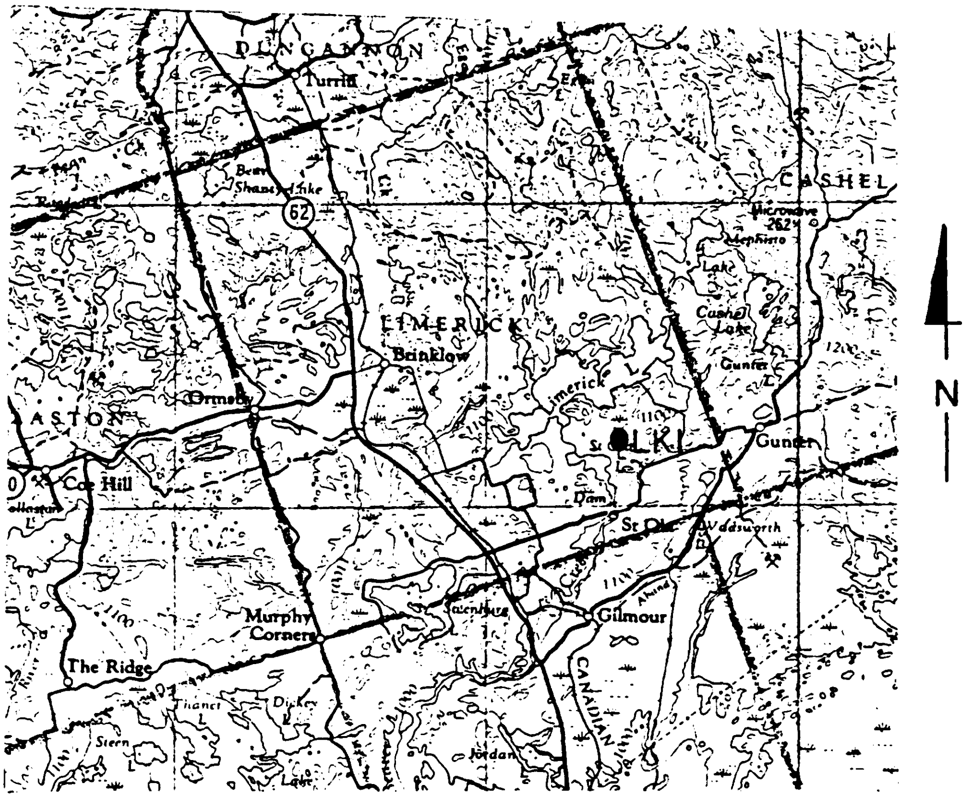


Figure 40: Location Map of the Limerick Township Talc Occurrence.
(Scale 1:250,000)

LK1: Limerick Township, Concession IV, Lot 7

Rock Association: Carbonate

Access: This occurrence is located about 800 m south of Limerick Lake, and can be reached by roads leading east and north from St. Ola.

Description: Lumbers (1969) reported:

"Talc is relatively common in metasomatized carbonate metasediments near the south end of the albite granite intrusion in lot 7, concession IV, Limerick Township...The talc mineralization, which is intimately associated with iron-titanium oxide minerals and iron-bearing silicate minerals, is not of sufficient size, purity and whiteness to be of commercial interest."

Reference Map: Ontario Geological Survey Map 2197, Limerick Township

References: Lumbers (1969, p. 96)

Madoc Township

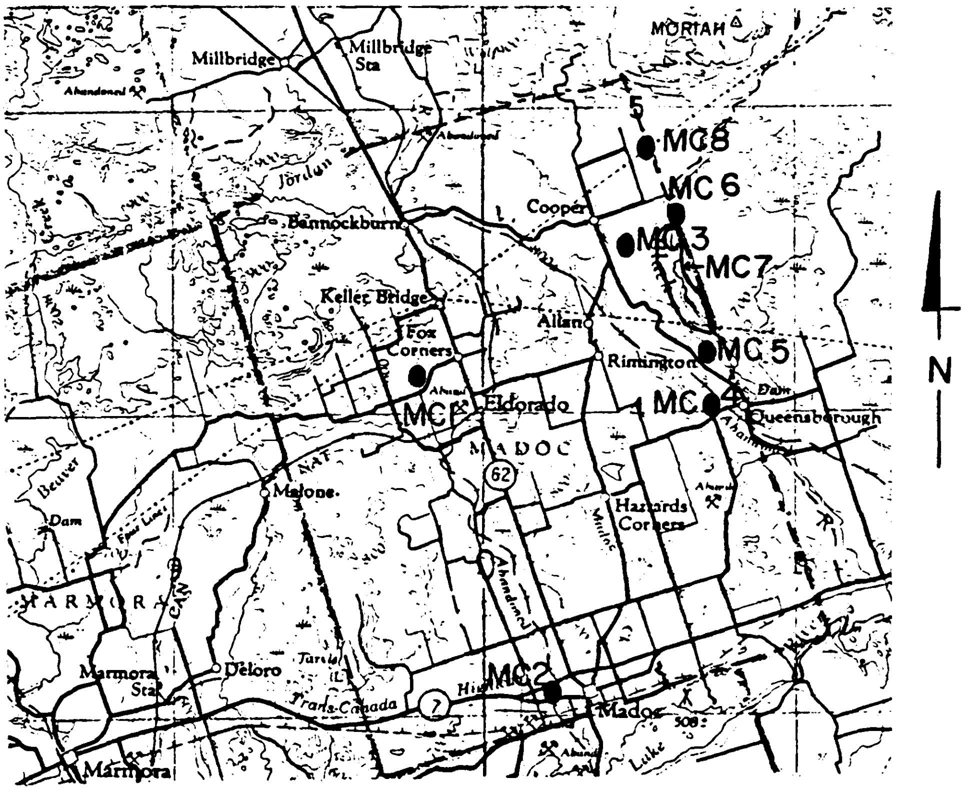


Figure 41: Location Map of the Madoc Township Talc Occurrences. (Scale 1:250,000)

MC1: Madoc Township, Concessions IV, V, Lots 20, 21

Eldorado Mining and Milling Company

Rock Association: Carbonate

Access: This deposit is located on the Moira River, about three km northwest of Eldorado. A small road leads into the property from Hastings road number 11.

Description: The area of this deposit is underlain by dolomitic marble, and by flat-lying Paleozoic rocks. Outcrop is sparse. The talc is contained in a grey to white talc-dolomite schist. This rock appears to be composed of 0.5 to 20 percent quartz, and 50 to 80 percent dolomite. Wilson (1926) reported that the talc schist in the area of the workings averaged 20 percent talc. The talc is disseminated in fine flakes throughout the rock; the quartz occurs in lenses, stringers, and disseminated grains. The talc-dolomite schist forms a bedding-conformable layer about 60 m thick within dolomite (Figure 42).

A unit of grey talcose schist strikes northeast across the eastern end of the property. The dolomite and talc-dolomite schist are folded in an antiform that plunges approximately 30 degrees to the northeast, and the talc-dolomite schist is intruded by two small feldspar porphyry sills. The Precambrian age rocks are overlain by flat-

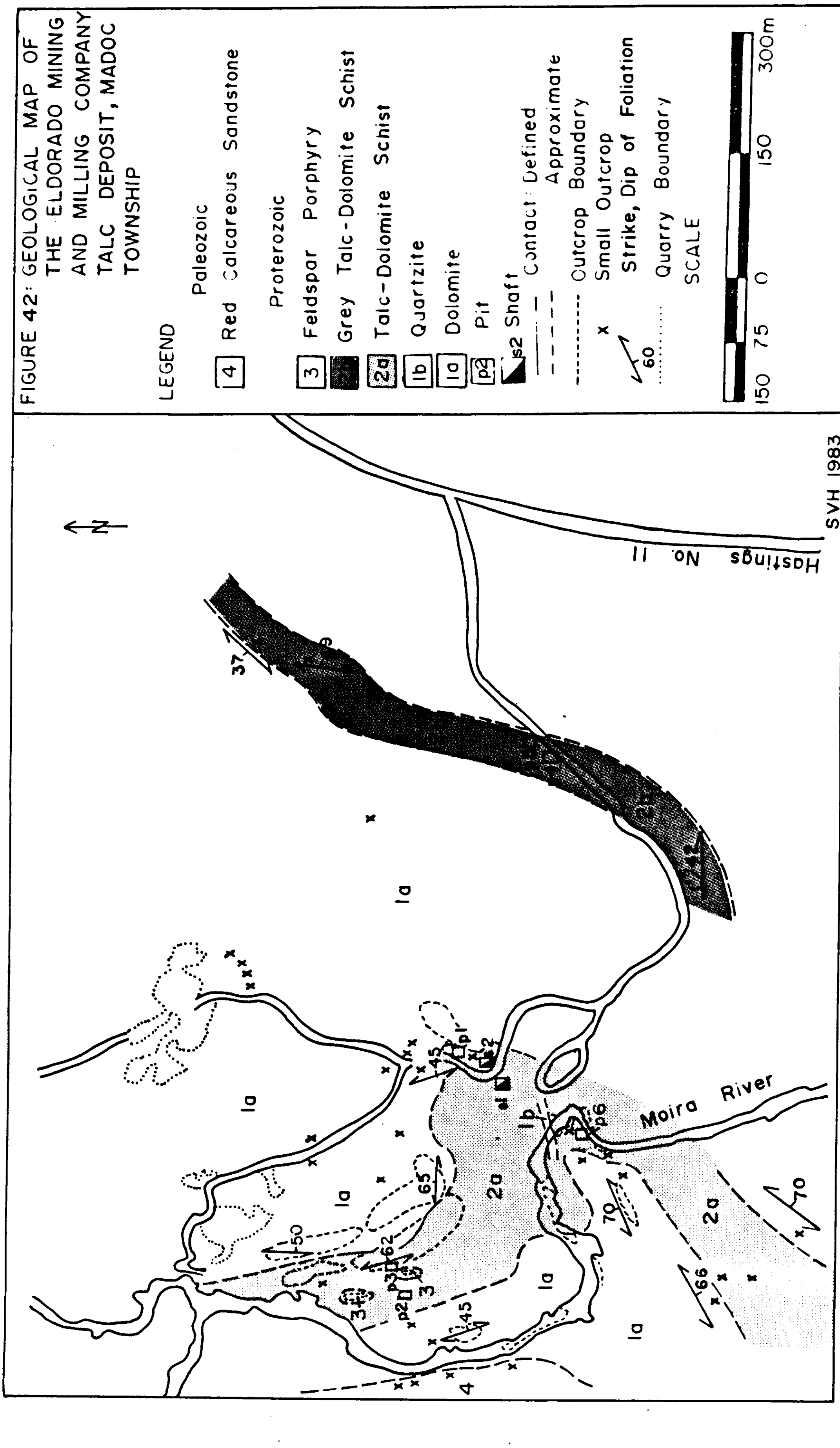


FIGURE 42: GEOLOGICAL MAP OF THE ELDORADO MINING AND MILLING COMPANY TALC DEPOSIT, MADOC TOWNSHIP
LEGEND
Paleozoic
4 Red Calcareous Sandstone
Proterozoic
3 Feldspar Porphyry
2b Grey Talc-Dolomite Schist
2a Talc-Dolomite Schist
1b Quartzite
1a Dolomite
p2 Pit
s2 Shaft
Contact: Defined
Approximate
Outcrop Boundary
Small Outcrop
Strike, Dip of Foliation
Quarry Boundary
SCALE
150 75 0 150 300m
Moira River
Hastings No. 11
SVH 1983
N

lying calcareous sandstone and limestone of Paleozoic age, west of the Moira River.

The talc is very white and is disseminated throughout the host rock. The highest observed grades occur in the closures of minor folds, and the closure of the large antiform may contain the highest overall grade of ore as the mine workings are located there.

Field mapping did not determine the along-strike dimensions of the talc-dolomite unit. More talc-bearing rock may exist along strike, outside the mapped area.

History: Wilson (1926) reported:

"Mining operations were undertaken (in) 1911 (by) the Eldorado Talc and Silica Company. This company carried on operations until the end of 1913. In March, 1914 reorganization occurred and a new company known as Eldorite, Limited took over the property and continued operations intermittently to September, 1916 when the mine and mill once more became idle. In February, 1919 a third company, the Eldorado Mining and Milling Company acquired the property, but in November, 1920 operations were once more discontinued and since that time have not been resumed."

"(The bulk of the work) on the property was performed from two shafts...These shafts are connected at a depth of 65 feet (20 m) by a succession of large openings up to 60 feet (18 m) in diameter formed in mining the talc-dolomite schist...At 200 feet (61 m) the shafts are connected by a drift...At the time the property closed down in 1920, no mining had been attempted at this level except that performed in driving the drifts and crosscuts.

The equipment on the property when the mine was last operated included two mills of the air-flotation type, one for treating the white talc-dolomite schist and the other for the (grey schist)...and all the machinery necessary for operating on the scale of 50 tons a day."

Reference Map: Ontario Geological Survey Map 2154, Madoc Township and part of Huntingdon Township.

References: Hewitt (1968, p. 29; 1972, p. 35, 36)

Spence (1922, p. 31-32; 1940, p. 72-74)

Wilson (1926, p. 68-77)

MC2: Madoc Township, Concession V, Lot 2

Seymour Iron Mines

Rock Association: Carbonate

Access: This occurrence is located a short distance east of the railway track, west of Madoc.

Description: Wilson (1926) reported:

> Small quantities of steatite, "an earthy variety of talc" were observed by Harrington (1874) in specimens from the Seymour iron mine. The occurrence is evidently only of mineralogical interest.

Reference Map: Ontario Geological Survey Map 2154, Madoc Township and part of Huntingdon Township

References: Harrington (1874, p. 204, 205)

Wilson (1926, p. 77)

MC3: Madoc Township Concession X, Lot 24

Rock Association: Ultramafic

Access: This occurrence, which is located southeast of Cooper, can be reached by a dirt track that leads east and south from the farm house on this lot.

Description: This talc was noted by Hewitt (1968) on his map of Madoc Township, but was not referred to in the accompanying report.

A brief field examination revealed that there are at least two outcrop areas that contain talc (Figure 43).

Two rock types were observed. A breccia comprised of epidotized fragments in a chlorite matrix is interlayered with a talc-carbonate rock that grades 20 to 50 percent talc.

If the talc rock continues under overburden between the two outcrops, there may exist a talcose zone having a strike length of 150 m and a width of at least 10 m.

The talc at this locality is white in colour, and it may be possible to beneficiate the ore to a high quality talc product.

Reference Map: Ontario Geological Survey Map 2154, Madoc Township and part of Huntingdon Township, by D.F. Hewitt, 1968.

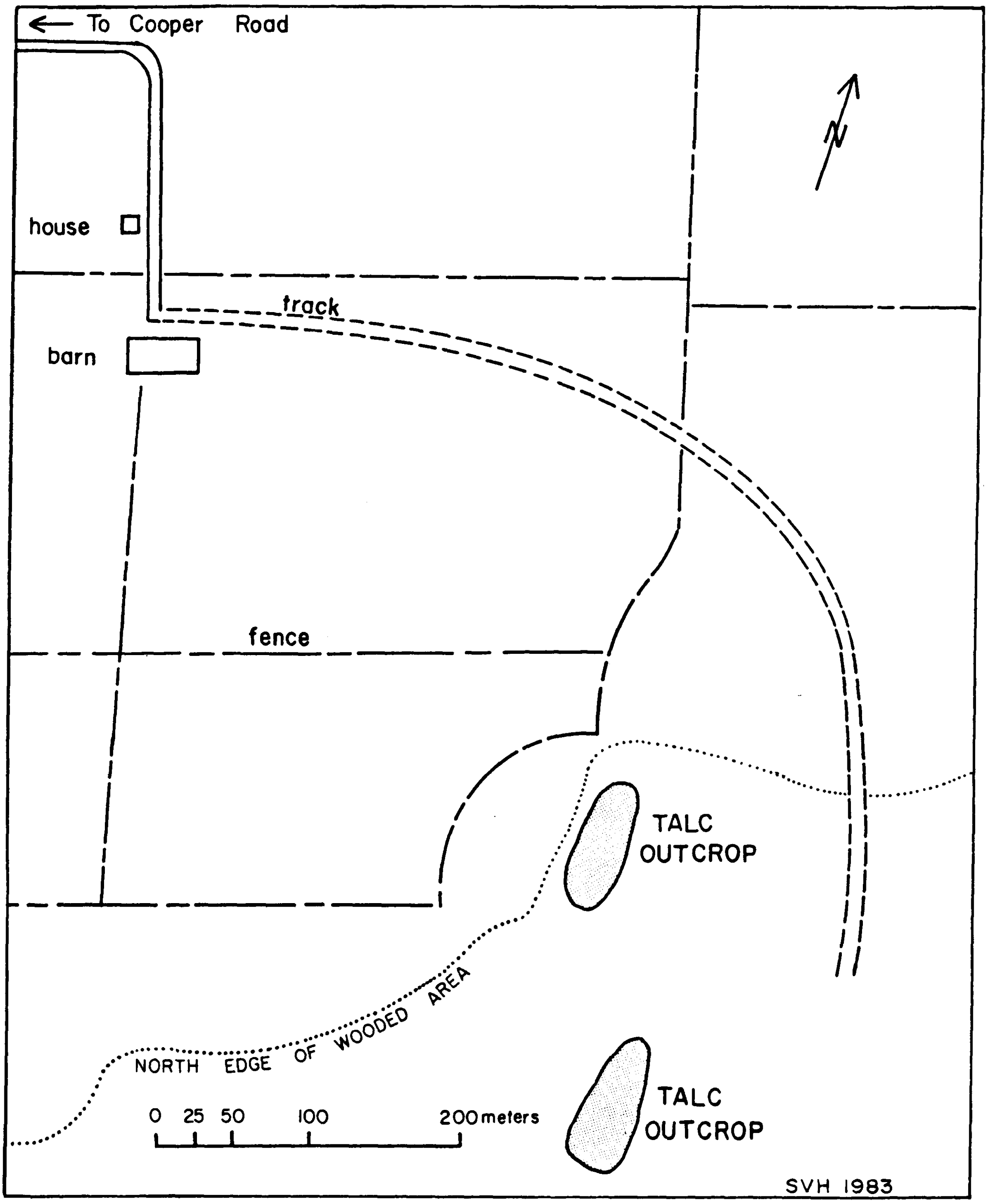


FIGURE 43: SKETCH MAP: LOCATIONS OF TALC-BEARING OUTCROPS ON CON. X, LOT 24, MADOC TOWNSHIP (MC 3)

MC4: Madoc Township, Concession XI, Lot 15

Rock Association: Ultramafic

Access: This lot is adjacent to paved roads.

Description: Wilson (1926) reported:

"A zone of impure talc-dolomite schist five feet (1.5 m) wide is exposed in a prospect pit 10 feet (3 m) square and five feet (1.5 m) deep on the slope of a rocky ridge situated a few hundred feet (60 to 100 m) east of the farm house on this lot. The foliation in the schist is uniform along the east wall of the opening, but elsewhere is irregular. This deposit, like those in Elzevir Township to the eastward, is an alteration zone in the greenstone lava flows of the Grenville series that form an extended area along the boundary between Madoc and Elzevir Township. The continuation of the zone to the south is drift covered, but it is absent in a bare outcrop lying transversely across the strike of the zone 200 feet (60 m) to the north."

Reference Map: Ontario Geological Survey Map 2154,

Madoc Township and part of Huntingdon Township

References: Hewitt (1968, p. 29; 1972, p. 34, 35)

Spence (1940, p. 74)

Wilson (1926, p. 77)

MC5: Madoc Township, Concession XI, Lot 17 West Half

Rock Association: Ultramafic

Access: The occurrence is located about 175 m east of the paved road that runs north from Queensborough, on land that belongs to Kevin Barry.

Description: At this locality, amphibolite (metamorphosed basalt) strikes northwest and dips steeply to the southwest. A prospect pit has been opened up on an outcrop area that lies on the northeast side of a northwest-trending valley. This pit exposed a 2.5 m wide, foliation-conformable vein of dolomite-talc rock. Amphibolite adjoining the vein has been sheared, and has a slaty texture. Thin section examination showed that the green amphibole that constitutes 90 percent of this wall rock has been ground into small, elongate grains that define the foliation.

The vein material is made up of 80 percent talc, 20 percent dolomite or magnesite and a small amount of magnetite. The talc vein could not be traced in outcrop northwest of the pit, but may continue under overburden to the southeast.

Reference Map: Ontario Geological Survey Map 2154, Madoc Township and part of Huntingdon Township

MC6: Madoc Township, Concession XI, Lots 22, 23, 24, and Elzevir Township, Concession I, Lot 24 (Cooper Occurrence)

Rock Association: Ultramafic

Access: The general area of these occurrences is accessible by roads east of Cooper, but the individual showings must be reached on foot.

Description: Dillon and Barron (1985, p.30-31) mapped this area (Figure 44). The following description is summarized from their report.

- Most extensive exposures of talc mineralization are located in the north-east part of the Cooper area, with small discontinuous zones exposed throughout the property.

