

DIMENSION STONE QUARRIES IN BRITISH COLUMBIA*

By G. V. White

INTRODUCTION

At the turn of the century British Columbia produced a variety of quality dimension stone for both domestic and foreign markets. The industry flourished until the 1930s when many of the producing quarries closed. At present most dimension stone used in British Columbia is imported.

The objectives of an evaluation of dimension stone sites around the province, carried out during 1985-1986, are:

- (1) To identify dimension stone deposits with good development potential.
- (2) To cut and polish sets of samples for promotional purposes.
- (3) To promote significant deposits by producing brochures documenting the quality of the stone and the development potential of the sites.

This report describes 13 sites examined during 1986 (Figure 4-8-1). Descriptions are listed by geographical location rather than rock type, starting in eastern British Columbia.

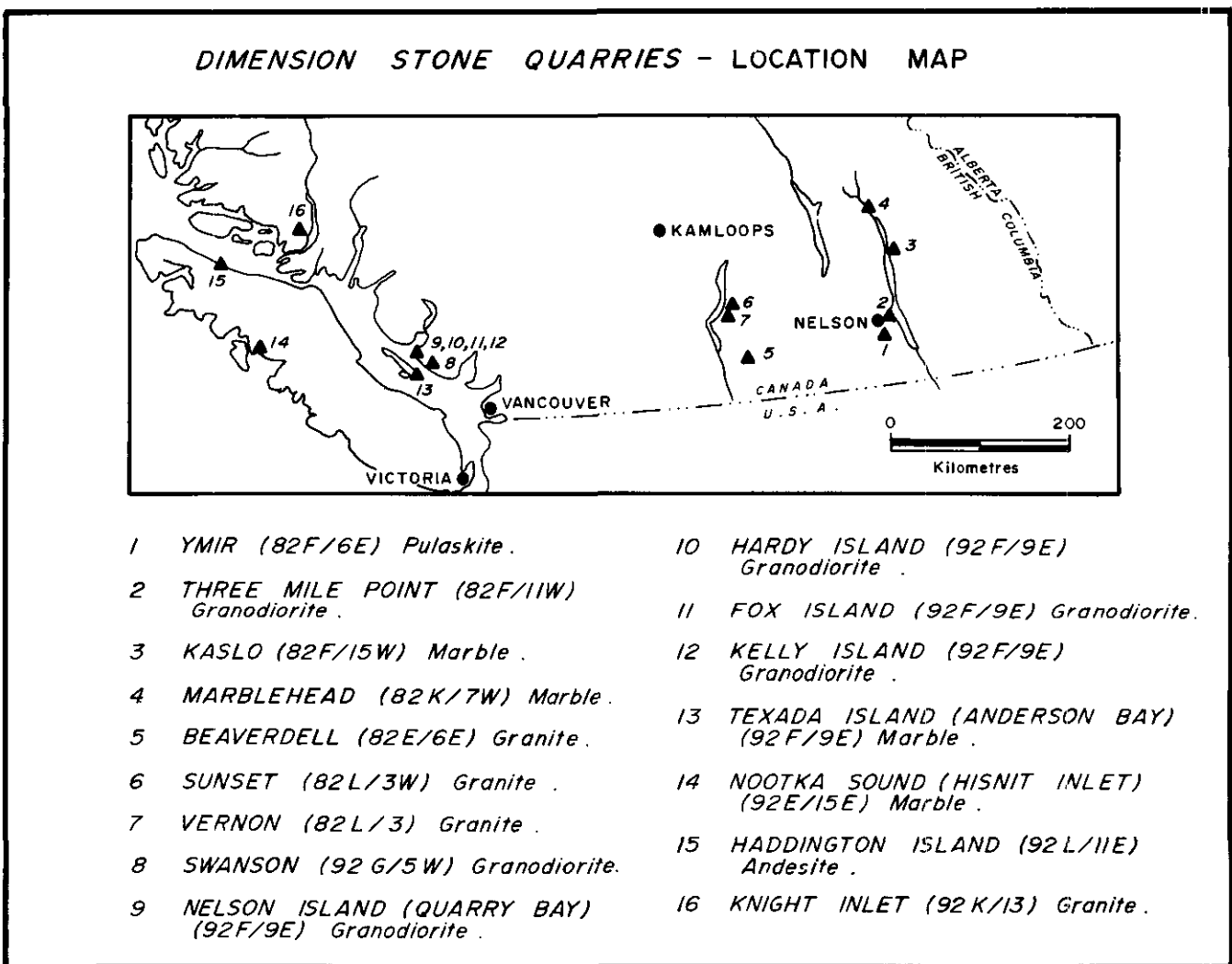


Figure 4-8-1. Dimension stone location map.

* This project is a contribution to the Canada/British Columbia Mineral Development Agreement.
British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1986, Paper 1987-1.

