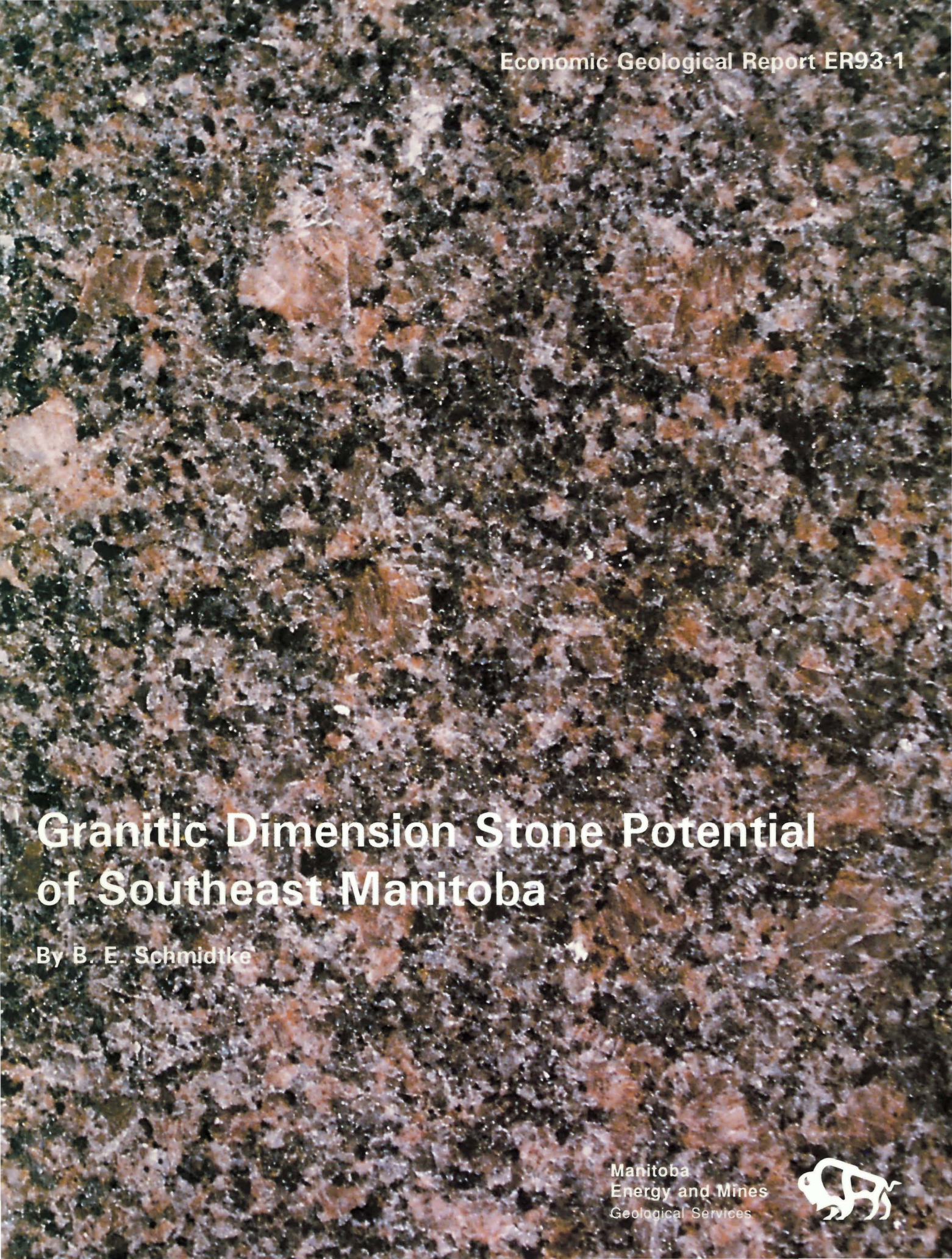

Economic Geological Report ER93-1

Granitic Dimension Stone Potential of Southeast Manitoba

By B. E. Schmidtke

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Winnipeg, 1994

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INTRODUCTION

A granitic dimension stone resource assessment of a 20,000 km^2 area in southeast Manitoba (Fig. 1) was initiated under the 1984-1989 Canada-Manitoba Mineral Development Agreement to assess the Precambrian Shield of southeast Manitoba for potential dimension stone quarry sites. The primary focus of the study was to identify a source of rock that could be used in the building stone and monument trades. This program was developed in response to requests from industry, which has a renewed interest in locating and developing new dimension stone quarries due to increased demand. The objectives of this project were:

1. to evaluate the dimension stone potential of intrusions in southeast Manitoba;
2. to identify specific outcrops that have the potential to be quarried for dimension stone; and,
3. to provide a data base of dimension stone potential for utilization in land use planning.

An initial reconnaissance of the granitic plutons was undertaken in 1985. Field work in 1986 and 1987 concentrated on mapping, sampling and drilling high potential outcrops selected from the 1985 survey.

This report is divided into two sections. The first section provides a summary of those intrusions that have the potential to be dimension stone producers. The second section provides a detailed documentation of all intrusions examined during the survey.

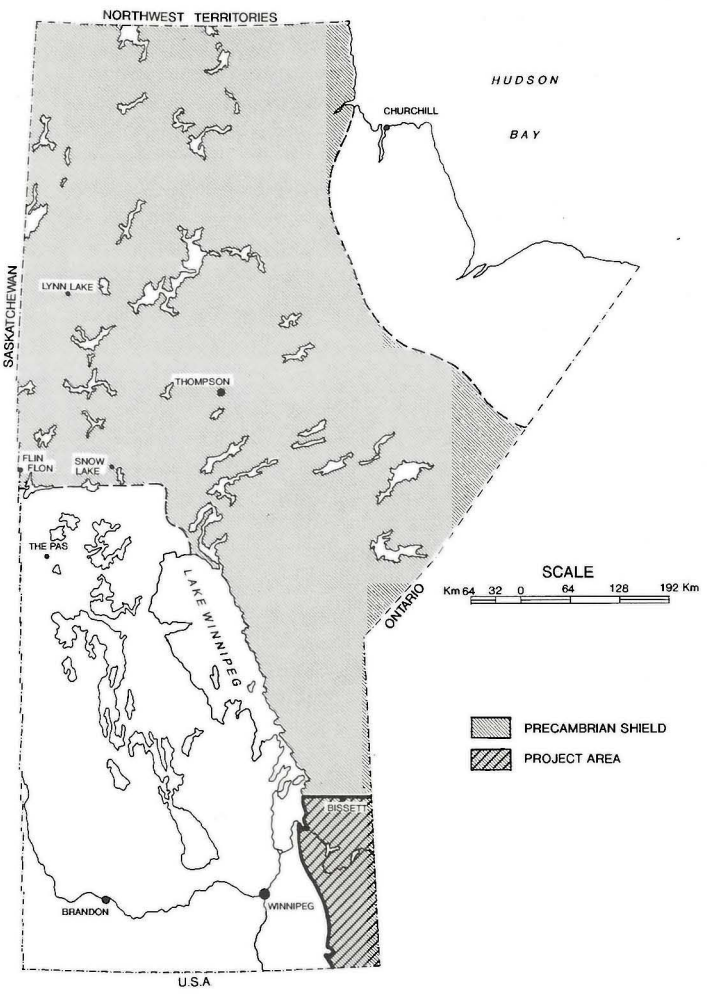


Figure 1: Project area of the dimension stone assessment conducted in southeast Manitoba.

METHODOLOGY

The project area is underlain by the Precambrian Shield (Fig. 1). Granitic plutons with high potential were selected from geology maps (Cerny *et al.*, 1981; Davies, 1953, 1954; Janes, 1976a, 1976b, 1976c, 1976d, 1976e, 1976f, 1978a, 1978b, 1978c; McCrank, 1985; McRitchie, 1969a, 1969b, 1969c, 1969d, 1969e, 1969f; Springer; 1952). Generally, the geologically youngest plutons possess the properties required of a dimension stone deposit because they have not been deformed and fractured as the older plutons were during the emplacement of subsequent intrusions.

Areas that appeared to have high dimension stone potential were located using 1:75 000 scale infrared aerial photographs. Specific outcrops were selected for follow-up studies from 1:15 840 scale black-and-white airphotos that cover the high potential areas. The criteria used to screen high potential outcrops using aerial photograph interpretation is described on page 3.

Selected granitic outcrops within a one kilometre distance of usable roads were documented for the physical characteristics required in a dimension stone quarry. The required properties that can be assessed in the field are:

1. widely spaced, preferably orthogonal fractures that will allow removal of blocks with a minimum trimmed size of 2.0 by 1.25 by 1.25 m;
2. widely spaced, or preferably the absence of, veins;
3. homogeneous, attractive and fashionable colours and textures;
4. the absence of minerals that pluck when polished, or oxidize and cause unsightly rust spots when exposed to the elements; and
5. road access.

The outcrops were examined and sampled. The distance between fractures, fracture orientation, homogeneity of colour and texture, and mineralogy were documented. Hand samples were taken for polishing to determine if any of the minerals plucked when polished.

After the reconnaissance study, outcrops considered to have the highest potential were documented in detail. Fracture maps were made to illustrate the spacing and orientation of both fractures and very coarse grained veins. Blocks, approximately 30 cm on a side, were taken using a cobra drill and feather-and-wedge sets. Professionally polished samples were made from several of these blocks.

A large percentage of the project area is located in Whiteshell and Nopiming Provincial Parks (Fig. 2). Park policies, plans and precedents regarding mineral extraction were taken into consideration when choosing sites for detailed documentation. Rock exposures near cottage subdivisions, hiking trails and other recreational facilities were avoided in the detailed mapping and sampling phase of the assessment. In Whiteshell Provincial Park, detailed work was limited to those zones that had been defined in the Whiteshell Master Plan as suitable for limited mining activities. The user should check current provincial park plans before embarking on any exploration programs in a Provincial Park.[1]

ACKNOWLEDGMENTS

Assistance was provided in the field by Ron Jonsson, Brad Smith, Tannis Gibson, Don Gaye, Stewart Schaffer, and Perry Yamada. Ted Coppola of Canital Granite Ltd., Sandy Peterson and Will Kelly of Cold Spring Granite (Canada) Ltd., Carter Nelson of Nelson Granite, and Curd Hos and Dianne Challifoux of Canadian Shield Quarries are thanked for their advice and support throughout the project. Bill Mandziuk of the University of Manitoba is also thanked for his help in the Falcon Lake area. Technical review and supervision was provided by G.H. Gale. The manuscript was edited by D.A. Baldwin; Shirley Henrie did the desktop publishing.

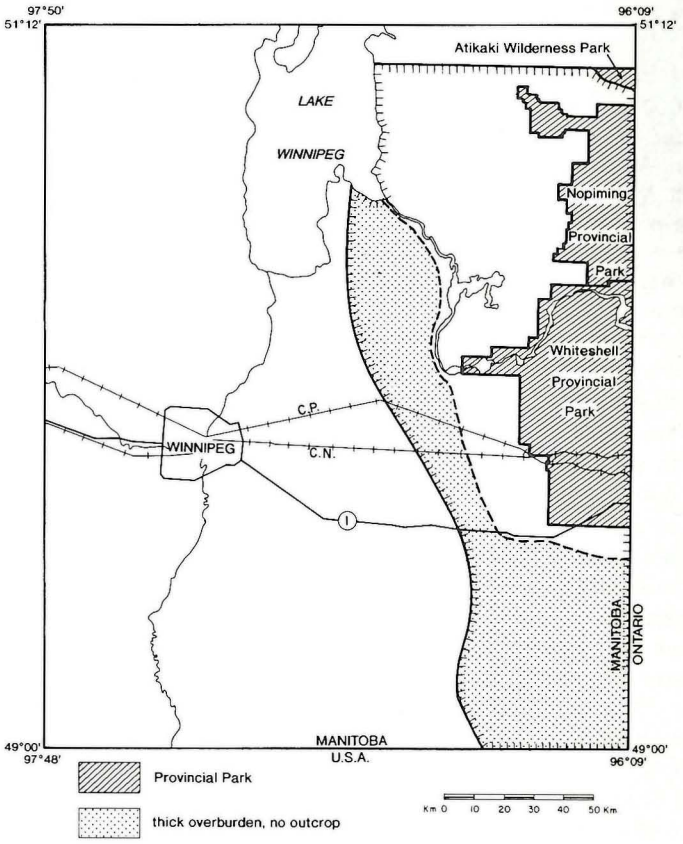


Figure 2: Location of Provincial Parks that overlap the dimension stone project area. The dimension stone project area is indicated by hachures. Note that approximately two thirds of the project area is within Whiteshell, Nopiming and Atikaki Provincial Parks, and areas of thick overburden.

1 Available through: Parks Branch, Manitoba Department of Natural Resources, Westrow Industrial Mall, 1495 St. James Street, Winnipeg, Manitoba R3H 0W9

PART I: POTENTIAL SOURCES OF DIMENSION STONE IN MANITOBA

DIMENSION STONE

"Granite dimension stone" includes all crystalline igneous rocks that are cut and finished to a predetermined size. The dimension stone industry definition of "granite" encompasses all light coloured igneous rock: granite, syenite, quartz monzonite and granodiorite. "Black granite" includes all dark coloured igneous rock: gabbro, norite, and diorite. Granite is fashioned into tombstones, mausoleums, floor and wall paneling, curbing, paving and decorative pieces. Stone is a traditional building material of great strength, durability and beauty. Historically, stone was used extensively in construction for structural and decorative applications. Lightweight concrete and steel have replaced stone in structural applications, but stone has regained popularity as decorative wall and floor coverings, counter tops and furniture in commercial and residential buildings. Granite dimension stone has a variety of industrial uses, including: rollers for paper mills, precision surface plates for fine machine work, and grindstones and millstones (Lefond, 1983).

The Canadian dimension stone industry has experienced rapid growth within the past decade. This reflects an international trend of strong stone sales that can be attributed to several factors:

1. Advanced technology has reduced the cost of producing granite slabs less than a centimetre thick, and improved installation techniques have reduced construction costs;
2. The strong economy of the mid- to late-1980's fueled a construction boom. Many recently constructed buildings are clad in granite. In Winnipeg, the Bank of Montreal addition, completed in 1984, is clad in grey granite from Europe and the Investor's Building, opened in 1987, is clad in red granite from Texas;
3. Stone is fashionable again and, in many instances, its use is preferred to the concrete, glass, and steel exterior claddings that were popular in the recent past; and
4. Stone counter tops, flooring, patios and furniture are becoming popular in the residential building industry.

CHARACTERISTICS OF A DIMENSION STONE DEPOSIT

Only a few of the outcrops documented during the reconnaissance phase of this study display physical features requisite for a dimension stone deposit, *i.e.,*:

- widely spaced, orthogonal fracture sets;
- acceptable ASTM strengths (as per Annual Book of ASTM Standards);
- homogeneous and attractive colours and textures;
- absence of deleterious minerals that pluck when polished, or rust when weathered;
- proximity to transportation routes, finishing facilities and markets.

The most important feature of a dimension stone deposit is widely spaced fractures that facilitate the removal of orthogonal blocks with a minimum trimmed size of 2 by 1.25 by 1.25 m (Ted Coppola, pers. comm., 1987); modern finishing equipment cannot cut smaller blocks economically. If the fractures are closely spaced, a rock has little potential as a source of dimension stone. Outcrops with orthogonal vertical and horizontal fracture orientations are preferred because the rocks are easy to quarry. Closely fractured rocks may be used to make ornaments if they polish well, have an attractive and unusual colour and texture, are road accessible, and are located close to markets.

The best dimension stone sites are either low-relief, flat, virtually fracture-free outcrops, or high ridges with step-like ledges and widely spaced vertical fractures. The frequency of vertical fractures in ledged outcrops decreases with depth, and it is not uncommon to find a rock free of vertical fractures that underlies a ledge. A high ridge with closely spaced fractures may occur adjacent to a low, flat, unfractured outcrop.

Unfractured outcrops are difficult to identify on 1:15 840 aerial photographs because fractures are not always visible at this scale. The "Tie Creek" site, a large, flat, unfractured rock outcrop, was used as a reference during this study because it has a very distinctive appearance on aerial photographs. In comparison to other outcrops in the area, there are no patterns of relief, lineation or evidence of vegetation growth. The outcrop stands out as a bald, white area on the aerial photograph (Fig. 3).

Ledges can often be distinguished on aerial photographs as apparent lines oriented parallel to the long axis of a ridge. If the ledges are large enough to be distinguished on 1:15 840 aerial photographs, the rocks are generally massive and possibly suitable for the production of large blocks of dimension stone. A large outcrop with a number of ledges is illustrated on an aerial photograph in Figure 4.

Outcrops with closely spaced, acutely oriented linear features, and prolific vegetation growth are generally unsuitable dimension stone prospecting areas because of closely spaced fractures.

Vertical and some horizontal fracture patterns can be assessed on the outcrop. Variation in fracture patterns at depth can be assessed by drilling and test quarrying. However, a deposit is not proven to be quarriable until large blocks of rock of consistent colour and texture that meet ASTM strength standards and take a smooth finish have been obtained.

Dimension stone must meet ASTM specifications for natural building stone in order to be used in construction. These specifications include standards for compressive strength, modulus of rupture, absorption, and specific gravity (see Annual Book of ASTM Standards, Standard C615-85).

Dimension stone must have a fashionable, attractive and homogeneous colour and texture. Schlieren, colour variations, and other heterogeneities are permissible, provided they are homogeneously distributed throughout the deposit. Coarse grained textures are popular for building facings, tiles and furniture, but not for tombstones. Fine- to medium-grained equigranular rocks are suitable for all applications. Minerals that impart a schiller to the polished surface, such

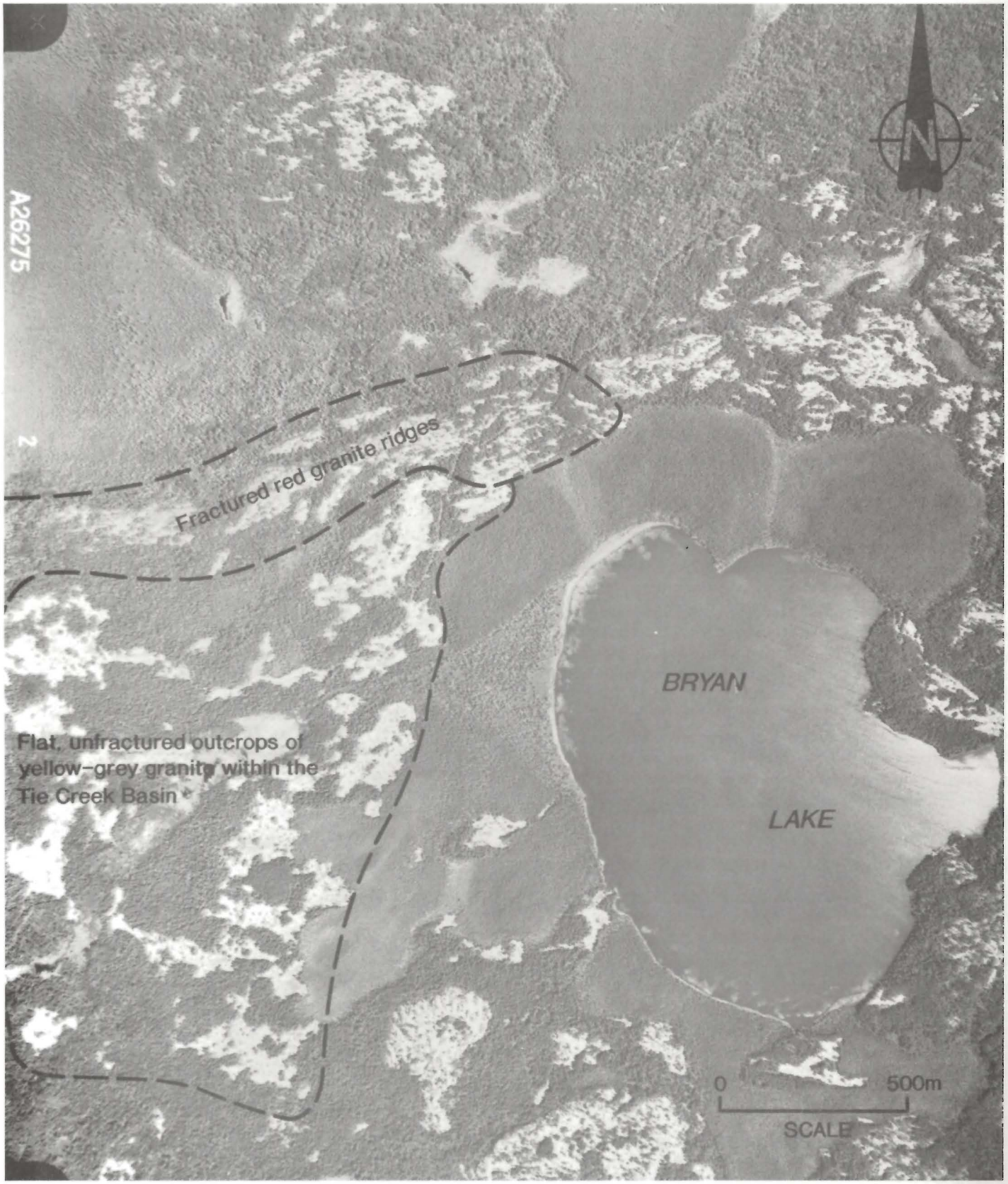


Figure 3: Aerial photograph of the Tie Creek area. Outcrops of yellow-grey granite appear as bald white areas west of Bryan Lake. Lack of vegetation on the yellow-grey outcrops indicates the absence of large-scale fractures.

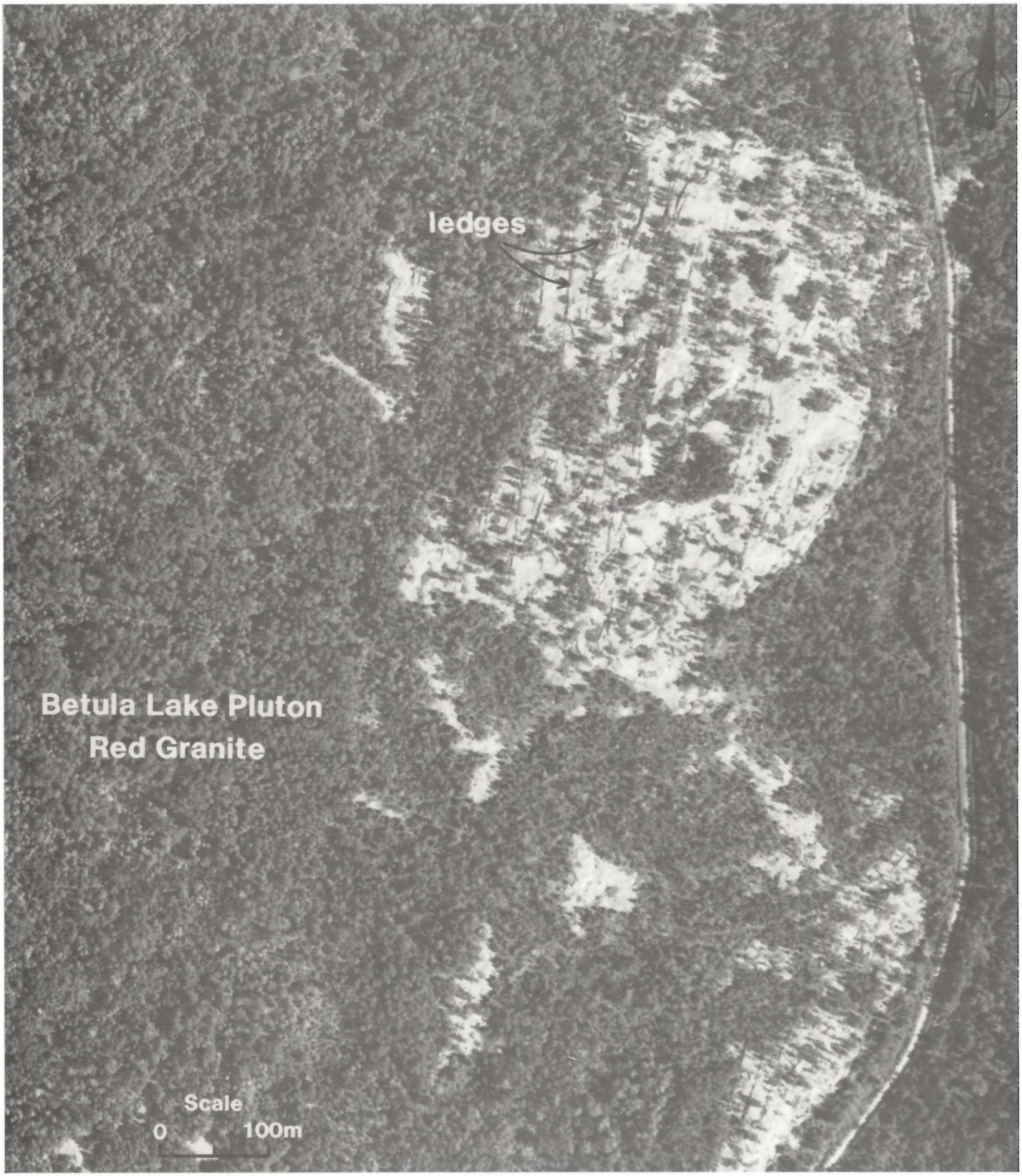


Figure 4: Ledges on an outcrop of red granite in the Tie Creek area. The ledges are visible as fine lines parallel to the long axis of the outcrop and indicate a widely spaced orthogonal fracture pattern. The photograph has been enlarged for illustrative purposes.

as peristerite, moonstone, and labradorite, can be desirable in dimension stone deposits.

Deleterious minerals that pluck when polished, or rust and "bleed" when exposed to moisture, must be absent or occur only in minute quantities that will not mar the polished surface. Altered feldspar, olivine, ferromagnesian minerals and micas are likely to pluck when polished. Garnet and corundum are difficult to polish because of their hardness, but can add beautiful colours and textures to finished dimension stone.

Distance to finishing facilities and markets affects the viability of a dimension stone deposit. The shorter the distance a stone is transported to finishing plants and markets, the less costly it is to produce. Some types of stone command a higher market price than others and the extra cost of long transport distances is not a detriment to production: a black, green or blue stone sells at a relatively higher price than other colours and can be transported more economically over greater distances than the more common red and pink colours.

Manitoba's geographic position is an advantage in the western and midwestern North American stone market. Granite quarries are located near the southwest limit of the Precambrian Shield; thus, Manitoba stone costs less to transport to the western provinces and states than does an equivalent stone from the eastern provinces and states.