- Talc mineralization occurs as discontinuous veinlets and fracture fillings 2-5 cm thick within altered chloritic amphibolites and as large lenses 5 to 60 m thick and up to 300 m in strike length.

- Talc zones parallel the foliation and are hosted in a chlorite-dolomite schist.

- Mineralization consists of talc-chlorite-dolomite schists with minor serpentine. Serpentine appears to be restricted to low grade talc zones with high carbonate content.

- Talc content varies from 30 to 70 percent with average grades of 50 to 60 percent.

- Mineralized samples contain fine foliated masses of talc separated by lenses of fine chlorite and having disseminated porphyroblasts of coarser grained carbonate (dolomite).

- Fine-grained late veinlets of carbonate cross-cut foliation and trace amounts of fine-grained opaque iron oxides occur with the late carbonate stringers.

- Preliminary investigations in this area indicate talc mineralization of sufficient size and grade to warrant extensive detailed exploration.

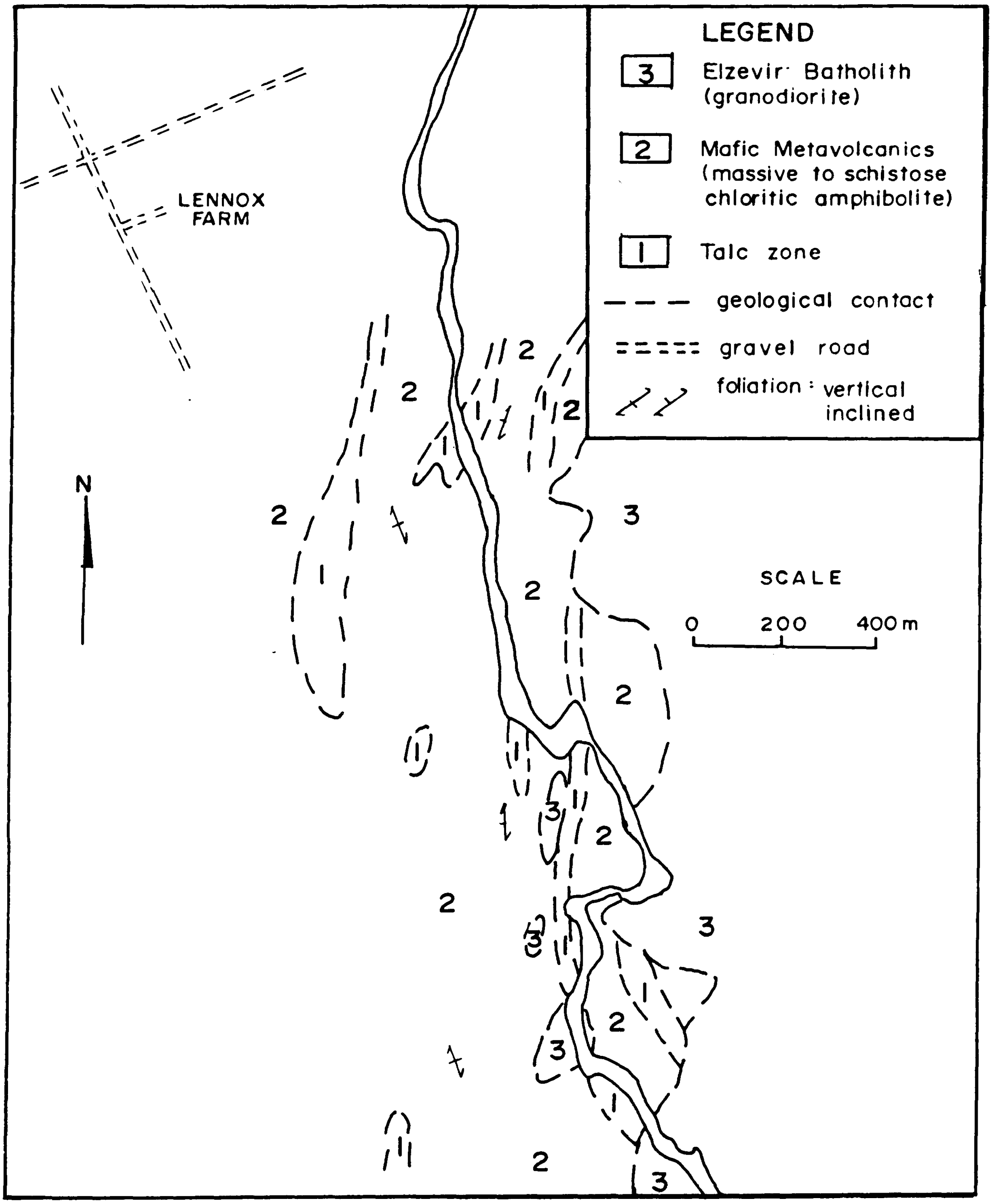


FIGURE 44. GEOLOGICAL MAP OF TALC OCCURRENCES ON CON I, LOTS 22, 23, 24, MADOC TOWNSHIP, AND CON I, LOT 24, ELZEVIR TOWNSHIP, MC 6 (after Dillon and Barron 1983, and Meillon 1985).

In 1988, diamond drill core from a talcose zone on the east half of lot 22, concession XI was subjected to flotation tests to determine talc recovery (LeBaron, 1988). The sample, consisting of about 45% talc, 25% dolomite, 25% serpentine, and minor chlorite and magnetite, gave a talc yield of 36% (80% recovery) at 90% brightness with 3.5% acid solubles. This represents a good quality product suitable for use in the paint, paper, and plastics industries.

History: Roger Young of Havelock, Ontario diamond drilled these talc showings in 1982 (Kingston and Papertzian, 1983).

Additional drilling by Twin Buttes Exploration in 1985 indicated "a possible 2 million-ton talc deposit to a depth of 30 m." (Northern Miner, Oct. 28, 1985). A report by J.J. Meillon (1985) for Twin Buttes indicated 2.2 million tonnes in the "Cooper West Zone" and 780,000 tonnes in the "Cooper East Zone", both grading 30 to 33% recoverable talc.

Reference Maps: Ontario Geological Survey Map 51d, Grimsthorpe-Kennebec Area

Ontario Geological Survey Map 2154, Madoc Township and part of Huntingdon Township

References: Dillon and Barron (1985, p.30-31)

Kingston and Papertzian (1983, p. 186)

LeBaron (1988, p.354-355)

Meillon (1985, p.12)

MC7: Madoc Township, Concession X, XI, Lots 18-21

Rock Association: Ultramafic

Access: This area of multiple talc occurrences is accessible by Hastings Road No. 20, but individual occurrences must be reached on foot.

Description: This area was explored for talc by the Ontario Geological Survey in 1983 (Dillon and Barron, 1985). This reconnaissance survey identified a number of talc bodies in Elzevir and Madoc Townships (ER4), the locations of which are shown in Figure 29. This occurrence represents the extension of the Elzevir township occurrence, ER4, northward into Madoc township and occurrence MC6. For a description of the talc zones, see occurrence ER4, Elzevir township.

References: Dillon and Barron (1985, p. 32-39)

MC8: Madoc Township, Concession XI, Lot 28

Rock Association: Ultramafic

Access: About 2.5 km northeast of the village of Cooper, a dirt road follows the hydro line east from the concession road. Talcose rocks are exposed along the hydro line road near the Madoc-Elzevir township line.

Description: Geological mapping of the area by LeBaron (1987) indicated a zone of talc-chlorite-serpentine-carbonate-altered ultramafic rock within a sequence of massive to strongly foliated metabasalts, about 1.7 km northwest of the Elzevir granodiorite batholith (Fig. 45). The zone is at least 10 m wide and 300 m long, striking N70^{o}E and dipping about 60^{o}N. It appears to extend westward below a Paleozoic outlier (Shadow Lake Formation calcareous, feldspathic quartz sandstone and minor limestone) and may represent the northward extension of the zone at occurrence MC3, located at the southern margin of the Paleozoic outlier.

The talcose rocks are generally pale green talc-serpentine-carbonate schists containing 20 to 30% talc. A small pit on the south side of the hydro line road at the Madoc-Elzevir township line contains highly oxidized, friable rock composed of about 50% talc, 40% carbonate, and 10% magnetite

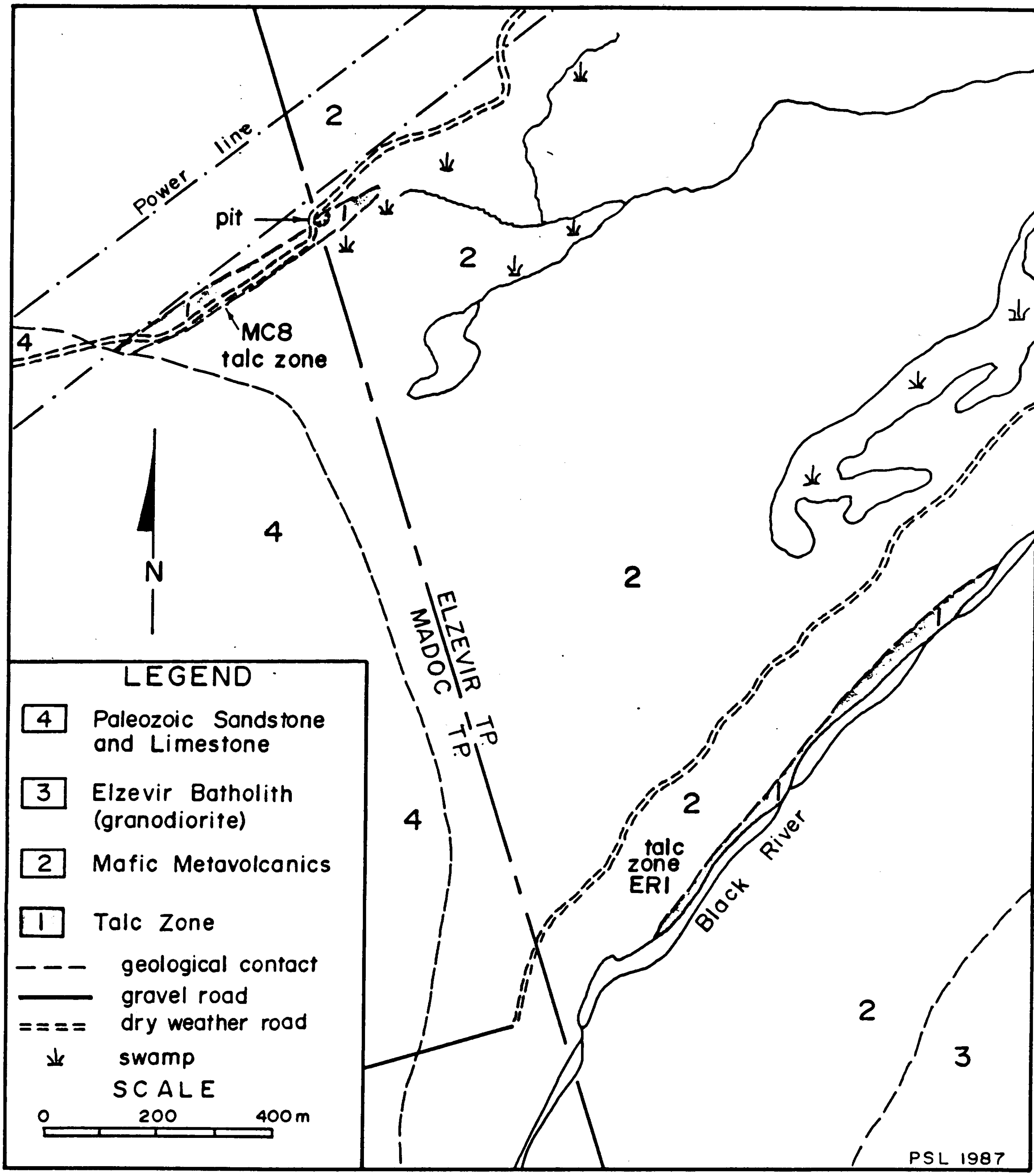


FIGURE 45: GEOLOGICAL SKETCH MAP OF TALC OCCURRENCE ON CON. XI, LOT 28, MADOC TP. (MC8); also showing occurrence ER1, Elzevir Tp.

and hematite. The rock has a red colour due to pervasive hematite staining of the carbonate grains.

The zone strikes eastward into a swamp. This occurrence has good potential for a large tonnage of moderate grade.

Reference Map: Ontario Geological Survey Map 2154, Madoc Township and Part of Huntingdon Township, by D.F. Hewitt, 1968.

Reference: LeBaron et al (1987)

MO1: Mayo Township, Concession X, Baker and Wanamaker Lot

Rock Association: Carbonate

Access: This eastern part of Mayo township is readily accessible by road. The exact location of the occurrence is not known.

Description: Wilson (1926) reported:

"Specimens of fine, compact white to pale grey talc were shown the writer by Mr. Donald Henderson, of Madoc, which he had obtained on the Baker and Wanamaker lot near Hartsmere, Concession X (A on some maps), Mayo Township. The talc occurs in a zone up to 18 inches (45 cm) wide on the margin of a diorite dyke and can be seen at intervals for 200 feet (60 m)."

ODM Map 1955-8 shows a belt of marble trending eastward through the Wanamaker Lake-Hartsmere area, bounded by paragneiss to the south and granite to the north.

Reference Map: Ontario Geological Survey Map 1955-8, Dungannon and Mayo Townships

References: Spence (1940, p. 77)

Storey and Vos (1981, p. 192)

Wilson (1926, p. 78)

Tudor Township

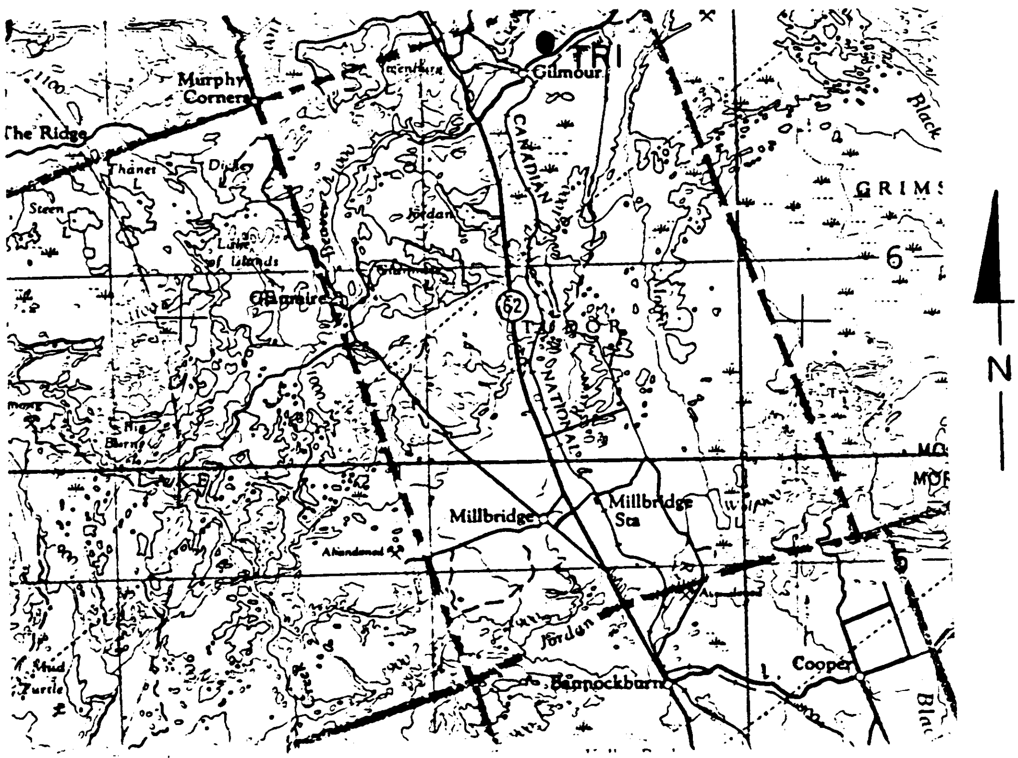


Figure 46: Location Map of the Tudor Township Talc Occurrence. (Scale 1:250,000)

TR1: Tudor Township, Concession XVIII, Lots 8, 9, 10

Rock Association: Carbonate

Access: This occurrence lies a short distance north of the road that leads east from Gilmour to Wadsworth Lake.

Description: Talc in this area is contained in marble, in an area of marble, clastic sedimentary rocks and volcanic rocks south of a trondjemite pluton (Figure 47).

This talc was noted by Allen (1976) who reported:

"Coarse-grained talc is very common in calcite marble south of the Wadsworth trondhjemite, in the area between the skarn and the amphibole-calcite isograd."

Reference Map: Ontario Geological Survey Map 2168, Tudor Township by Lumbers, 1969.

Reference: Allen (1976, p.101, 119)

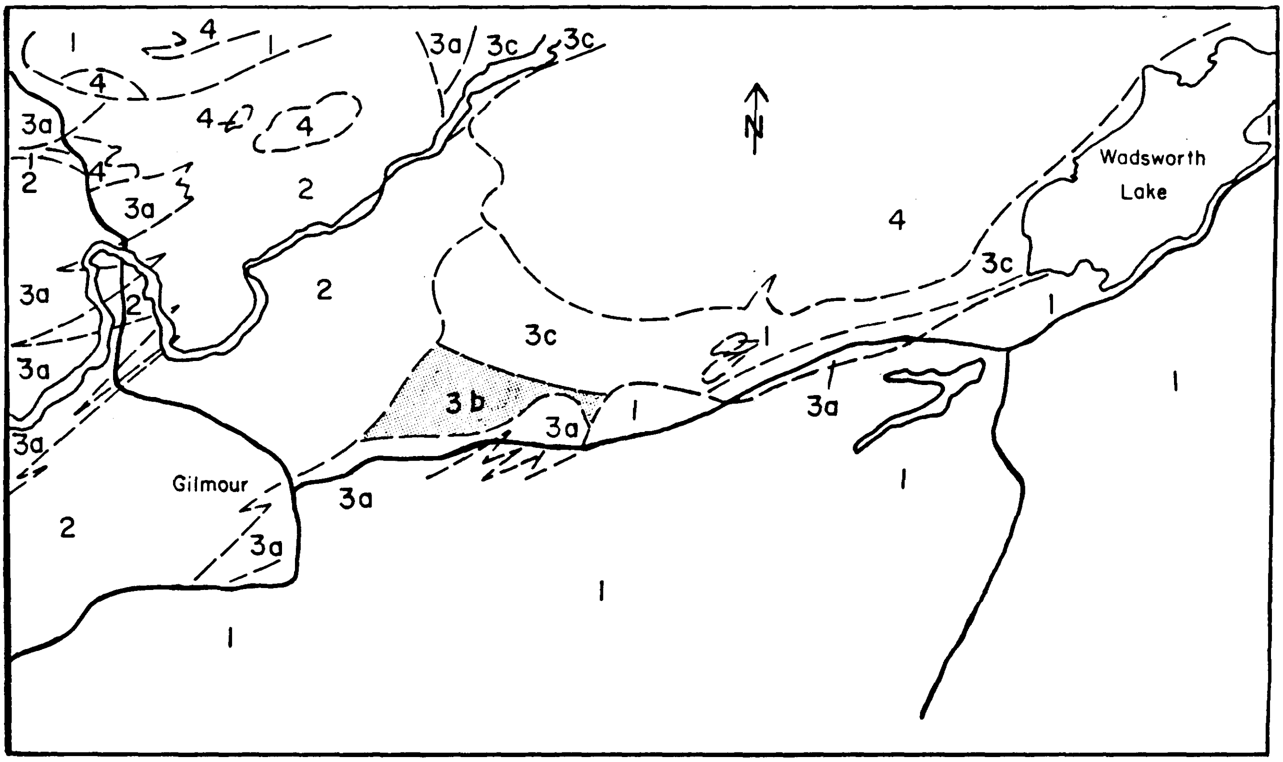


FIGURE 47: GEOLOGICAL MAP OF TALC OCCURRENCE ON CON. XVIII, LOTS 8,9,10, TUDOR TOWNSHIP (TR 1)

LEGEND

4	INTRUSIVE ROCK
3c	SKARN
3b	TALC - BEARING MARBLE
3a	MARBLE
2	CLASTIC SEDIMENTS
1	VOLCANIC ROCK
–––	INTERPRETED GEOLOGICAL CONTACT
——	ALL-WEATHER ROAD

GEOLOGY AFTER ALLEN(1976) and LUMBERS(1969)

SCALE

0 500 1000 1500 2000 2500 m

Wollaston Township

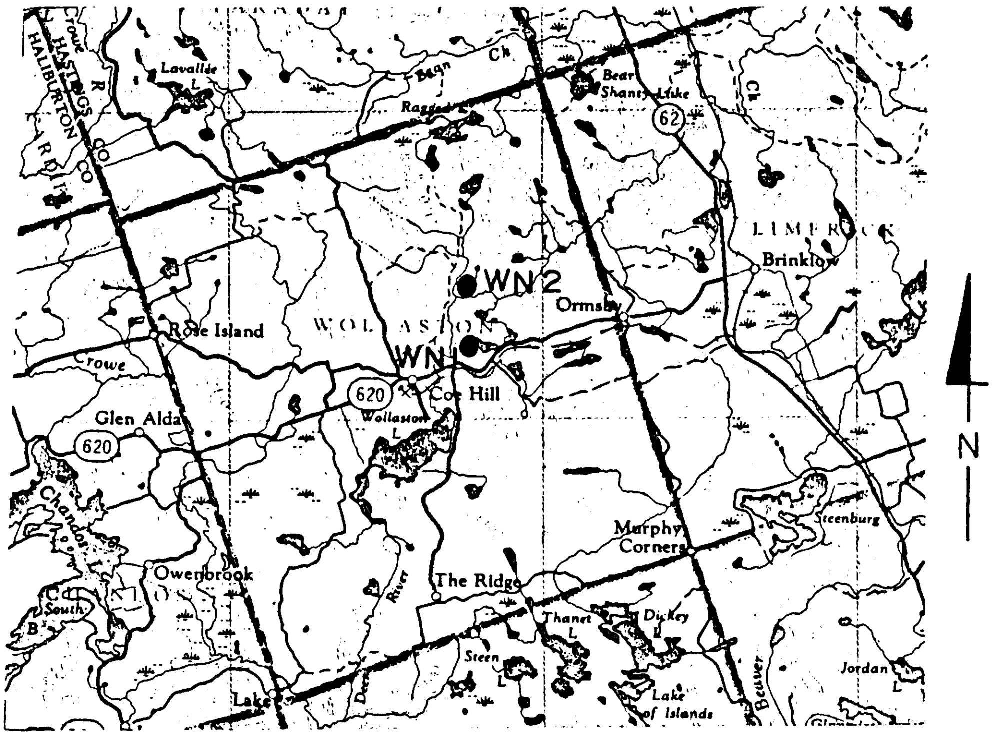


Figure 48: Location Map of the Wollaston Township Talc Occurrences.
(Scale 1:250,000)

WN1: Wollaston Township, Concession IX, Lot 9

Rock Association: Carbonate

Access: The area in which this talc deposit occurs is readily accessible by Hwy 620 to Coe Hill.

Description: Spence (1940) listed this locality as a talc occurrence hosted by dolomitic marble.

Mapping by Hewitt (1959) indicated that the area is underlain by marble and para-amphibolite, but did not indicate any talc.

Reference Map: Ontario Geological Survey Map 2020, Wollaston Township, by D.F. Hewitt, 1959.

Reference: Spence (1940, p. 80)

WN2: Wollaston Township, Concessions X, XI, Lots 8, 9

Rock Association: Carbonate

Access: A field southwest of the occurrence is accessible by road. From this field a snowmobile trail crosses the Deer River and leads to the prospect pits.

Description: Thomson (1943) reported:

> "A showing of rather hard, white talc-bearing rock on or near lot 10, concession X, Wollaston Township, has been investigated for its talc content. Two test pits, 1100 feet (335 m) apart have been sunk on the zone of white rock, which is exposed at intervals along the side of a narrow valley bounded by outcrops of crystalline dolomite. This zone strikes N 20 degrees E and dips to the west. On the footwall side of the zone there are small areas of syenitic intrusives. In the south pit the white rock is 10 feet (3 m) in width.
>
> The white rock contains some talc, but the greater part is composed of fairly hard minerals. Microscopic examination shows that it is very fine-grained and made up largely of tremolite or anthophyllite with a few grains of carbonate."

A field examination (Figure 49) showed the north pit to contain the most talc. In this pit a white talc rock is interlayered with dolomite. Thin section examination of the talc rock showed it to be composed of 75 percent talc, with serpentine, dolomite and feldspar. The grade across the zone is much less than 75 percent talc due to dilution by layers of dolomite.

The south pit contains tremolitic dolomite. The

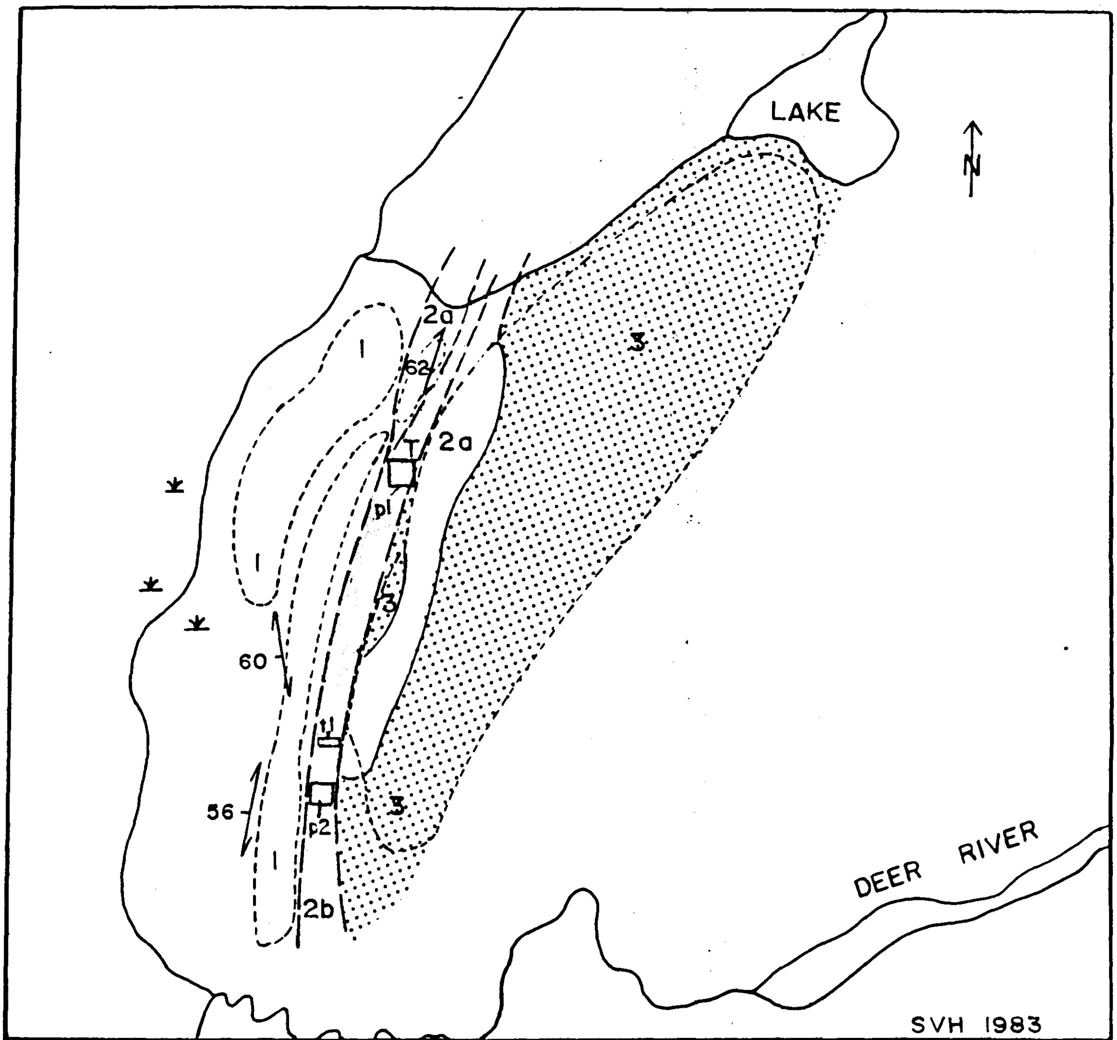


FIGURE 49: GEOLOGICAL MAP OF TALC OCCURRENCE CON. X,XI , LOTS 8,9 , WOLLASTON TOWNSHIP (WN 2)

LEGEND

- 3 SYENITE
- 2b TREMOLITIC DOLOMITE
- 2a DOLOMITE
- 1 AMPHIBOLITE
- T TALC
- PIT
- TRENCH
- 56 STRIKE AND DIP OF FOLIATION

SCALE

0 100 200 300 400 500 m

talc and tremolite occur in a sheared zone that is topographically expressed as a north-trending, steep-sided valley.

History: Thomson (1943) stated:

"It is reported that five holes, aggregating about 600 feet (180 m) of core, were drilled across the zone (during the 1930's) under the supervision of Roy Taylor of Madoc."

Reference Map: Ontario Geological Survey Map 2020, Wollaston Township.

References: Hewitt (1962, p. 54; 1972, p. 36, 37)

Thomson (1943, p. 72)

LANARK COUNTY

Dalhousie Township

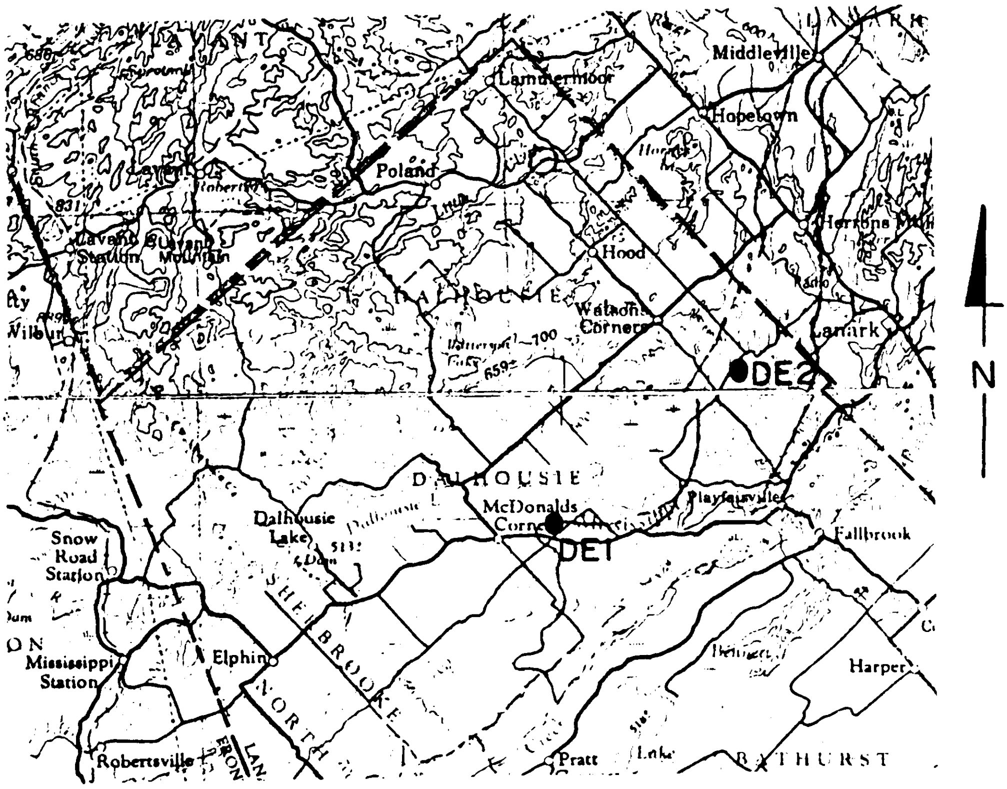


Figure 50: Location Map of the Dalhousie Township Talc Occurrences.
(Scale 1:250,000)

DE1: Dalhousie Township, Concession VIII, Lot 6

Rock Association: Carbonate

Access: The occurrence lies along Lanark County Road 12, about 1.8 km east of McDonald's Corners.

Description: Immediately north of a crossroad, in the southeast corner of this lot, a marble outcrop ridge trends northeast (Figure 51).

Along the southeast edge of this ridge a northeast-striking, steeply-dipping zone contains flakes of talc comprising three percent of the rock. Overburden on the southeast edge of this exposure may possibly mask higher grade (and therefore softer) talc rock. The exposed width of talcose rock is about 2m and if the zone continues across strike to the southeast, it could have a thickness of up to 6m.

A thin section of the talc rock showed it to be composed of 87 percent dolomite and calcite, 10 percent tremolite and three percent talc, with small amounts of serpentine and hematite. Marble exposed to the southeast of the talc zone contains phlogopite layers and tremolite.

Reference Map: Ontario Geological Survey Map 1956-4, Clarendon-Dalhousie-Darling area.

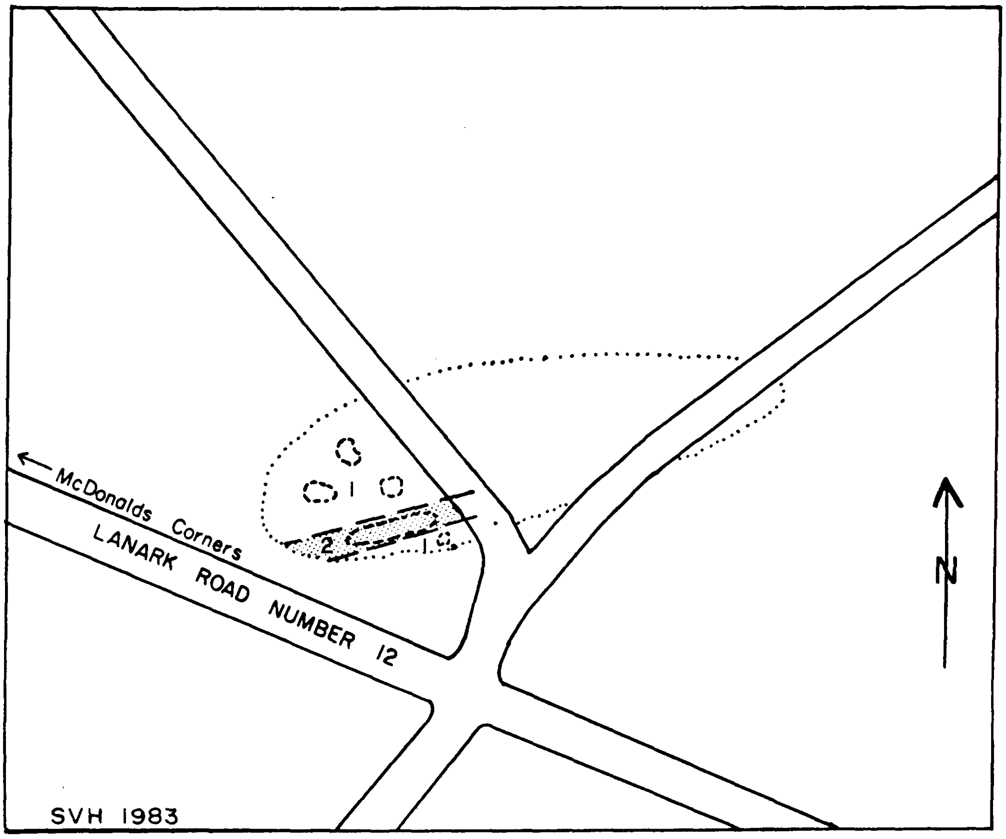
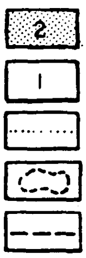


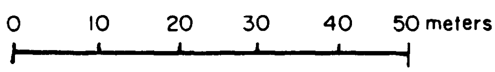
FIGURE 51: SKETCH MAP OF TALC OCCURRENCE ON CON VIII, LOT 6, DALHOUSIE TP.(DE.1)

LEGEND



TALC-BEARING MARBLE
TREMOLITIC MARBLE
OUTLINE OF OUTCROP RIDGE
OUTLINE OF OUTCROP AREA
GEOLOGIC CONTACT

SCALE



DE2: Dalhousie Township, Concession II, Lots 5, 6

Rock Association: Carbonate

Access: The talc at this locality is exposed in roadside outcrops along Lanark County Road 12.

Description: Smith (1958) indicated talc might occur in the northeast-trending, 800 m wide belt of tremolitic marble that hosts this occurrence.

Storey and Vos (1981) identified small amounts of talc in the centres of tremolite layers, in samples from this area. They stated:

"The units trend about 045 degrees and dip 15 degrees to 40 degrees south. The tremolite makes up 10 to 20 percent of the rock, the rest being medium to fine-grained white dolomite and magnesian marble."

A field inspection located talc at three localities (Figure 52). Talc interlayered with tremolite was found in large, loose, locally-derived blocks of dolomitic marble at FH4. A large outcrop on the south side of the road at FH6 contains two talc-tremolite-carbonate layers about 50 cm thick that grade 10 percent talc. At FH5, thin talc-tremolite layers in an outcrop grade 20 percent talc.

Reference Map: Geological Survey of Canada Map 1362 A, Carleton Place.

Ontario Geological Survey Map 1956-4, Clarendon-

Dalhousie-Darling area.

References: Smith (1958, p. 38)

Storey and Vos (1981, p. 192, 193)

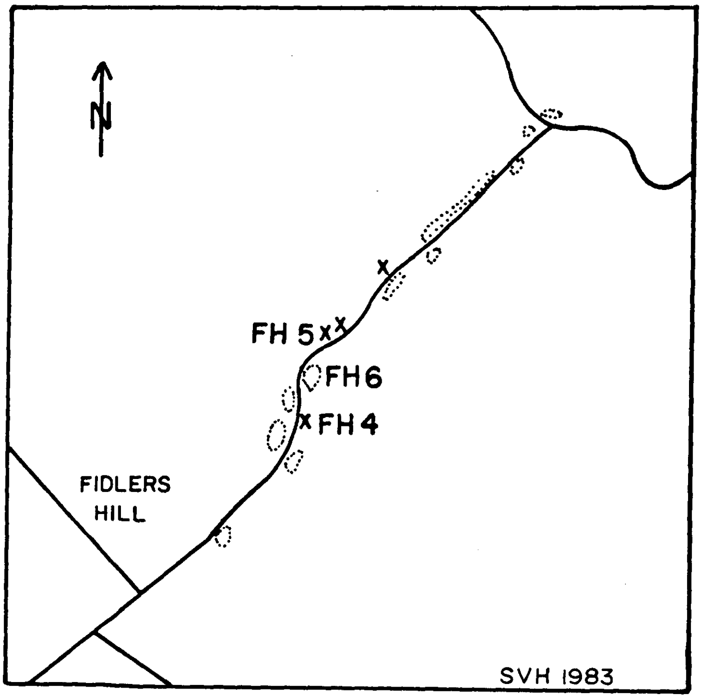


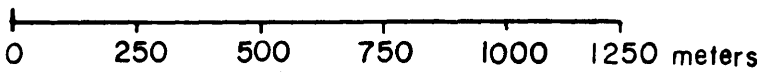
FIGURE 52: TALC OCCURRENCES ON CON. II, LOT 5,6, DALHOUSIE TOWNSHIP (DE 2)

LEGEND

x OUTCROPS

TALC OCCURS AT FH 4, FH 5, FH 6

SCALE



Lanark Township

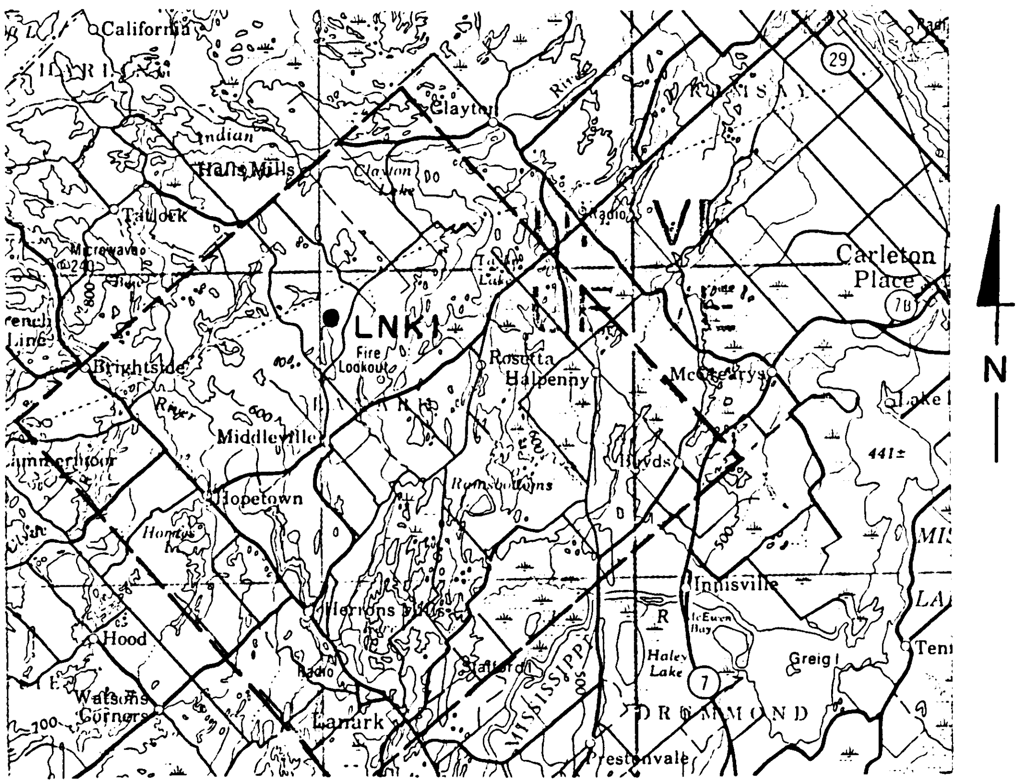


Figure 53: Location of the Lanark Township Talc Occurrence

(Scale 1:250,000)

LNK1: Lanark Township, Concession VIII, Lot 20

Rock Association: Carbonate

Access: The occurrence, located about 14 km north of the village of Lanark, can be reached by following a paved road north from Middleville on Lanark County Road 16 for a distance of about 4 km. From this point, a single lane road leads northwest about 500 m to the outcrop area.