Most granitic intrusions in southeast Manitoba are too fractured and heterogeneous in colour and texture to be potential sources of dimension stone. Even within the best intrusions there are very few outcrops that have the requisite dimension stone characteristics. In southeast Manitoba, the highest potential outcrops occur within the "Betula Lake Pluton", the "Lac du Bonnet Batholith" and the "Medika Pluton" (see summary on pages 7-11 and detailed descriptions on pages 16, 24-44): these are the youngest intrusions within the project area that are exposed within one kilometre of an existing road.

TERMINOLOGY

The terminology used by the dimension stone industry is different from standard geological terminology. Terminology used by the dimension stone industry is defined in the following table and is used in this report.

DIMENSION STONE INDUSTRY TERMINOLOGY

accessory minerals
Minerals that occur in minute quantities and do not affect the polish or appearance of the rock are referred to as accessory minerals. Accessory minerals that affect a finished surface by plucking are referred to by their correct mineralogical term, *e.g.,* altered sphene, epidote. Minerals that rust and bleed are identified as iron minerals.

ashlar
Rectangular pieces of non-uniform size that are set randomly in a wall.

biotite
Dark coloured minerals such as biotite, hornblende, etc.

black granite
Any crystalline igneous rock that is dark grey, dark green, dark brown, dark blue or black. Typically, these are gabbro, norite, diabase and similar mafic intrusive rocks (Storey, 1986).

bleeding
Rust stains caused by the decomposition of certain minerals to ferric oxide (Currier, 1960).

building stone
All natural stone used in building construction (structural support, curtain walls, veneer, floor tiles and ornamental stone).

dimension stone
i) United States Bureau of Mines definition: all forms of building stone.
ii) industry definition: stone that is cut and finished to predetermined size (Currier, 1960).

feldspar
Any type of feldspar crystal (microcline, plagioclase, etc.).

granite
Any light coloured crystalline igneous rock. This term includes granite, syenite, quartz, monzonite and granodiorite (Storey, 1986).

hair lines
Very narrow fractures that may not be visible on the outcrop surface.

iron minerals
A general term for small particles of metallic sulphides or oxides of such metallic elements as iron, copper and titanium (Currier, 1960).

knots
Segregations of dark or light coloured minerals that give rise to unsightly spots, which disrupt the harmonious mixture of even sized minerals (Currier, 1960).

mixture
The overall aspect of the stone that results from the colour, size and distribution of the components (Currier, 1960).

monumental stone
Granite and marble stone used in the manufacture of grave markers, mausoleums, and memorials.

peristeritic
Rock that shows a blue lustrous reflection on the surfaces of feldspar crystals.

streaks
Concentrations of minerals of the same colour along a line. Biotite streaks are the most common and troublesome (Currier, 1960).

unfractured
A granite outcrop described as unfractured has no large scale fractures. Microfractures are always present.

variegated granite
Includes a wide variety of gneissic, igneous and metamorphic rocks, both uniformly layered and nebulitic (Storey, 1986).

vein
Thin sheet-like intrusion into a fracture; may be the same rock type as the host rock, but with a different grain size, or may be a different rock type than the host rock.

waves
Schlieren.

GEOLOGICAL TERMINOLOGY

Definition of all technical terms highlighted in bold in the text are given below for ease of use by the reader.

altered sphene
A powdery yellow substance formed from a breakdown of the mineral sphene ($CaTiSiO_5$), a common accessory mineral in granites, to anatase (TiO_2) and calcite ($CaCO_3$). Altered sphene plucks when polished and leaves pits on the finished surface.

anatase
A titanium-bearing mineral, TiO_2, that occurs as an alteration product of other titanium minerals, in this case, sphene ($CaTiSiO_5$).

calcite
A common rock-forming mineral, calcite ($CaCO_3$) occurs in granite of the Betula Lake Pluton as an alteration product of sphene ($CaTiSiO_5$). It is soft and plucks from the polished surface, marring the polish.

dip of fracture
The angle that a fracture makes with the horizontal, measured perpendicular to the **strike** of the fracture.

garnet
A brittle, transparent to subtransparent mineral that occurs as an accessory mineral in some granites. Garnets are usually red, but occur in a variety of colours. Garnets are difficult to polish because of their hardness, but can impart attractive colours and textures to finished surfaces. The chemical formula for garnet is $A_3B_2(SiO_4)_3$, where A is Ca, Mg, Fe^{+2}, Mn^{+2} and B is Al, Fe^{+3}, Mn^{+3}, Cr.

inclusion
A fragment of previously crystallized rock within a granite or other type of intrusive rock.

intrusion
An igneous rock mass formed by emplacement of magma into preexisting rock.

muscovite
A light coloured mica mineral.

pluton
See 'intrusion'.

porphyritic
A textural term that describes large crystals set in a groundmass of smaller crystals.

strike of fracture
The azimuth of a fracture as it intersects the horizontal.

CHARACTERISTICS OF GRANITIC PLUTONS WITH DIMENSION STONE POTENTIAL IN SOUTHEAST MANITOBA

Portions of the Lac du Bonnet Batholith (LDBB), the Betula Lake Pluton (BLP) and the Medika Pluton (Fig. 5) are potential sources of dimension stone. Outcrops of these intrusions have similar features, namely:

1. Flat or low relief, generally with widely spaced fractures; high ridges and hills are more intensely fractured;
2. Interior surface plateaus of large ridges have a lower fracture frequency than the sides of the ridges;
3. Rounded hill-like outcrops have nonorthogonal, closely spaced fractures;
4. Vertical fractures appear to decrease in frequency with descending ledges in all three plutons. Evidence in the LDBB from drill core and Atomic Energy of Canada Ltd.'s Underground Research Lab (URL) indicates that both vertical and horizontal fractures disappear with depth;
5. The most unfractured outcrops in the LDBB and BLP are yellowish-grey phases of these predominantly red intrusions. These outcrops appear to underlie red granite outcrops in the BLP. Yellow-grey granite of the LDBB underlies red granite where both have been observed in drill cores and in the URL;
6. The rock tends to have a deeper red colour adjacent to fractures. The absence of red colouration in the yellow-grey phases may be related to the absence of fractures; and
7. There is some evidence that the unfractured outcrops of all three plutons have high horizontal stresses that cause "destressing" fractures to occur when rock is removed. For example, there is spalling of rock on the tunnels and the shaft walls below the 240 m level of the URL shaft (R. Everitt, pers. comm., 1991), the near-surface quarry floor pops up in the Medika Pluton, and pop-ups have been observed in the yellow-grey granite of the BLP. This indicates that the frequency of vertical and horizontal fractures in the BLP probably decreases with depth as it does in the LDBB. Therefore, an outcrop of this rock with closely spaced fractures at surface may have widely spaced fractures at depth. Generally, it is not economically feasible to remove the overlying highly fractured rock to find areas with widely spaced fractures.

At the outset of this project it was thought that outcrops with the highest potential for dimension stone production were the low-lying flat outcrops with no fractures visible at surface. **However, outcrops with widely spaced vertical fractures now appear to be better targets because some stress release has occurred and this reduces the problem of destressing fractures, which can occur when the rock is quarried.**

Information obtained from the URL shaft and drill cores from the LDBB indicates that the deeper yellow-grey granite has fewer vertical and horizontal fractures than the overlying pink granite. The yellow-grey granite of the BLP, which has not been drilled to date, is also devoid of large-scale horizontal and vertical fractures. However, it could ex-

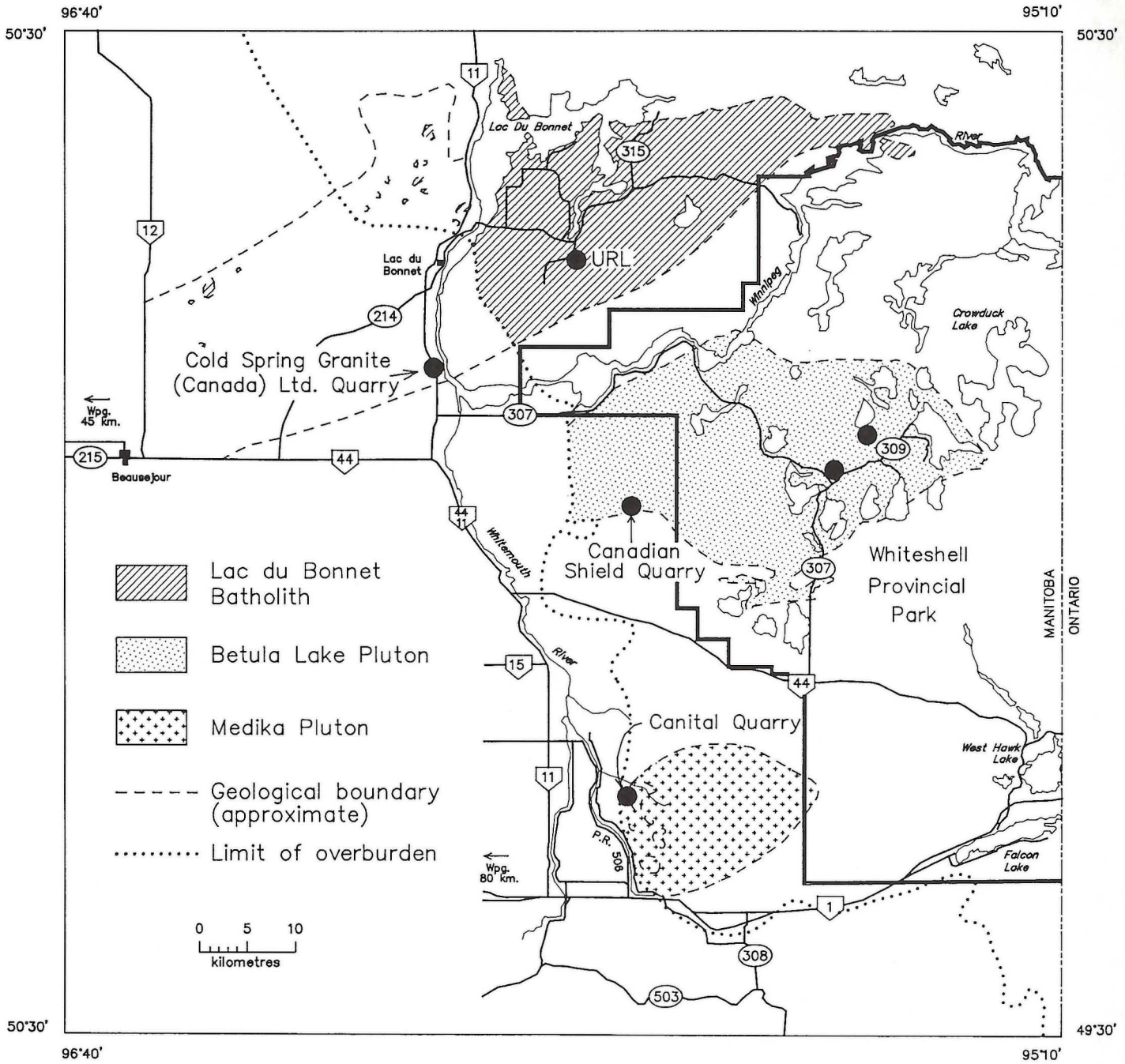


Figure 5: Location of the Lac du Bonnet Batholith, Betula Lake Pluton and Medika Pluton. These three intrusions are potential sources of dimension stone.

hibit a stress field with high horizontal compressive stresses that will cause fractures during or after quarrying.

Rounded hill-like outcrops in all three plutons tend to have closely spaced fractures. It appears that exfoliation of layers of granite with closely spaced nonorthogonal fractures produces rounded hill-like outcrops, whereas exfoliation of outcrops with orthogonal fracture sets produces orthogonal, ledged ridges.

SUMMARY

The LDBB, BLP and Medika Pluton (Fig. 5) have the highest potential for dimension stone production in southeast Manitoba.

LAC DU BONNET BATHOLITH

The extent of the LDBB is shown in Figure 5. Cold Spring Granite (Canada) Ltd. operates a granite quarry on a medium grained, red granite outcrop of the LDBB located approximately 5 km southwest of the town of Lac du Bonnet. Both yellow-grey and pink-red granite occur in the LDBB. Although a few outcrops have fractures spaced more than 2 m apart, most outcrops have fractures spaced less than 1 m apart. However, the frequency of vertical and horizontal fractures decreases with depth at the Cold Spring Granite (Canada) Ltd. quarry. The subvertical fractures are widely spaced below the first lift (approximately 3 m). **All outcrops of the LDBB that occur west of PR 317 and south of the south shores of Lac du Bonnet can be considered potential sources of dimension stone because the frequency of fractures may decrease with depth as they do at the Cold Spring quarry.** Further assessment of the LDBB using a combination of drilling and radar seismic surveys could be done to assess the dimension stone potential of the outcrops with closely spaced fractures at surface.

Streaks, very coarse grained veins, and colour variations are distributed randomly throughout this granite. The veins are commonly closely spaced and vary in width from 1 cm to 1 m. Variegation is localized within the outcrops. Several grades of rock, from variegated to even grained, could be produced from one quarry.

The sites that were mapped in detail are shown on Figure 6. Fracture maps and detailed descriptions are presented on pages 38-44.

BETULA LAKE PLUTON

Most of the BLP is situated in the north half of Whiteshell Provincial Park (Fig. 5). A number of outcrops with the potential to be sources of dimension stone are located between Meditation Lake in the east and PR 307 south of Nutimik Lake in the west (Fig. 7). Additional outcrops with the physical features required in a dimension stone are found within the cottage subdivisions at White and Jessica lakes south of the junction of PR 307 and PR 309, but have been excluded as high potential sites because quarrying activities would conflict with recreational uses. Several outcrops of BLP granite (Fig. 8) occur near the fireguard road that forms the western boundary of the Whiteshell Provincial Forest between Seven Sisters and Darwin. Several of these outcrops are potential sources of dimension stone, and the Canadian Shield Quarry is located at one of these outcrops.

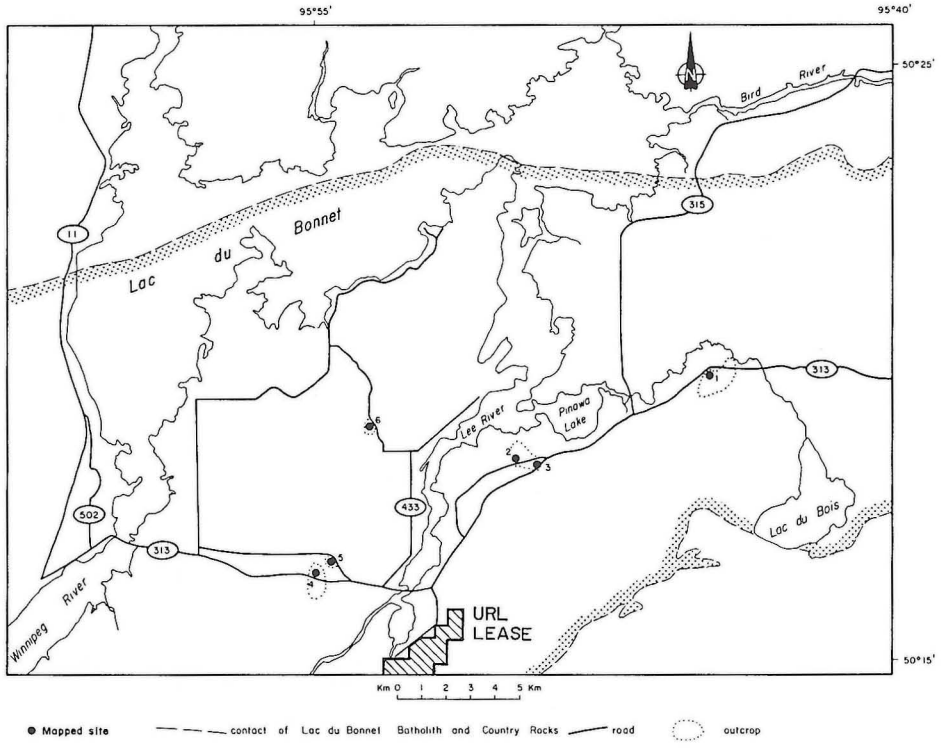


Figure 6: Sites examined in detail within the Lac du Bonnet Batholith.

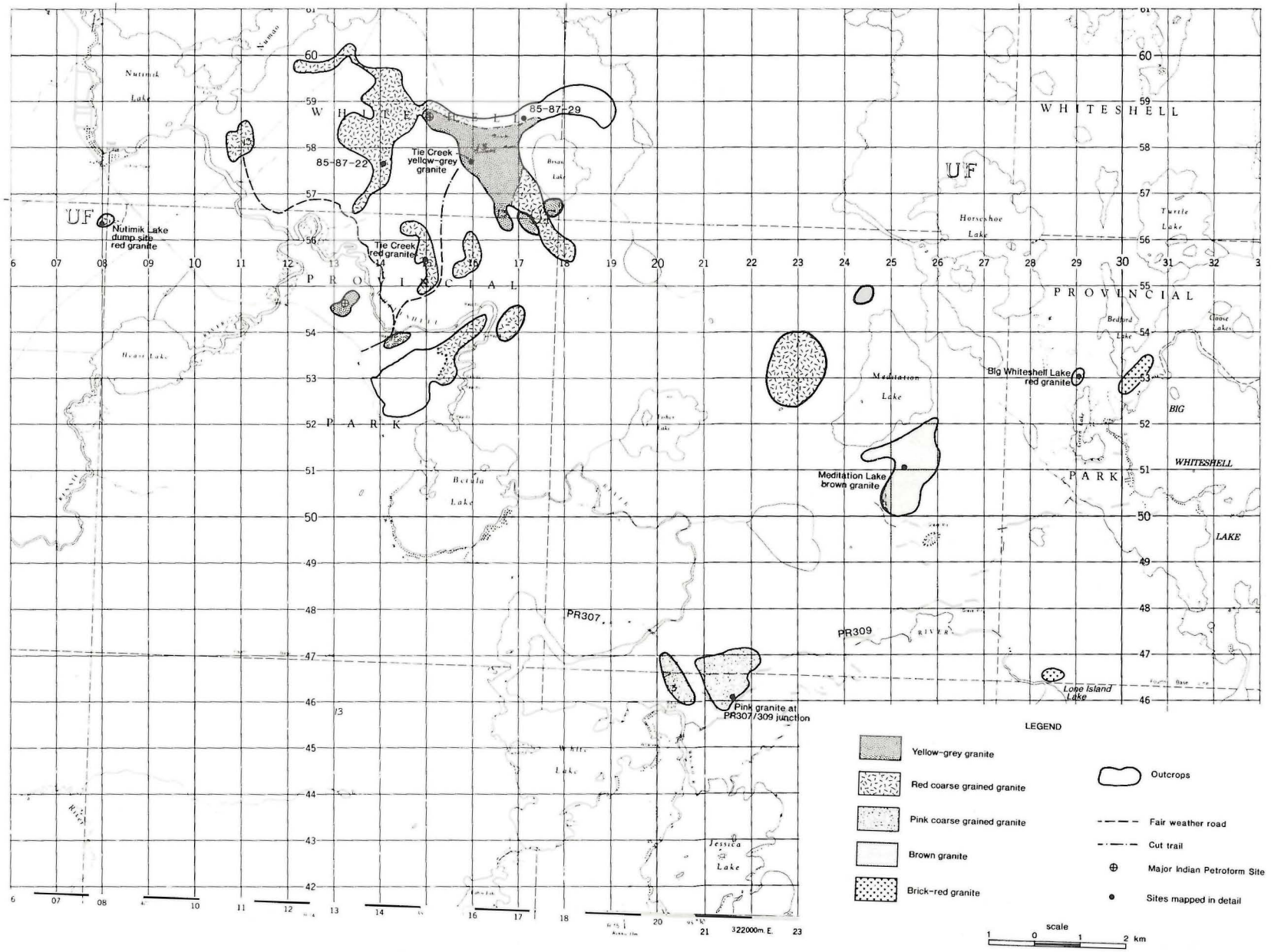


Figure 7: Sites examined within the Whiteshell Provincial Park portion of the Betula Lake Pluton.

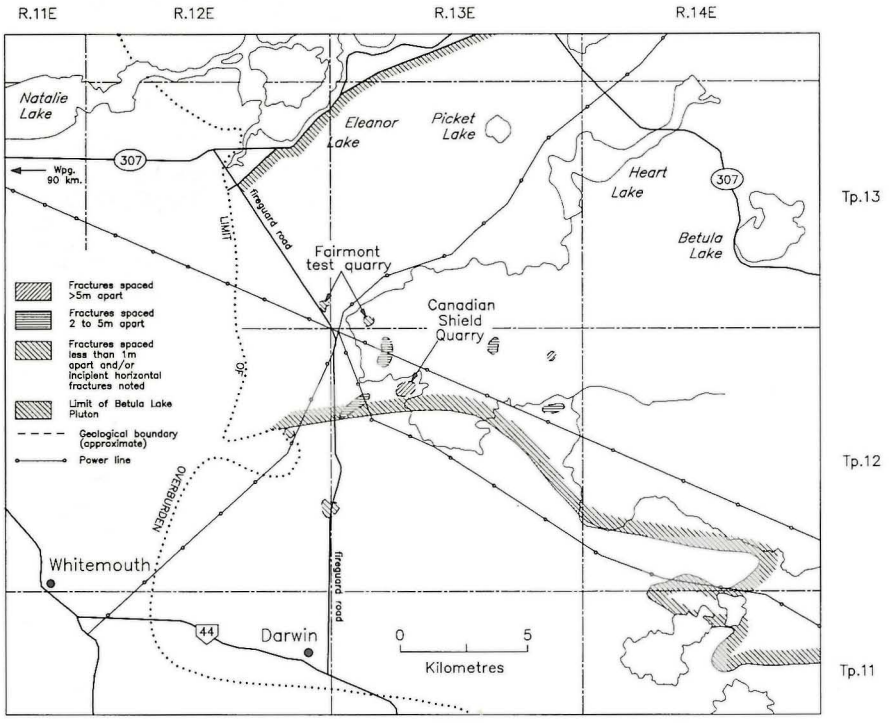


Figure 8: Sites examined within the portion of the Betula Lake Pluton that occurs outside of Whiteshell Provincial Park.

The BLP granite is coarse grained, shows colour and textural variegation, and has widely spaced horizontal and vertical fractures on some outcrops. Yellow, red, pink and brown granites are observed at surface in the BLP; it is not known if they change with depth. Variegation in the rock is the result of black streaks, elongated black knots and an alignment of tabular feldspar crystals. A schiller is prominent on large feldspar crystals. **Altered sphene** is found in most outcrops; it plucks when polished and leaves powdery yellow pits on the polished surface.

The location of outcrops examined for dimension stone potential are shown on Figures 7 and 8; fracture maps and descriptions of high potential outcrops are presented on pages 24-48.

MEDIKA PLUTON

Outcrops of the Medika Pluton occur outside Whiteshell Provincial Park between Medika and Prawda (Fig. 9). Generally, the outcrops are surrounded by swamp and are difficult to access. Canital Granite Ltd. holds a lease on an area with mahogany-coloured granite located within the Medika Pluton.

The texture and composition of the granite are similar to that of the BLP granite with large tabular twinned feldspar crystals, grey-brown quartz and black biotite. Samples taken from the surfaces of these outcrops tend to be pink to red, but weathering obscures the true colour of the granite. A more detailed description and diagram are presented on page 16.

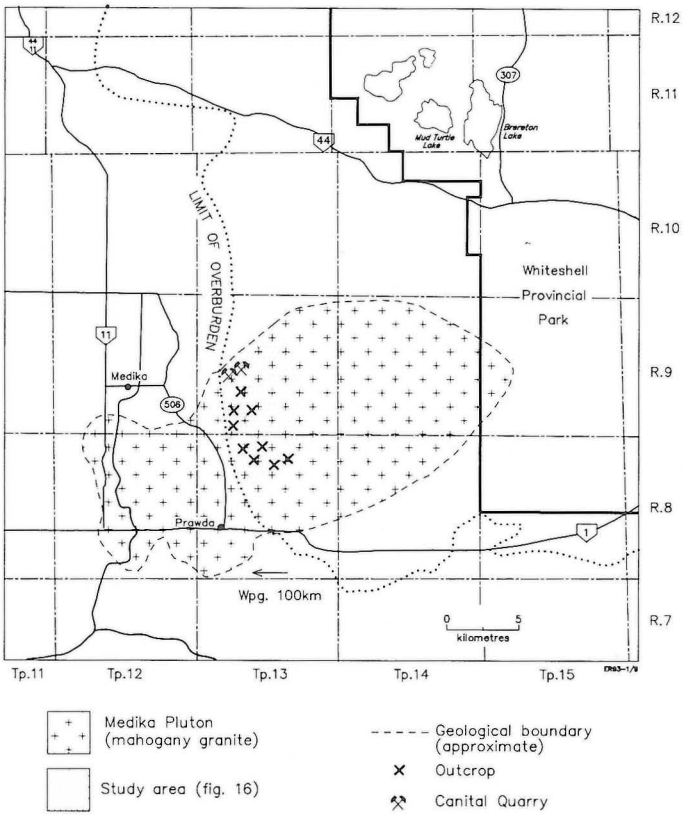


Figure 9: Sites examined within the Medika Pluton. The boundaries of the pluton that extend beyond the limit of overburden were inferred from aeromagnetic surveys.

PART 2: INVENTORY OF POTENTIAL SOURCES OF DIMENSION STONE

For the purpose of this inventory, southeast Manitoba was divided into the four areas (Fig. 10):

1. Granitic bodies south of Trans-Canada Highway No. 1.
2. Granitic bodies between Trans-Canada Highway No. 1 to the south and Red Rock Lake to the north;
3. Granitic bodies between Red Rock Lake to the south and Bird River to the north; and,
4. Granitic bodies between Bird River to the south and Black River to the north.