Description: This previously undocumented occurrence was noted by W.T. Grant (drill core library geologist, Ministry of Northern Development and Mines, Bancroft, personal communication, 1988) during a study of marble samples collected for a previous report on the chemistry of Grenville carbonate rocks. Sample number 1551 in Papertzian and Kingston (1982) is an altered carbonate rock consisting of about 50% calcite, 40% tremolite, 10% talc, and traces of very fine graphite. The talc is platy, medium-grained, and closely associated with tremolite (probably a product of retrograde metamorphism of tremolite).

The mineralogy of sample 1551 indicates a favourable environment for the formation of talc in this part of Lanark township.

Reference Map: Geological Survey of Canada Map 1362A, Carleton Place; Reinhardt and Liberty, 1973.

References: Papertzian and Kingston (1982)

Lavant Township

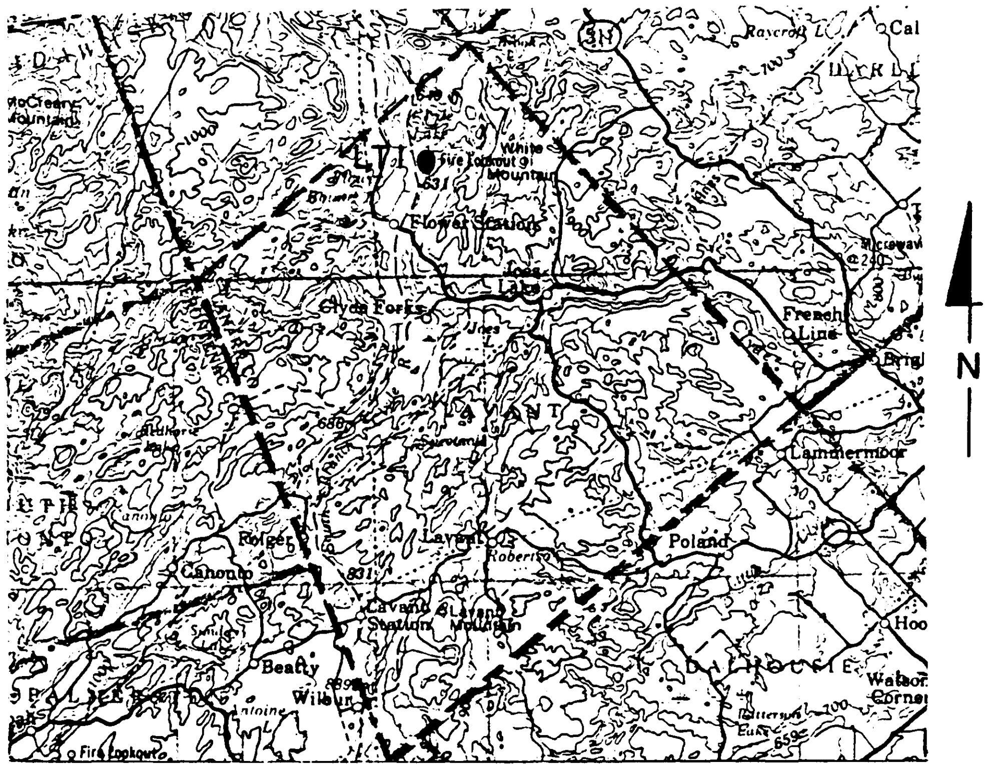


Figure 54: Location Map of the Lavant Township Talc Occurrence.
(Scale 1:250,000)

LT1: Lavant Township, Concession III, Lot 24 East Half

Rock Association: Carbonate

Access: The area of this occurrence is easily reached on foot from the driveable road that runs north-south on the old railway bed east of Flower Lake.

Description: Spence (1940) reported:

> "The deposit consists of a low, denuded hogsback, about 50 feet (15 m) wide and extending 300 feet (90 m) in a northeast direction. Several small prospect pits have been opened at the base on the west side. The apparent dip is 20 degrees east.
>
> The material of the ridge, as exposed on the surface and in the pits is a fine-grained, white, siliceous, serpentinized dolomite representing a band of altered high-magnesia limestone in the Precambrian gneiss-limestone complex. The silica is prominent on weathered surfaces as small nodules or stringers of quartz, that form possibly five percent of the mass. The rock effervesces freely with acid, showing that considerable calcite is present. The magnesium silicate present would appear to be more of the nature of serpentine than talc, as very little talc can be detected under the microscope, and there is not sufficient present to impart more than a slight slip to the powder, which is distinctly gritty."

The outcrop referred to by Spence (1940) is "one-fourth mile" (400 m) from the old railway bed. An outcrop similar to that described by Spence was found about 650 m from the old railway track but no prospect pits were apparent. This outcrop is comprised mainly of well-layered, fine-grained white dolomite that contains quartz nodules. The west side of this outcrop contains soft, green, serpentinized dolomite that contains stringers and patches of talc constituting possibly two percent of the rock.

History: Test pits were put down prior to 1922 (Spence 1940) and diamond drilling was carried out by T.B. Caldwell of Perth (Storey and Vos 1981).

Reference Map: Ontario Geological Survey Map 1956-4, Clarendon-Dalhousie-Darling area.

References: Hewitt (1972, p. 45-47)
Satterly (1944, p. 192-193)
Spence (1940, p. 78)
Storey and Vos (1981, p. 194, 195)
Wilson (1926, p. 94)

Pakenham Township

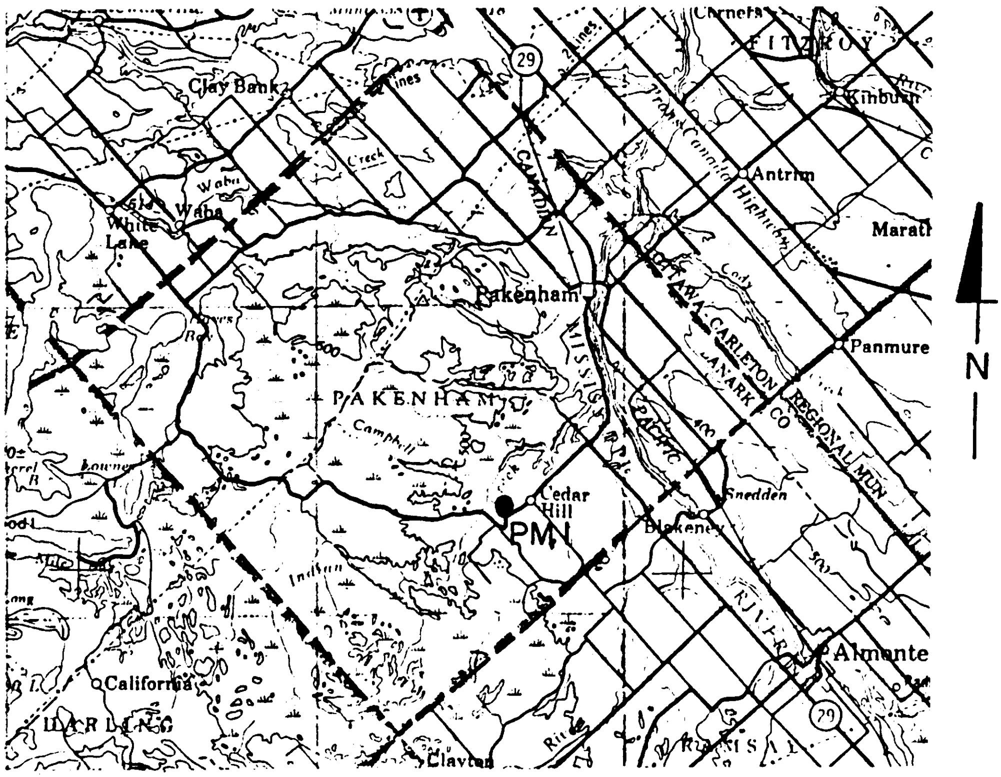


Figure 55: Location Map of the Pakenham Township Talc Occurrence. (Scale 1:250,000)

PM1: Pakenham Township, Concession VI, Lot 6

Rock Association: Ultramafic

Access: The prospect lies at the end of a dirt road on the farm in this lot.

Description: Spence (1940) reported:

"The talc on this lot consists entirely of a soft, yellowish to pale brown rensselaerite-steatite, derived from narrow, dyke-like bodies of pyroxenite enclosed in white, crystalline dolomite. The original pyroxene form of the pyroxene crystals has been preserved. The dolomite in contact with the pyroxenite and quartz bodies has been partly serpentinized. None of the exposures indicate any large body of clean steatite, and most of the broken rock consists of a mixture of this material with dolomite, serpentine and quartz. It grinds to a fairly white powder which, however, lacks slip on account of the impurities present, but might yield an inferior grade of talc for roofing or rubber purposes."

A field inspection indicated there may be a large body of talc rock at this locality (Figure 56). The talc rock has been exposed in trenches over a width of 20 m, but may continue under overburden to a width of 100 m.

The talc forms a thick layer within quartzite. The occurrence lies within an area that was mapped by Hill (1974) as marble, and some blocks of marble were found at the south pit.

The talc rock was examined in thin section and found to be composed of 80 percent talc that has replaced pyroxene crystals 6 to 10 mm in diameter, and 10 percent carbonate. The high grade and

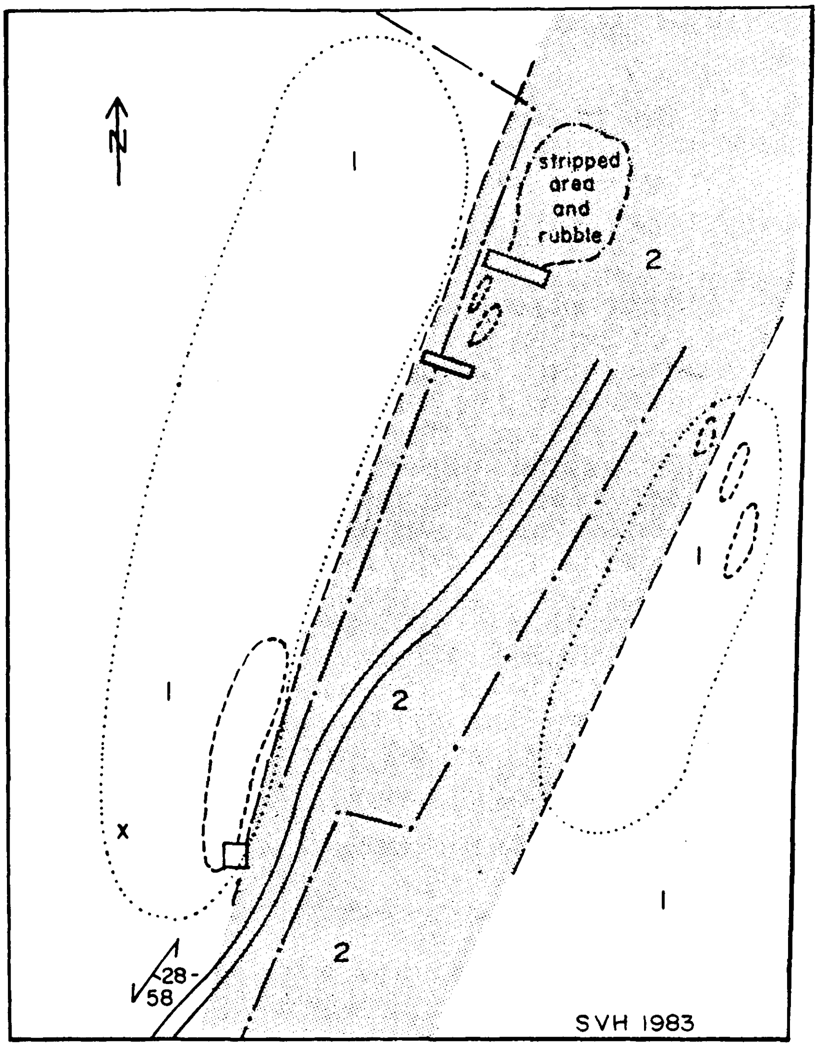


FIGURE 56: GEOLOGICAL SKETCH MAP OF TALC DEPOSIT ON CON. VI, LOT 6, PAKENHAM TOWNSHIP (PM I)

LEGEND

- 2 ALTERED PYROXENITE TALC ROCK
- 1 QUARTZITE
- INTERPRETED GEOLOGICAL CONTACT
- AREA OF HIGH GROUND
- OUTCROP
- PIT
- TRENCH
- FENCE

SCALE

0 25 50 75 100 200m

potentially large volume of this talc zone make it a good candidate for more detailed evaluation as a source of talc.

The material of this occurrence also appears to be a good carving stone.

History: Spence (1940) reported:

"In 1937 some prospecting was done on this lot by J. Bell of Almonte, who opened several small surface pits...The original intention was to develop the deposit as a source of stone for the production of cut and turned small ornamental articles."

Reference Map: Geological Survey of Canada Map 1363 A, Arnprior, 1974, by P.A. Hill

References: Hewitt (1972, p. 47, 48)

Satterly (1944, p. 194, 195)

Spence (1940, p. 79)

Storey and Vos (1981, p. 195, 196)

LEEDS COUNTY

Rear of Leeds and Lansdowne Township

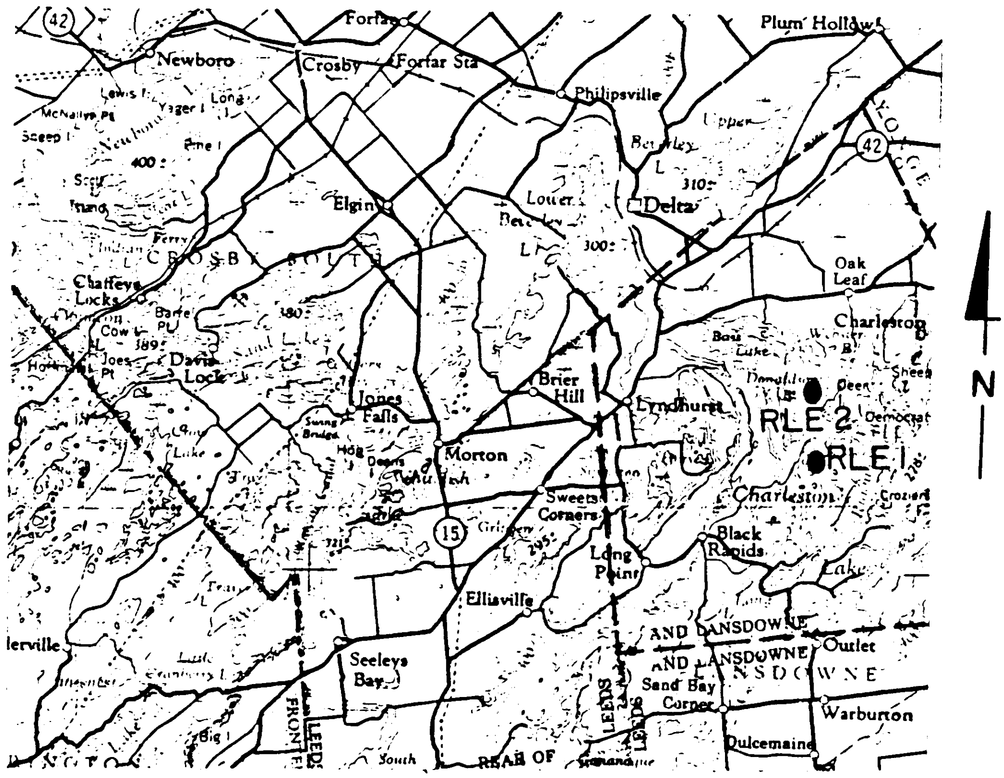


Figure 57: Location Map of the Rear of Lansdowne Township Talc Occurrences.

(Scale 1:250,000)

RLE1: Rear of Leeds and Lansdowne Township, Concession IX, Lots A15, A16

Rock Assciation: Carbonate

Access: This occurrence is located at the south end of Tallow Rock Bay of Charleston Lake, and can be reached by boat.

Description: Wynne-Edwards (1967) identified this occurrence, and reported:

"Talc occurs with serpentine near Tallow Rock Bay, Charleston Lake...Talc-tremolite assemblages are common in the quartzite-limestone transition members around Charleston and Red Horse Lakes. The talc occurs as aggregates of tiny flakes showing high birefringence and is seen to be similar to muscovite under the microscope. The arregates are pseudomorphous after some pre-existing mineral, which is probably diopside, as some pseudomorphs retain as a distinct rectangular cleavage."

Reference Map: Geological Survey of Canada Map 1182 A, Westport

Reference: Wynne-Edwards (1967, p. 11)

RLE2: Rear of Leeds and Lansdowne Township, Concession X, Lots A15, A16

Rock Association: Carbonate

Access: The occurrence is located west of Deer Island, Charleston Lake and is accessible by boat. Wynne-Edwards (1967) reported that talc occurs with phlogopite in this mica prospect.

Description: Geological Survey of Canada Map 1182 A showed the area to be underlain by interlayered quartzite and marble or calc-silicate rock, and by paragneiss.

Reference Map: Geological Survey of Canada Map 1182 A, Westport

Reference: Wynne-Edwards (1967, p. 11)

South Burgess Township

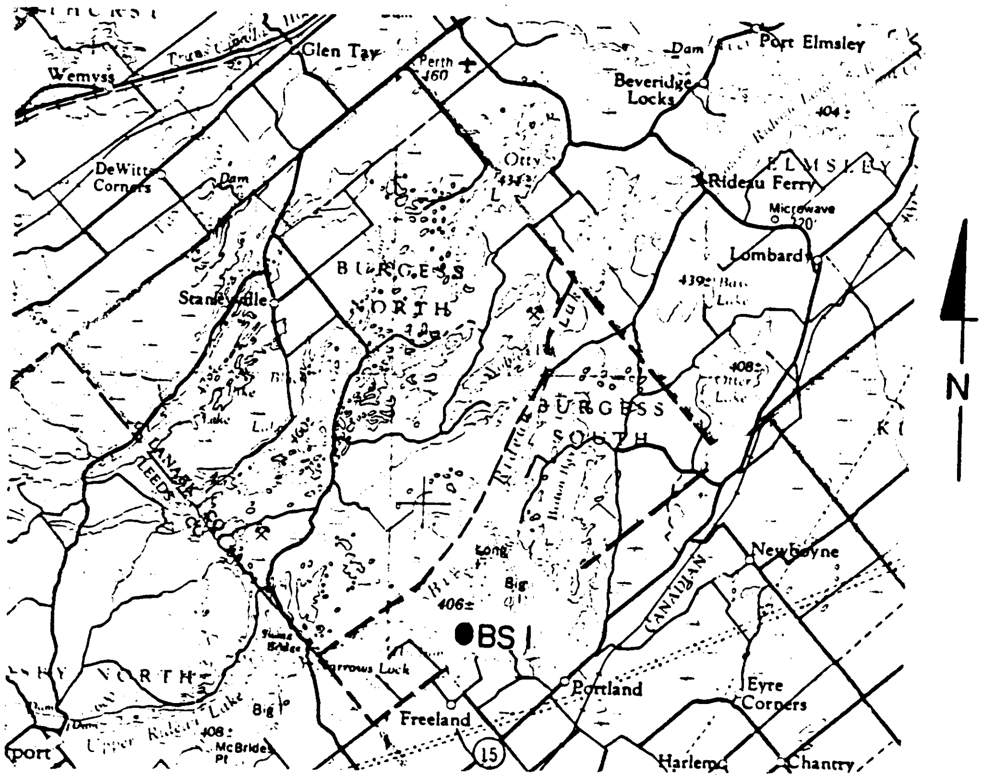


Figure 58: Location Map of the South Burgess Township Talc Occurrence.

(Scale 1:250,000)

BS1: South Burgess Township, Concession I

Rock Association: Carbonate

Access: This deposit is located on Grindstone Island in Big Rideau Lake, and is accessible by boat.

Description: Spence (1922) reported the following:

"The material of the deposit is a soft, brown to grey-green, altered pyroxenite. The rock is, variously, medium to coarse-grained, and varies somewhat widely in the degree of alteration it has under-gone. In some parts of the quarry, fairly fresh, unaltered pyroxenite predominates. Pink calcite occurs locally in considerable amount. The rock has all the appearance of a typical mica-bearing pyroxenite that has undergone pronounced, local metamorphism by solutions from a later pegmatite intrusion, with complete or partial alteration of the pyroxene to rensselaerite or pyrallolite. No pegmatite was observed in the pit.

A sample of the stone from the stock pile near the old loading wharf, ground to pass 100 mesh, yielded a dirty, grey-white powder having little or no slip."

Wilson (1926) stated that the material at this locality "consists almost entirely of a fine, massive green serpentine."

Geological survey of Canada Map 1182 A does not indicate the presence of talc, but shows a graphite deposit in carbonate metasediments on Grindstone Island.

History: Spence (1922) stated:

"Between the years 1893 and 1899 a quantity of rock was quarried on this island and shipped by scow to Montreal, via the Rideau Canal, to be used in the manufacture of roofing. The operators were the Sparham Roofing Company, of Montreal."

"...The workings consist of a single, almost circular, pit, opened in the east face of the low buff fronting the lake. This pit measures 75 feet (23 m) across, and has been carried down to lake level, with a depth of about 25 feet (8 m)."

Reference Map: Geological Survey of Canada Map 1182 A, Westport.

References: Spence (1922, p. 33, 34; 1940, p. 80)

Wilson (1926, p. 95)

South Crosby Township

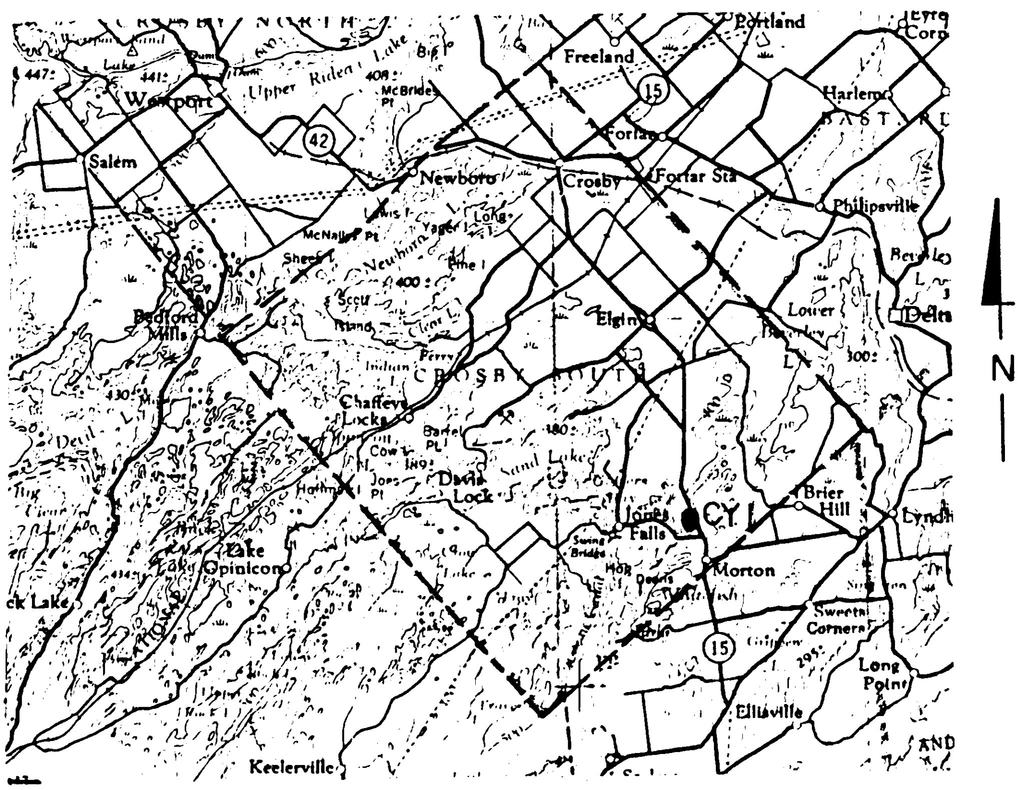


Figure 59: Location Map of the South Crosby Township Talc Occurrence.

(Scale 1:250,000)

CY1: South Crosby Township, Concession IV, Lots 5 and 6

Rock Association: Carbonate

Access: This occurrence is exposed in a road cut on highway 15 at the top of the hill 1.6 km north of Morton.

Description: Wynne-Edwards (1967) reported:

"A thin dolomitic limestone member is interbedded with dark cordierite gneisses. There, a rather hard, green, massive talc occurs as patches in white limestone veined with serpentine. These break into fragments with parallel sides, presumably a relic [sic] of pyroxene cleavage."

Reference Map: Geological Survey of Canada Map 1182 A, Westport

Reference: Wynne-Edwards (1967, p. 11)

LENNOX AND ADDINGTON COUNTY

Ashby Township

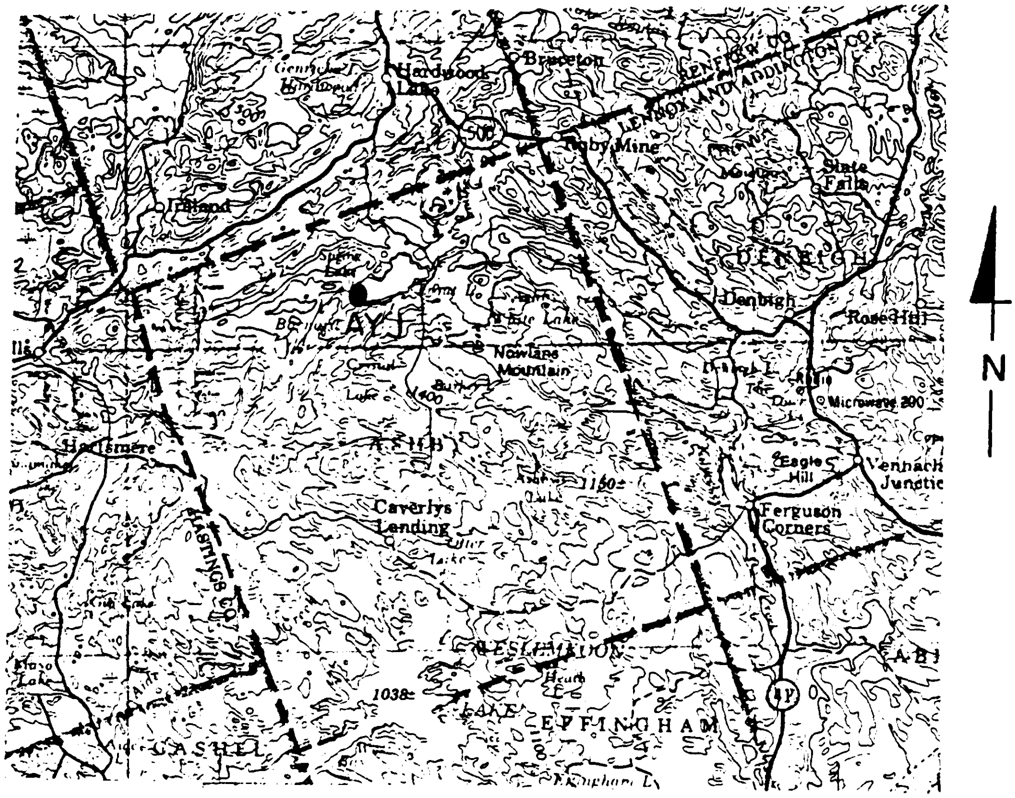


Figure 60: Location Map of the Ashby Township Talc Occurrence.

(Scale 1:250,000)

AY1: Ashby Township, Former Concession XIV, Lot 17

(subdivision annulled)

Rock Association: Carbonate

Access: The occurrence is located on a rocky peninsula at the west end of Len Lake, and can be reached by boat.

Description: This occurrence was noted by Evans (1964), who reported:

"A small pit about eight feet (2.5 m) across and four to six feet (1.2 to 1.8 m) deep has been blasted into a banded and silicated marble. The silicate minerals include colourless to pale-green asbestiform tremolite, talc and quartz. The banding is due to the alternation of layers rich in tremolite, talc and quartz or carbonate, with layers containing a mixture of these minerals. This banding strikes N 67 degrees E and dips at about 83 degrees N. Crossing the banding at right angles are veins of asbestiform tremolite. These are generally 1/4 inch to one inch (0.5 to 2.5 cm) thick; the widest vein is six inches (15 cm) across. They do not offset the banding, and there is no evidence that they have formed along shears. These cross-cutting veins usually end where they meet the tremolite-rich bands of the host rock, and the result is a poorly-developed rectangular network of tremolite seams. The longest tremolite fibres found are 1 1/4 inches (3 cm) in length.

The talc-rich bands in the host rock are up to seven inches (18 cm) thick; some are almost pure white talc.

An older and shallower pit about 20 feet (6 m) long and two to four feet (0.6 to 1.2 m) deep, is also present.

Reference Map: Ontario Geological Survey Map 2031, Ashby Township

Reference: Evans (1964, p. 31, 32)

Kaladar Township

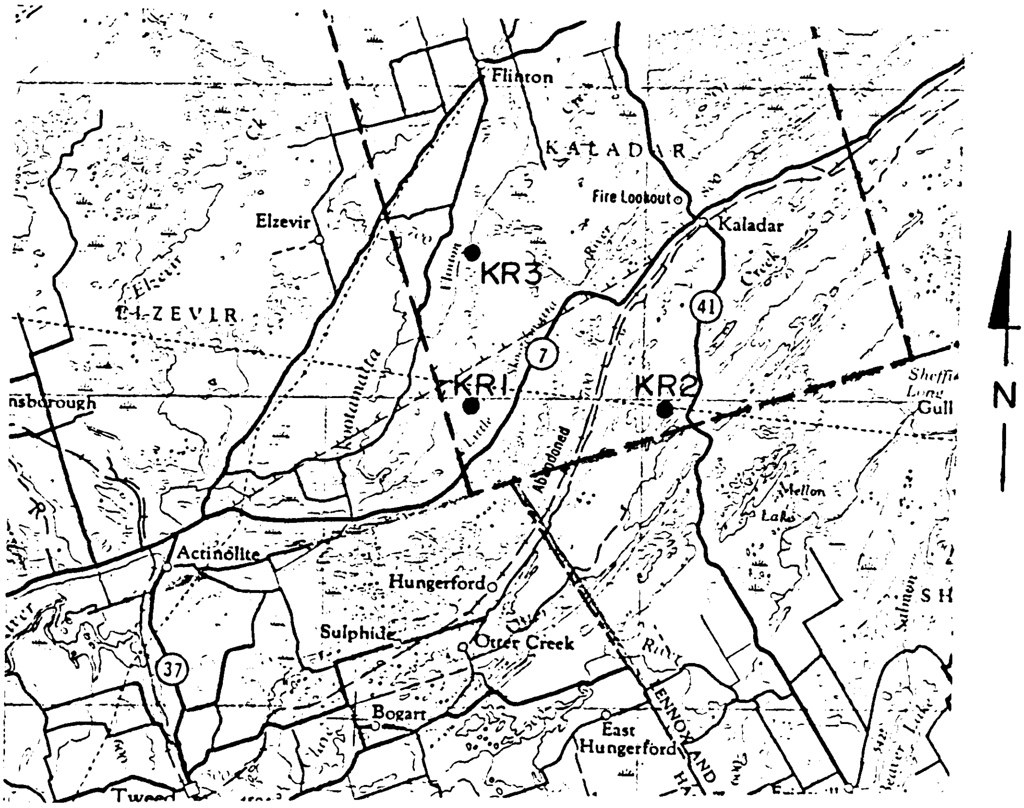


Figure 61: Location Map of the Kaladar Township Talc Occurrences.

(Scale 1:250,000)

KR1: Kaladar Township, Concession I, Lot 5

Rock Association: Carbonate

Access: The occurrence lies between highway 7 and the Flinton road, and can be reached on foot from either road.

Description: This occurrence was noted by Spence (1922) as one that did not appear to be of economic importance.

Ontario Geological Survey Map 51 d shows the area of this occurrence to be underlain by grey granite. However, Spence (1922) reported that the occurrence is dolomite-hosted.

Reference Map: Ontario Geological Survey Map 51d, Grimsthorpe-Kennebec Area

References: Spence (1922, p. 38; 1940. p. 80)

KR2: Kaladar Township, Concession V, Lot 2

Rock Association: Carbonate

Access: The general area of this occurrence may be reached by walking along the power line that crosses highway 41 about 5.5 km south of Kaladar.

Description: Wilson (1926) reported:

"Several prospect pits for talc have been opened up in this lot. In one of these zones, soapstone and talc schist from one inch (2.5 cm) to one foot (30 cm) wide, separated by dolomite containing radial aggregates of tremolite, were observed by H.D. Squires, who assisted the writer during the field season of 1924. The pit in which the talc was seen is situated near the west end of the lot and is 12 feet (3.7 m) wide, and 10 feet (3 m) deep. The total width of talc is two feet (60 cm). The strike of the talc zones and the dolomite is north 28 degrees east and dip 63 degrees southeast."

Reference Map: Ontario Geological Survey Map 51 d, Grimsthorpe-Kennebec Area.

References: Hewitt (1972, p. 49)

Wilson (1926, p. 94)

KR3: Kaladar Township, Concession II, lot 13

Rock Association: Ultramafic

Access: From the Upper Flinton Road (east of the Skootamatta River), about 6.5 km south of Flinton, a bush road leads east for 1 km to an abandoned quarry in talcose ultramafic rock on the east side of Flinton Creek.

Description: A 20 m wide band of altered ultramafic rock, striking northeast and dipping vertically, is bordered to the west by calc-silicate metasediments and to the east by siliceous metasediments and pegmatite (Figure 62).

The 20 m wide ultramafic band consists of two units of coarse-grained talc-anthophyllite-carbonate separated by a 3 m band of chlorite schist and siliceous metasediment. A thin section study of the altered ultramafic rock indicated a composition of 60% talc, 30% anthophyllite, and 10% dolomite (Verschuren et al, 1986, p.115). A more probable average talc content, however, is about 30%.

The occurrence is similar to those in Cashel township, showing retrograde metamorphism of coarse anthophyllite rosettes to talc. About 2.5 km to the north, along Flinton Creek, is another exposure of talc-anthophyllite-carbonate rock,

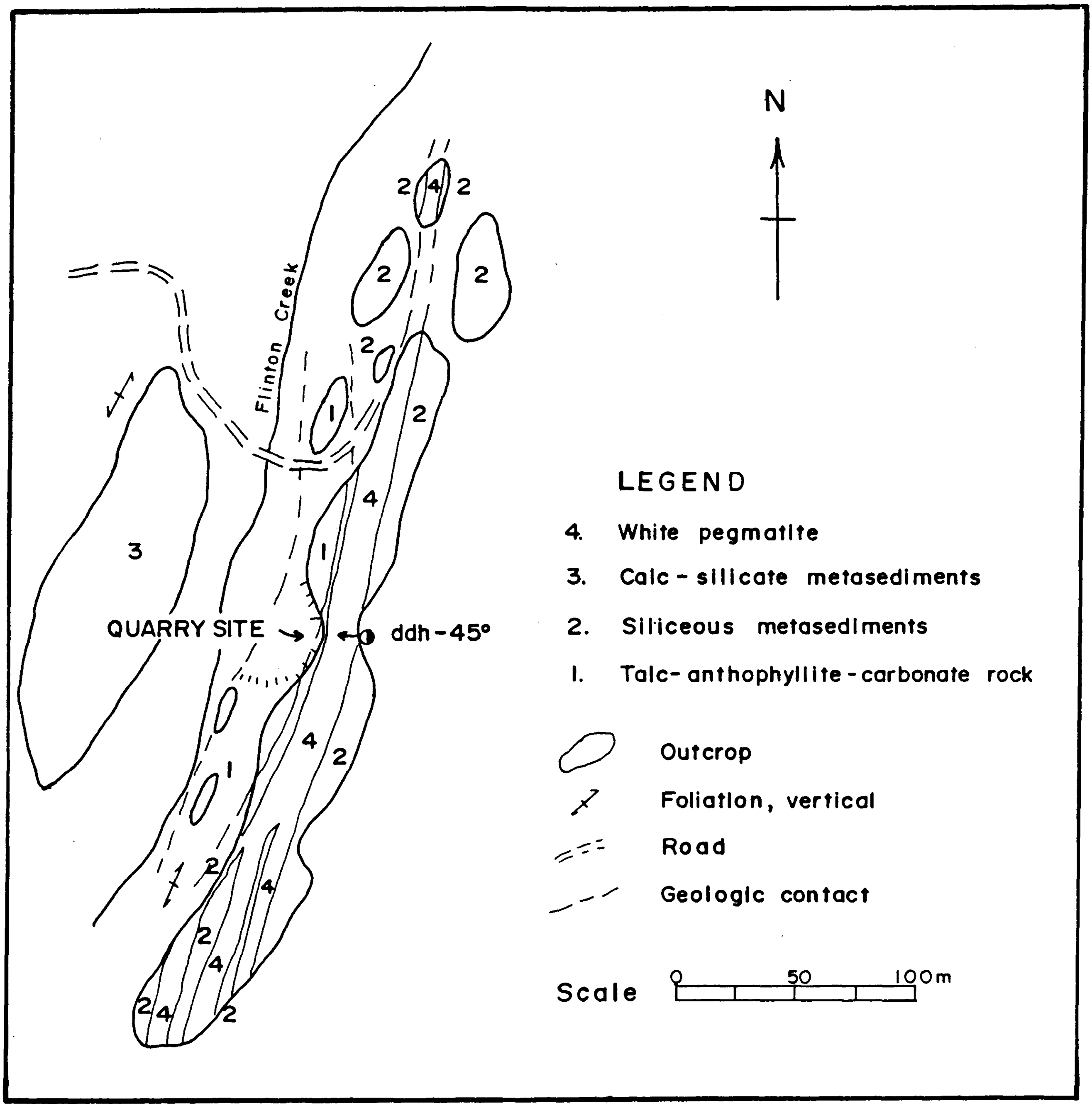


FIGURE 62 : GEOLOGICAL SKETCH MAP OF TALC-ANTHOPHYLLITE OCCURRENCE, CON II, LOT 13, KALADAR TWP. (KR3)
(after Verschuren et al 1986)

and 4 km to the south (on the hydro line, east of the Flinton Road) is a 300 meter-wide zone of ultramafic rock locally altered to anthophyllite-carbonate with minor talc (Fig. 12).

These occurrences indicate an extensive zone of altered ultramafic rock with potential for local concentrations of talc.

History: The quarry was operated in 1984 to produce a decorative facing stone for wood stoves. In 1981, the zone was tested by one diamond drill hole by the property owner, C.R. Young of Havelock.

Reference Map: Ontario Geological Survey Map 2432, Kaladar

References: Verschuren et al (1986, p.115-119)
LeBaron (1988, p.355-357)

PETERBOROUGH COUNTY

Belmont Township

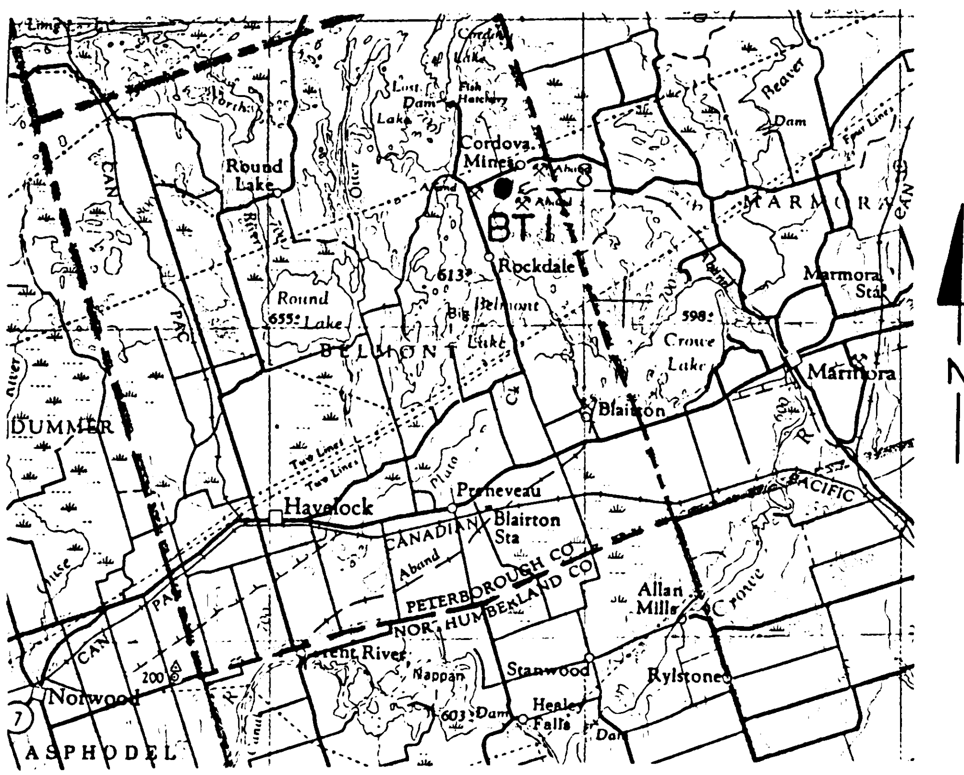


Figure 63: Location of the Belmont Township Talc Occurrence

(Scale 1:250,000)

BT1: Belmont Township, Concession I, lot 20

Rock Association: Carbonate

Access: The occurrence lies about 0.8 km southwest of the village of Cordova Mines. Access is by Peterborough County Road 48 to Cordova Mines; the occurrence is about 400 m south-southwest of the Cordova Mines baseball field.