AREA 1: SOUTH OF TRANS-CANADA HIGHWAY NO. 1

EAST BRAINTREE RED COARSE GRAINED GRANITE AND GREY-BLACK VARIEGATED GRANITE

Geological map reference: Preliminary Map 1976F-2 (Janes, 1976b)

Red, very coarse grained granite and grey-black variegated granite, which is intruded by the former, occur near East Braintree (Fig. 11). Both types of granite were quarried previously for dimension stone. The quarries are accessed by PR 308 south from Trans-Canada Highway No. 1 at the turnoff to East Braintree (Fig. 12). The red granite quarry is located adjacent to a gravel road, whereas small quarries of

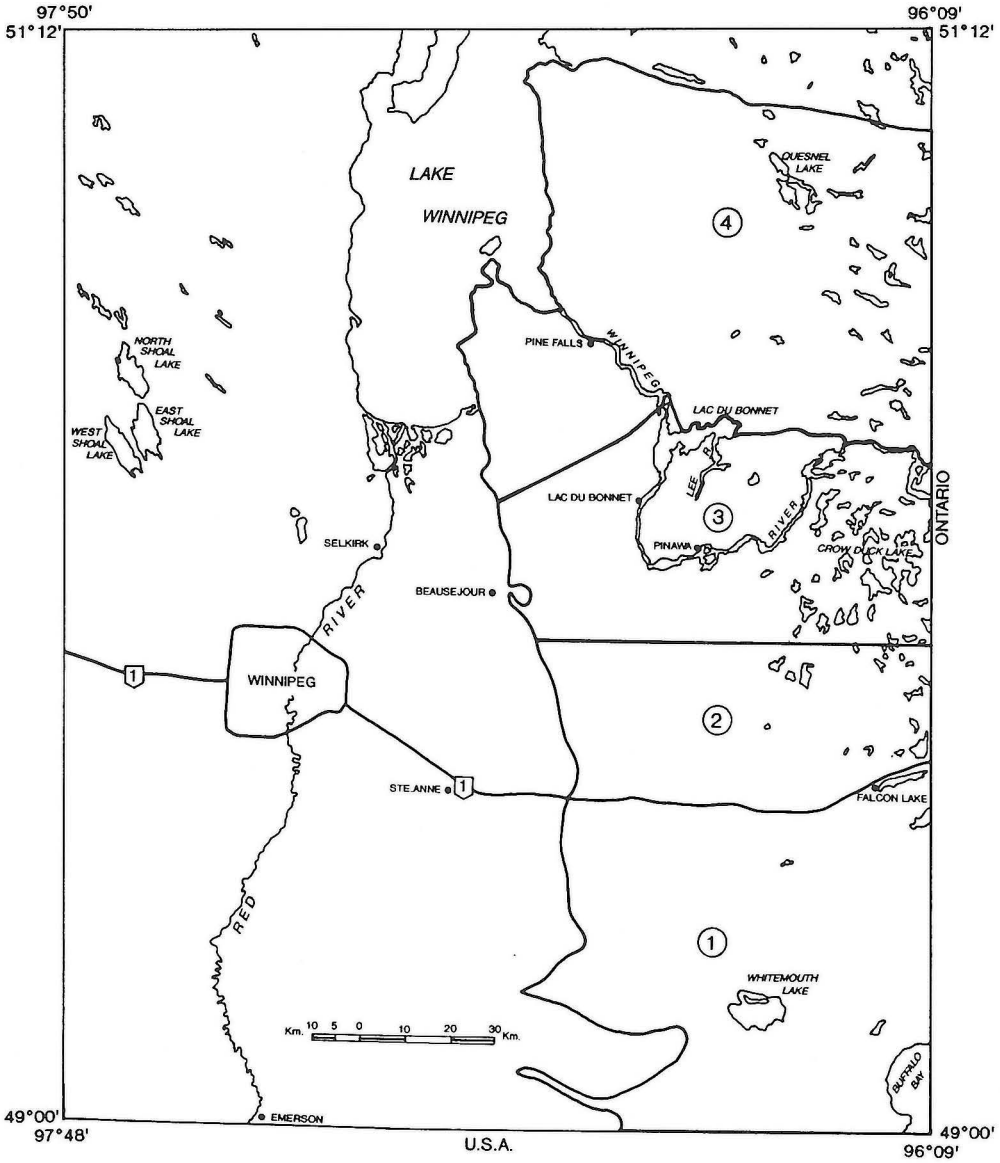


Figure 10: Subdivision of the dimension stone project area. Circled numbers indicate the four subdivisions used in this report and refer to areas 1 to 4 in the text.

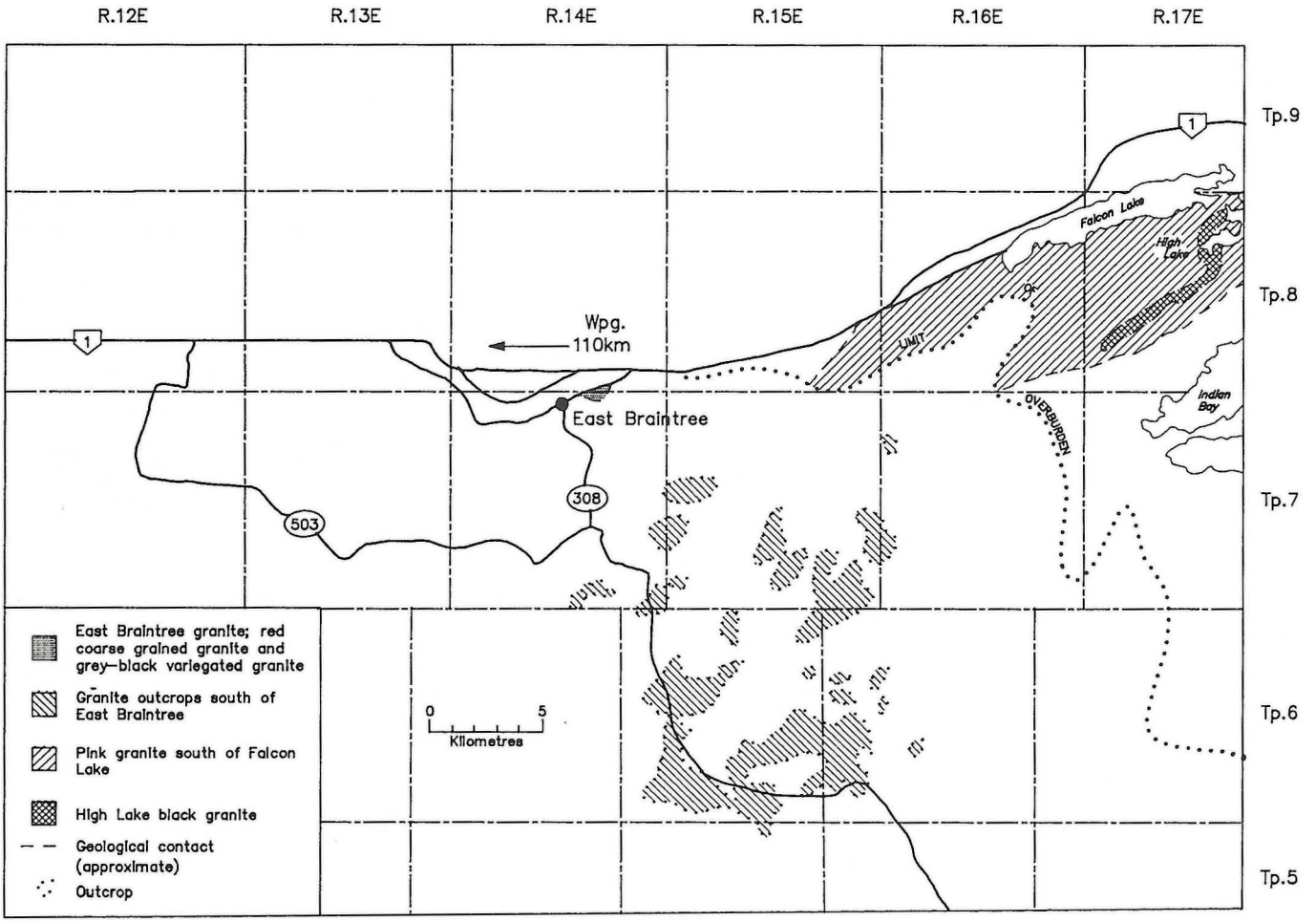


Figure 11: Index map of Area 1 (Fig. 10). The geological contacts that extend beyond the limit of overburden are inferred.

the grey variegated granite are located south of the red granite quarry (Fig. 12).

The East Braintree granite quarries (Fig. 12) are the oldest abandoned dimension stone quarries in southeast Manitoba. The stone was first mentioned in 1916 when it was called the "Pipeline Granite". Brookeville Granite Quarries Limited was formed in 1921 and produced two types of granite, the St. Cloud Red and St. Cloud Grey, until 1924. Production figures from this period are unknown. The McMunn Granite Company removed 30 tonnes of stone from the quarries between 1964 and 1967. The property has not been leased since 1973. The red granite quarry is adjacent to the fire tower and the grey-black granite quarries are approximately 150 m south of the fire tower.

The red granite varies from medium- to very coarse-grained and has well formed feldspar crystals up to 15 cm in length. Some of the feldspars are **peristeritic** and give the stone a blue schiller, which is particularly noticeable in some of the very coarse grained feldspar crystals. The granite is composed mainly of feldspar and quartz with rare, 3 to 5 cm long biotite crystals that pluck when polished.

Blocks of red granite with dimensions of up to 1.5 m by 1.0 m by 1.0 m are found at the abandoned quarry. Fractures are spaced from less than 1 m up to 3 m apart. Textural and grain size variations and the presence of large biotite crystals caused a high waste factor in this quarry. This rock may be a suitable source of granitic aggregate.

South of the abandoned quarry sites, there are outcrops of medium- to very coarse grained granite with widely spaced fractures. Most of the granite is free of black minerals, but large crystals of black biotite occur in the coarse grained sections.

The grey variegated granite, which is older than the red granite, has closely spaced nonorthogonal fractures and one metre square, irregularly shaped blocks found at two abandoned quarries. The colour and texture of the rock are very attractive: white feldspar eyes are separated by black mafic bands.

Figure 12: Location of abandoned quarries near East Braintree. The grey-black granite is probably a large inclusion of older granite within the red granite (Fig. 11).

GRANITE SOUTH OF EAST BRAINTREE

Geological map reference: Preliminary Map 1976F-2 (Janes, 1976b)

Outcrops of pink to buff granite are located within an area of extensive swamp with a high water table along PR 308 south of East Braintree, approximately 120 to 130 km east of Winnipeg (Figs. 11, 13). Samples from roadside outcrops take a smooth polish, but show colour, textural and grain size variations between outcrops. The exposures adjacent to the road are generally too small to adequately evaluate fracture patterns. Two large flat outcrops (outlined on Figure 13) identified on aerial photographs and briefly examined during a 1989 helicopter survey appear to have moderate potential, but require further study.

PINK GRANITE SOUTH OF FALCON LAKE

Geological map reference: Preliminary Map 1978F-1 (Janes, 1978a)

Pink coarse grained granite occurs south of Falcon Lake approximately 140 km east of Winnipeg (Figs. 11 and 14). Access is via the road to the cottages on the south shore of Falcon Lake (Fig. 14). The rock is intersected by thin veins of fine grained pink granite and very coarse grained granite. Samples from this area contain coarse grained, pale pink feldspar crystals in a medium grained, predominantly pink, groundmass of feldspar, quartz and biotite. The outcrops form high ridges and have fractures spaced less than 1 m apart. This granite is not considered a potential source of dimension stone because the fractures are too closely spaced.

HIGH LAKE BLACK GRANITE

Geological map reference: Preliminary Map 1978F-1 (Janes, 1978a), Map 50-6 (Springer, 1952)

The High Lake black granite (Figs. 11, 14) occurs on the southwest shore of High Lake, approximately 140 km from Winnipeg. It can be accessed by a 7 km winter road through swamp that intersects the road to the Falcon Lake ski hill.

The fine- to medium-grained black granite intrusion contains inclusions of recrystallized volcanic rocks and is cut by veins of fine grained white granite and very coarse grained pink granite. Polished samples of the black granite are dark grey to black. The presence of blue quartz imparts a three-dimensional look to the polished samples. Outcrops of this rock are generally poorly exposed and closely frac-

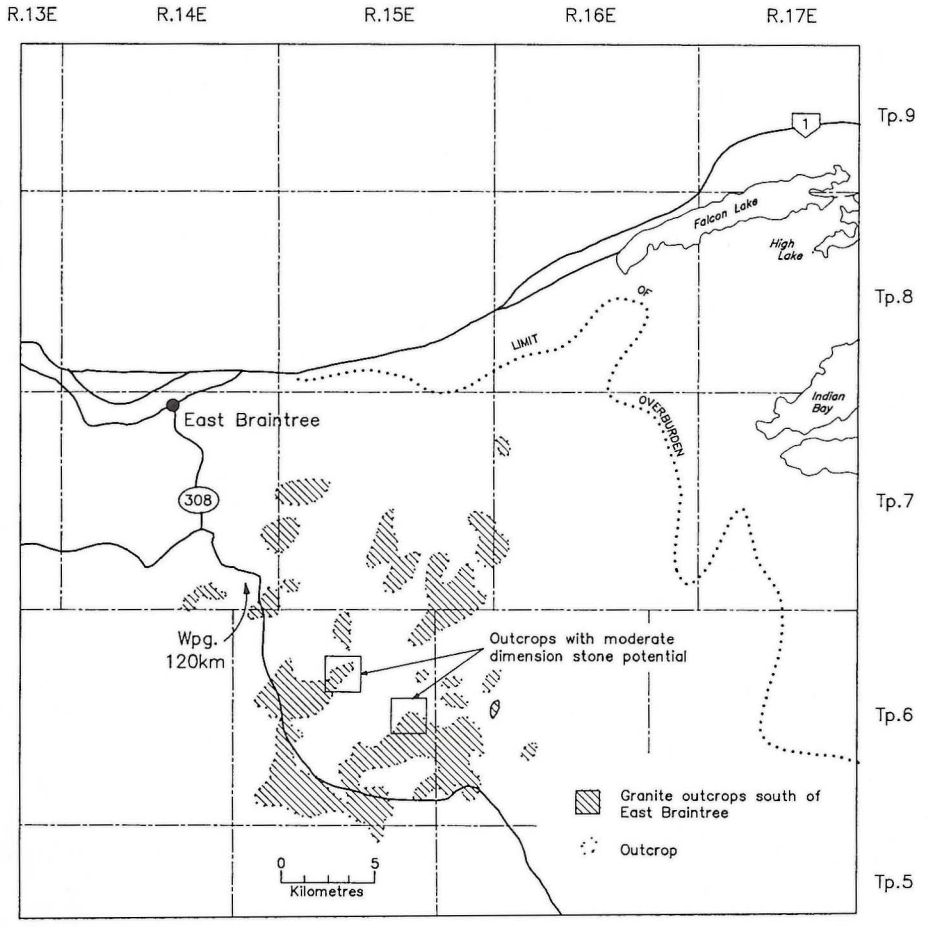


Figure 13: Sites examined for dimension stone potential south of East Braintree. These sites are isolated outcrops surrounded by swamp.

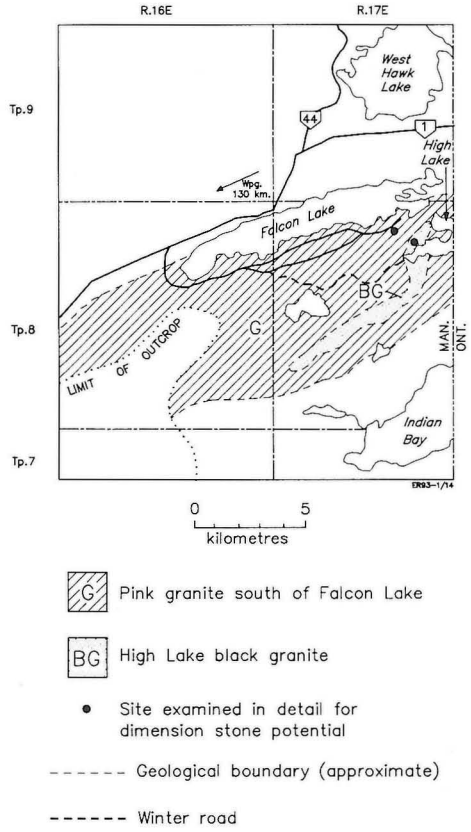


Figure 14: Locations of coarse grained pink granite and black granite south of Falcon Lake.

tured. Nonorthogonal vertical fracture sets are spaced from less than 1 m to 2 m apart; however, the average distance between fractures is less than 1 m. Difficult access, closely spaced fractures and common veins indicate that this rock has little potential as a dimension stone.

AREA 2: TRANS-CANADA HIGHWAY NORTH TO BRERETON LAKE

MEDIKA MAHOGANY GRANITE

Geological map reference: Preliminary Map 1976F-2 (Janes, 1976b)

Several large, unfractured outcrops of very coarse grained red to mahogany granite occur east of Medika (Fig. 9), approximately 100 km from Winnipeg (Fig. 15). The rock has 1 to 2.5 cm tabular feldspar crystals that exhibit a schiller similar to those found in rocks of the BLP.

Some of the outcrops have vertical and horizontal fractures spaced tens of metres apart. Unfractured outcrops in the Medika area are located at least 1.5 km from the existing road and are surrounded by swamp and farmland. Several outcrops, labelled 1 and 2 on Figure 16, are presently leased by Canital Granite Ltd.

Outcrops at site 2 directly east of the Canital quarries are flat, unfractured, coarse grained, red to mahogany granite similar to that at site 1. Outcrops with some relief have fractures that are generally spaced several metres apart. Southeast of the Canital quarries, a series of north-trending outcrops appear, from aerial photographs, to have few fractures (Fig. 16). South of these outcrops, the exposures contain finer grained, variegated granite with closely spaced fractures, as well as coarser grained granite. Further evaluation of this area is warranted.

McMUNN PINK GRANITE

Geological map reference: Preliminary Map 1976F-2 (Janes, 1976b)

Exposures of fine- to medium-grained, pale pink, variegated granite that consists of feldspar, quartz and biotite occur near Trans-Canada Highway No. 1 in the vicinity of the McMunn Hotel, approximately 100 km east of Winnipeg (Figs. 15, 17). Three outcrops near Trans-Canada Highway No. 1 and one approximately 2 km north of the highway were evaluated for their dimension stone potential. Most of the outcrops within this granite have closely spaced fractures and variable colour and texture.

Site MG-1 (Fig. 17), located 2 km north of the highway and 1 km west of some gravel pits, is a series of rounded ridges with vertical and horizontal fractures spaced several metres apart. Three fracture sets are present: two are suborthogonal to each other, and the third is oblique. Veins of very coarse grained granite, spaced less than 10 m apart, are present. The pale pink colour and medium grain size are homogeneous throughout the outcrop.

Sites MG-2 and MG-3 (Fig. 17), located between the McMunn hotel and the gravel pits, are accessible via service roads to the Trans-Canada pipe line. Horizontal and vertical fractures are generally less than one metre apart. The grain size varies from fine to coarse. Several small outcrops near MG-2 have vertical fractures spaced several metres apart, but most of the outcrop in these areas has closely spaced fractures and variable colour and texture.

Site MG-4 (Fig. 17) has fractures spaced up to 15 m apart. The grain size varies from fine to coarse. Colour variations, black streaks and very coarse grained veins occur throughout the rock. An abandoned test pit is located on the southwest corner of the outcrop. A horizontal fracture is visible approximately one metre below the surface of the outcrop. Several small nonorthogonal blocks with maximum dimensions of approximately 1 m^3 remain at the site.

The pink granite intrudes an older grey granite that crops out in several places along Trans-Canada Highway No. 1 in the vicinity of the McMunn Hotel. The fractures in this grey granite are closely spaced, and outcrop surfaces are rust stained from bleeding of iron minerals. These rocks are not considered to be potential sources of dimension stone due to the closely spaced fractures and the presence of iron minerals.

GLENN GREEN GRANITE

Geological map reference: Preliminary Map 1978F-1 (Janes, 1978a)

The Glenn green granite (Figs. 15, 18) is situated approximately 1 km north of Trans-Canada Highway No. 1, 5 km northeast of the village of Glenn and 120 km east of

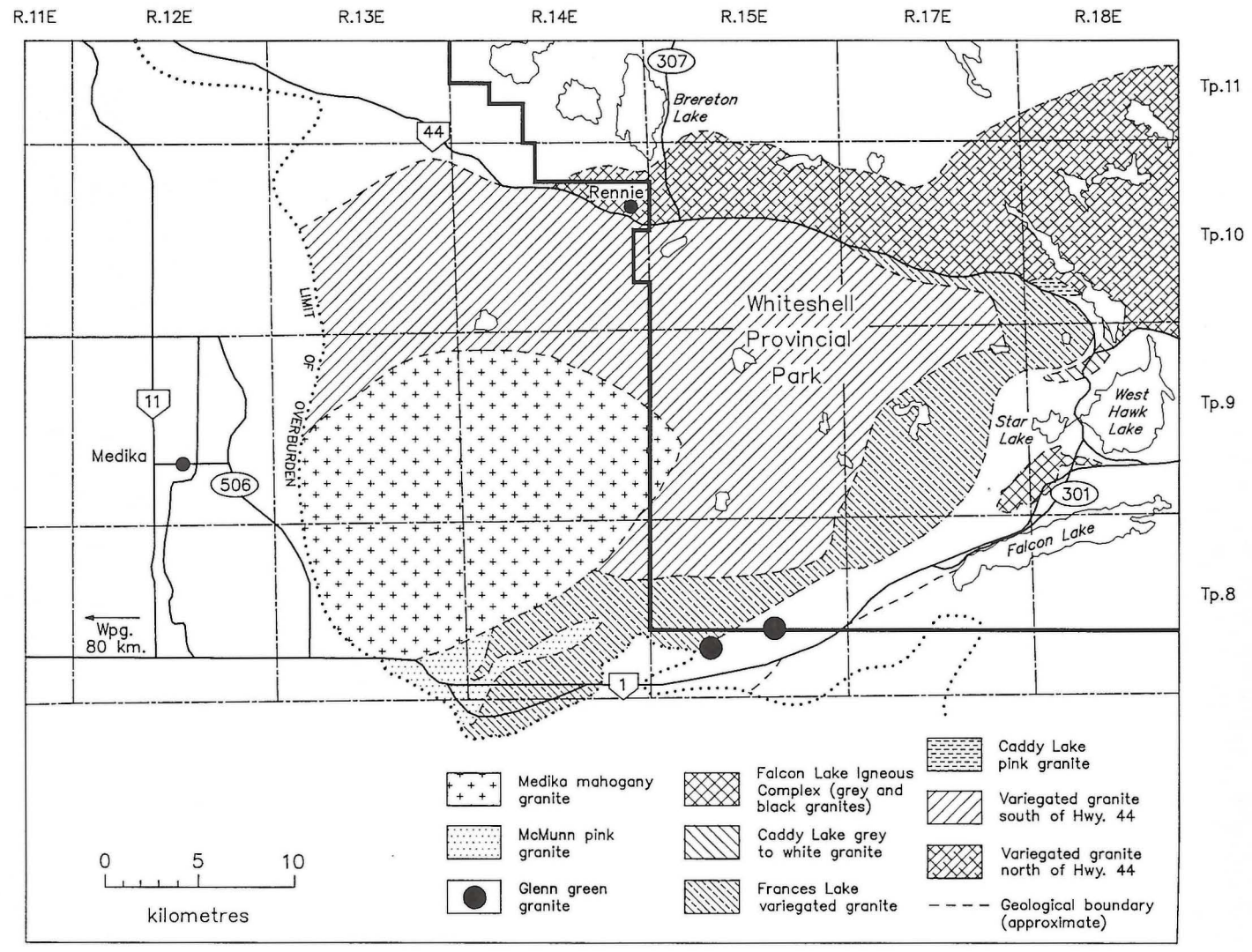


Figure 15: Index map of Area 2 (Fig. 10)

Winnipeg. Access is by a trail through swamp across the Trans-Canada pipe line.

The Glenn green granite is an approximately 100 by 100 m body with an equigranular, medium grained texture and attractive green colour. The granite is finer grained at the contact with the surrounding rock. Green feldspar and black biotite are the main constituents; quartz and iron minerals are present in minor amounts. Iron minerals are disseminated throughout the rock, and old records indicate that bleeding produced unsightly rust spots on monuments made from this stone. Biotite plucks when the rock is polished, making it difficult to obtain a smooth finished surface.

The fractures are less than 1 m apart and the fracture orientation is nonorthogonal. The bottom of the old quarry appears to have more widely spaced fractures than the surface; this suggests that the frequency of vertical fractures probably decreases with depth.

Glenn quarry

The Glenn quarry (Fig. 18) was first opened by Joe Wirth in 1946. In 1948, the Shoal Lake Granite Company was formed to quarry rock for monuments. The rock was removed mainly by feather wedging; however, some black powder was used to blast it free. By the spring of 1949, polishing was done near the quarry site. Blocks were moved 150 m to the camp, where they were smoothed and leveled using a manually operated hammer and chisel machine, and then polished with a motorized polishing wheel that was directed manually over the block faces. Operations ceased in 1951.

Stone from the Glenn quarry could possibly be used to make decorative ornaments because it has an unusual and attractive green colour. The body of green granite is too small and the fractures are too closely spaced to support a quarry for large blocks.

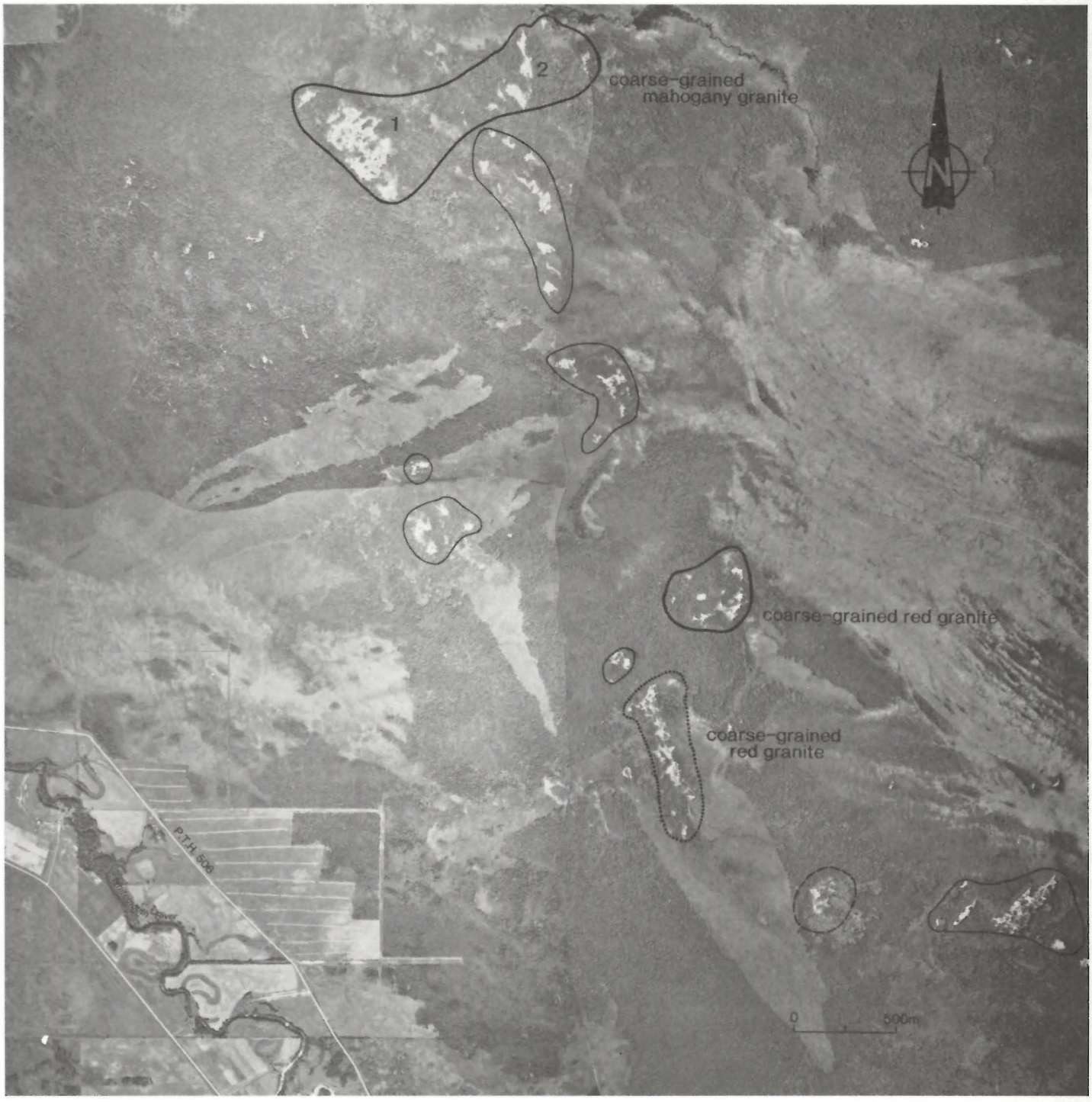


Figure 16: Aerial photograph mosaic showing outcrops of mahogany granite of the Medika Pluton that were studied for dimension stone potential (Fig. 9). The heavy solid line indicates moderate to high dimension stone potential based on field examination. The light solid line indicates moderate to high potential based on aerial photograph interpretation (Fig. 9). The dotted line indicates low potential based on field examination, and the dashed line indicates low potential based on aerial photograph interpretation.

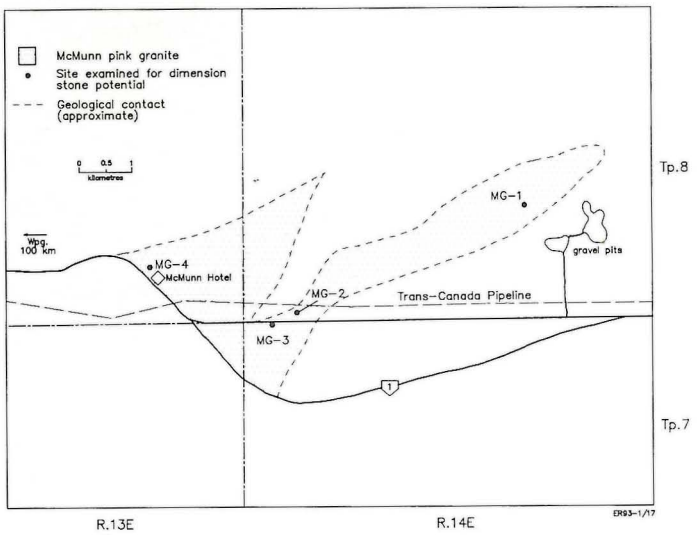


Figure 17: Sites examined in detail in the McMunn pink granite.

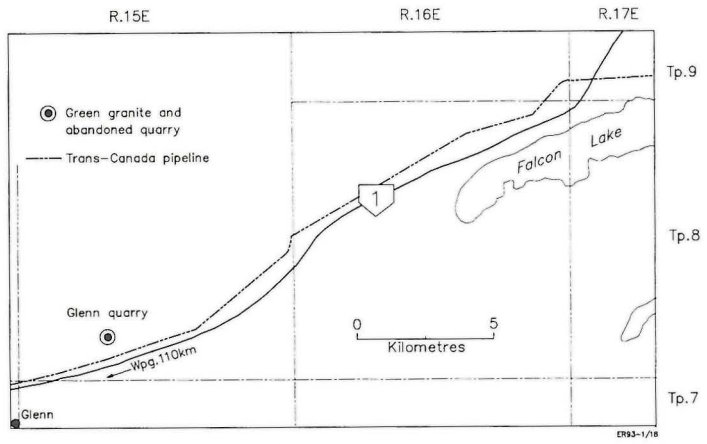


Figure 18: Site examined in detail in the Glenn green granite. The size of the body of green granite is exaggerated for illustrative purposes.

FALCON LAKE BLACK AND GREY GRANITES

Geological map reference: Preliminary Map 1978F-1 (Janes, 1978a)

The "Falcon Lake Igneous Complex" (FLIC) occurs in Whiteshell Provincial Park between Star Lake and PR 301, approximately 130 km east of Winnipeg (Figs. 15, 19).

The regional geological setting of the FLIC is illustrated in Figure 20. The FLIC is a 9 km^2 zoned pipe-like **intrusion** with concentric units of black granite and grey-black granite that surround a grey granite core. Mandziuk (1986) has identified the outermost phases as five distinct black granites (Fig. 20). Black granites 3 and 4 contain abandoned dimension stone quarries. Black granites 1 and 3 have the highest potential as dimension stone producers. Black granites 2 and 5 were not accessed.

Black granite 1

Black granite 1 (Fig. 20) is a fine- to medium-grained black rock that contains some coarse grained feldspar crystals, which are aligned and give the polished rock a variegated appearance. The polished rock is black with fine grained white speckles. Pinhead-sized crystals of disseminated iron minerals are visible on the polished surface.

Three subvertical fracture sets were recorded: two are orthogonal and one is oblique. The maximum spacing of fractures is 1.5 to 2.0 m, but the average spacing is less than a metre. The distance between horizontal fractures is not known because they are not exposed.

Most of black granite 1 has to be excluded from development because it is located adjacent to the village of West Hawk Lake and the West Hawk Lake trailer park.

Black granites 3 and 4

A quarry in black granite 4 was opened in 1938 by L.H. Sprange of Winnipeg. Rock from this pit contained iron minerals that rusted on the exposed surfaces of quarried blocks. A second pit was opened in black granite 3, which contains fewer iron minerals. Monument and building stone were produced until 1952 and marketed under the trade name "Winblack". Production of 760 tonnes was recorded from 1944 to 1952; peak production of 170 tonnes was attained in 1948, but production records are incomplete. The lease was cancelled in 1964.

Black granites 3 and 4 are medium- to coarse-grained with a speckled black-and-white colour. Both black granites have igneous layers that give a variegated appearance to the polished surface. Dykes of grey granite intrude black granite 4. Inclusions of older units are found in both black granites.

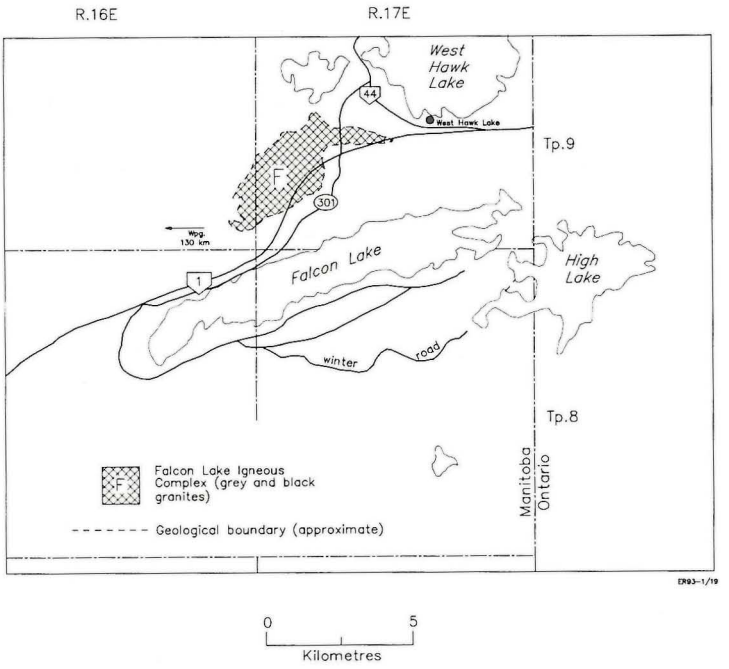


Figure 19: Location of the Falcon Lake Igneous Complex.

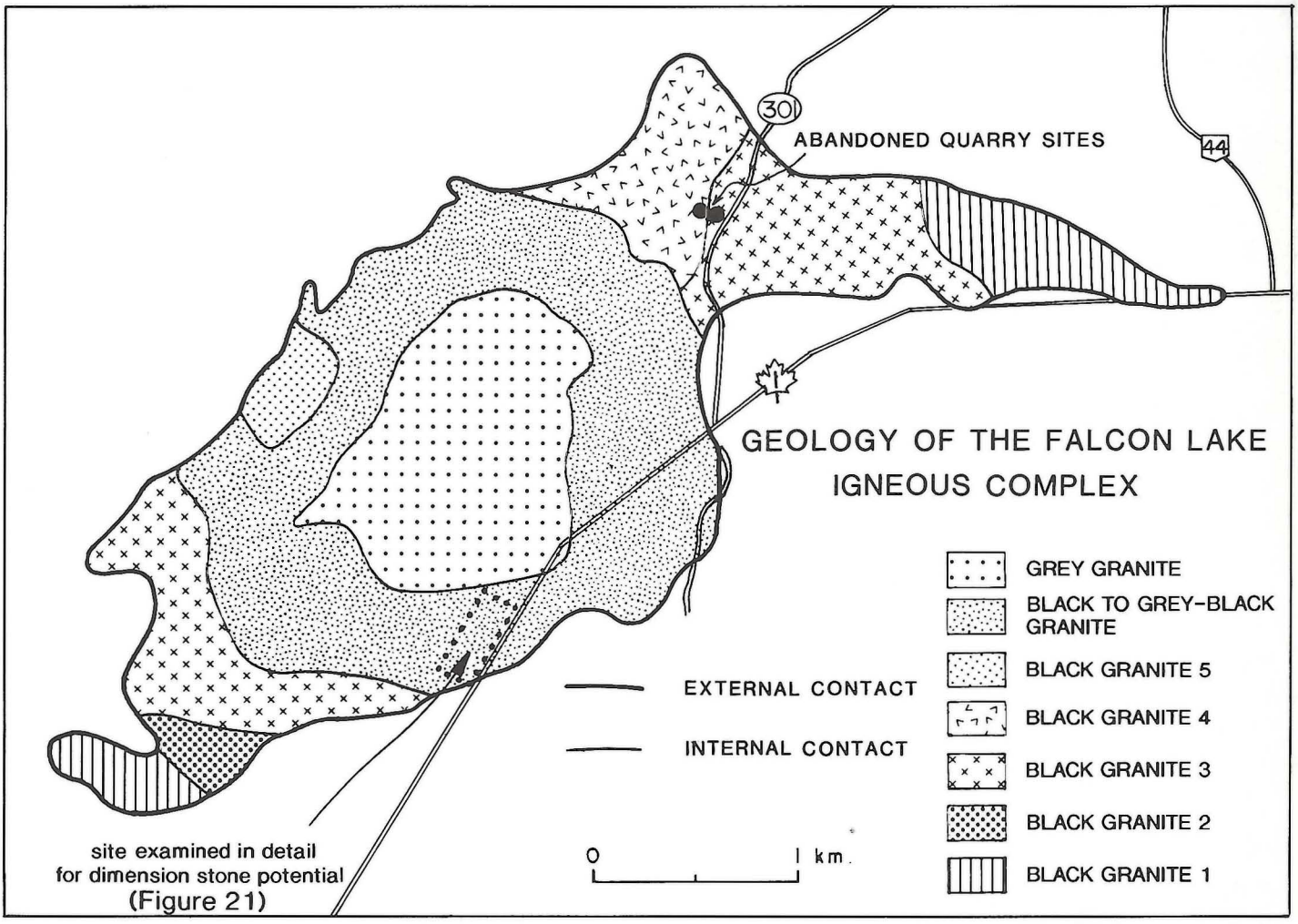


Figure 20: Geology of the Falcon Lake Igneous Complex (after Mandziuk, 1986). The complex contains grey and black granites. External contacts are those between the external limits of the Complex and the surrounding rock; internal contacts are those between subsequent phases of the complex.

Outcrops of black granite 3 are accessible via Trans-Canada Highway No. 1 and PR 304. Polished samples from several sites within black granite 3 are coarse grained with black and white flecks. The darkest coloured samples were collected from the bottom of the quarry, and it is possible that rock from the other sites would also be darker coloured at depth.

Nonorthogonal vertical and shallow-**dipping** fracture sets in black granite 3, usually less than 1 m apart, result in irregularly shaped blocks. The waste factor of a quarry in this rock would be high because most of the quarried blocks would be small and nonorthogonal.

Black granite 4 does not have a high potential for dimension stone production because it contains a high percentage of iron minerals.

Grey-black granite

The black to grey-black granite (Fig. 20) grades from black granite on the outermost edge of the unit to grey-black granite adjacent to a grey granite core. This rock consists of feldspar, biotite, quartz and accessories.

Ridges of grey-black granite occur approximately 100 m north of Trans-Canada Highway No. 1 (Figs. 15, 21). The north face of the ridge labelled 1 on Figure 21 is a steep cliff from which boulders of grey-black granite have exfoliated and fallen into the gully below. The southeast face is a road cut.

Flat outcrops on the top of the ridges 3 and 4 are relatively well exposed and have widely spaced major fractures. These outcrops have many small fractures and quartz veins interspersed between the major fractures. The distance between all types of fractures averages less than 1 m, but some fractures are up to 2 m apart. Some exfoliated blocks are over 2 m in length, which also indicates widely spaced fractures. At least 90% of the exfoliated blocks are small and nonorthogonal. On ridge 1, small areas (less than 100 m^2) with widely spaced fractures are interspersed between larger areas (greater than 100 m^2) with closely spaced fractures.

The predominant **strike of fractures** on this outcrop is east-west. Fracture measurements taken along ridges east of the outcrop that was mapped in detail indicate that most of the fractures intersect each other at oblique angles.

Horizontal fractures present on the steep cliff on the north face of ridge 1 are spaced an average of 0.7 m apart. Three diamond drill holes were cored (Fig. 21) to determine the horizontal fracture spacing, but results were inconclusive, because it was impossible to tell if some of the breaks were caused by drilling or natural fracturing.

Several outcrops of medium grained, grey-black granite occur on the road to the abandoned Sunbeam-Kirkland gold mine in the centre of the granite body and along a power line. Fresh surfaces of this rock have a blue-green tint; polished samples are dark grey with a yellow cast. Fractures in the grey-black granite outcrops are generally spaced less than 1 m apart. Suborthogonal fracture sets are interspersed with randomly oriented fractures. Rock from outcrops along the mine road (Fig. 21) split into 5 cm thick slices parallel to the dominant fracture set.

The FLIC grey-black and grey granites have been used in ashlar fireplaces and rock gardens in several cottages at Star Lake.

Grey granite

The grey granite is the youngest phase of the FLIC. Closely spaced fractures, which occur in concentric rings around the breccia pipes that host the gold deposit, and the presence of iron minerals eliminate this rock as a potential source of dimension stone.

VARIEGATED GRANITE NORTH OF HIGHWAY 44

Geological map reference: Preliminary Map 1976F-3 (Janes, 1976c), Map 50-6 Rennie-West Hawk Lake Area (Springer, 1952)

Grey to buff variegated granite extends from Rennie, 110 km east of Winnipeg in the western part of Whiteshell Provincial Park, eastward for 35 km to the Manitoba-Ontario border near West Hawk Lake (Figs. 15, 22). The variegated granite is composed predominantly of feldspar, quartz and biotite, varies in colour and texture, and has nonorthogonal fractures spaced less than 1 m apart. Pink, very coarse grained veins, 2-4 cm wide, crosscut the foliation. All outcrops studied exhibit nonorthogonal, closely spaced, vertical fractures. Fracture sets are well developed on individual outcrops, but fracture orientations vary from outcrop to outcrop.

In roadside outcrops north of West Hawk Lake on PR 312, rocks have closely spaced horizontal fractures and vary in colour and grain size from a fine grained pink variegated granite with large feldspar crystals to a fine grained, grey, variegated granite over a distance of 10 m. In the Rennie-Brereton Lake area, the variegated granites accessed by Hwy 44 and PR 307 are buff to brown with a variegated texture.

The variegated unit has little potential for dimension stone production because it has closely spaced nonorthogonal fractures and wide variations in colour and texture.

CADDY LAKE PINK GRANITE

Geological map reference: Preliminary Map 1976F-3 (Janes, 1976c), Map 50-6 (Springer, 1952)

Pink granite occurs due west of Caddy Lake in Whiteshell Provincial Park, approximately 130 km east of Winnipeg (Figs. 15, 23). Outcrops are accessed by a cottage road to the west of Caddy Lake. The homogeneous, pink, medium grained rock is composed of feldspar, quartz and biotite. Three major sets of nonorthogonal vertical and horizontal fractures are spaced less than 1 m apart. Coarse grained veins parallel the dominant southeast-**striking** fracture set. This granite has low potential for dimension stone production because it has closely spaced nonorthogonal fractures and numerous very coarse grained veins.

Figure 21: Ridges of grey-black granite within the Falcon Lake Igneous Complex. These outcrops have the most widely spaced fractures observed within the complex (ref. Figure 19).

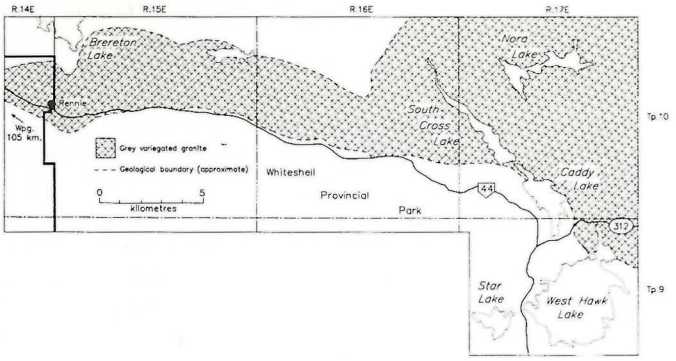


Figure 22: Location of grey variegated granite, north side of Provincial Highway 44, Whiteshell Provincial Park.

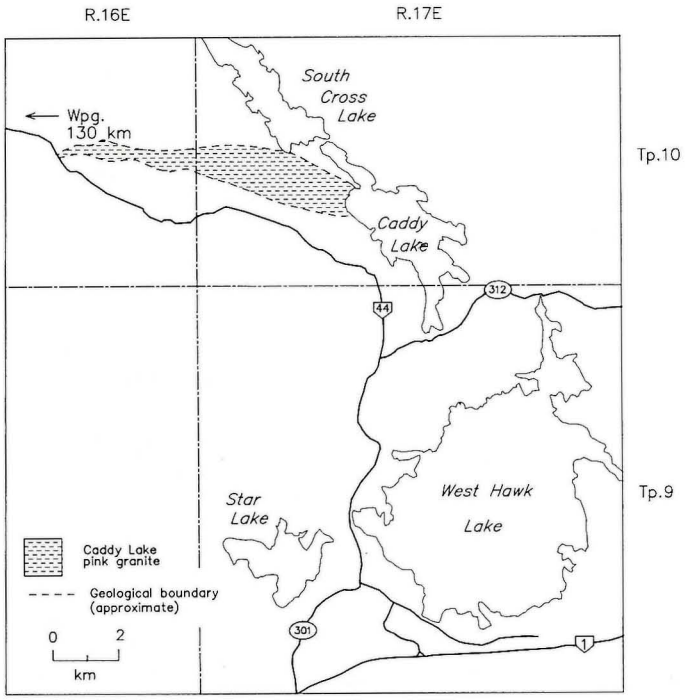


Figure 23: Location of the Caddy Lake pink granite.

CADDY LAKE GREY TO WHITE GRANITE

Geological map reference: Preliminary Map 1976F-3 (Janes, 1976c), Map 50-6 (Springer, 1952)

A grey to white, fine- to medium-grained granite occurs between West Hawk Lake and Caddy Lake (Figs. 15, 24). Two abandoned quarries of this granite are located on each side of Highway 44 near Caddy Lake (Fig. 24), approximately 130 km east of Winnipeg.

Grey-white granite outcrops underlie an area of less than 0.5 km^2. The stone takes an excellent polish. It contains minor iron minerals that do not appear to rust or bleed after years of exposure and small red **garnets**.

Three subvertical fracture sets are present; the most widely spaced fractures are 1 to 2 m apart. The rock is cut by numerous, closely spaced, very coarse grained veins.

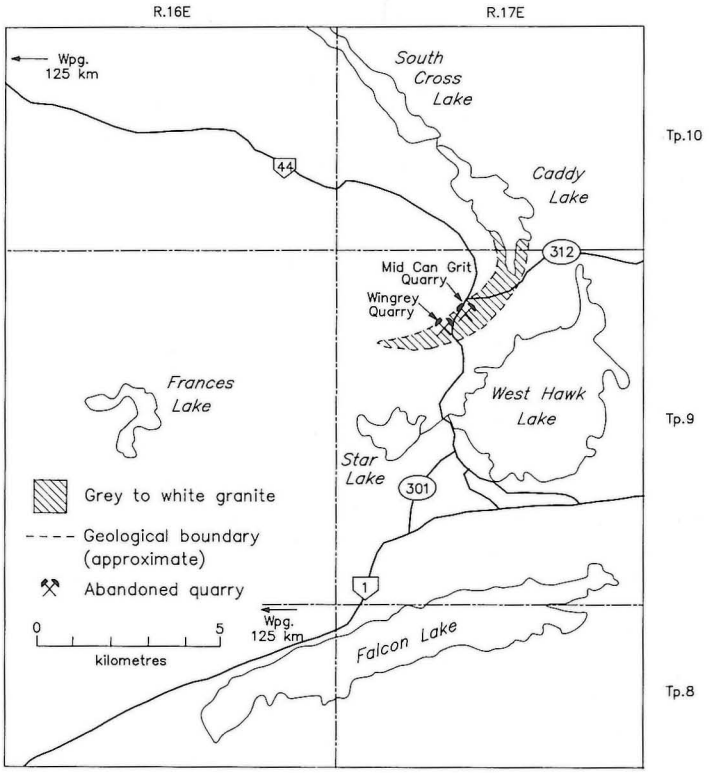


Figure 24: Location of the Caddy Lake white granite and quarries.

Horizontal fractures in the abandoned quarries are less than 1 m apart, but some of these fractures may be blast induced. Most of the granite within this intrusion is pink. This rock does not have potential to be a dimension stone producer because the fractures are closely spaced and the colour is variable.

Wingrey quarry

The Wingrey quarry is located on the west side of Highway 44 approximately 1.2 km north of West Hawk Lake in Whiteshell Provincial Park (Fig. 24).

The quarry was first staked in 1933 by L.H. Sprange for Memorial Marble and Tile Company Ltd. The Sprange family held the property until 1964, when the best quality stone was exhausted. Blocks were removed using jackhammers, tripod drills, plugs and feathers, and black powder. Quarried stone was trucked to Winnipeg for finishing. The waste factor of the quarry was greater than 80% because of the closely spaced fractures and veins and the colour variations. From 1964 until 1972, the north half of the property was held by D. Sutherland; quarried rock was used for exposed aggregate facings. The property has not been leased since 1972. Rock on the east side of Highway 44 (Fig. 24), directly across from the Wingrey quarry, was quarried as a source of "chicken grit" and decorative aggregate from 1962 to 1964 by the Mid Can Grit Company. This property has remained open since 1964.

Blasting has probably reduced the strength of this rock. The area of pure white rock is very small and it is

doubtful that enough has been left undisturbed by blasting to ensure an economic dimension stone operation.

Small outcrops of white granite are exposed north of the abandoned quarry near Caddy Lake. Colour variations, closely spaced fractures, and proximity to the Caddy Lake and West Hawk Lake cottage subdivisions make the outcrops unlikely prospects for a dimension stone quarry.

FRANCES LAKE VARIEGATED GRANITE

Geological map reference: Preliminary Map 1976F-3 (Janes, 1976c), Map 50-6 (Springer, 1952)

The Frances Lake variegated granite is located within Whiteshell Provincial Park. Large outcrops are visible on the south side of Highway 44 from Rennie, 110 km east of Winnipeg, to Lily Pond Lake, 130 km east of Winnipeg (Figs. 15, 25). No cottage developments are located in the area, but Lily Pond Lake, McGillivray Falls hiking trail, Frances Lake canoe route, and Hanson Creek are all Whiteshell Provincial Park recreational facilities located within the boundaries of the intrusion. Outcrops surrounding these sites were not evaluated during this study.

The least fractured outcrops identified on aerial photographs occur in the vicinity of Lily Pond Lake (Fig. 26). Access to these outcrops is from Highway 44 through swamp surrounding Lily Pond Lake. Some outcrops are accessible directly from the road at the start of the McGillivray Falls hiking trail. Variegation in this intrusion is most pronounced in the thin western arc that parallels the highway west of Lily Pond Lake (Fig. 25). These outcrops tend to have more closely spaced fractures than outcrops in the vicinity of Lily Pond Lake.

Less extensive exposures of this granite occur north of Highway 44, separated from the highway by cliffs of metasedimentary rocks.

Evaluation efforts were concentrated on outcrops in an area of approximately 1.25 km^2 southeast of Lily Pond Lake with high rounded outcrops because they appeared to be the least fractured rocks in the area (Fig. 26). The outcrops sampled are not visible from either Lily Pond Lake or the highway where tourists stop to enjoy the view.

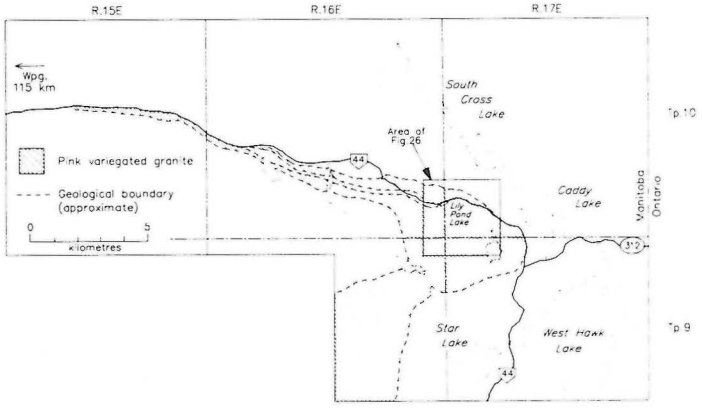


Figure 25: Location of part of the Frances Lake variegated granite.

The fractures are generally shallow **dipping** and spaced less than 2 m apart. Veins of red granite and very coarse grained granite are common. The texture of the rock is variable, changing from a variegated pink granite with coarse grained feldspar crystals to a medium grained, equigranular, red granite. Some rusting and bleeding occurs locally.

Several outcrops of the Frances Lake variegated granite between Lily Pond Lake and Rennie were also examined. All outcrops were found to have closely spaced, shallow **dipping** fractures and variable colours and textures similar to the outcrops south of Lily Pond Lake.