Description: A low, wooded ridge trends northward along the concession line from the southwest corner of lot 20, con I.

Talcose rock is exposed in the east face of an overgrown trench at the top of the ridge (Figure 64). The rock is a talc-tremolite-carbonate schist striking about N60^{o}W and dipping 65^{o}NE. Talc content appears to be about 60% in the trench but an outcrop several meters south of the trench is estimated to contain 80% talc. The talc is pseudomorphic after bladed aggregates of tremolite.

DeKemp (1984) has identified a series of metamorphic zones within the thermal aureole of the Cordova Gabbro (Figure 5). The talc occurrence is situated near the transition from talc-quartz-calcite to tremolite-talc-calcite assemblages. The parent rock is a stromatolitic marble composed of alternating quartz and

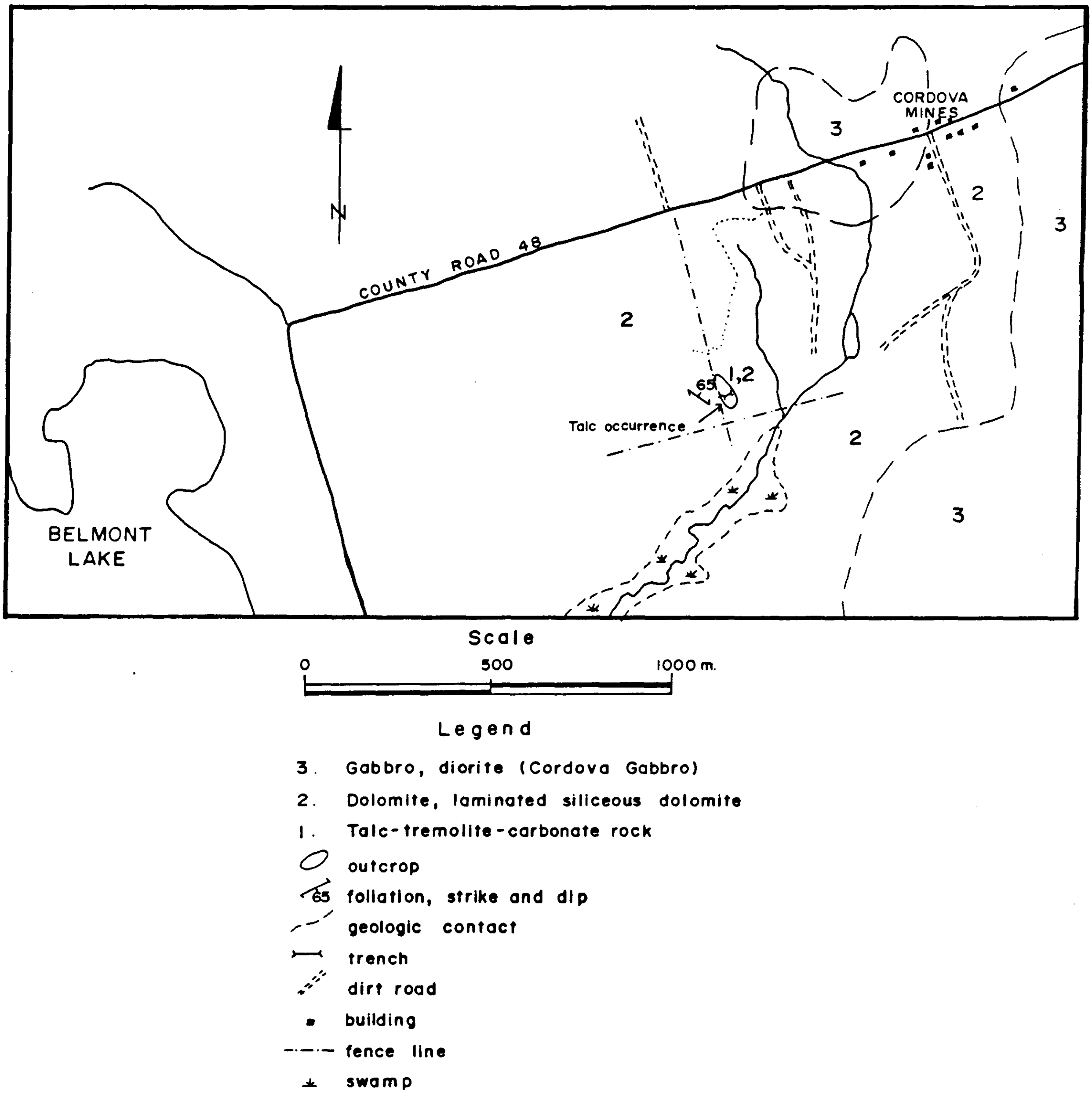


FIGURE 64 : GEOLOGICAL SKETCH MAP OF THE TALC OCCURRENCE ON CON I, LOT 20, BELMONT TWP. (BT1). (modified from de Kemp, 1984)

dolomite-rich laminae. These rocks can be seen on a hill 100 m west of the occurrence and relict laminated textures are present in some rocks close to the trench.

The host rocks and mineral assemblages are very similar to those at the Canada Talc Mine in Madoc township, suggesting that the carbonate rocks bordering the Cordova Gabbro have good potential for talc mineralization. The creek about 100 m east of the talc occurrence occupies a topographic low that should be considered as a potential talc exploration target. Other than the trench in the BT 1 talc zone, there is no evidence or record of previous exploration for talc in this area. This occurrence is also discussed in Part I of this report in the section on carbonate-hosted talc.

Reference Map: Ontario Geological Survey Map P.2488, Belmont and Southern Methuen Townships.

Reference: deKemp (1984)

RENFREW COUNTY

Blithfield Township

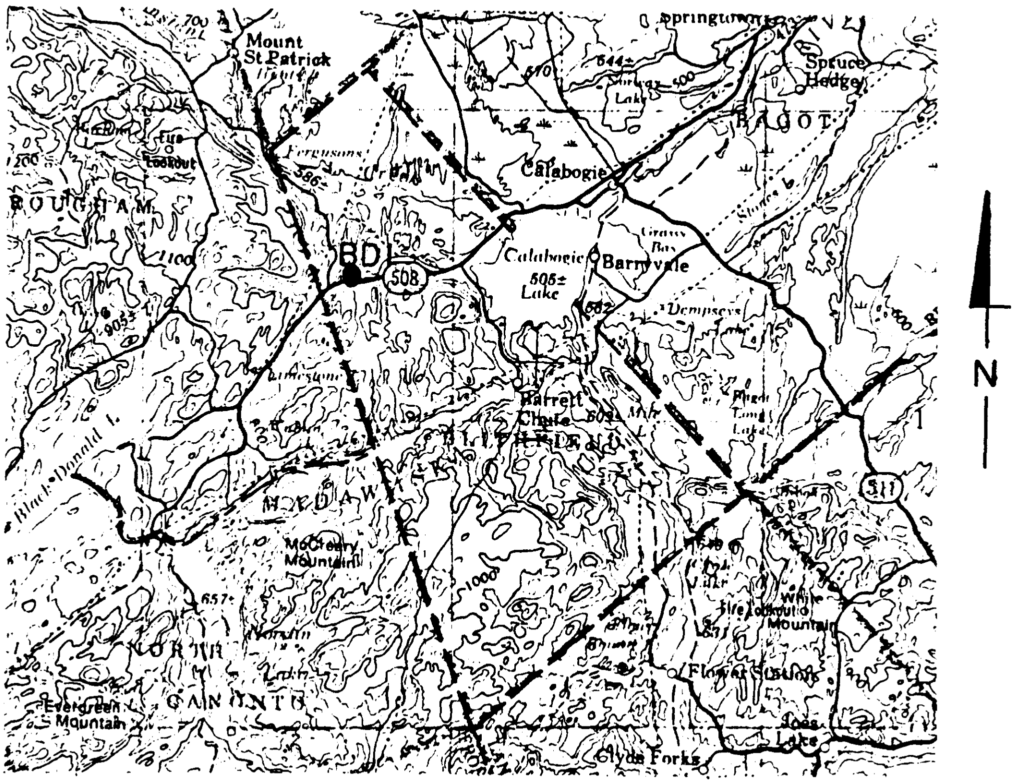


Figure 65: Location Map of the Blithfield Township Talc Occurrence.
(Scale 1:250,000)

BD1: Blithfield Township, Concession IV, Lot 22

Rock Association: Carbonate

Access: The occurrence is located 200 m northwest of the old Calabogie-Black Donald road and reportedly can be reached by a trail beginning in a gravel pit (Satterly, 1945).

Satterly (1945) described this talc-asbestos showing as follows:

"The workings are on the west side or top of a north-south ridge of coarse white crystalline limestone which strikes N 10 degrees W and dips 35 degrees E. They consist of an open cut, which is 25 feet (7.6 m) long, 10 feet (3 m) wide, and 12 feet (3.7 m) deep, and 130 feet (40 m) north of the open cut a trench, somewhat overgrown, 45 feet (13.7 m) long, four feet (1.2 m) wide, and four feet (1.2 m) deep, which curves from N 45 degrees to 65 degrees E.

The north wall of the open cut is a slip striking N 50 degrees E, and dipping 75 degrees SE. Striations on the wall pitch 25 degrees E. The face of the open cut shows a number of additional slips branching off from the main one, and the limestone across the entire width of the open cut has been crushed and altered to a pale-green rock consisting of serpentine, talc, calcite, tremolite, and more rarely chlorite. Asbestos and coarse calcite fill the slips. On the main slip coarse, white to pale-green or creamy-pink calcite forms lenses up to one by two feet (30 by 60 cm), and white-weathering, pale-green, slip-fibre asbestos forms veins from paper-thin to three inches (7.5 cm) in width. the fibres range from one to four inches (three to 12 cm) in length. No cross-fibre was seen.

In the trench a curving slip is exposed, which contains slip-fibre asbestos up to 3 1/2 inches (10.5 cm) in length. The width of the asbestos is from paper-thin to two inches (5 cm)."

History: Vos (1971) reported:

"In 1945 and 1946 a small tonnage of tremolite asbestos, valued at $2925, was produced by L.M. Carswell of Renfrew."

Reference Map: Ontario Geological Survey Map 53 b,

Renfrew Area.

Ontario Geological Survey Map 2462,

Renfrew Area.

Ontario Geological Survey Map P2565,

Industrial Minerals of the Algonquin

Region, Pembroke Area.

References: Hewitt and Satterly (1953, p. 4)

Lumbers (1982, p. 46)

Satterly (1945, p. 19)

Storey and Vos (1981, p. 196)

Vos (1970, p. 25)

Horton Township

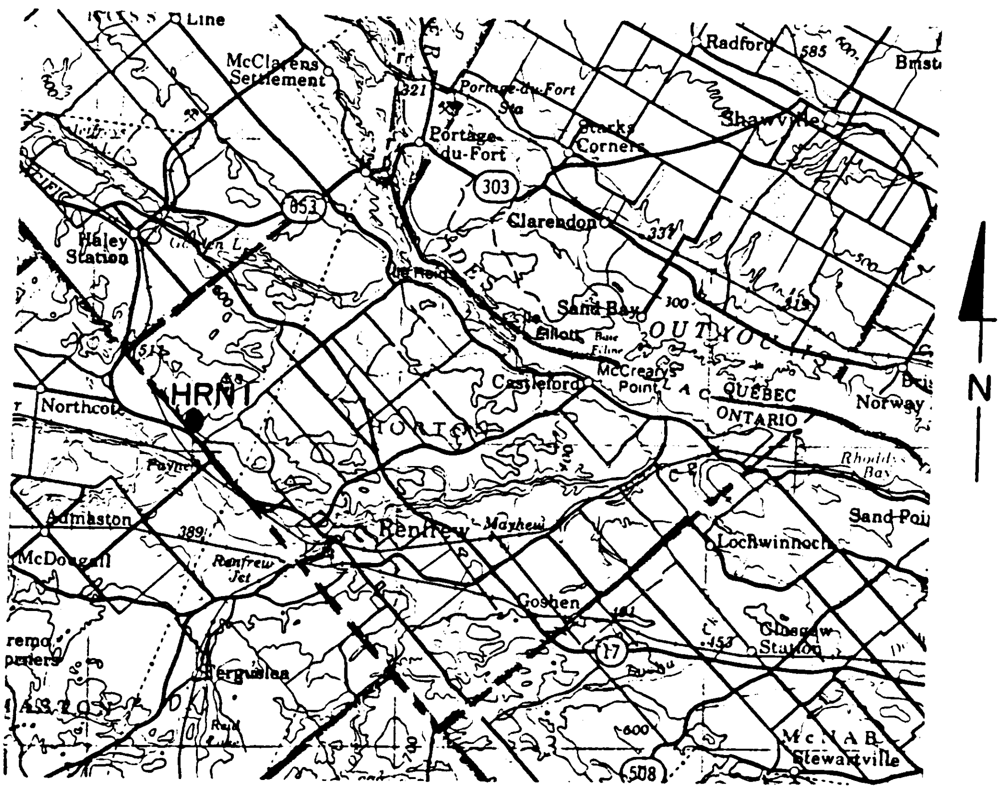


Figure 66: Location Map of the Horton Township Talc Occurrence.

(Scale 1:250,000)

HRN1: Horton Township, Concession I, Lot 21

Rock Association: Carbonate

Access: This quarry is located on the northwest side of old highway 17, 5.3 km north of Renfrew.

Description: Goudge (1938) described this stone quarry, which contains talc and graphite, as follows:

"It is opened in the side of a steep hill facing the highway and a 30-foot (9 m) face of coarse-grained, bluish white dolomite is exposed. The apparent strike of the deposit is north and south and the prevailing dip is to the east at an angle of 40 degrees, but considerable faulting and folding is in evidence. Two openings separated by 20 feet (6 m) of siliceous dolomite containing talc, graphite, white mica and scaly masses of white chlorite have been made."

History: This quarry produced stone.

Reference Maps: Ontario Geological Survey Map 53 b, Renfrew Area.

Ontario Geological Survey Map 2462, Renfrew.

Ontario Geological Survey Map P2565, Industrial Minerals of the Algonquin Region.

Reference: Goudge (1938, p. 170)

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1985: Geology of the Sharbot Lake Area, Frontenac and Lanark Counties, Southeastern Ontario; Ontario Geological Survey Report 228, 70p., with Map 2471.

Wolff, J.M. and Smith, D.A.
1979: Geology of the Long Lake Area; Ontario Geological Survey Preliminary Map P.2246, Geological Series, Scale 1:15,840 or 1 inch to 1/4 mile. Geology 1978. Compilation 1978.

Wynne-Edwards, H.R.
1962: Geology, Gananoque, Ontario, scale 1 inch to 1 mile; Geological Survey of Canada Map 27-1962.

1967: Westport Map-Area, Ontario, with Special Emphasis on the Precambrian Rocks; Geological Survey of Canada Memoir 346, 142 p., with Map 1182 A.

Appendix 1

Geochemical Classification of the Tudor Formation Metavolcanic Rocks

The mafic metavolcanic rocks of the Tudor Formation have been classified as tholeiitic basalts (Condie and Moore 1977). Recent geological mapping and sampling of ultramafic and mafic rocks within a belt of Tudor Formation metavolcanics in Elzevir, Grimsthorpe, Madoc, and Cashel townships has indicated that basaltic and ultramafic komatiites may also form a part of the volcanic succession near the base of the Tudor Formation (LeBaron et al 1987, and LeBaron 1988). The ultramafic rocks were considered by Brown et al (1975) to represent oceanic crust underlying the mafic metavolcanics.

Classification of the ultramafic rocks as volcanic is based primarily upon contact relationships and the presence of thin, metasedimentary layers between ultramafic units. Both geological and geochemical classifications of these rocks are limited by poor exposure and high degree of alteration. Ultramafic rocks in the area of this study have undergone amphibolite grade metamorphism, which has obliterated most original structures and may have considerably changed the primary chemical composition. However, the following diagrams indicate that the tholeiites and basaltic komatiites show good correlation with less altered Archean equivalents. The ultramafic rocks correspond less closely to those from Archean greenstone belts, but are scattered within the komatiitic field. The high degree of scatter may reflect the intensity of alteration within the Tudor Formation ultramafics.

Of the 100 samples of Tudor Formation rocks plotted on the diagrams, 90 are from the Elzevir-Cashel belt (Figures 10a and 10b, Part I of this report) and 10 are from the Kaladar-Anglesea belt (Figure 12, Part I of this report). All data have been recalculated to 100 weight percent (anhydrous). Figure A is a Jensen Cation Plot showing the trend from komatiitic to tholeiitic composition in rocks of the Tudor Formation, similar to the compositional trend in rocks of a komatiitic-tholeiitic succession from the Abitibi greenstone belt, Timmins-Matachewan area shown in Figure B.

Figure C is a CaO-MgO-Al_2O_3 diagram of 100 analyses of Tudor Formation rocks with the komatiitic, tholeiitic, and mixed tholeiitic/calc-alkalic field boundaries of Grunsky et al (1987). Similar plots of analyses from the Abitibi greenstone belt (Figure D) and the Barberton greenstone belt of South Africa (Figure E) show good correlation with the Tudor Formation in the tholeiitic and basaltic komatiitic fields. However, within the ultramafic komatiitic field, there is a lower degree of correlation; the Tudor Formation samples are highly scattered, generally showing higher CaO:Al_2O_3 ratios than the Abitibi and Barberton komatiites. The poor correlation in the ultramafic komatiite field may reflect the difference in metamorphic grade between the Tudor Formation samples (amphibolite facies) and the Abitibi and Barberton samples (greenschist facies). Because the tholeiites and basaltic komatiites are less susceptible to alteration than the ultramafics, they show a higher degree of correlation despite the differences in metamorphic grade.

Figure F is a TiO_2-MgO diagram of 39 samples from the Tudor Formation which lie within the komatiitic field on Figure C. These samples show a trend similar to that of komatiitic and associated rocks of the Barberton greenstone belt (Figure G), but are more scattered and generally show lower TiO_2:MgO ratios. As in the CaO-MgO-Al_2O_3 diagrams, the Tudor Formation and Barberton basaltic komatiites show a higher degree of correlation than samples within the ultramafic field. Figure H is an Al_2O_3-MgO diagram for the same 39 komatiitic samples from the Tudor Formation as are shown in Figure F. Comparison with komatiitic and associated rocks from the Barberton greenstone belt (Figure I) indicates lower Al_2O_3:MgO in the Tudor Formation ultramafic rocks and higher Al_2O_3:MgO in the Tudor Formation basaltic komatiites.

Studies of the Abitibi and Barberton komatiities have used analyses of samples showing little alteration in order to provide consistent data which represents as closely as possible the primary geochemical characteristics. For example, Viljoen et al (1982) excluded all samples with high H_2O and CO_2 contents as well as those showing a high degree of deformation, and Grunsky et al (1986) excluded all samples with greater than 10% loss on ignition. Using these criteria, virtually all of the Tudor Formation ultramafic rocks would be excluded from the komatiite database, therefore a deviation from the trends shown by Abitibi and Barberton komatiities as shown in the diagrams above may reflect the high degree of alteration in the Tudor Formation samples.

This preliminary study suggests that the Tudor Formation metavolcanic rocks can be subdivided into komatiitic and tholeiitic suites based upon geochemical and geological characterisitcs. However, because this study is based upon analysis of small number of highly-altered rocks, further work is recommended in order to verify the existence of true komatiites in the Tudor Formation.

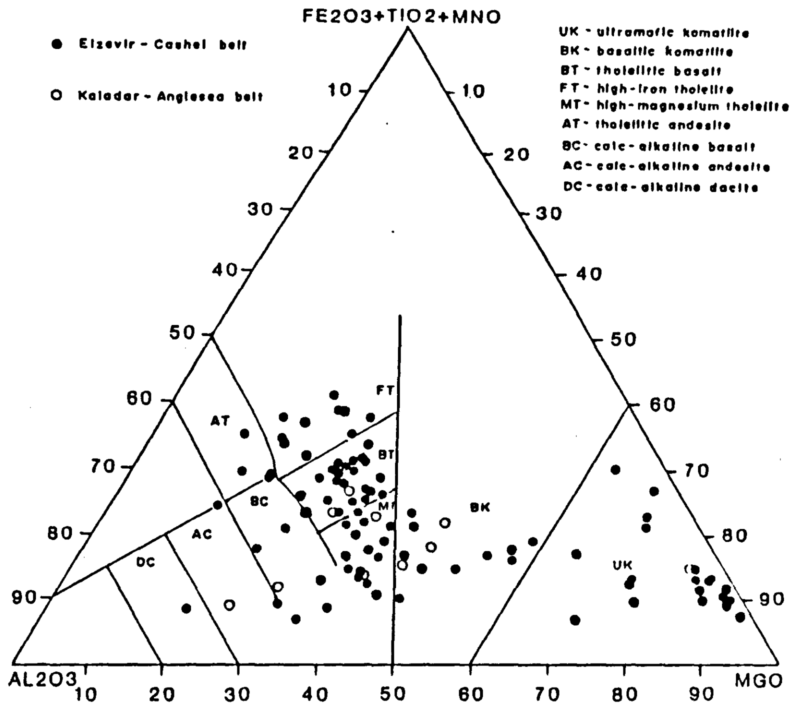

FIGURE A: Jensen cation plot of 100 analyses from the Tudor Formation

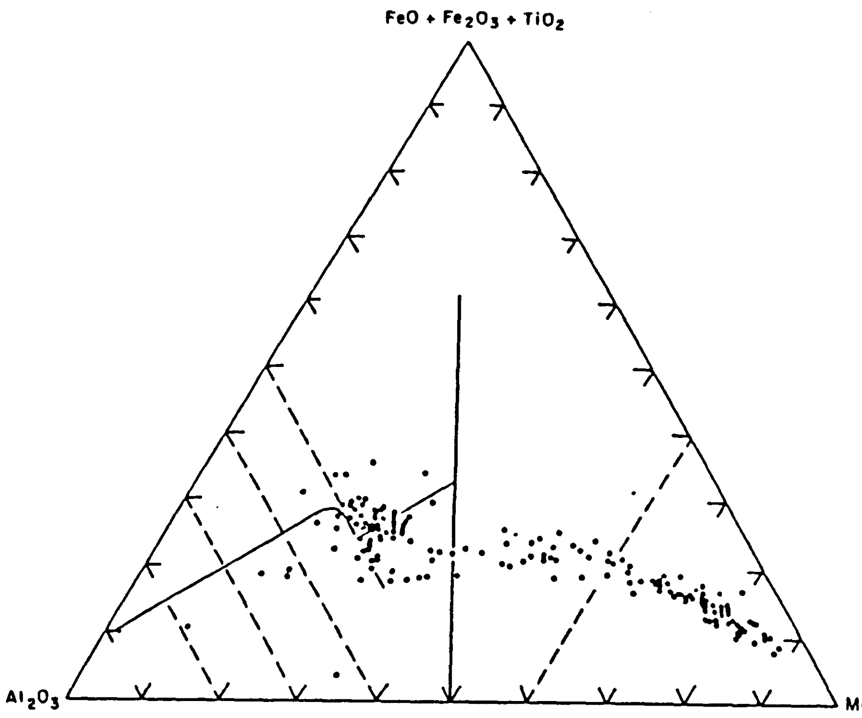

FIGURE B: Jensen cation plot of analyses from the Abitibi greenstone belt, Timmins - Matachewan area (from Jensen and Pyke 1982)

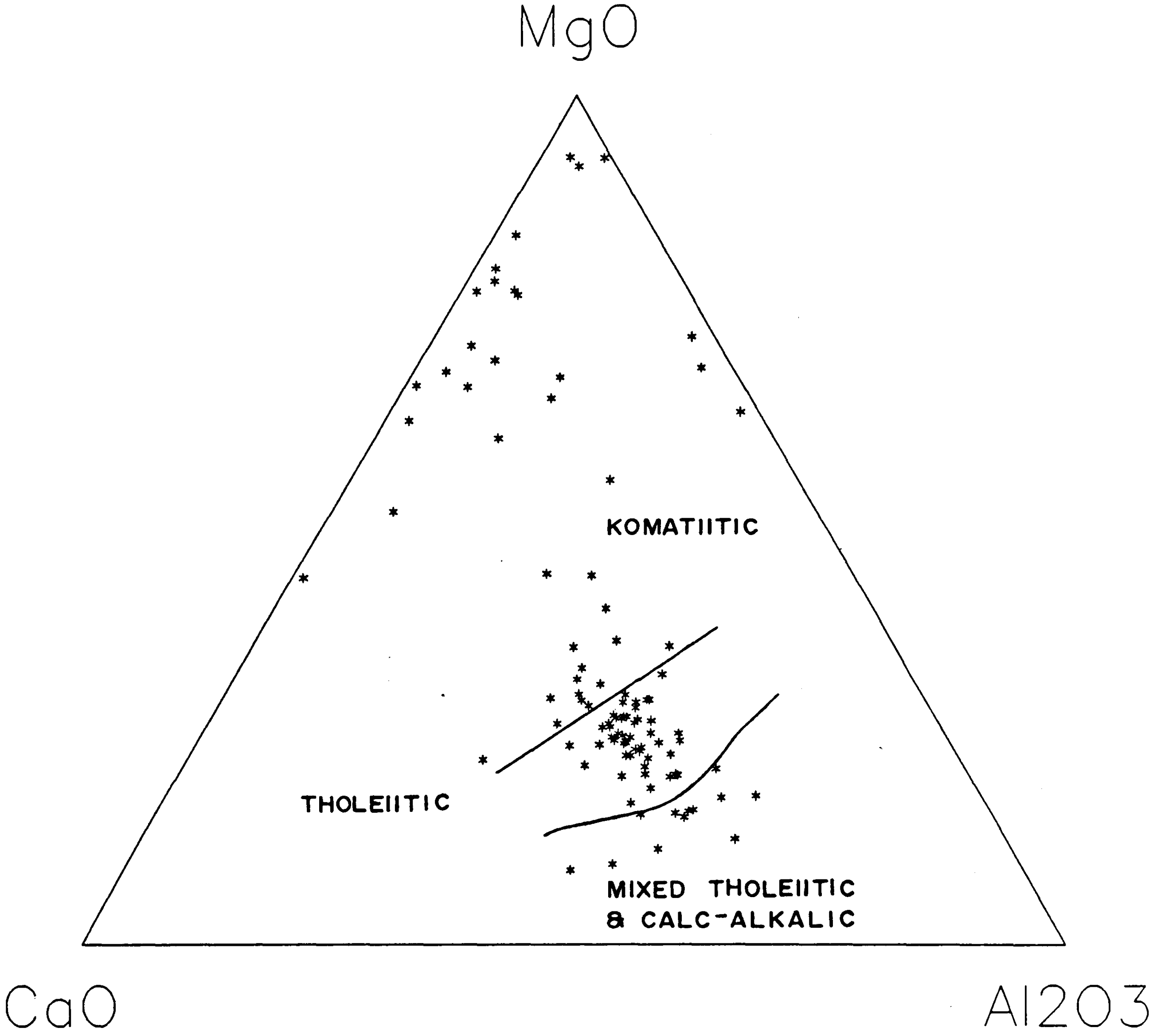

FIGURE C: CaO-MgO-Al2O3 diagram of 100 analyses from the Tudor Formation. Field boundaries are from Grunsky et al (1987).

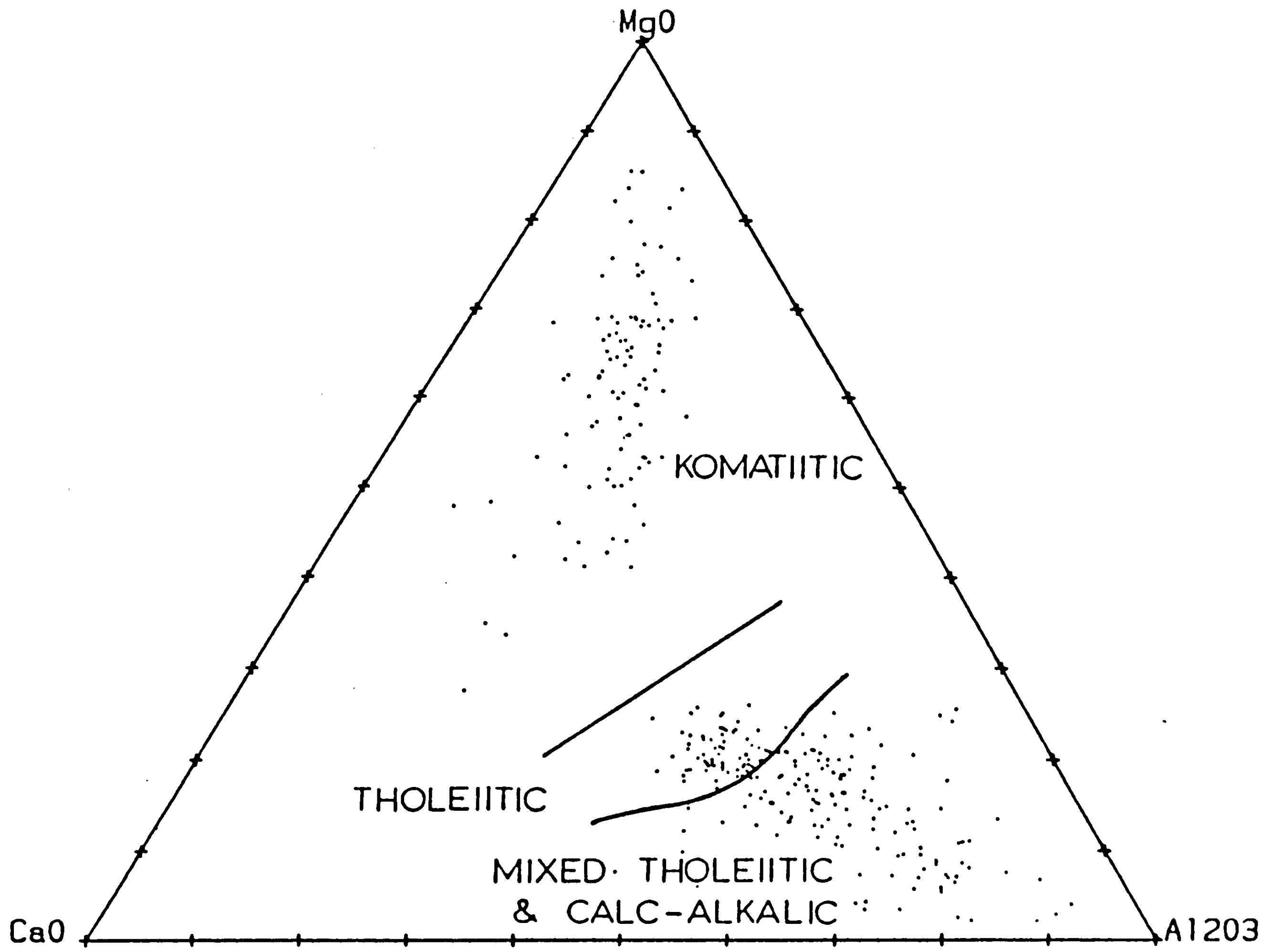

FIGURE D : CaO-Al2O3 diagram of analyses from the Abitibi greenstone belt (from Grunsky et al 1987)

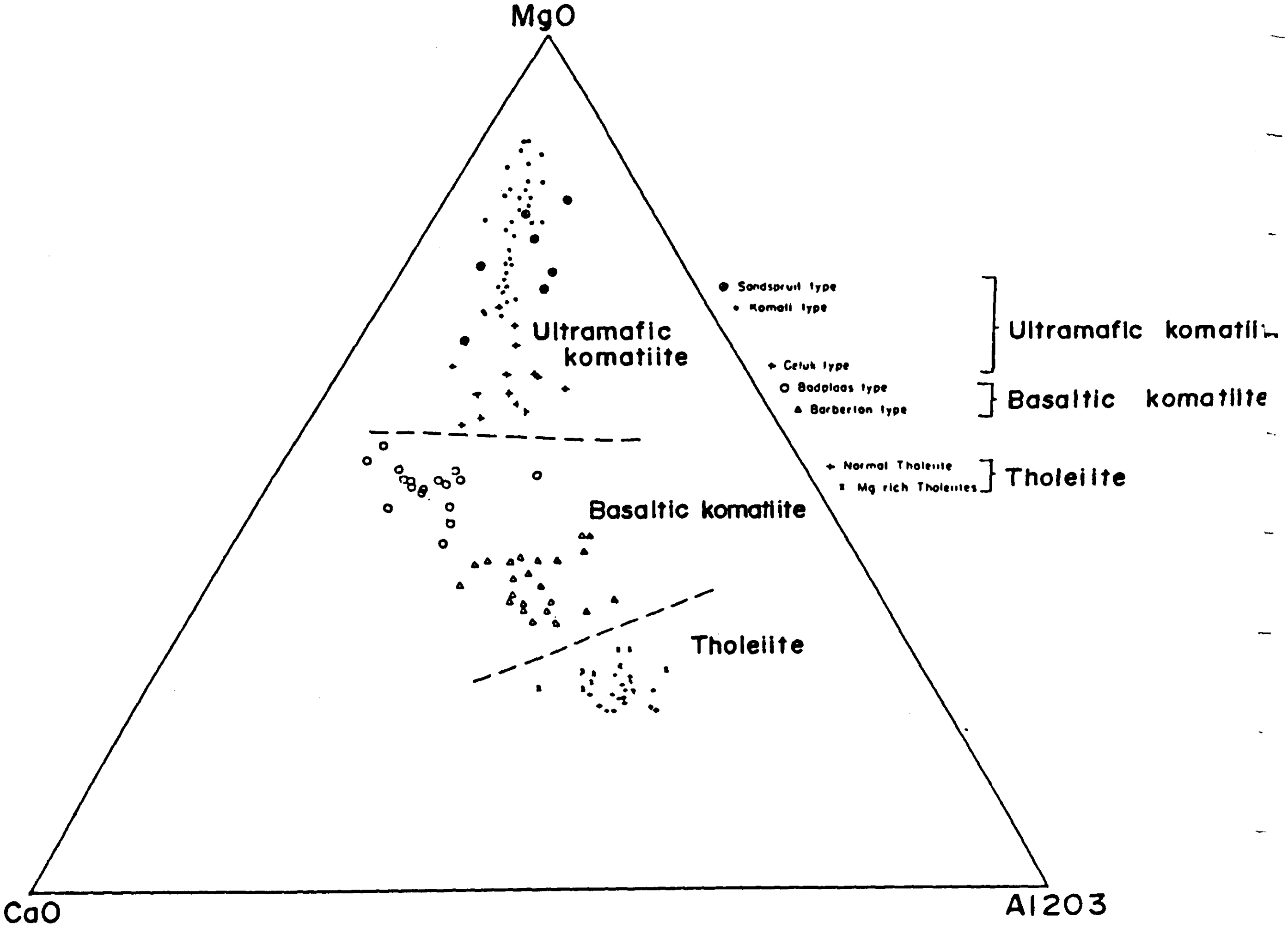

FIGURE E: CaO - MgO - A l 203 diagram of analyses from the Barberton greenstone belt, South Africa (after Viljoen et al 1982).

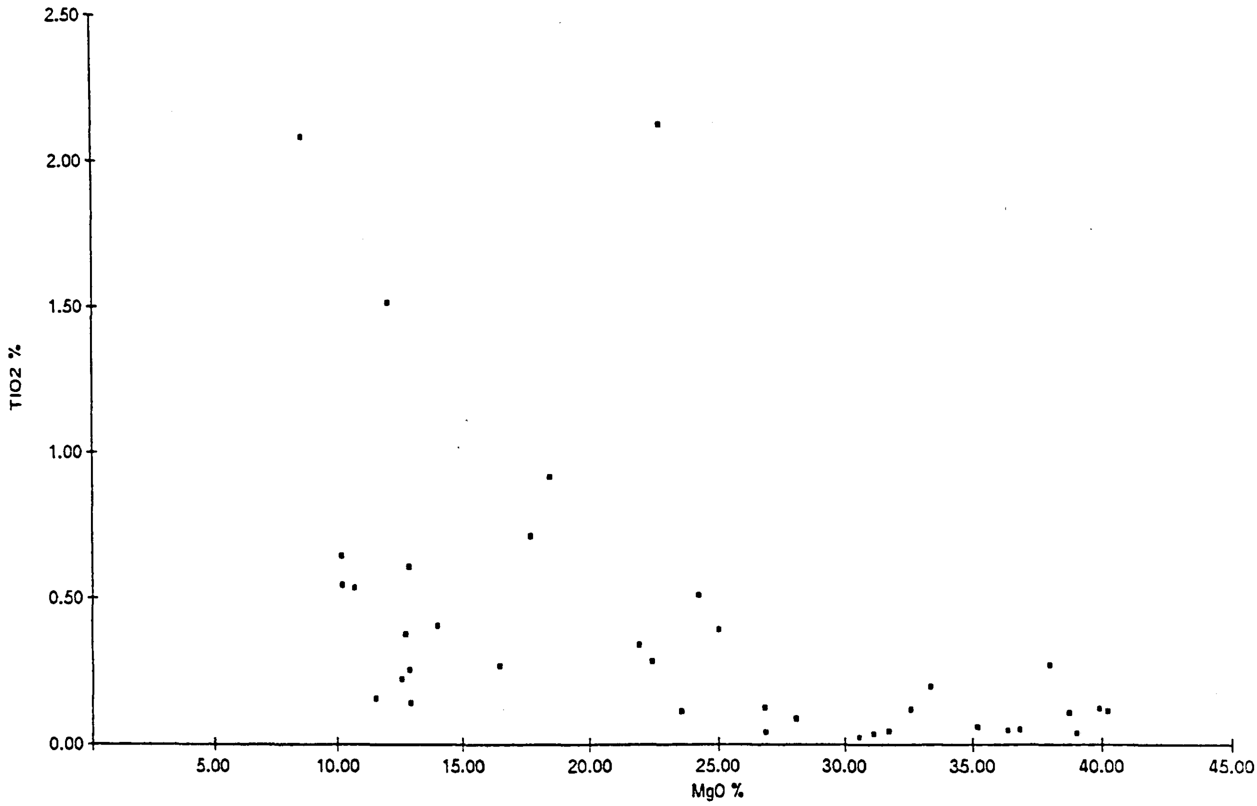

FIGURE F: TiO 2 - MgO diagram of Tudor Formation samples from the komatiite field in Figure C.

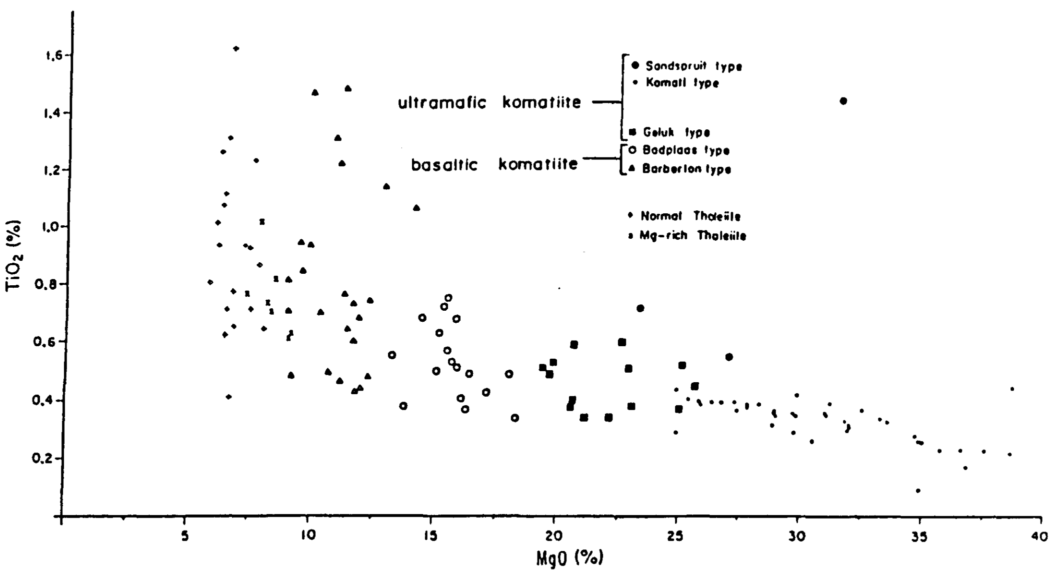

FIGURE G: TiO2 – MgO diagram of komatiites and associated rocks from the Barberton greenstone belt, South Africa (from Viljoen et al 1982).