Polished samples of this rock have a beautiful colour and texture. Large ovoid pink feldspar crystals are set in darker coloured variegated bands of finer grained feldspar, quartz and biotite. Small grains of iron minerals in the rock occur in concentrations that may be too small to cause visible rusting and bleeding on finished surfaces.

BLACK GRANITE VEINS

Geological map reference: Map 50-6 (Springer, 1952)

Several black granite veins occur throughout the Caddy Lake-West Hawk Lake area (Springer, 1952) close to cottage areas. These late veins contain iron minerals and are only a few metres in width, which eliminates them as a source of dimension stone.

GREY VARIEGATED GRANITE SOUTH OF HIGHWAY 44

Geological map reference: Preliminary Map 1976F-3 (Janes, 1976c), Map 50-6 (Springer, 1952)

This is a fine- to medium-grained, buff to grey, variegated granite located mainly south of Highway 44 in the Rennie area approximately 110 km east of Winnipeg (Figs. 15, 27).

Variegation is produced by an alignment of biotite crystals. Narrow, very coarse grained veins are parallel to the textural variegation. Fractures in this rock are spaced less than 1 m apart and are nonorthogonal. Polished samples are dingy grey brown. The closely spaced fractures and the nondescript colour indicate that this intrusion has little potential as a source of dimension stone.

AREA 3: BRERETON LAKE TO BIRD RIVER

BETULA LAKE PLUTON

Geological map reference: Preliminary Maps 1976F-5 (Janes, 1976d), 1977F-2 (Janes and Malyon, 1977b)

The 650 km^2 main body of the BLP (Figs. 28, 29) is located within Whiteshell Provincial Park between Nutimik Lake to the north and Red Rock Lake to the south. It extends from the east shore of Whiteshell Lake westward to Eleanor Lake.

Janes (1976) and Janes and Malyon (1977) mapped two units, a coarse grained, red to brown granite and a brick-red granite. For the purpose of this study, both units are referred to as BLP granite. Both rock types contain

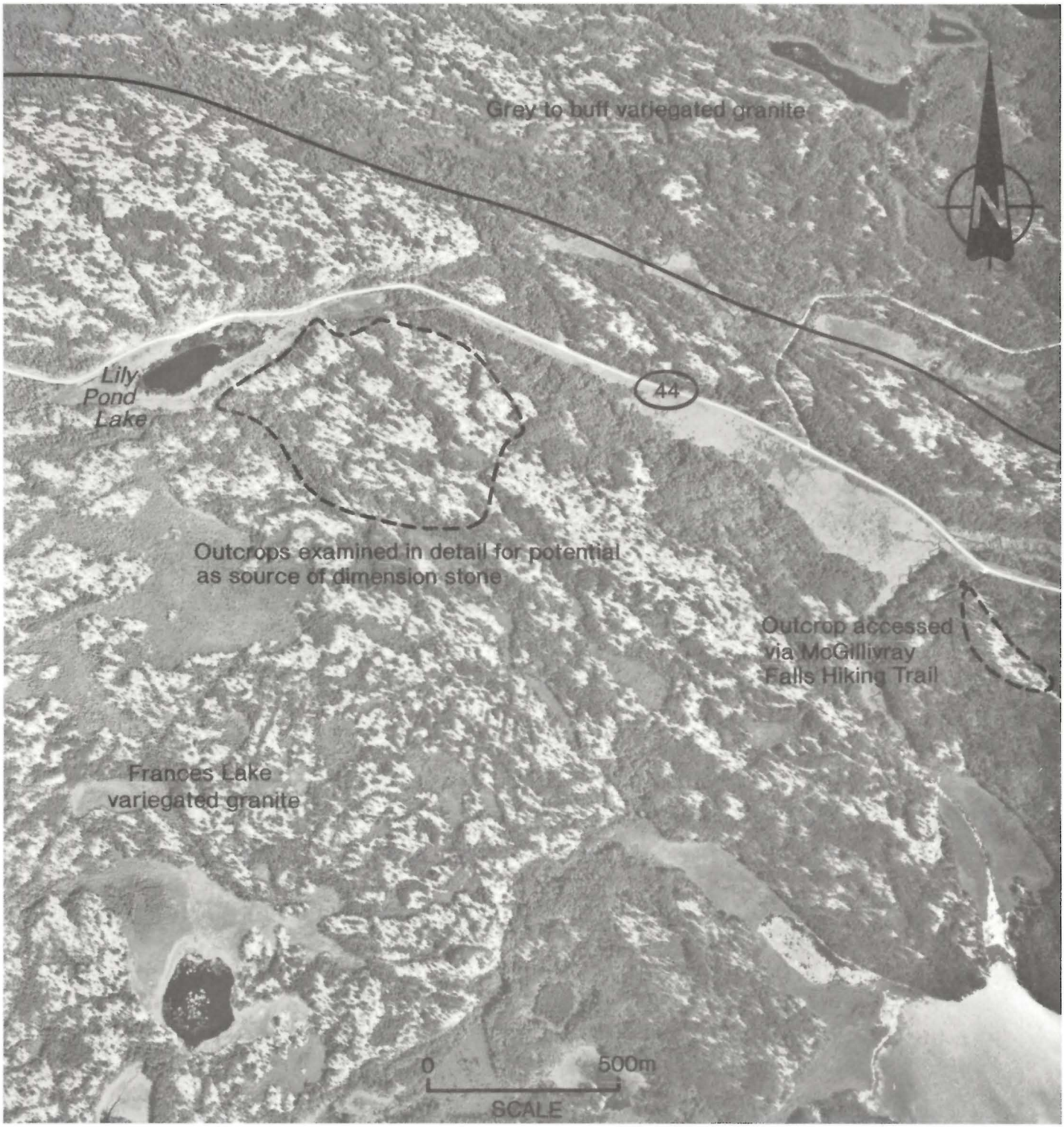


Figure 26: Sites examined in detail in the Frances Lake variegated granite (Fig. 25).

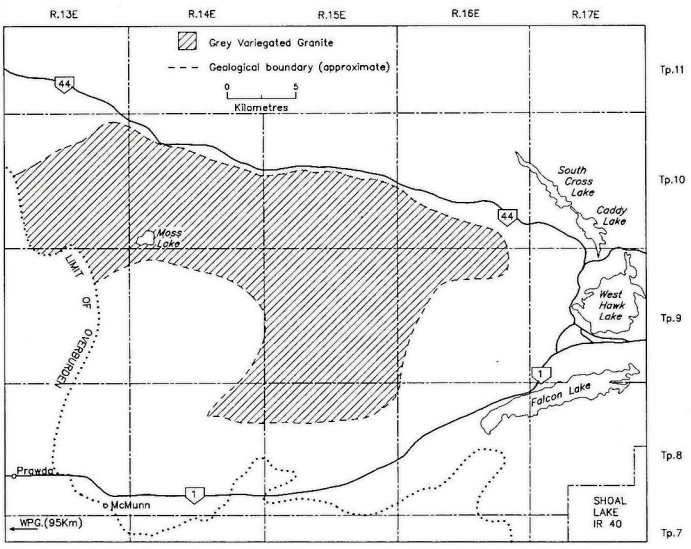


Figure 27: Location of grey variegated granite south side of Highway 44.

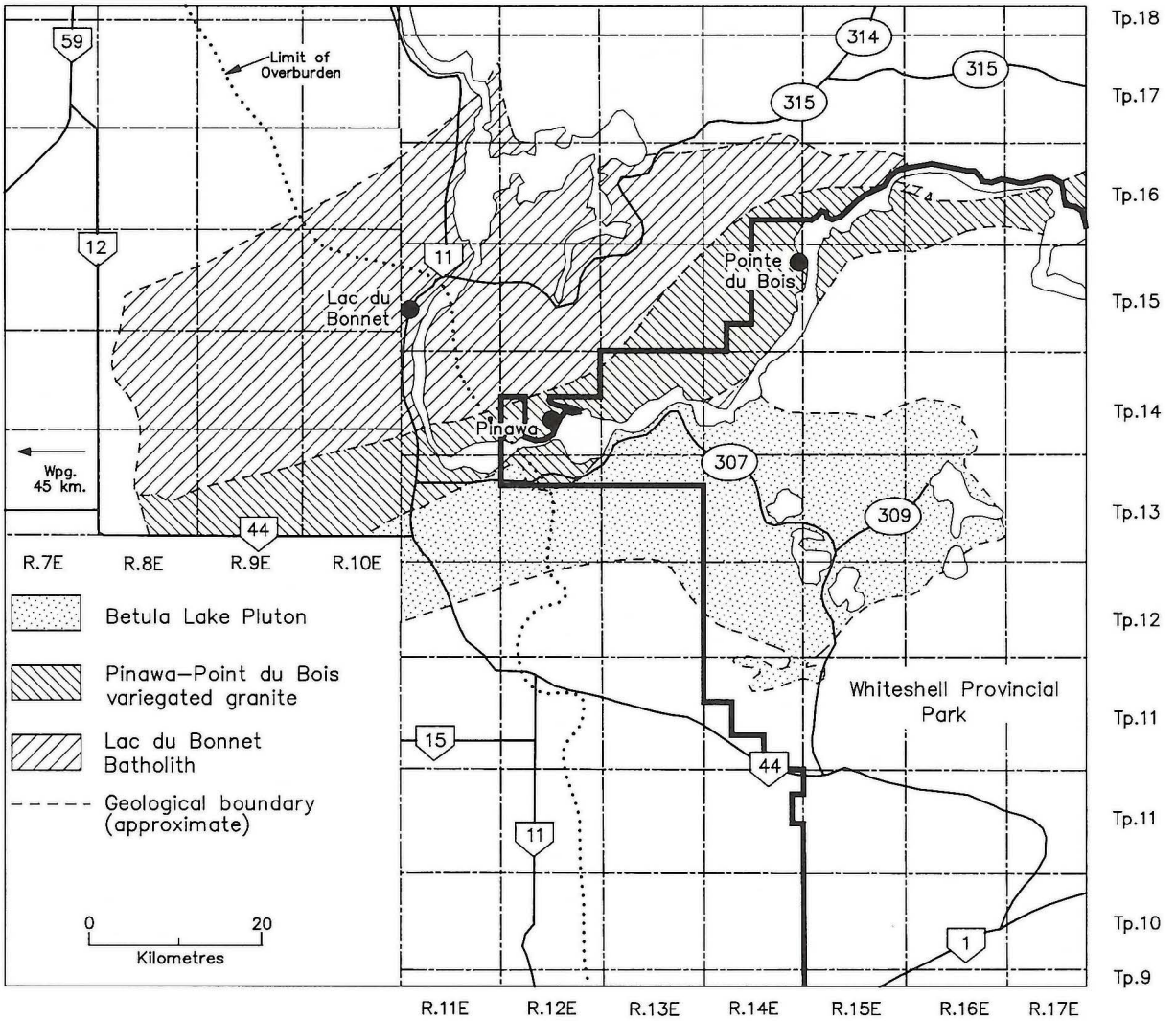


Figure 28: Index map of Area 3.

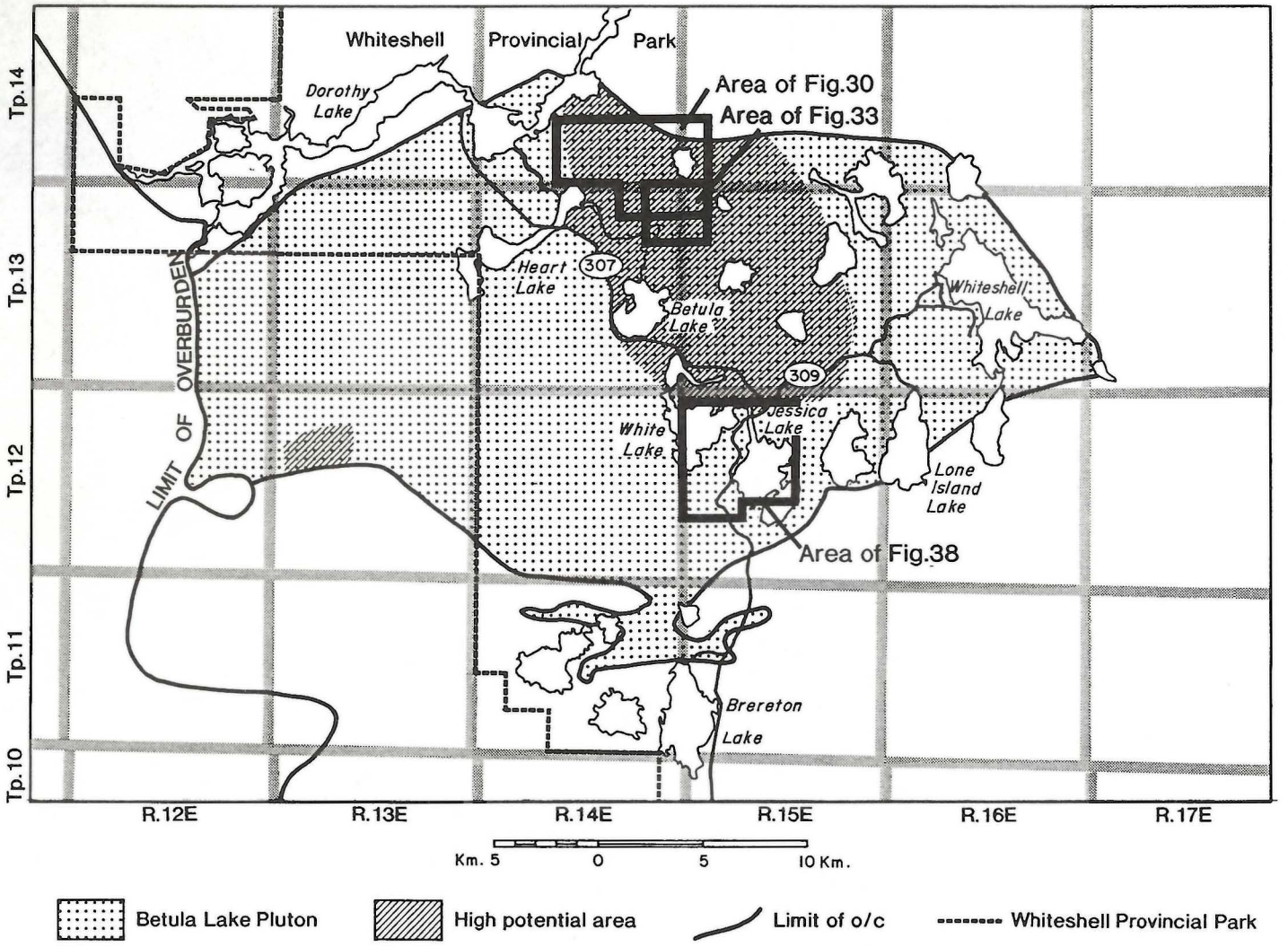


Figure 29: Location of the Betula Lake Pluton.

coarse grained, twinned feldspar crystals, and outcrops of both tend to have widely spaced orthogonal fractures.

This granitic rock contains 1-5 cm tabular feldspar crystals, quartz, biotite, and accessories. Many of the feldspar crystals exhibit a schiller. **Anatase** and **calcite** result from alteration of **sphene** and cause powdery yellow pits in the rock.

Based on field data, the BLP is the youngest intrusion south of the Winnipeg River System (Janes, 1976; Janes and Malyon, 1977). Rb-Sr radiometric dates have not confirmed this, but have shown that the time of intrusion was similar to that of other granitic bodies in southeastern Manitoba (Farquharson and Clark, 1971).

Outcrops within this pluton have high potential for dimension stone production. Several outcrops have fractures spaced more than 2 m apart. Four distinctly different colours are available: yellow, red, pink, and brown. The texture is attractive and marketable, and most areas are near roads.

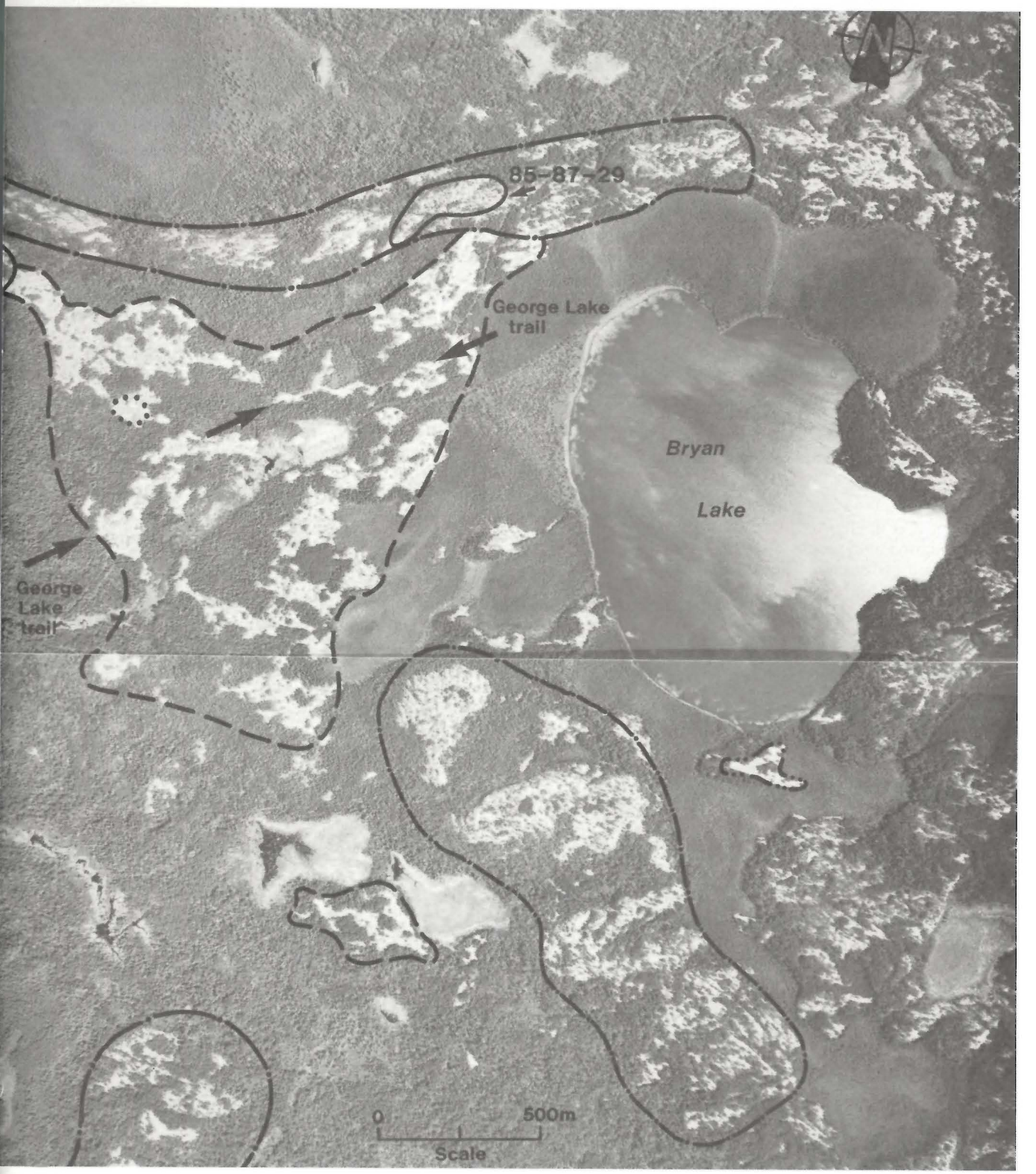
Tie Creek Basin

Part of the BLP is located in the vicinity of Nutimik Lake within Whiteshell Provincial Park (Fig. 7). Outcrops east of PR 307 and south of Nutimik Lake are located within the "Tie Creek Basin" and have high potential for dimension stone production. The most homogeneous and unfractured outcrops of the BLP are located within the Tie Creek Basin at least 5 km from cottages at Nutimik and Betula Lakes. Both yellow-grey and red, coarse grained granite outcrops occur in this area (Fig. 7).

Yellow-Grey Granite within the Tie Creek Basin

This rock has an attractive and unusual yellow-grey colour, is coarse grained and appears to be unfractured. The yellow-grey granite may have high potential for dimension stone production if it is not subject to high compressive stresses similar to those exhibited in unfractured outcrops in the Medika Pluton and the LDBB. Three exposures of the yellow-grey granite were examined (Figs. 29, 30).

Figure 30: Outcrops of yellow-grey granite surrounded by outcrops of red granite in the Tie Creek area. The outcrops of yellow-grey granite examined in the field are outlined with a dashed line, and those inferred to be yellow-grey granite by aerial photograph interpretation are outlined by a dash-double dot line. The Tie Creek petroform site, which occurs on the main exposure of yellow-grey granite, is outlined with a solid line. Red granite outcrops examined in the field are outlined by a dash-dot line (Fig. 29) The dotted line surrounds the map area shown in Figure 31.


N
85-87-29
George Lake
trail
Bryan
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George
Lake
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0
500m
Scale

The Tie Creek outcrop (the larger of two outcrops outlined by a dashed line on Fig. 30) is 2.5 by 1.5 km in size and appears to be unfractured. It is located approximately 130 km from Winnipeg, 5 to 7 km from cottages at Nutimik and Betula Lakes, and is accessed by a fair weather road that becomes a hunting trail approximately 1.5 km south of the outcrop. The rock contains 1 to 2 cm tabular yellow-grey feldspar crystals, quartz, biotite and accessory magnetite. Rusted iron minerals are visible locally on exfoliated slabs. Coarse grained veins, black streaks and knots parallel a slight variegation. One vertical fracture and no horizontal fractures were found in the entire outcrop area. A single hand sample was collected from an exfoliated slab for polishing. The outcrop is impossible to sample with a rock hammer because it is flat. The massive nature of this outcrop is illustrated on Figure 31.

An outcrop of yellow-grey granite (the smaller of two outcrops outlined by a dashed line on Figure 30) occurs approximately 0.5 km south of the main Tie Creek outcrop between two small swamps (Fig. 30). At this site, the rock is similar in structure, colour, texture and mineralogy to the Tie Creek outcrop.

Another outcrop that may be yellow-grey granite (outlined by a dash-double dot line on Fig. 30) occurs 1.5 km east of the main outcrop immediately south of Bryan Lake. This site, which was identified on an aerial photograph, appears to have the same structure as outcrops of the yellow-grey granite.

A fourth outcrop of unfractured coarse grained yellow-grey granite occurs adjacent to PR 307 north of Betula Lake, approximately 125 km from Winnipeg. This outcrop is the location of the Bannock Point petroform site. This collection of petroforms is an historic site within Whiteshell Provincial Park that is frequented by tourists. Observation towers are set on the rock and a plaque describing the site is located at the start of the trail that leads to the outcrop. This outcrop is not considered to be a source of dimension stone, even though it is structurally and mineralogically identical to the "Tie Creek" outcrop, because it is too small to contain a quarry that would not be visible from the petroform site.

Red Granite

Outcrops of red granite surround the yellow granite (Fig. 7) and appear to overlie it. The outcrops with the highest potential are ridges that have up to 2.5 m ledges and widely spaced vertical fractures at surface. Ridges with the highest potential can be accessed by the fair weather road that leads to the Tie Creek site, approximately 130 to 135 km east of Winnipeg.

Red, coarse grained granite is similar to the yellow-grey granite in texture and mineralogy. Outcrops of red granite along the north flank of the Tie Creek outcrop grade into yellow-grey granite within a few metres. Samples of the red granite contain powdery yellow **altered sphene** that plucks when polished and leaves pits. Microfractures, particularly in the feldspars, are inherent to rocks of the BLP, but

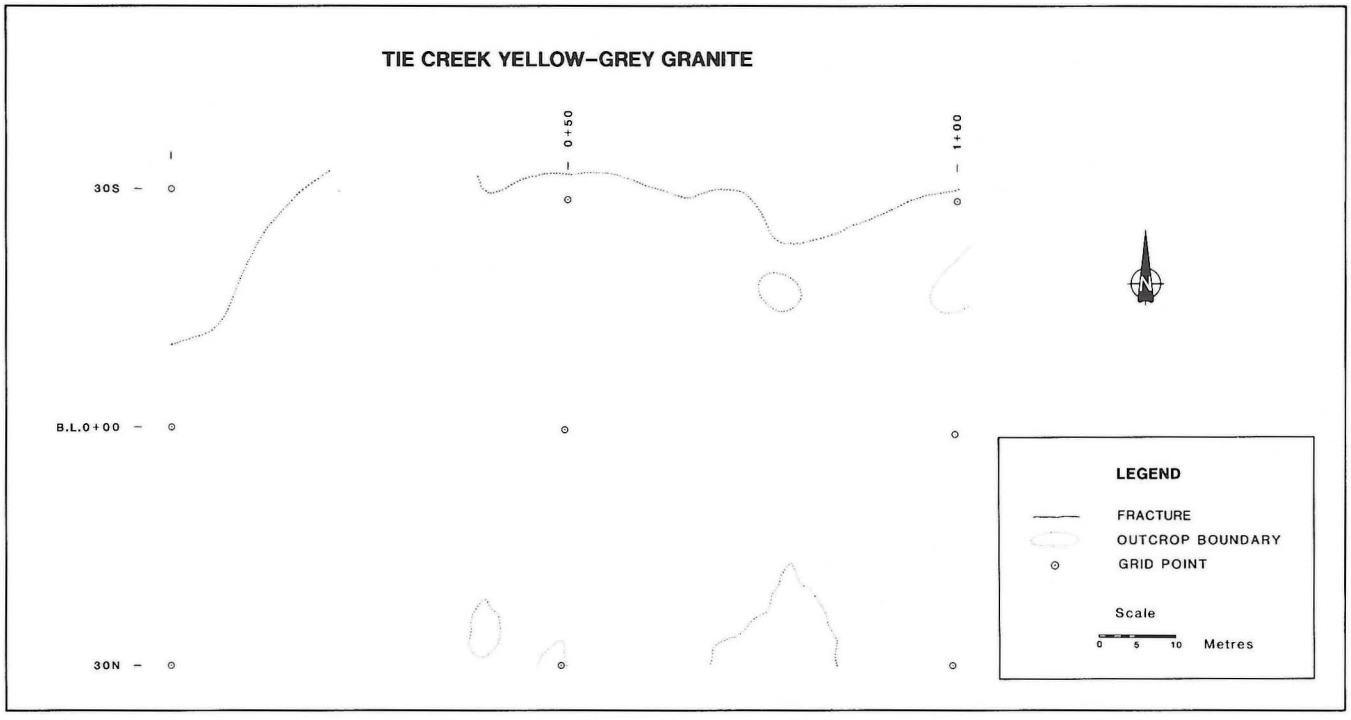

Figure 31: Fracture map of a yellow-grey granite outcrop in the Tie Creek area. Note the absence of subvertical fractures (Fig. 7 and 30).

are particularly deep and obvious in samples of red granite from the Tie Creek Basin. The rock has numerous, very coarse grained veins and contains ovoid black knots up to 10 cm in length. The tabular feldspar crystals display an attractive schiller when polished.