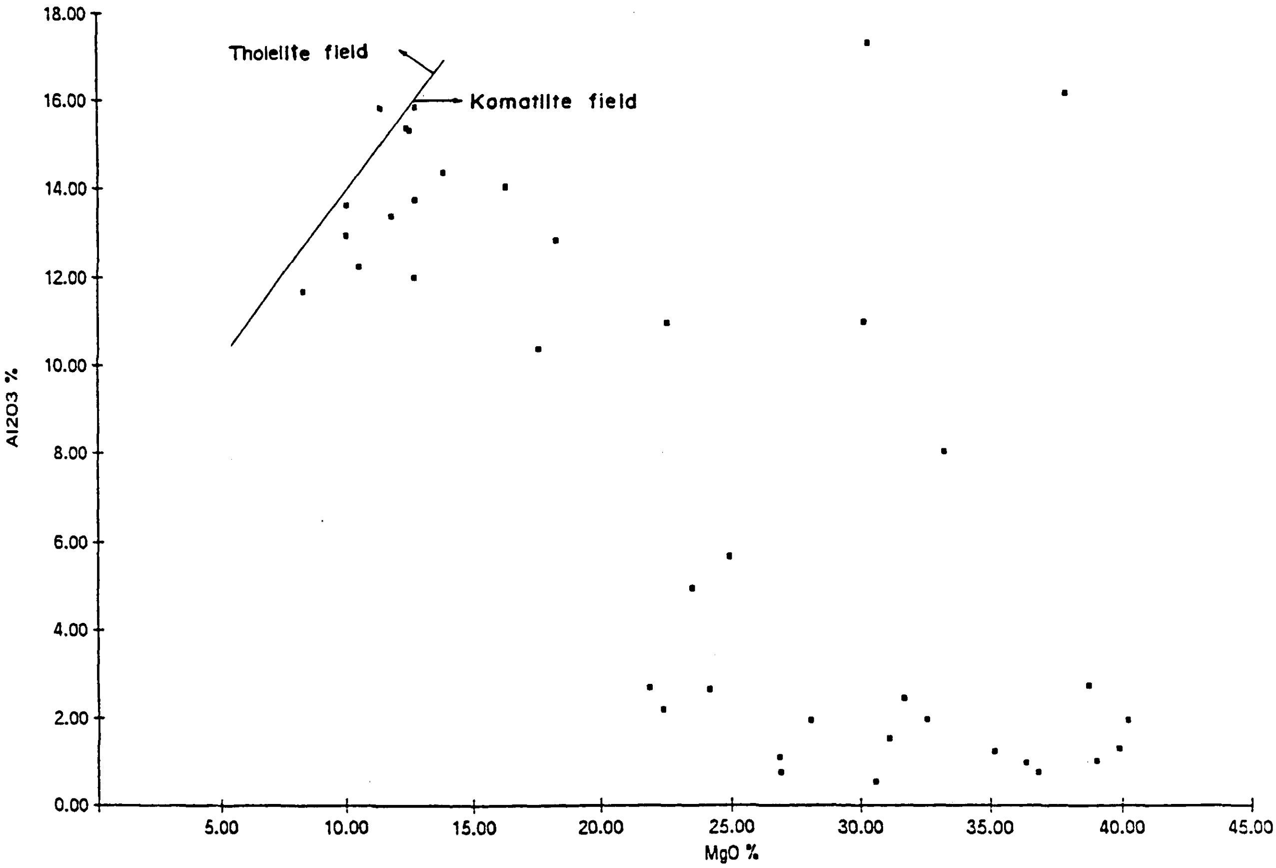

FIGURE H: Al2O3 - MgO diagram of Tudor Formation samples from the komatiite field in Figure C. Tholeiite/Komatiite field boundary is from Viljoen et al (1982).

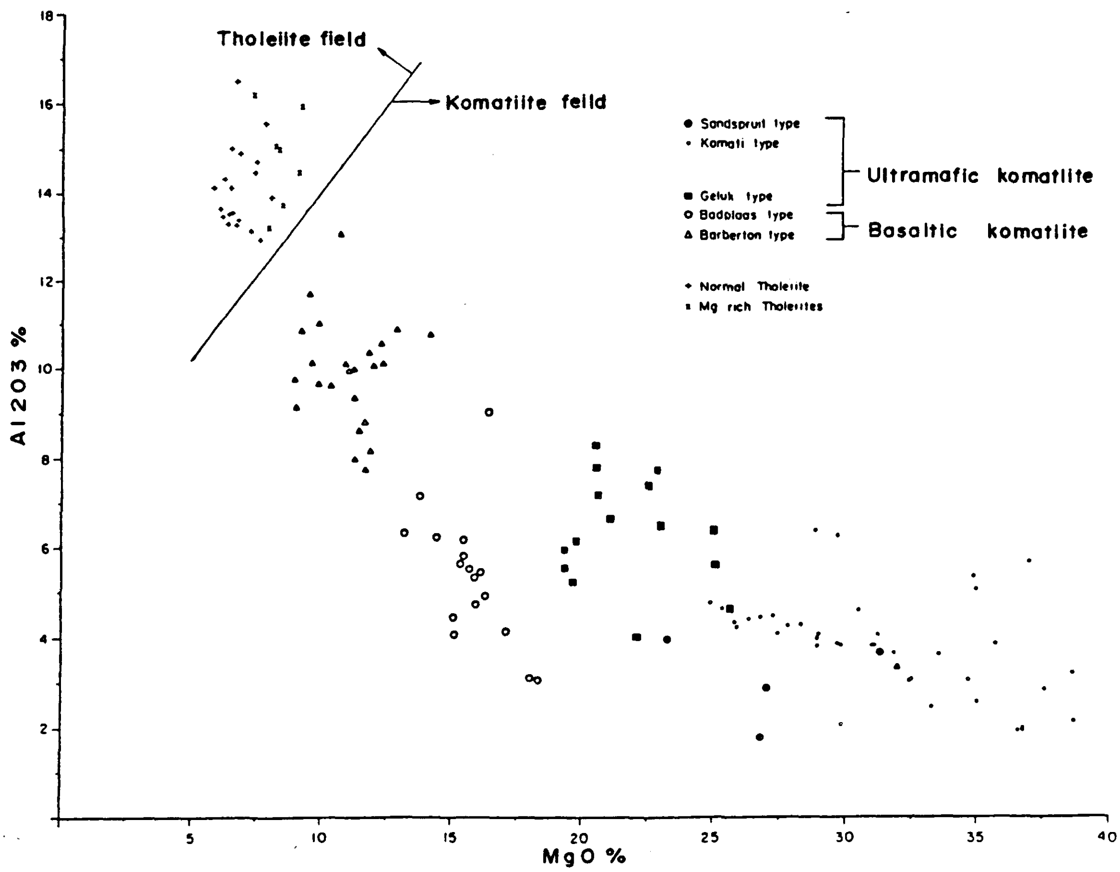

FIGURE I : Al2O3 - MgO diagram of komatiitic and associated rocks from the Barberton greenstone belt, South Africa (from Viljoen et al 1982).

Appendix 2

Flotation Study on Three Types of Talc-containing Ore, by I.M.D. Laboratories Ltd., Sept. 10, 1988

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FLOTATION STUDY ON

THREE TYPES OF TALC CONTAINING ORE

PROJECT 90185

REPORT 90185-1

Prepared For: Ontario Ministry of
Northern Development & Mines
23 Spring Street, P.O. Box 70
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Prepared By: I.M.D. Laboratories Ltd.
September 10, 1988

I N D E X

1.0 SUMMARY

Results from the processing study indicate the following:

- From sample C-M-1 approximately 30% talc can be extracted by flotation. Product has a dry brightness of 88% and an acid soluble level of 4.5% (best result).

- From sample CY-1 approximately 20% of talc can be extracted by flotation. Product brightness is in the order of 90% with acid solubles at 5.0% (best result).

- From sample M-Y-1 approximately 40% of talc can be extracted having a brightness of 90% with acid solubles of 3.54% (best result).

- Wet grinding resulted in the best product quality, when floated with a reagent combination of calgon (mixed polyphosphates) calcium hypochlorite and an alcoholic frother.

- Based on recovery only, samples M-Y-1 and C-M-1 may be considered of economic interest. Sample C-Y-1 has relatively low yield, however, it may be blended with the other ore types. Sample M-Y-1 has a high residual iron content despite high intensity magnetic separation. This indicates the possibility of substitution of iron for magnesium in the talc crystal structure.

- Further work on these types of ores is considered warranted, primarily to optimize processing parameters and achieve optimum product quality.

- A summary of results is given in tables 1, 2, and 3.

TABLE #1

SUMMARY RESULTS SAMPLE C-M-1

Sample Test #	Grind % -325 Mesh		pH Flotation	REAGENTS			Flotation Stages	% Talc Yield	% Dry Brightness	% Acid Solubles
				Calgon	Other*	Frother**				
	Dry	Wet		Gr/Tonne	Gr/Tonne	Gr/Tonne				
C-M-1 -1	62.6	--	11.0	1000	--	100	5	29.2	88.7	5.73
C-M-1 -2	72.0	--	11.0	1000	--	100	5	30.3	88.3	6.19
C-M-1 -3	80.8	--	11.0	1000	--	100	5	30.1	86.4	6.20
C-M-1 -4	64.0	--	9.2	1000	--	100	5	31.3	87.7	7.70
C-M-1 -5	64.0	--	12.1	1000	--	100	5	27.4	87.9	5.75
C-M-1 -6		61.6	11.0	1000	1000	100	5	26.0	87.9	4.49

* Other is Calcium Hypochlorite 65%
** Frother is Dowfroth 250

Flotation stages consist of rougher float, scavenger float and three cleaner floats
pH adjustment is by addition of dilute N_aOH

Comments: Coarses grind gave best overall results for dry ground products
Addition of calcium hypochlorite and wet grinding resulted in
product with lowest acid solubles

TABLE #2

SUMMARY RESULTS SAMPLE C-Y-1

Sample Test #	Grind % -325 Mesh Dry	Wet	pH Flotation	REAGENTS Calgon Gr/Tonne	Other* Gr/Tonne	Frother** Gr/Tonne	Flotation Stages	% Talc Yield	% Dry Brightness	% Acid Solubles
C-M-1 -1	62.6	--	11.0	1000	--	100	5	22.4	90.0	9.74
C-M-1 -2	72.0	--	11.0	1000	--	100	5	23.6	90.2	11.70
C-M-1 -3	82.6	--	11.0	1000	--	100	5	21.1	89.5	9.88
C-M-1 -4	59.0	--	9.6	1000	--	100	5	22.2	89.3	9.27
C-M-1 -5	59.0	--	9.4	1000	1000	100	5	19.2	89.8	7.41
C-M-1 -6		61.4	9.4	1000	1000	100	5	18.8	89.8	5.02

* Other is Calcium Hypochlorite 65%
** Frother is Dowfroth 250

Comments: Acid solubles are high for all grinds and flotation conditions except for wet ground material and the addition of calcium hypochlorite to depress dolomite.

Further work on this type of ore should lead to improvements in product quality.

TABLE #3

SUMMARY RESULTS SAMPLE M-Y-1

Sample Test #	Grind % -325 Mesh		pH Flotation	REAGENTS			Flotation Stages	% Talc Yield	% Dry Brightness	% Acid Solubles
				Calgon	Other*	Frother**				
	Dry	Wet		Gr/Tonne	Gr/Tonne	Gr/Tonne				
M-Y-1 -1	60.4	--	11.0	1000	--	100	5	38.5	89.0	8.09
M-Y-1 -2	70.6	--	11.0	1000	--	100	5	41.0	89.6	8.75
M-Y-1 -3	78.5	--	11.0	1000	--	100	5	42.4	88.1	10.24
M-Y-1 -4	59.6	--	9.6	1000	--	100	5	46.8	88.0	9.92
M-Y-1 -5		60.6	9.4	1000	1000	100	5	35.9	90.4	3.54

* Other is Calcium Hypochlorite 65%
** Frother is Dowfroth 250

Comments: Finer grinding results in loss of product quality with respect to acid solubles

Wet grinding and addition of calcium hypochlorite resulted in significant improvement in product quality

2.0 INTRODUCTION

Three samples of talc containing ore identified as samples C-M-1, C-Y-1 and M-Y-1 were submitted to I.M.D. Laboratories Ltd. for the purpose of extracting talc by flotation.

The objectives of the study were as follows:

- To determine the fineness of grind required for effective separation of talc from the other minerals contained in the ore.

- Based on results from preliminary tests, select the optimum grind, and other process parameters to achieve satisfactory recovery and product quality in subsequent tests.

Based on the mineralogical compositions as provided, the presence of carbonate minerals dictated the use of a neutral or basic floation process. Talc is a readily flotable mineral and the greatest difficulty is to achieve selective separation from the other minerals.

3.0 SAMPLE PREPARATION

3.1 Crushing

Each of the samples was crushed to -1/2" using a jaw crusher. This was followed by staged rolls crushing to minus 10 mesh. The minus 10 mesh products were then split into six samples of 1.2 kilogram. Small samples were split out for chemical analysis of the feed material.

3.2 Grinding

From each material, three samples were dry ground in a ceramic lined ball mill using fused alumina grinding media. Grinding times were selected to give grinds of approximately 60, 70 and 80% passing 325 mesh (45 micron). Three unground samples were kept in reserve for additional tests.

4.0 CHEMICAL ANALYSIS OF HEAD SAMPLES

Each of the head samples were analyzed by x-ray fluorescence for their chemical composition. This gave the following results.

TABLE #4

CHEMICAL ANALYSIS OF HEAD SAMPLES

Element	C-M-1	C-Y-1	M-Y-1
S_1O_2	36.1	34.1	37.4
Al_2O_3	1.87	1.22	2.95
CaO	9.72	10.90	6.60
MgO	26.3	25.8	26.0
Na_2O	0.24	0.14	0.09
K_2O	0.03	0.02	0.01
Fe_2O_3	5.85	6.03	7.50
MnO	0.17	0.15	0.13
T_1O_2	0.16	0.10	0.40
P_2O5	0.02	0.02	0.05
L.O.I.	17.8	20.6	16.6

5.0 FLOTATION

All flotation tests were conducted in a Wemco, 1 kg laboratory flotation cell.

For the first three tests on each of the samples, all reagents and operating conditions were kept constant.

5.1 Reagents and Addition Rates

Calgon - (Mixed Polyphosphates) 1 kg/tonne Stage Added

pH	11.0	Adjusted with dilute N_aOH	
Frother	Dowfroth 250	0.1 kg/tonne	Stage Added

5.2 Flotation Conditions

5.2.1 CONDITIONING — at 40% solids for 10 minutes with Calgon addition, followed by pH adjustment and dilution of pulp to 25% solids and addition of frother

5.2.2 FLOTATION — Flotation consisted of a combined rougher/scavenger float, followed by three cleaner floats on the talc concentrate.

All flotation was conducted in open circuit Tailings from each flotation stage were filtered, dried and weighed.

5.2.3 MAGNETIC SEPARATION Each of the final flotation concentrates was given low and high intensity wet magnetic separation. Magnetic waste was collected, dried and weighed.

The non-magnetic talc fraction was filtered, dried and weighed for the purpose of calculating product yield.

6.0 PRODUCT TREATMENT

A twenty-five gram (25) sample of talc concentrate was taken from each of the nine concentrates for determination of acid solubles content.

100 gram of each concentrate was ground in a small ceramic mill to 100% passing 325 mesh (45 micron) for the purpose of conducting tri-stimulus brightness.

7.0 TEST RESULTS - PRELIMINARY TESTS

Table #5 gives results on talc yield, dry brightness and acid soluble. For the nine preliminary flotation tests.

Table #5
Preliminary Test Results

Sample #	% -325 Mesh	% Talc Yield	% Dry Brightness	% Acid Solubles
C-M-1 -1	62.6	29.2	88.7	5.73
C-M-1 -2	72.0	30.3	88.3	6.19
C-M-1 -3	80.8	30.1	86.4	6.20
C-Y-1 -1	62.4	22.4	90.0	9.74
C-Y-1 -2	72.0	23.6	90.2	11.70
C-Y-1 -3	82.6	21.1	89.5	9.88
M-Y-1 -1	60.4	38.5	89.0	8.09
M-Y-1 -2	70.6	41.0	89.6	8.75
M-Y-1 -3	78.5	42.4	88.1	10.24

Comments: Acid solubles generally increase with a decrease in particle size and unacceptably high in all cases. This indicated a need for process modification.

8.0 DISCUSSION OF PRELIMINARY RESULTS

Results show that product quality diminishes with reduced particle size, indicating that a coarser grind results in better flotation selectivity. Product yields from test to test do not vary significant suggesting similar recovery will be achieved within a broad range of fineness of grind.

Acid solubles are indicative of carbonate minerals in the talc concentrate, suggesting a modification of the flotation process is required to improve selectivity. The approach selected was to emphasize effective depression of carbonate minerals.

It was decided to investigate the effect of pH on product quality, i.e. acid solubles, followed by the use of calcium hypochlorite as a depressant of carbonate minerals and wet versus dry grinding. This resulted in more test than originally estimated. However, these tests were necessary to evaluate these factors.

8.1 Effect of pH

Table #6 shows the effect of lower or higher pH on talc yield and acid solubles using the coarsest grind.

TABLE #6

EFFECT OF pH ON
TALC YIELD & ACID SOLUBLES

Sample #	Grind % -325 Mesh	pH	% Talc Yield	% Dry Brightness	% Acid Solubles
C-M-1-1	62.4	11.0	29.2	88.7	5.75
C-M-1-4	64.0	9.2	31.3	87.7	7.70
C-M-1-5	64.0	12.1	27.4	87.9	5.75
C-Y-1-1	62.4	11.0	22.4	90.0	9.74
C-Y-1-4	59.0	9.6	22.2	89.3	9.27
M-Y-1-1	60.4	11.0	38.5	89.0	8.09
M-Y-1-4	59.6	9.6	46.8	88.0	9.92

Comments:

Sample C-M-1 Increased acid solubles at lower pH
No change at higher pH

Sample C-Y-1 Slightly lower acid solubles at lower pH. Not conclusive

Sample M-Y-1 Increased acid solubles at lower pH.

8.2 Discussion of Results

pH had a decided effect on acid solubles in two of the three samples. In both samples C-M-1 and M-Y-1 there is a significant increase in acid solubles at lower pH. In test C-M-1-5 higher pH had no detectable influence on acid solubles.

Based on these results it was decided to evaluate the effect of calcium hypochlorite in addition to calgon for suppression of carbonate minerals and to evaluate wet versus dry grinding.

Table #7 shows the comparison of calgon versus calgon plus calcium hypochlorite on sample C-Y-1.

Table #7

Effect of Calcium Hypochlorite

Sample	Grind % -325	Calgon	Ca-Hypo-Chlorite	% Talc Yield	% Solubles
C-Y-1-1	62.4	1 kg/t	--	22.4	9.74
C-Y-1-5	59.0	1 kg/t	1 kg/t	19.2	7.41

Comments:

Addition of calcium hypochlorite resulted in a significant reduction in acid solubles indicating better selectivity. The absolute level of acid solubles is still above acceptable level.

Following this test it was decided to investigate wet grinding with addition of calcium hypochlorite and compare results with dry ground material. Table #8 gives the results of these tests.

Table #8

Effect of Wet Grinding And Addition Of
Calcium Hypochlorite On Talc Yield And
Acid Solubles

SAMPLE	Dry Grind % -325	Wet Grind % -325	Calcium Hypochlorite kg/tonne	Calgon kg/tonne	Talc Yield %	% Acid Solubles
C-M-1-1	62.6		--	1.0	29.2	5.73
C-M-1-6		61.6	1.0	1.0	26.0	4.49
M-Y-1-1	60.4		--	1.0	38.5	8.09
M-Y-1-5		60.6	1.0	1.0	35.9	3.54
C-Y-1-1	62.4		--	1.0	22.4	9.74
C-Y-1-5	59.0		1.0	1.0	19.2	7.41
C-Y-1-6		61.4	1.0	1.0	12.8	5.02

In all cases there is a significant reduction in acid solubles in wet ground samples and with addition of calcium hypochlorite. Each of these process changes affected acid insolubles favourably.

9.0 PRODUCT CHEMICAL ANALYSIS

From each sample, products produced from the best two floation tests were analyzed for their chemical composition. In all cases this included the first float of each sample, i.e. coarsest grind and the wet ground sample floated with calgon plus calcium hypochlorite.

Table #9

Product Chemical Analysis

Element	C-M-1-1	C-M-1-6	C-Y-1-1	C-Y-1-6	M-Y-1-1	M-Y-1-5
S_1O_2	58.8	60.3	55.5	59.0	56.5	58.9
Al_2O_3	0.43	0.33	0.77	.69	0.91	0.59
CaO	1.43	0.88	2.73	1.38	1.91	0.79
MgO	29.5	30.0	28.5	29.2	28.0	28.8
Na_2O	.01	.01	0.01	0.01	0.01	0.01
K_2O	0.03	.01	0.05	0.01	0.01	0.01
Fe_2O_3	2.11	2.08	2.83	2.48	4.71	4.39
MnO	.03	0.03	0.04	0.03	0.04	0.02
T_1O_2	.04	0.04	0.06	0.05	0.04	0.04
P_2O5	.02	0.03	0.02	0.02	0.02	0.02
L.O.I.	6.70	6.08	8.54	6.54	7.85	6.16

10.0 CONCLUSIONS

Testwork as conducted indicates that talc concentrates of average quality can be extracted using the process as employed. Further improvements are considered possible with exploratory work to optimize the flotation process.

Chemical analysis indicate that the products still contain other minerals as indicated by AL_2O_3, C_aO and Fe_2O_3 content. In the case of Fe_2O_3 it is not unlikely that the iron is partly in solid solution, as a substitution of Fe_2O_3 for MgO in the talc crystal structure. This is quite common and in this case is supported by the lower than theoretical values for MgO in the talc products.

Based on dry brightness, acid solubles and product chemistry products can be classed as "average" quality. Only actual testing of these products in various industrial talc applications can verify product performance.

Initial results are encouraging and are such that further, more detailed testing with the objective of optmizing the process is warranted.