Three subvertical fracture sets are present in red granite within the Tie Creek basin. Two of the sets are vertical and approximately orthogonal to each other, and **strike** north-northeast and east. The north-northeast fracture set forms the ledges that are visible as parallel lines on aerial photographs of the red granite (Fig. 4). A third set is northwest striking and commonly shallow **dipping**. Fractures are spaced from one metre to several metres apart on the ridges. The distance between fractures tends to be greater in the interior plateaus of the ridges than on the edges, which indicates that some of the fractures result from exfoliation along the cliffs. Figure 32, a fracture map of the site labelled Tie Creek red granite on Figure 7, shows widely spaced vertical fractures and 0.2 to 5.0 m high ledges.

Large, unfractured outcrops of coarse grained red granite occur near Pine Point rapids (Fig. 33). These outcrops have few vertical fractures and are a potential source of dimension stone. A similar outcrop of red unfractured granite, which is not accessible by road, occurs across the Whiteshell River from Pine Point rapids.

Site 85-87-22

A ridge of coarse grained red granite occurs west of, and adjacent to, the Tie Creek yellow granite (Figs. 7, 30). At its highest point, this ridge is approximately 10 m high and has near vertical faces. Horizontal fractures are probably several metres apart as indicated by large orthogonal blocks that exfoliate from the ridges. Interior plateaus on top of the ridge have fractures that are spaced up to 10 metres apart, but more closely spaced vertical fractures occur along the sides of the ridges. The grain size varies from medium- to coarse-grained, but most of the rock is coarse grained. Grain size variations are localized within small areas, and changes in grain size are abrupt.

Site 85-87-29

This site is located on the eastern extension of the ridge where site 22 is located (Figs. 7, 30). The coarse grained red granite contains ovoid mafic knots and minor, very coarse grained veins. Two vertical fracture sets that **strike** at 020° and 110° azimuth create a perfectly orthogonal fracture pattern. The 110° fractures are parallel to the ridge and are more common than the 020° fractures. Spacing between fractures of both orientations varies from <1 m to several metres. The third shallow **dipping** fracture set typical of red granite outcrops in the BLP was not observed at this site. The top of the ridge is approximately 4 m above the yellow granite at its highest point and indicates that horizontal fractures are widely spaced. Access to this area is via the George Lake trail, which crosses the Tie Creek outcrop.

Red granite outcrops west of PR 307

Most of the outcrops of coarse grained red granite located outside the BLP and within Whiteshell Provincial Park do not appear to have high potential as dimension stone because they either are located close to cottages and areas of high recreational use, or have closely spaced fractures or variable colour and texture.

Coarse grained red granite also occurs outside of the Tie Creek Basin along PR 307. It is similar to red granite within the Tie Creek Basin, but does not have consistently widely spaced fractures and tends to be fine- to coarse-grained. Outcrops documented during this study are shown on Figure 7.

Nutimik Lake Dump Site

An outcrop of coarse grained red granite exposed beside the Nutimik Lake garbage dump site (Fig. 7) is a rounded hill with closely spaced fractures. Three fracture sets are present; two are orthogonal to each other and a third is oblique (Fig. 34). Hairline fractures that parallel the oblique fracture set are found on smooth glaciated surfaces that have been recently cleared of overburden. On some outcrops, these fractures are obscured by the rough texture of the weathered surface. The distance between fractures is generally less than 2 m at this site.

Polished samples of this rock are deep red with an attractive schiller imparted by large, tabular feldspar crystals. **Altered sphene** plucks when polished and leaves powdery yellow pits on the surface that mar the finish.

The outcrop is accessible from the road connecting PR 307 to the Nutimik Lake dump approximately 115 km east of Winnipeg.

PINK GRANITE AT THE JUNCTION OF PR 307 AND PR 309

Geological map reference: Preliminary Map 1976F-5, NTS 52L/3W & part of 52L/3E (Janes, 1976d)

A 5 km^2 outcrop of pink coarse grained granite of the BLP is located at the junction of PR 307 and PR 309 (Fig. 7), approximately 135 km from Winnipeg. A portion of the outcrop at site 85-87-16, located approximately 1 km east of the junction of PR 307 and PR 309, was mapped in detail (Fig. 35). The mapped area can be accessed via an abandoned wood-cutting road that follows the eastern margin of the outcrop north from PR 309.

The rock is pinkish-brown near PR 309, but becomes darker as the biotite content increases, especially in rocks north of the junction and along PR 307. Polished slabs of this rock have coarse grained pink tabular feldspar crystals up to 2.5 cm in length in a groundmass of medium grained feldspar, blue-grey quartz and biotite. Sphene and magnetite are accessories.

The major fracture sets are orthogonal. Fractures are spaced from 1 to 20 m apart in a suborthogonal pattern. Large, orthogonal blocks with minimum dimensions of 1.5 m, which have exfoliated from the side of the 3 m ledge that forms the east edge of the outcrop, indicate the presence of widely spaced horizontal fractures near surface. Some small

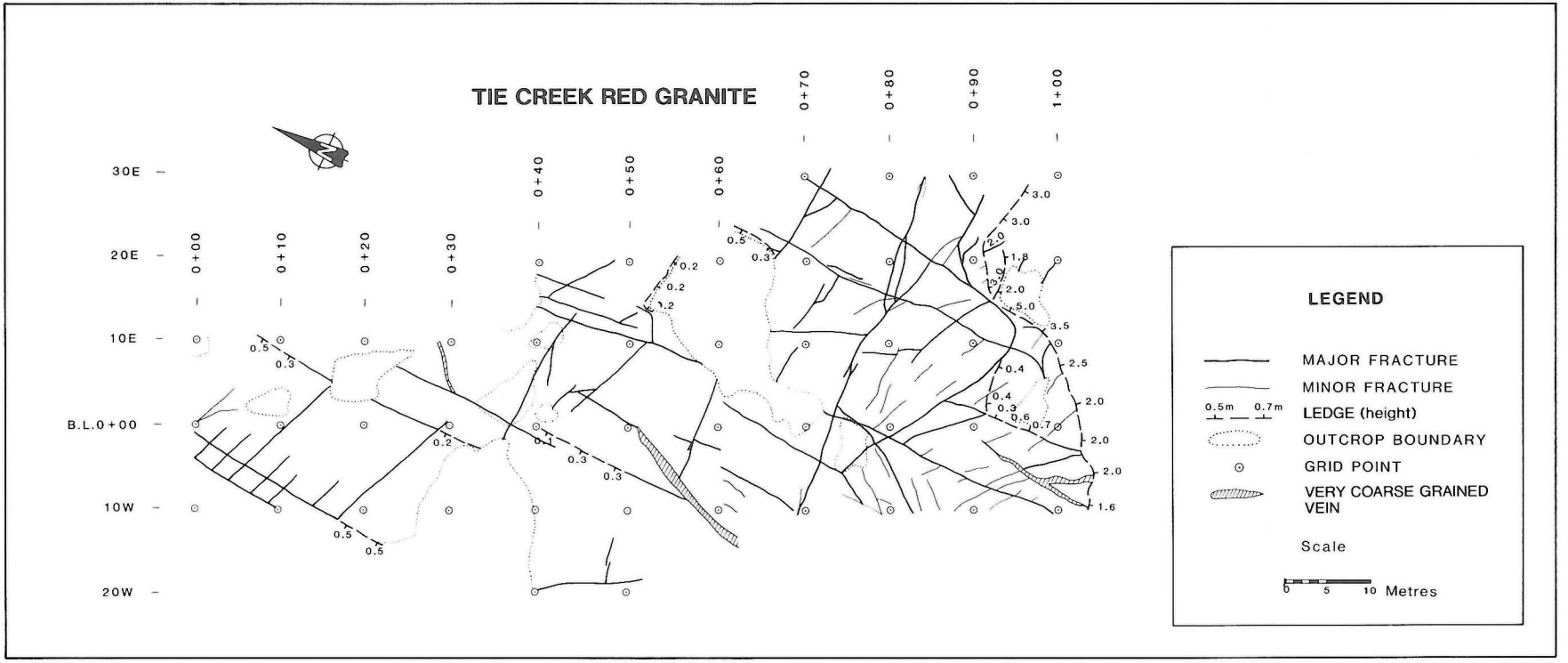

Figure 32: Fracture map of a red granite outcrop in the Tie Creek area (Fig. 7).

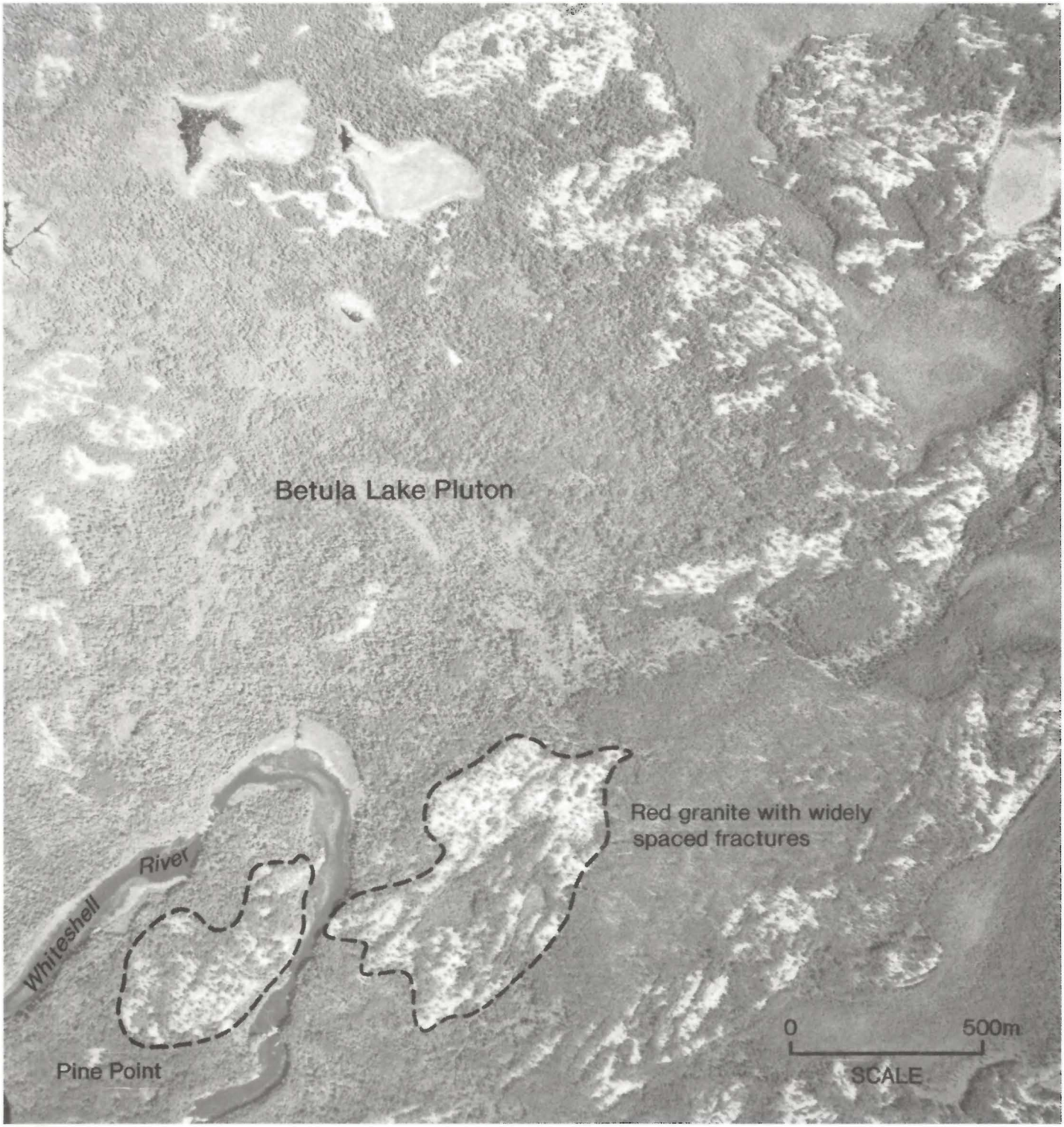

Figure 33: Outcrops of red granite near Pine Point Rapids (Fig. 29).

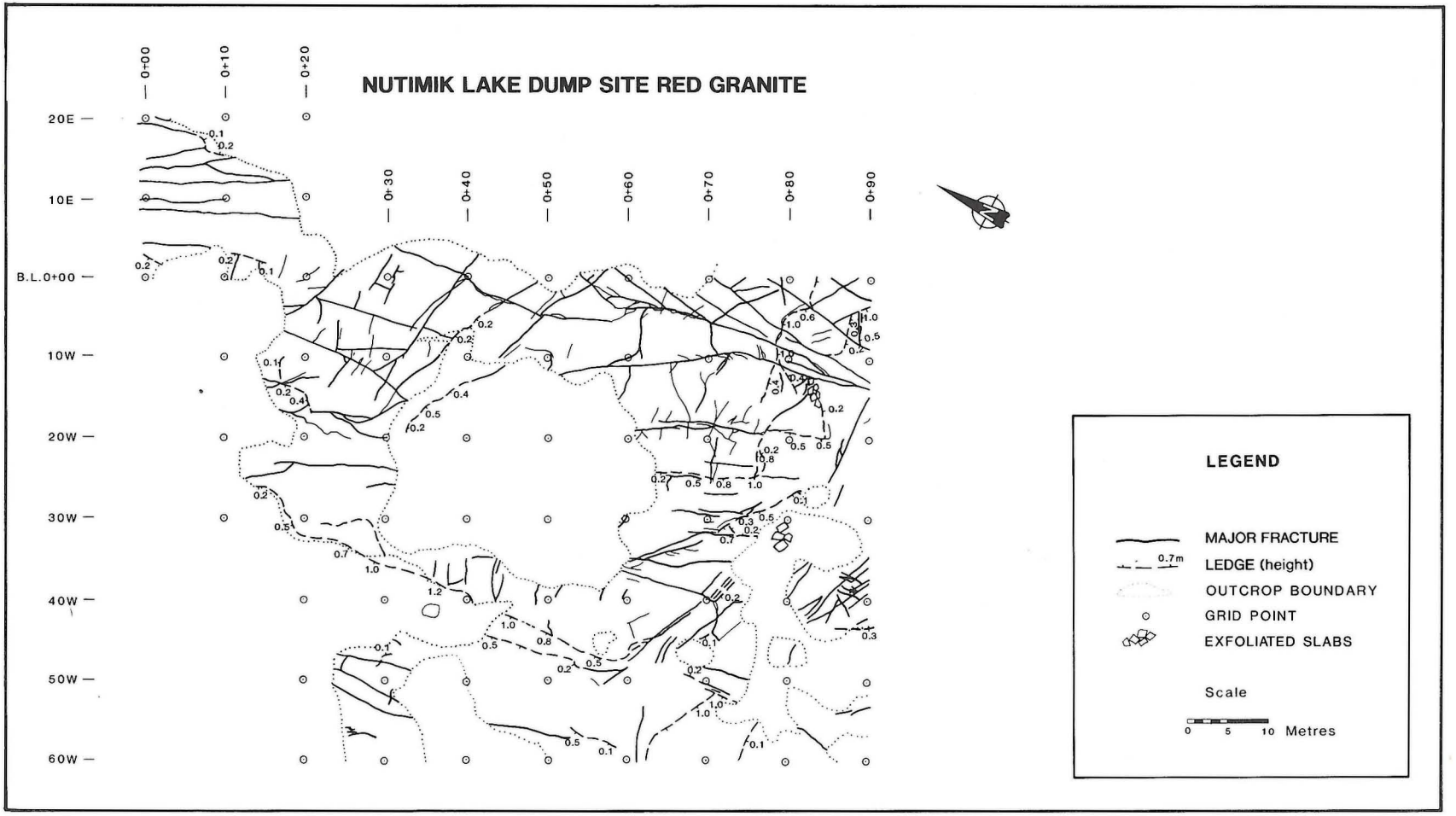

Figure 34: Fracture map of a red granite outcrop at the Nutimik Lake dump site (Fig. 7).

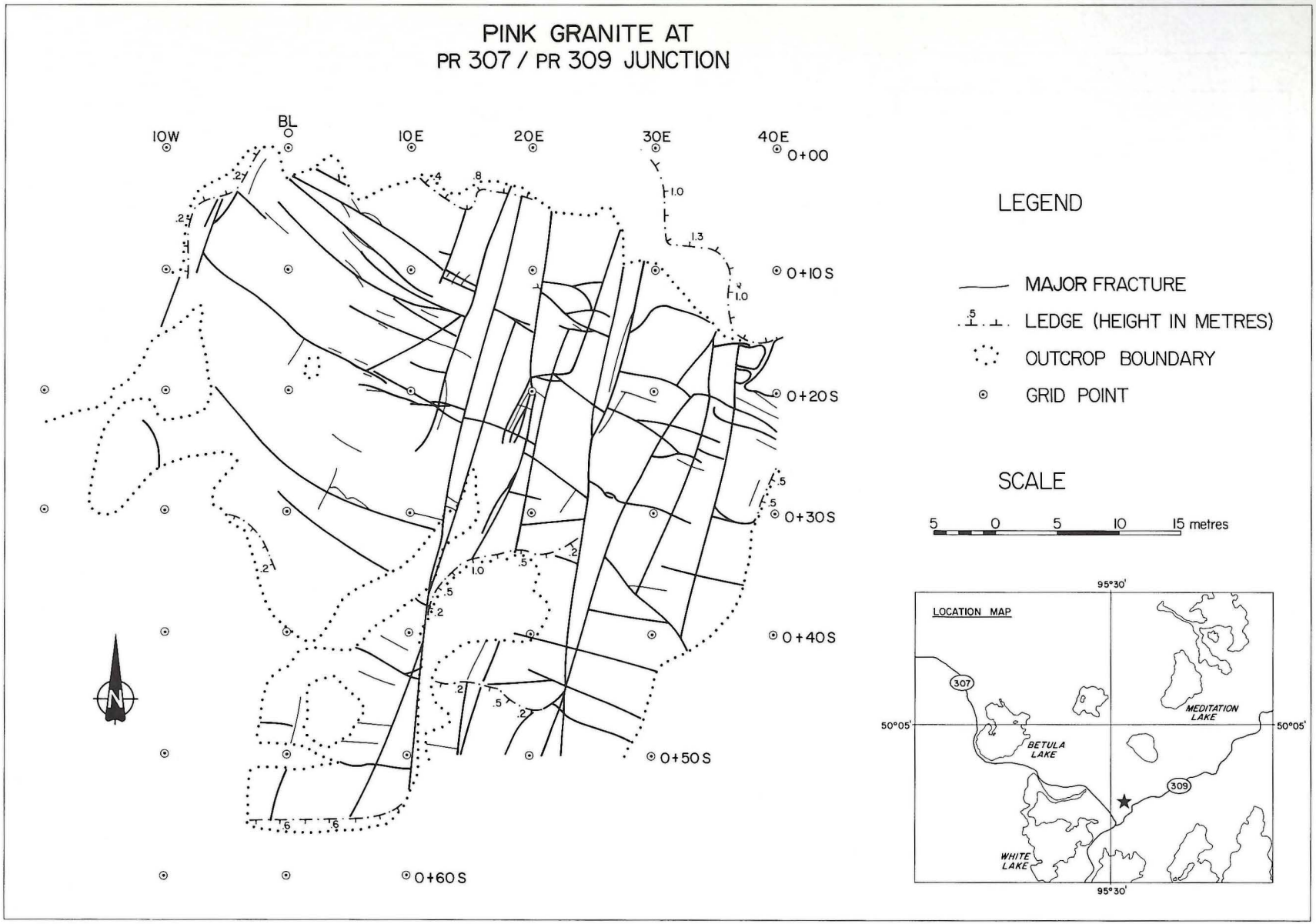

Figure 35: Fracture map of a pink granite outcrop at the junction of PR 307 and PR 309 (Fig. 7).

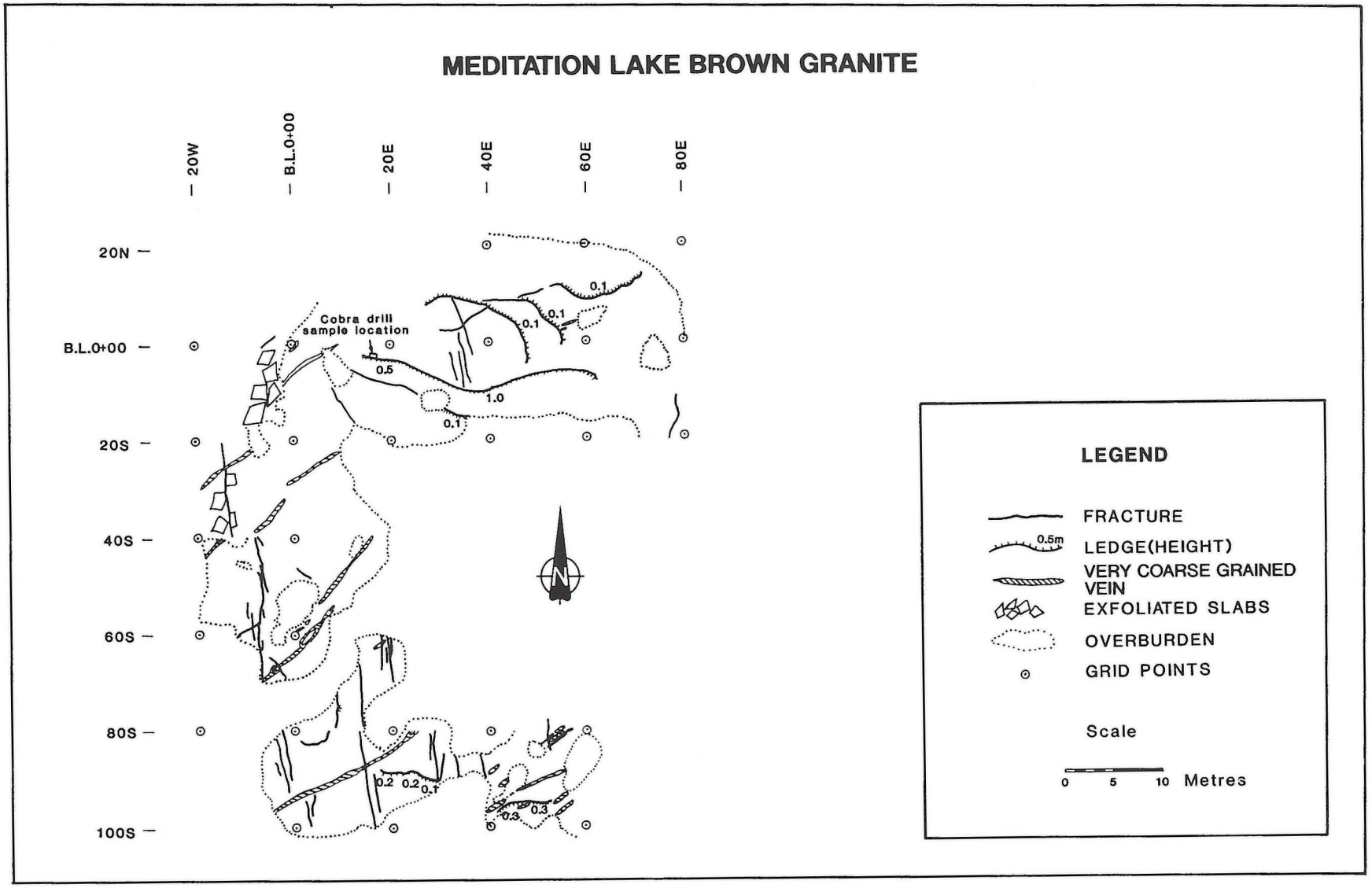

Figure 36: Fracture map of a brown granite outcrop near Meditation Lake (Fig. 7).

epidote-filled fractures and black, ovoid knots occur locally. Ledge faces beside the abandoned road are vertical.

MEDITATION LAKE BROWN GRANITE

There are no geological maps for this site, which is located approximately 145 km from Winnipeg. For the purpose of this report, this rock is included with the BLP because it occurs between the pink coarse grained granite and the brick red granite of the BLP, and contains large tabular crystals of feldspar. The brown granite outcrops are shown in Figure 7; they are accessed via a logging road north from PR 309.

Polished samples are brown with coarse grained feldspar crystals set in a variegated fine- to medium-grained groundmass of feldspar, quartz, biotite and accessory minerals. Fewer large feldspar crystals occur in the brown granite than in other granites of the BLP. Samples from this location take a relatively smooth polish, although the biotite tends to pluck.

The outcrops are wide, flat plateaus or gently rounded hills with widely spaced (generally >1.5 m) vertical fractures. Brick red, coarse grained granite veins are common throughout the rock. A fracture map of an outcrop of brown granite adjacent to the Meditation Lake road is shown in Figure 36.

The good access, structure, and attractive colour and texture of the rock make this location a potential source of dimension stone.

BRICK-RED GRANITE

Geological map reference: Preliminary Map 1976F-5, NTS 52L/3W & part of 52L/3E (Janes, 1976d)

Brick-red granite occurs in massive outcrops at Green Lake and north of Big Whiteshell Lake (Fig. 7). The only access to both the Green Lake and the Big Whiteshell Lake outcrops is through the Big Whiteshell Resort. The granite contains red feldspar, smoky grey quartz and minor biotite. The schiller from the deep red, coarse grained feldspar crystals is this rock's most attractive feature. This rock crumbles when sampled because it is intensely microfractured and drill core recovery for at least the first metre below the surface is virtually nil. A large sample taken with a cobra drill from a ledge fell apart over a period of several days.

Outcrops of brick-red granite on the north side of Big Whiteshell Lake are not fractured, but are located within 0.5 km of cottage sites. The sites examined do not appear to be potential sources of dimension stone.

Lone Island Lake

Coarse grained, variegated brick red granite, accessed by the road to the Lone Island Lake campground, occurs at the north end of Lone Island Lake (Fig. 7). High unfractured ridges of friable granite crop out between Big Whiteshell Lake and Lone Island Lake within 3 km of the Lone Island Lake campground, approximately 145 km from Winnipeg. This location is considered to have little potential as a source of dimension stone due to the friability of the rock and its proximity to recreation areas.

Big Whiteshell Lake Red Granite

This site occurs beside a road that extends north from the parking lot behind the Big Whiteshell Lake Resort (Fig. 7), approximately 150 km from Winnipeg.

Subvertical fractures are several metres apart and veins of fine grained red granite are widely spaced (Fig. 37). Polished samples from this site are a beautiful deep red colour, but contain microfractures. Samples taken with a cobra drill and feather-and-wedge sets fell apart within a few days. The friability of the rock, presence of microfractures, lack of an access route, and proximity to the Big Whiteshell Lake cottages suggest that this is not a suitable site for development of a dimension stone quarry.

JESSICA LAKE, WHITE LAKE AND RED ROCK LAKE

Outcrops around Jessica, White and Red Rock lakes are not considered to be potential sources of dimension stone because they are located close to cottage subdivisions, but for the purpose of inventory they are described here.

Unfractured outcrops of BLP granite occur adjacent to the Jessica Lake store, to cottages at White Lake and Jessica Lake, and on the north shore of Red Rock Lake (Fig. 38). All are accessed via PR 307 and are located approximately 130 to 135 km from Winnipeg.

Jessica Lake

The parking lot at the Jessica Lake store is a massive outcrop of red coarse grained granite. Flat unfractured outcrops also occur between the lake and PR 307, but these outcrops are within 1 km of cottage sites; otherwise this rock would be a potential source of dimension stone.

White Lake

Outcrops of unfractured coarse grained granite occur within the cottage subdivisions on the east shore of White Lake. Ledges and large exfoliated rectangular blocks occur on the west shore. These outcrops are close to cottages and recreational facilities at White Lake.

Ridges of massive coarse grained granite are exposed north of White Lake on the east side of PR 307. Pink feldspar crystals occur in a groundmass of blue-grey quartz and black biotite. The dominant fracture direction is south-southeast, parallel to the long axis of the ridges, and there are a very few east-striking fractures.

Red Rock Lake

Some outcrops around Red Rock Lake have widely spaced fractures and have large exfoliated orthogonal blocks around them. Most of the granite is red and fine to coarse grained.

FIREGUARD ROAD

Red and brown medium-grained granites are accessible via the fireguard road between PR 307 and Highway 44.

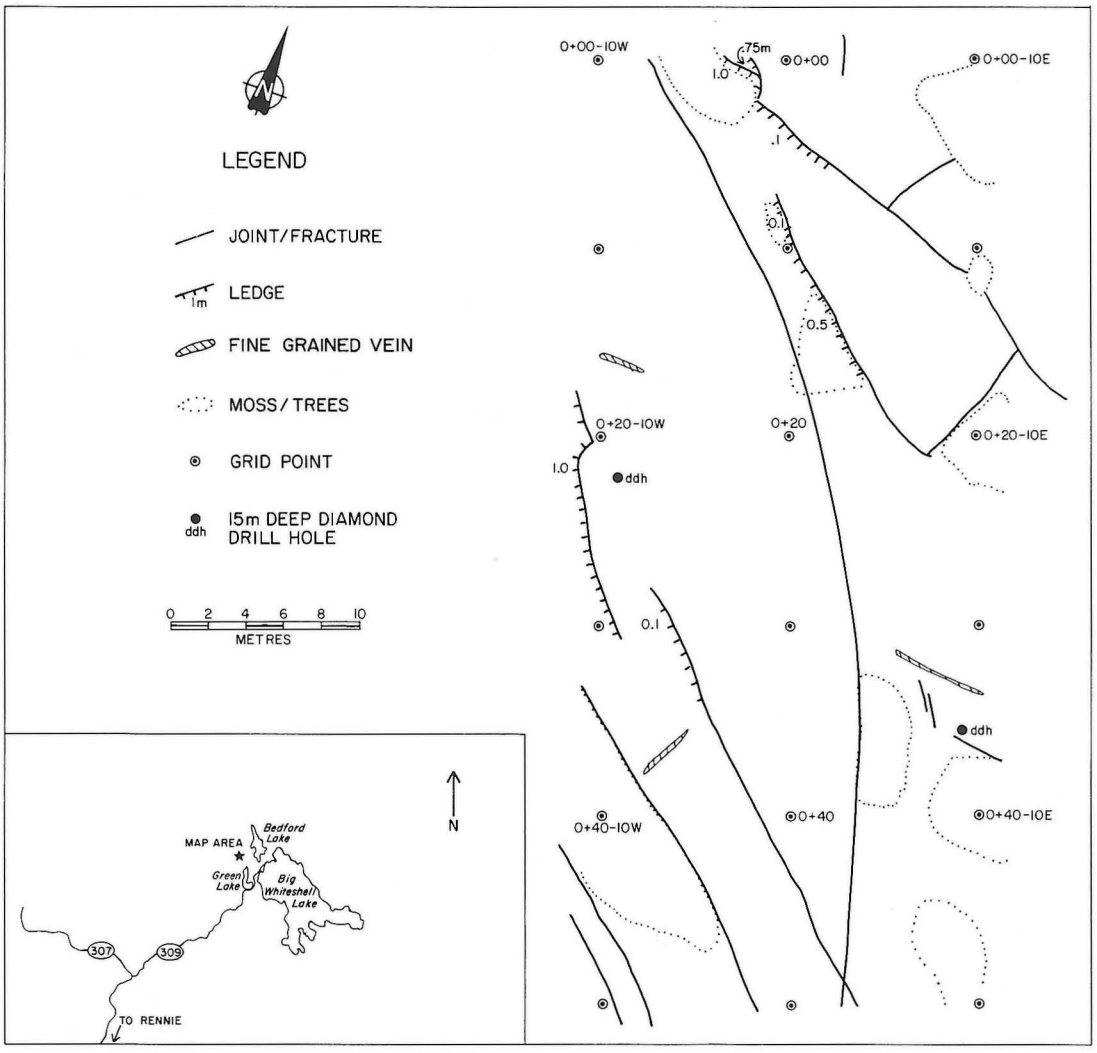

Figure 37: Fracture map of a brick-red granite outcrop near Big Whiteshell Lake (Fig. 7).

Sites examined for dimension stone potential, shown on Figure 8, are located 100 to 110 km from Winnipeg.

The Canadian Shield quarry produced blocks and slabs of red granite under the trade name "Royal Canadian Red". The brown granite was test quarried by Fairmont Granite and Canital Granite Ltd. Both companies found closely spaced (<1.5 m) subhorizontal hairline fractures that did not appear to decrease in frequency with depth. The close spacing of these fractures makes it difficult to quarry large blocks.

The Fairmont test pits and the Canadian Shield quarry are accessed via the fireguard road. Granite in outcrops to the north and south of these two quarries has variable colours and textures and closely spaced vertical and horizontal fractures. Outcrops located near the boundary of Whiteshell Provincial Park were examined during a 1989 helicopter survey. Some outcrops have the widely spaced vertical fractures required of a dimension stone deposit, but are located several kilometres from a road.

PINAWA VARIEGATED GRANITE

Geological map reference: Preliminary Map 1976F-8 (Janes, 1976f)

Outcrops of variegated pink to red granite occur along PR 309 from Seven Sisters to Dorothy Lake in the vicinity of the town of Pinawa and along the northern 5 km of the fireguard road (Figs. 28, 39). The granite contains black knots, up to 1 m, and has closely spaced fractures. The granite has low potential as a source of dimension stone due to the irregular texture and closely spaced fractures.

POINTE DU BOIS VARIEGATED GRANITE

Geological map reference: Preliminary Map 1976F-8 (Janes, 1976f)

The Pointe du Bois variegated granite is the eastern extension of the Pinawa variegated granite. This variegated to nebulitic grey granite occurs south of the LDBB (Figs. 28, 39). Road accessible outcrops were examined at Pointe du Bois. The nebulitic texture is attractive, but nonorthogonal

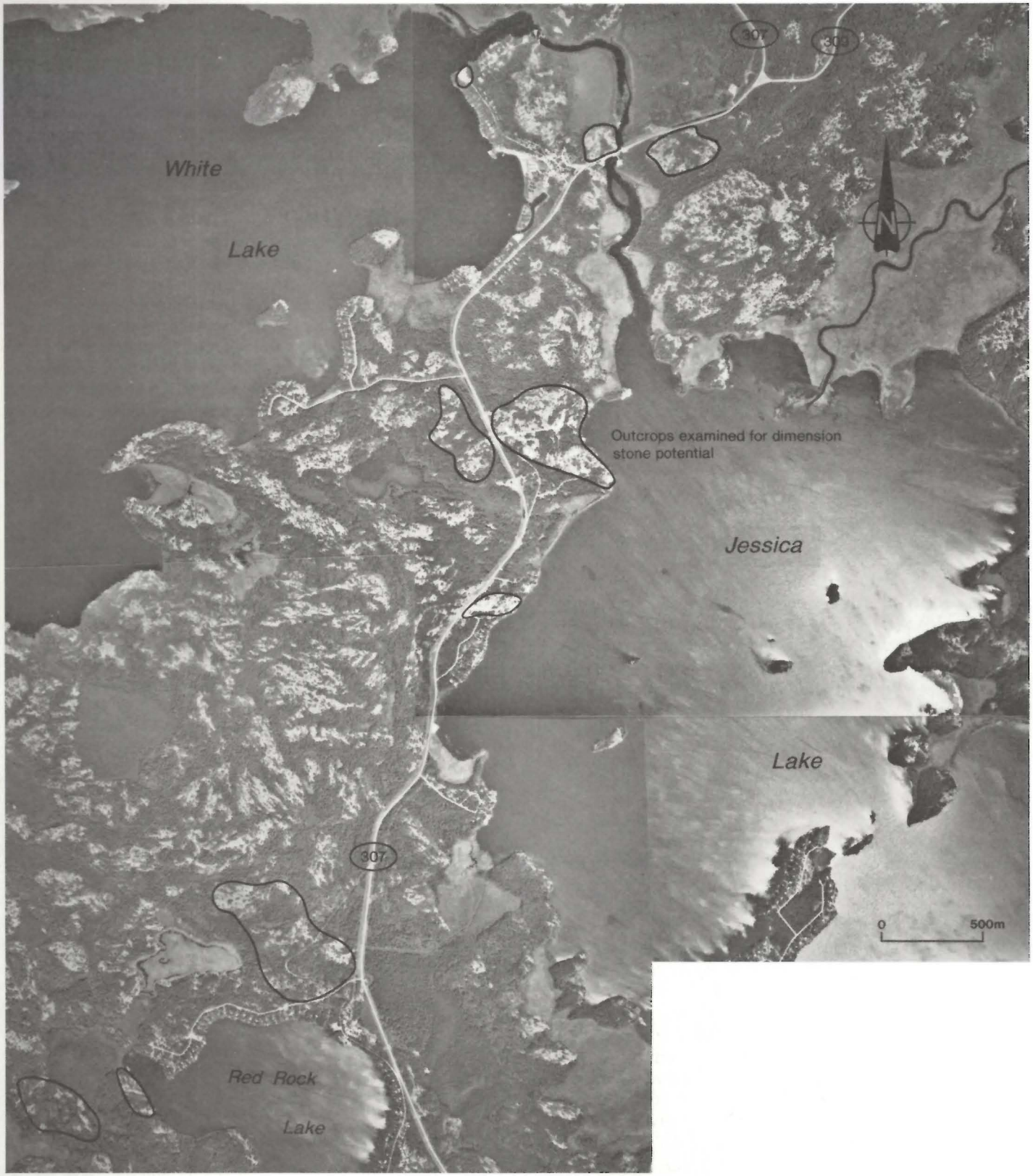

Figure 38: Outcrops examined as potential sources of dimension stone near White, Jessica and Red Rock lakes. Note the cottage subdivisions throughout the area (Fig. 29).

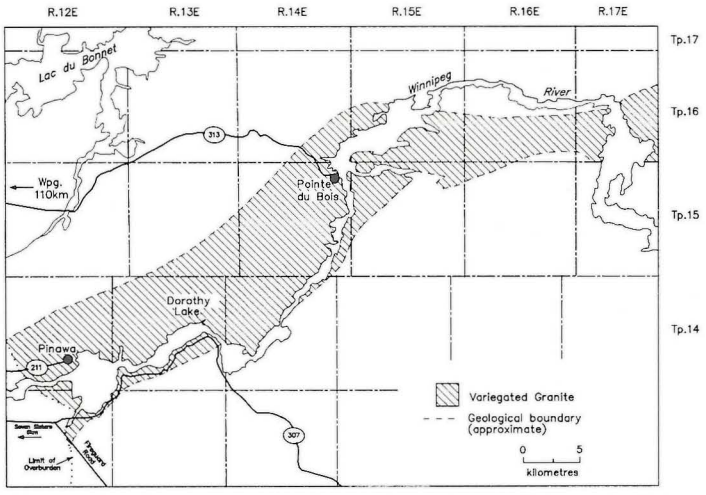

Figure 39: Location of variegated granite at Pointe du Bois and Pinawa.

fractures are spaced less than 1.5 m apart. This granite has low potential as a source of granitic dimension stone.

LAC DU BONNET BATHOLITH

Geological map reference: McCrank, 1985; Preliminary Maps 1969F-6 and 1969F-7 (McRitchie, 1969e, 1969f)

The geology of the Lac du Bonnet batholith (LDBB) has been described by McRitchie (1971), Tammemagi *et al.* (1980), Cerny *et al.,* (1981) and McCrank (1985). AECL reports by Tammemagi *et al.* (1980) and McCrank (1985) detail the geology and structure of the batholith and describe fractures on the surface of the batholith; these reports have been a valuable source of information for this study.

The LDBB is the source of dimension stone for the Cold Spring Granite (Canada) Ltd. quarry, which has produced stone since 1932 from an outcrop located southeast of the town of Lac du Bonnet.

The LDBB is the youngest intrusion in the Winnipeg River area (Tammemagi *et al.,* 1980; Fig. 28). The batholith is a predominantly pink granite that extends from Pointe du Bois southwestward beneath Paleozoic cover. The largest exposures of the batholith occur east of the town of Lac du Bonnet, but isolated outcrops are found as far west as the farmlands directly north of Beausejour. Six rock types were identified by McCrank (1985), of which two, pink **porphyritic** granite and grey **porphyritic** granite, were examined as potential sources of dimension stone.

The pink coarse grained granite is composed of feldspar, quartz, biotite and accessories. Black knots occur in some outcrops. Variegation in the rock is caused by the parallel orientation of large crystals, and the presence of black streaks. The textural variation is a liability because it is not always possible to produce a large amount of texturally consistent rock without large amounts of waste.

Most of the granite exposed is pink to pink-red. The intensity of the pink colouration appears to increase with increased fracture density.

Grey to yellow-grey, coarse grained granite of the LDBB is mineralogically and chemically similar to the pink coarse grained granite (McCrank, 1985). It underlies the pink granite structurally in the URL shaft and in drill cores. Outcrops of grey granite have a lower fracture frequency than outcrops of pink granite.

The central part of the batholith is the least deformed (Tammemagi *et al.*, 1980). Consequently, the outcrops with the lowest fracture frequency at surface and the highest potential for dimension stone production should occur towards the centre of this batholith.

McCrank (1985) noted four preferred fracture orientations: north-northeast, east, southeast and south-southeast. The north-northeast fractures are the most common, and are parallel to very coarse grained granite veins. Most of the fractures and granite veins are steeply **dipping** or vertical and would not be detrimental to quarrying operations. Four percent of the outcrops examined by Tammemagi *et al.* (1980) have one or fewer fractures per 2 m, which indicates a suitable structure for dimension stone extraction. The LDBB outcrops with the lowest fracture frequencies are also flat and low lying. The surrounding higher ridges have more closely spaced fractures, which suggests that most of the vertical fractures are a surface phenomenon similar to that observed in the BLP.

Cold Spring Granite (Canada) Ltd.

Cold Spring Granite (Canada) Ltd. operates a dimension stone quarry on a 1 km long outcrop of the LDBB southwest of the town of Lac du Bonnet along Highway 11 (Fig. 5). The rock was first quarried from 1933 to 1949 by Ivor Peterson for tombstones. The Cold Spring Granite Company reopened the quarry and has produced stone for monumental and construction purposes since 1959. In the past, blocks were removed from the outcrop with wire saws and cutting grit; now, seams are opened with flame cutters and blocks are removed using drilling and blasting techniques (Will Kelly, pers. comm., 1990). A plant is located on site, but most of the quarried rock is shipped to the company's main plant in Minnesota as rough blocks and wire-sawn slabs. The pink-red stone is marketed under two trade names: "Canadian Mist" is a variegated stone that is used mainly for mass-produced tiles, and "Colonial Rose" is a homogeneous equigranular stone that is used mainly for monuments. Both are pink-red, fine- to medium-grained granites that take a smooth, tight polish. They have become popular for interior residential use because the warm colour of the stone compliments wood.

Several grades of rock are produced from the quarry. The very coarse grained phases tend to be variegated, but other sections of the quarry are equigranular and homogeneous.

Dimension stone resource assessment in the Lac Du Bonnet Batholith

Approximately 4% of the outcrops within the LDBB have the fracture spacing at surface (Tammemagi *et al.,* 1980) that is required in a dimension stone deposit. As in the Cold Spring granite quarry, textural and grain size varia-

tions within the outcrops permit the production of several grades of stone. Lac du Bonnet granite has a characteristically high compressive strength (Schmidtke and Lajtai, 1985). It is popular for both monumental and building applications.

Outcrops of the LDBB near roads and with widely spaced fractures were mapped. Lac du Bonnet is a major agricultural, cottage and recreation area along the Winnipeg River system. Consequently, many outcrops are located on farmlands and within 1 km of cottages. Most sites chosen for detailed evaluation (Fig. 6) are located at least 1.0 km from habitations and cottages.

Rice Creek (Site 1)

This is an area of large flat massive outcrops adjacent to PR 313 approximately 3 km east of the junction of PR 313 and PR 315 (Fig. 6). The fracture pattern is illustrated in Figure 40. Superficial fractures **strike** east and are typically several metres apart. Very coarse grained veins **strike** north-northeast and are 4 to 10 cm wide. Horizontal fractures in the road cuts are less than 0.5 m apart, but appear to be blast induced. Ledges at the site mapped (Fig. 40) are approximately 0.5 to 1 m in height. Black waves and streaks occur in rocks on road cuts near the mapped outcrop. Black knots were also noted in areas of the outcrop that had been cleaned with bleach.

Pinawa Bay (Site 2)

Two outcrops, sites 2 and 3 on Figure 6, were mapped near Pinawa Bay. Site 2 (Fig. 41) is an abandoned test quarry pit. Several small blocks have been removed from two pits with a flame cutter, a plugger, and feather-and-wedge sets. The largest of the blocks measures 1 by 1 by 1.5 m and contains two, subhorizontal, very coarse grained veins within the space of 1 m. Figure 41 shows widely spaced fractures. On nearby outcrops that have higher relief, the fractures are more closely spaced, perhaps indicating that the frequency of subvertical fractures decreases with depth.

Fractures in the southern 60 m of site 3 are approximately 6 m apart. Fractures in the north part are exfoliation features spaced 1 to 2 m apart that extend approximately 30 cm into the outcrop. Only two very coarse grained veins were noted in the 5000 m^2 study area, but black streaks are common throughout. No ledges were exposed, therefore, the spacing of horizontal fractures is not known.

Lee River Dump Site (Site 4 and 5)

Outcrops near the Lee River dump site (sites 4 and 5 on Fig. 6) were mapped because, locally, the fractures are spaced several metres apart. The site is accessed by PR 313 and a service road that connects PR 433 and PR 313. The nearest cottages are approximately 2 km away. Outcrops on the north and south sides of PR 313 were documented for dimension stone potential.

The outcrop on the north side of the highway has more widely spaced vertical fractures at surface than the outcrop on the south side of the highway; horizontal fractures at both sites are greater than 1 m apart. Figure 42, a fracture map of the portion of site 4 that occurs north of PR 313, shows extensive areas with subvertical fractures spaced more than 5 m apart. Some of the subvertical fractures do not extend below the first horizontal fracture on ledges near the mapped area. A number of closely spaced, shallow-dipping, very coarse grained veins are exposed on outcrops and were intersected in drill core. The rock is orange-pink at surface and the colour remains the same throughout the 10 m depth intersected in drill core.

PR 433 (Site 6)

Several outcrops of the LDBB occur north of the Lee River dump site (site 6 on Figure 6) within 1 km of PR 433. The outcrop is a massive interior plateau in the centre of a ridge that has relatively closely spaced fractures. Several subhorizontal very coarse grained veins are up to 0.5 m wide. The colour of the granite varies from pink to red, and black streaks are abundant.

Isolated Outcrops Northeast of Beausejour

Three of the isolated outcrops that occur in farmlands north of Beausejour were documented during the 1985 reconnaissance survey. One outcrop (site 1, Fig. 43), located in the middle of a field next to the Allegra road, may be a potential source of dimension stone. The other two exposures (sites 2 and 3, Fig. 43) have widely spaced orthogonal fractures, but are located adjacent to farmhouses.

Several isolated outcrops located close to Lac du Bonnet have been, or are being, used as a source of granite aggregate; the rock is drilled, blasted and crushed on site. As the bush between Beausejour and Lac du Bonnet is cleared for farmland, more of these isolated outcrops are being exposed. Further evaluation of this area may be warranted in the future, because the shorter transportation distance to Winnipeg and the location outside of cottage and recreation zones will make suitable exposures attractive prospects for quarry sites.

Underground Research Laboratory Lease Area

AECL's Underground Research Laboratory is located in a large outcrop area south of PR 313 east of the Lee River (Fig. 6). The outcrops consist of pink-red and yellow-grey granite. The pink-red granite forms ridges with areas of widely spaced orthogonal fractures. Large orthogonal blocks have exfoliated from the ridges.

Several outcrops of pink granite with widely spaced fractures occur along the southern boundary of the URL lease. The yellow-grey granite occurs in a single flat unfractured outcrop with widely spaced, very coarse grained veins. Work by AECL indicates that the vertical fractures decrease in frequency with depth in the LDBB. Some outcrops with closely spaced vertical fractures at surface have widely spaced vertical fractures at depth. This has also been observed in the Cold Spring Granite quarry where surface fractures are <1 m apart, but many of these do not extend below the top lift. The outcrops mapped during this evaluation of the LDBB are probably not the only exposures that could be potential sources of dimension stone. The mapped exposures have widely spaced fractures at surface and are located near roads. Outcrops with closely spaced fractures at surface may also be potential sources of dimension stone,

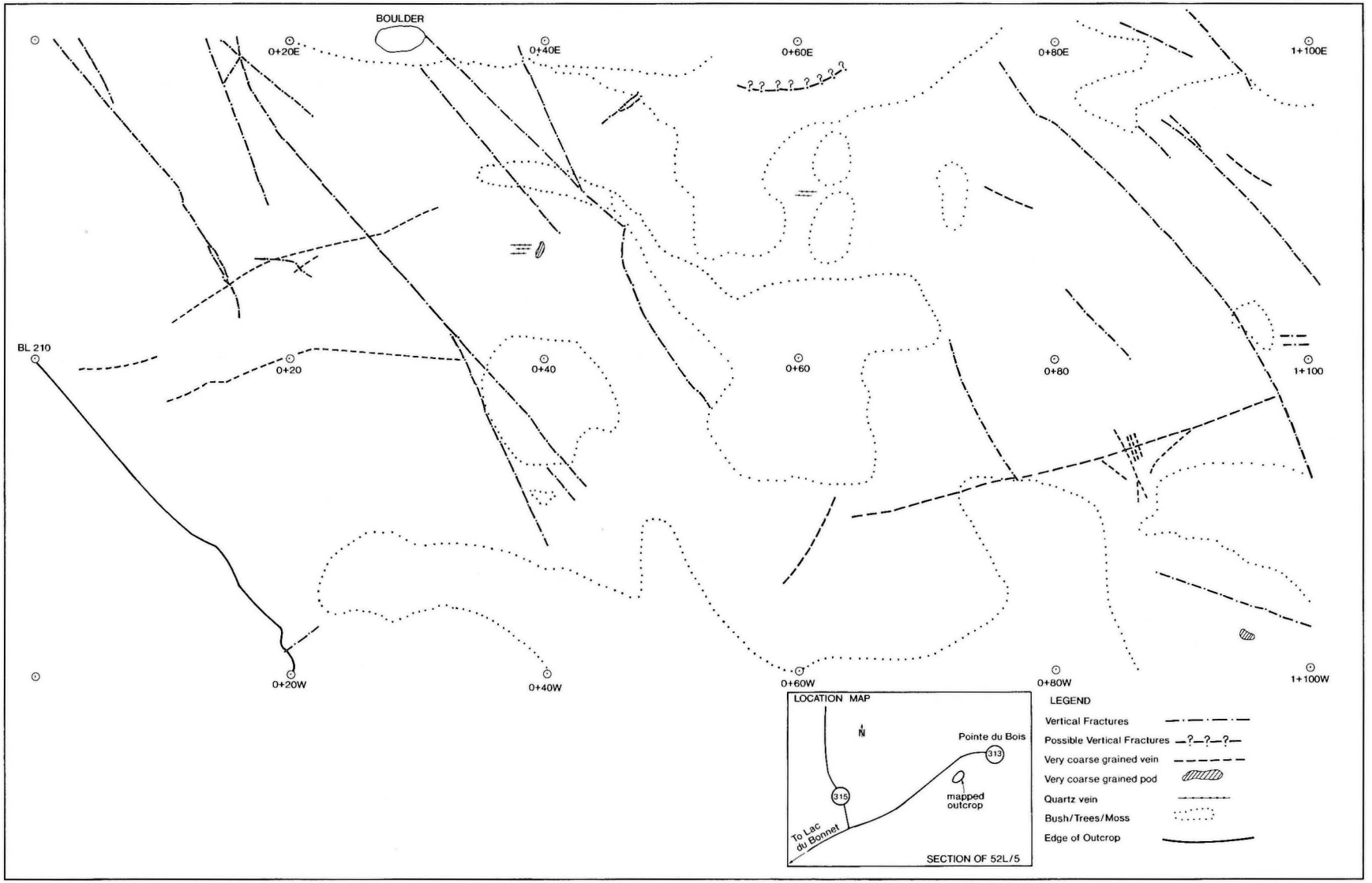

Figure 40: Fracture map of the Rice Creek outcrop in the Lac du Bonnet Batholith (site 1 on Figure 6).

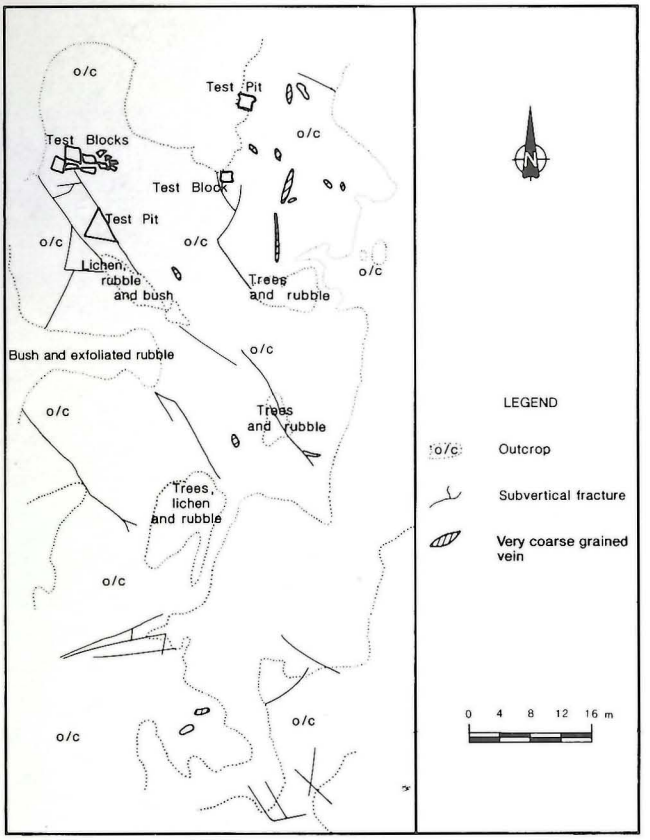

Figure 41: Fracture map of the Pinawa Bay outcrop in the Lac du Bonnet Batholith (site 2 on Figure 6).

because both the vertical and horizontal fractures spacings may decrease with depth.

The area underlain by LDBB to the east of Lac du Bonnet is heavily developed for recreation. The Pinawa Dam Heritage Park and several cottage subdivisions at Lac du Bonnet, Lee River, and Pinawa Bay are located in areas that could also have dimension stone potential. Other potential sites are isolated outcrops on the farmlands between Beausejour and the Town of Lac du Bonnet.

AREA 4: BIRD RIVER TO BLACK RIVER

Several granitic bodies were investigated in this area, however only the three shown on Figure 44 were examined in detail. Further work is required to assess the area for dimension stone potential.

GREAT FALLS GREY GRANITE

Geological map reference: Preliminary Map 1969F-4 (McRitchie, 1969d)

Grey granite is exposed along on Highway 11 north of Lac du Bonnet in the vicinity of Great Falls (Figs. 44, 45). Large orthogonal blocks, 1 to 1.5 m on a side, are present along road cuts. The rock is grey, medium to coarse grained, and locally variegated. Most of the outcrops are intruded by veins of pink granite of the LDBB.

The attractive grey colour and areas of widely spaced orthogonal fractures make this a medium potential source of dimension stone. Evaluation of outcrops located further from Highway 11 is warranted.

BLACK RIVER WHITE GRANITE

Geological map reference: Preliminary Map 1969F-1 (McRitchie, 1969a)

The Black River white granite is part of a gneissic complex that extends from Lake Winnipeg to the Ontario border (Fig. 44). Outcrops exposed along PR 304 north of Pine Falls at the bridge over the Black River were documented for dimension stone potential (Fig. 46).

Colour varies from pink to grey to white within 10 m intervals in drill core. Some of the granite contains biotite, whereas some contains **muscovite**, indicating two different types of granite. Veins of muscovite were intersected in drill core and the granite tends to split along these veins. Infrequent black knots are up to 0.5 m wide.

Some outcrops, notably those exposed along the banks of the Black River, have fractures spaced up to 5 m apart. Generally, the fractures are spaced less than 2 m apart. The horizontal fractures do not appear to decrease in frequency with depth in drill holes, and are spaced less than 1 m apart on average.

Closely spaced fractures, variations in colour and the presence of muscovite veins make this granite a low potential source of dimension stone.

INCONNU PINK GRANITE

Geological map reference: Cerny *et al.*, 1981

The Inconnu granite (Figs. 44, 47) is variegated buff to pink and medium to coarse grained. Only two outcrops were documented near Shoe Lake along PR 314. Outcrops of the Inconnu granite located near PR 314 are high rounded hills with closely spaced fractures and very coarse grained veins. This rock is a light pink, equigranular granite that takes a smooth, tight polish. Heavily fractured, heterogeneous Inconnu granite also occurs along the Cat Lake road (Fig. 47).

The north part of the Inconnu granite, which has not been documented for dimension stone potential, contains abundant very coarse grained veins, is distinctly variegated, and is finer grained than the medium to coarse-grained granite in the Shoe Lake area (Cerny *et al.*, 1981).

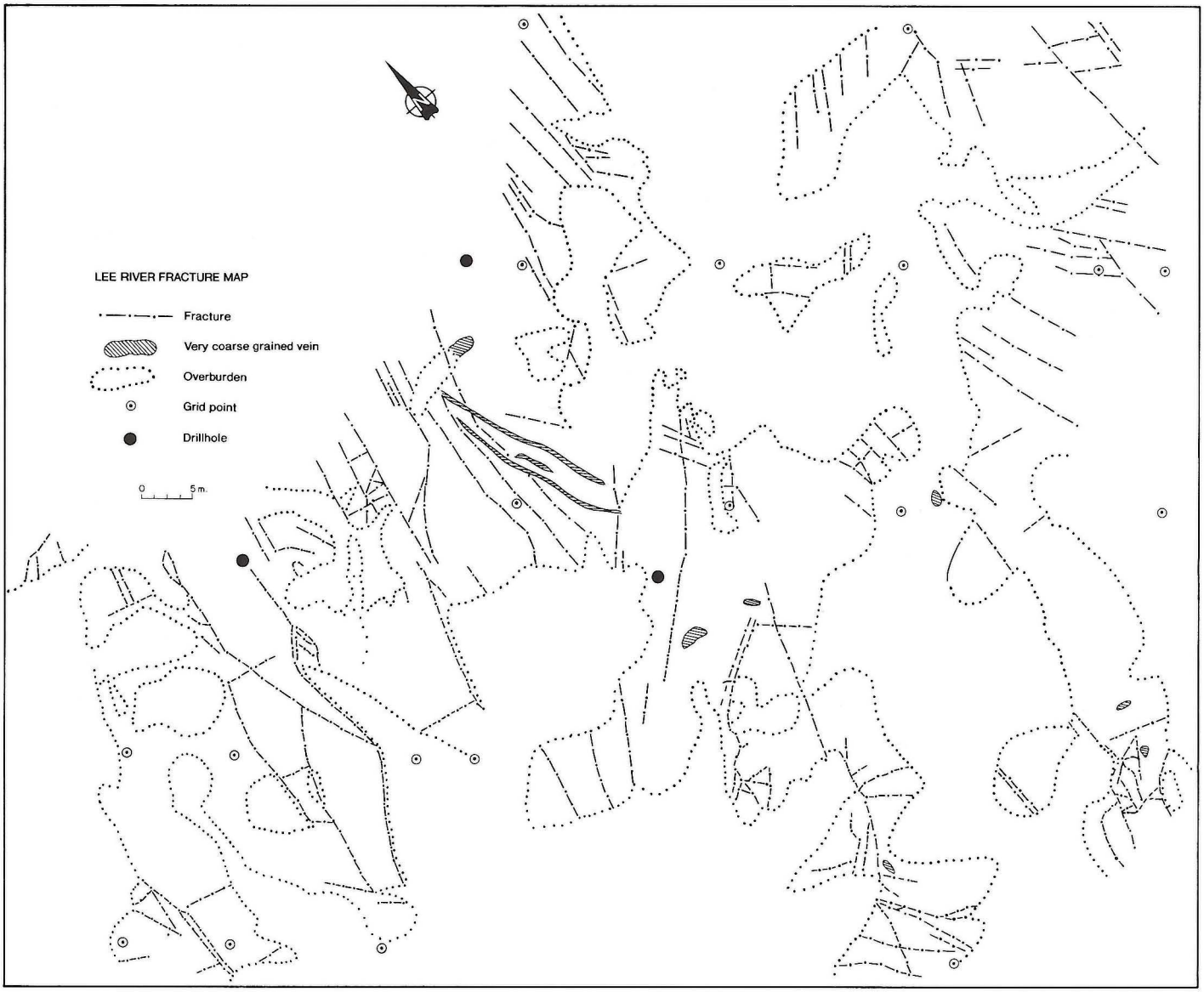

Figure 42: Fracture map of the Lee River dump site outcrop in the Lac du Bonnet Batholith. This map shows the portion of site 4 on Figure 6 that occurs north of PR 313.

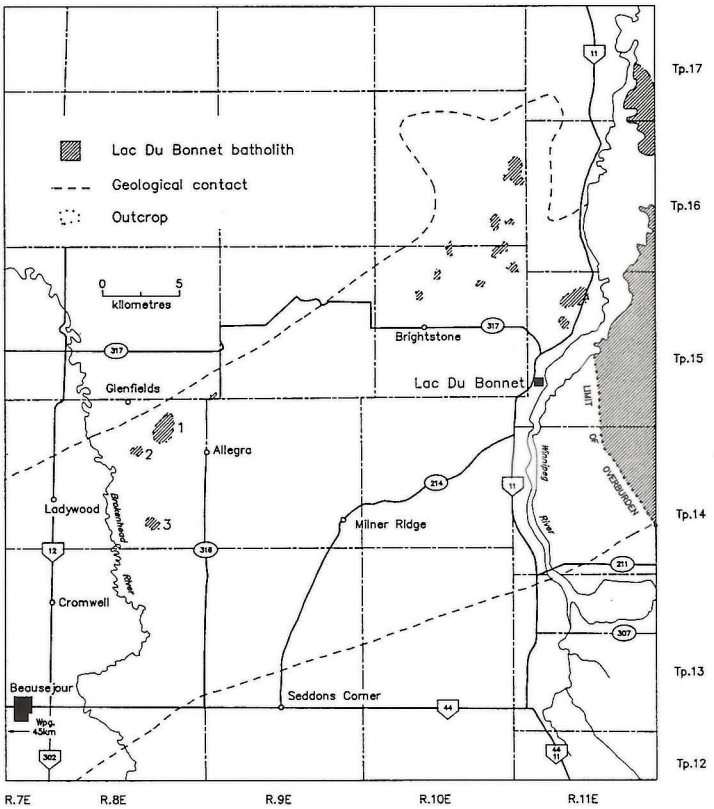

Figure 43: Locations of isolated outcrops of the Lac du Bonnet Batholith. The dotted line is the extension of the Lac du Bonnet Batholith beyond the limit of overburden.

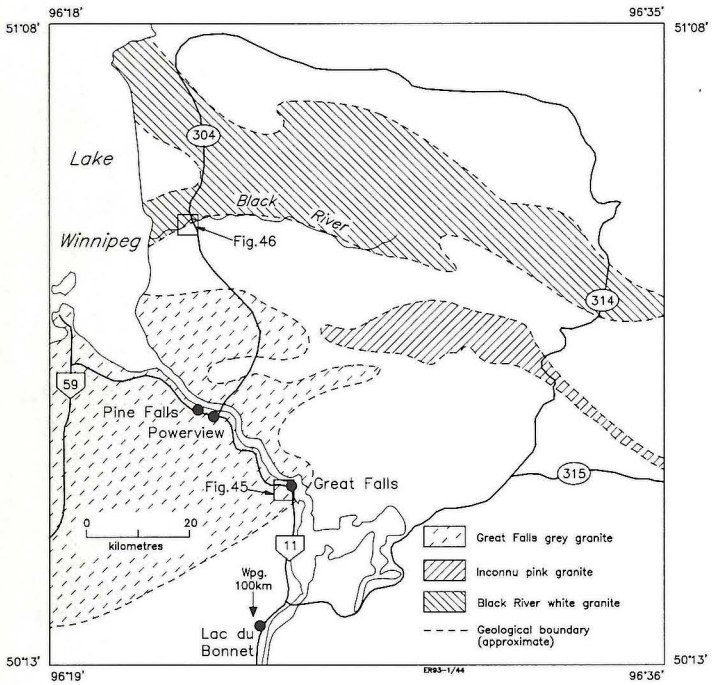

Figure 44: Index map of Area 4.

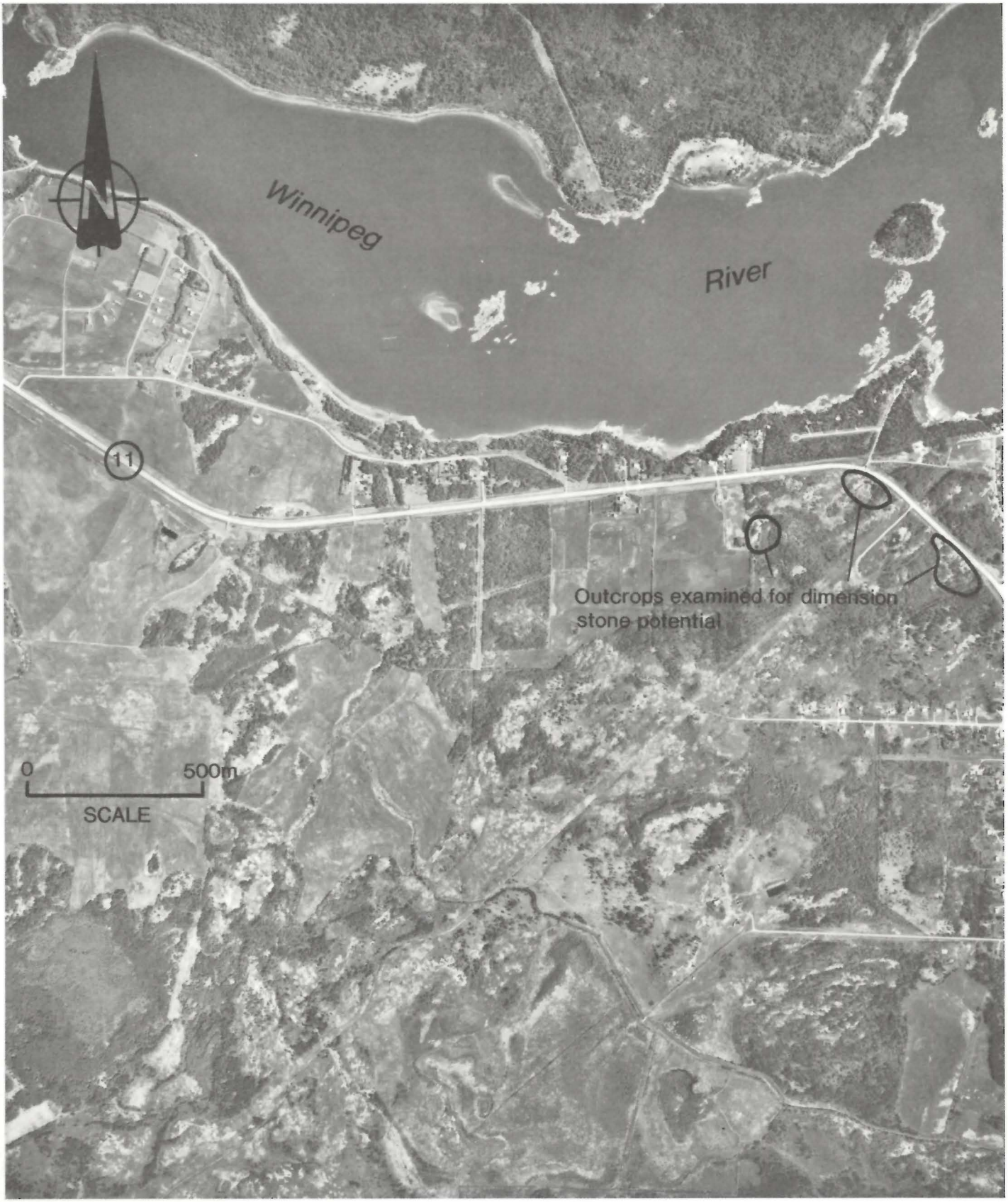

Figure 45: Aerial photograph showing outcrops examined near Great Falls (ref. Figure 44).

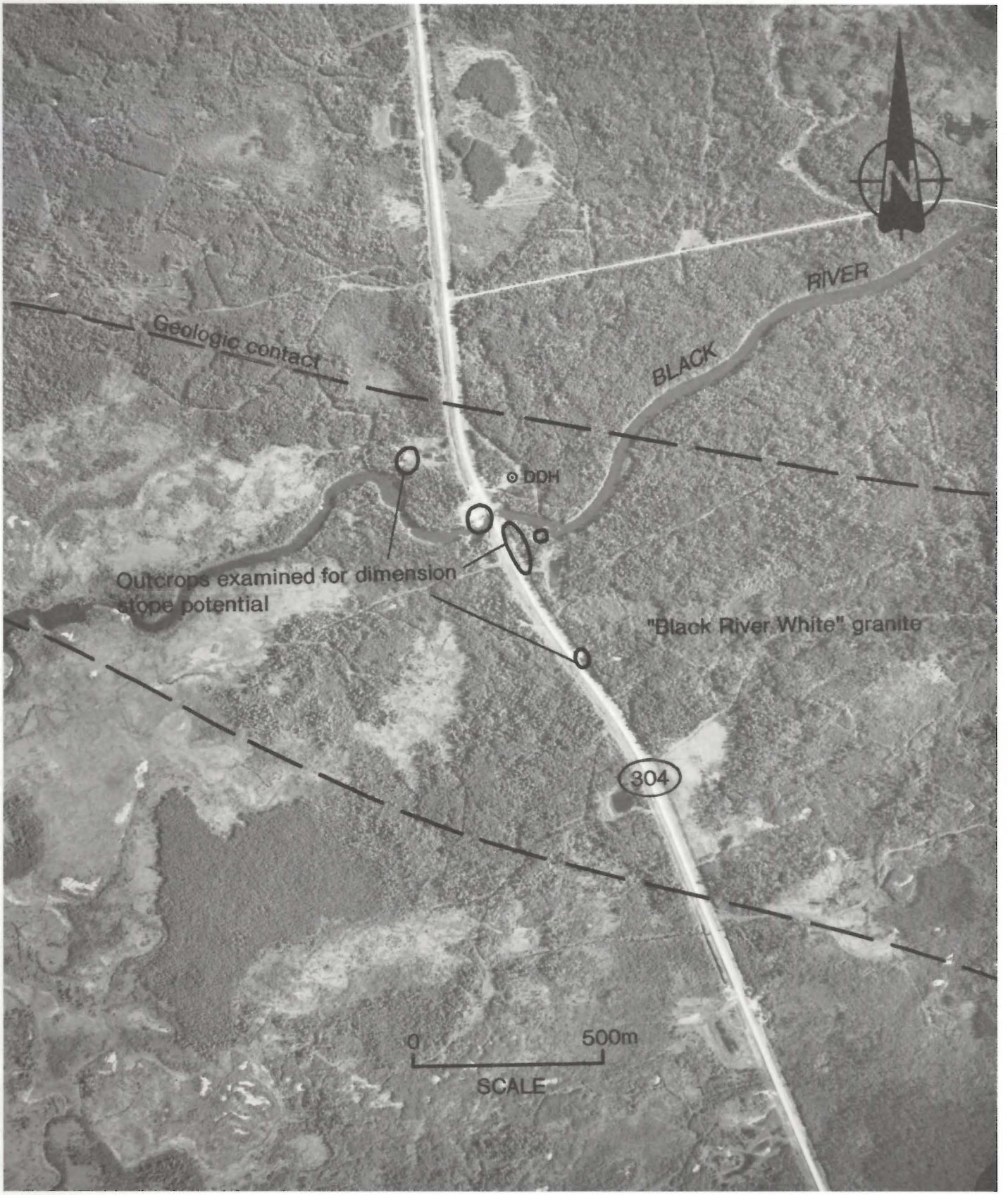

Figure 46: Aerial photograph showing the locations of Black River white granite outcrops (Fig. 44).

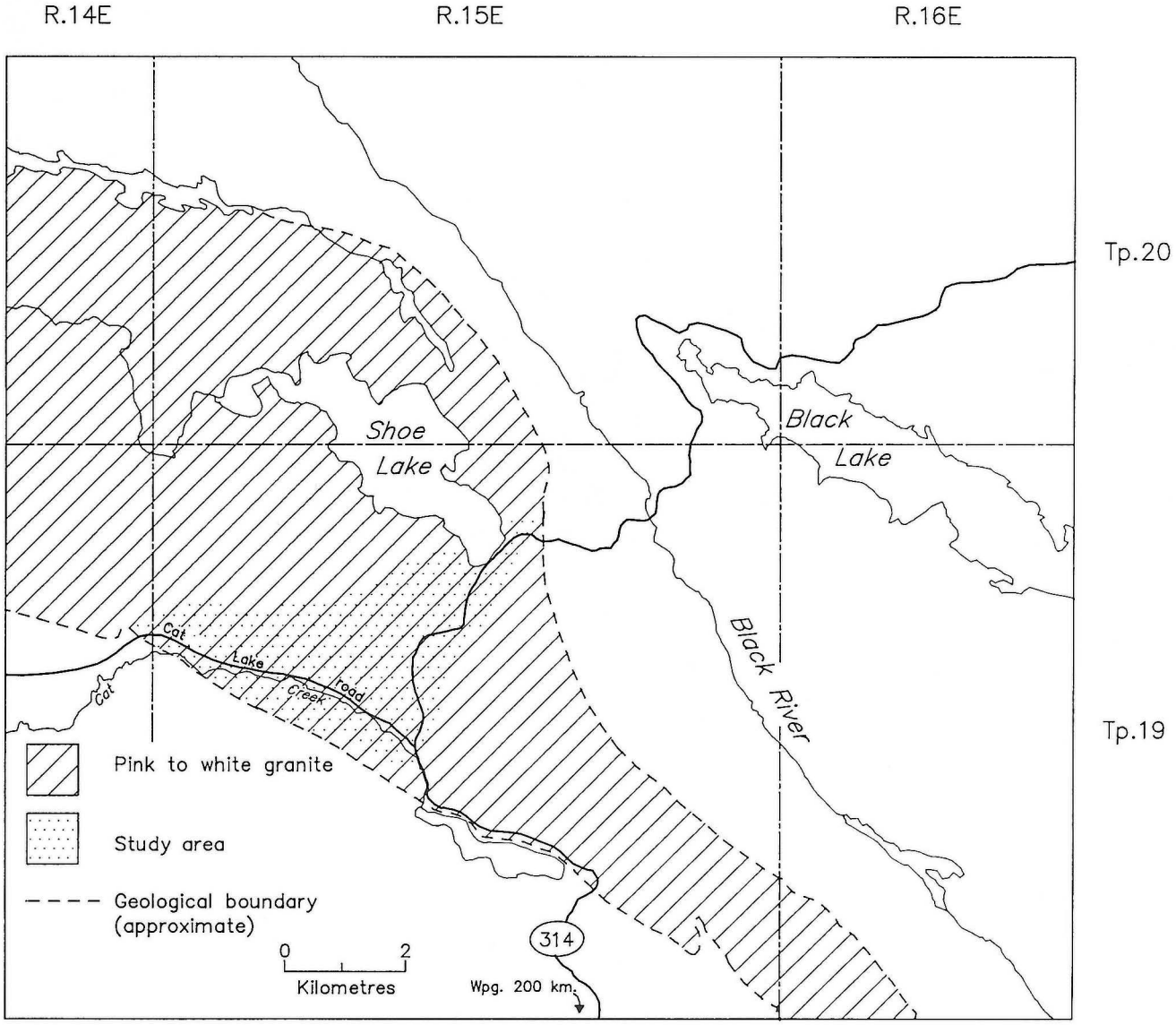

Figure 47: Area examined for dimension stone potential in the Inconnu Batholith.

CONCLUSIONS

The granitic bodies in southeast Manitoba that have the highest potential to be sources of dimension stone are the Lac Du Bonnet Batholith, the Betula Lake Pluton and the Medika Pluton. These are the geologically youngest and, consequently, the least deformed and fractured granitic bodies in the region. Some features that are common to all three granitic bodies are:

1. The frequency of vertical and horizontal fractures decreases with depth. This indicates that some outcrops with closely spaced fractures at surface may have widely spaced fractures within several metres of the surface; and
2. Some low-lying flat outcrops contain no visible fractures at surface, but show evidence of high compressive stresses that can cause fractures to occur in quarried blocks. These outcrops would be expensive to quarry because the surfaces of the outcrops are the only free surfaces that could be worked.

Two colours of granite, yellow-grey and pink, are present at surface in the LDBB. Outcrops of yellow-grey granite contain the most widely spaced fractures, but most are too small to support a quarry. Waves, knots and coarse grained veins occur throughout the outcrops of pink granite.

Five colours of granite were documented in the BLP: yellow-grey, red, brown, pink and brick-red. The rock is coarse grained in the central part of the intrusion within Whiteshell Provincial Park and medium grained along its western margin at the fireguard road between Seven Sisters and Darwin. Outcrops of yellow-grey granite have no or few fractures at surface, but may exhibit destressing fractures when quarried. Two outcrops of yellow-grey granite have aboriginal petroform sites located on them and commercial development is not permitted. Some outcrops of red, brown and pink granite have widely spaced fractures and may be suitable sources of dimension stone. The brick-red granite has common microfractures and crumbles when removed from the outcrop; this granite is not a potential source of dimension stone.

Outcrops of the Medika Pluton are potential sources of dimension stone. The granite is coarse grained, red to mahogany and some outcrops have widely spaced fractures.

Some geologically older granitic bodies exhibit some of the features required of a dimension stone and warrant further evaluation. These include the Great Falls grey granite located north of Lac du Bonnet along Highway 11, the Maskwa Lake granite in the vicinity of Tulabi Falls, east of Bird Lake, and the McMunn pink granite at McMunn.

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APPENDIX A
QUARRYING WITHIN MANITOBA'S PROVINCIAL PARKS

Most of the field area for this study is within Whiteshell Provincial Park and Nopiming Provincial Park. The boundaries of the two parks are shown on Figure 6. The Whiteshell Park Master Plan was used as a guide when choosing outcrops to be evaluated for dimension stone. Only the areas coded for limited mining activities in the extensive and intensive recreation zones were assessed for dimension stone potential.

EXTENSIVE RECREATION ZONES

"Generally, forestry and mining operations are permitted in Extensive Recreation Zones and all-weather roads may be developed in support of these activities. Any such operations will, however, be subject to terms and conditions of permits to explore, harvest and develop" (Whiteshell Master Plan, Section 2.3, p. 18).

INTENSIVE RECREATION ZONES

"Small scale forestry and mining operations may be permitted subject to special terms and conditions formulated through a review of applications for permits. Terms and conditions will ensure that primary recreational values are not compromised, operations are not aesthetically offensive to other users, and Special Areas, streams, lakeshores and critical fish and wildlife habitats are not impaired" (Whiteshell Master Plan, Section 2.4, p. 20).

Within these areas, a minimum buffer zone of 1.5 km has been applied to all the cottage and recreation sites. For example, several sites that have the physical properties required of dimension stone deposits have not been designated as high potential sites since quarrying would occur within 1.5 km of cottages.

A quarry within the park would be subject to restrictions and conditions imposed by park officials for all quarry operations and rehabilitation.

Petroforms occur on the Tie Creek yellow-grey granite within Whiteshell Provincial Park. A significant location, the "eight acre site" is located on the west extension of the outcrop, but the petroforms are surrounded and protected by a 3 to 4 m high, locked, chain-link fence. The yellow-grey granite has not been sampled with a cobra drill or a diamond drill, and requests for exploration leases have been turned down by the departments of Culture, Heritage and Citizenship and Natural Resources because of the reputed archaeological and religious significance of the site.