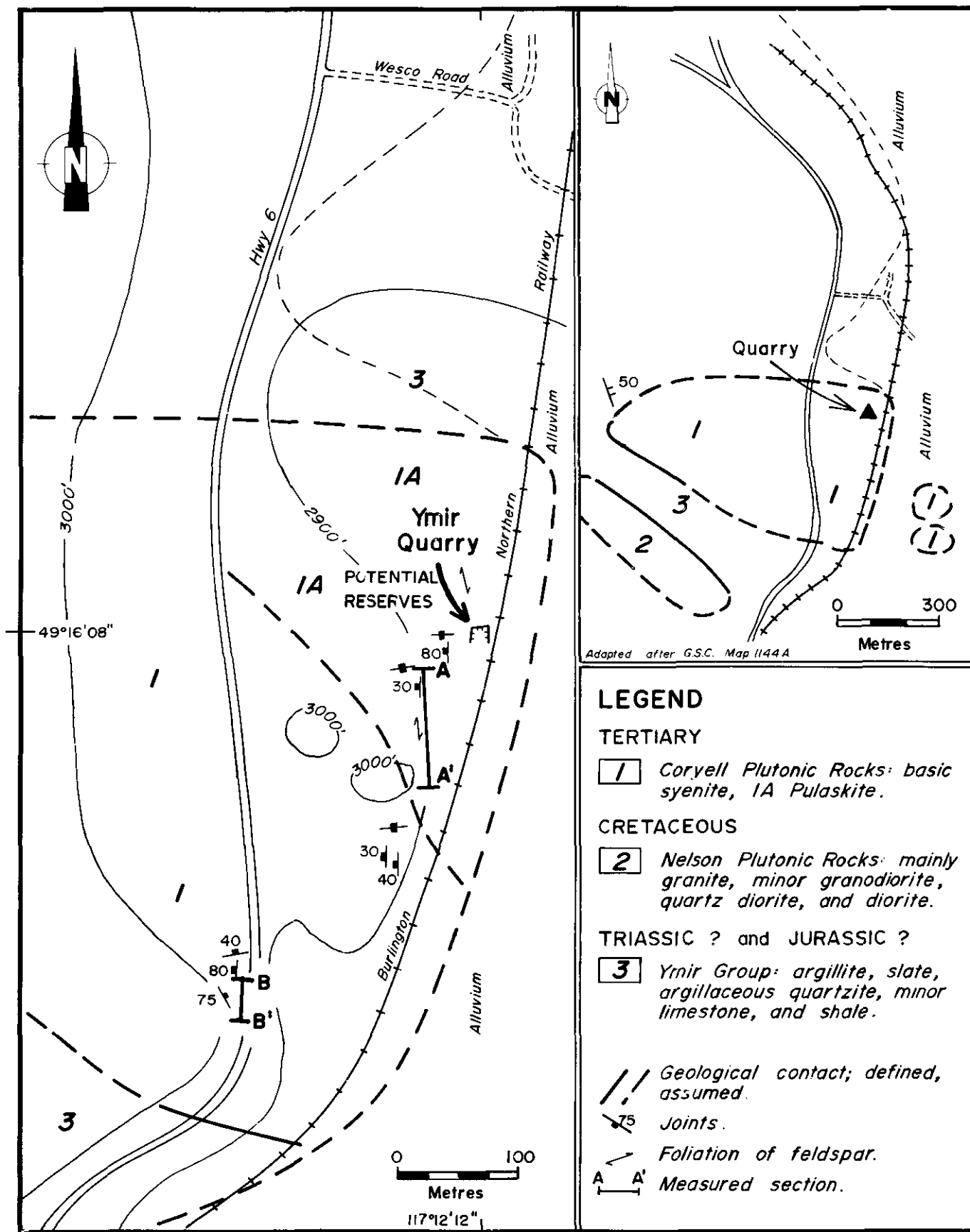


Figure 4-8-2. Ymir quarry (82F/6E).

KOOTENAY QUARRIES

PULASKITE — YMIR QUARRY (82F/6E)

Introduction

An abandoned dimension stone quarry (Mineral Inventory 82F-297), located approximately 1.1 kilometres south of the village of Ymir, produced monument and ornamental stone intermittently through the first half of the century (Carr, 1955; Plate 4-8-1). Known locally as "Ymir Pearl", the stone can be seen in Nelson where it was used in construction of the War Memorial.

Sample Description

Pulaskite has been quarried from the core of a basic syenite plug of the Tertiary Coryell plutonic rocks (Little *et al.*, 1963).

On fresh surfaces the pulaskite is mauve-grey although euhedral phenocrysts of green to black diopside (1 to 6 millimetres) and black blades of biotite (1 to 3 millimetres) darken the tone of the rock. The matrix consists of rectangular feldspars (up to 4.5 centimetres by 3 millimetres) which Drysdale (1917) identified as intergrowths of orthoclase and albite. In outcrop the large elongate feldspars, which schillerize a brilliant sky blue when wet, are consistently oriented between 330 and 360 degrees.

Infrequent patches of pyrite and a red-brown iron stain, derived from weathered blades of biotite, are visible in places. Weathered surfaces have a dull appearance as does the polished face of the Nelson War Memorial.

Quarry Development

The quarry is horseshoe shaped and lies immediately west of the Burlington Northern railway tracks (Figure 4-8-2). The east wall parallels the track at a bearing of 10 degrees. It is approximately 25 metres long and has a maximum height of 7 metres. The west wall is 14 metres long with a maximum height of 12.5 metres. The abandoned working face at the north end of the quarry is approximately 14 metres long and has a height of 4.6 metres.

The quarry is overgrown with heavy second growth forest and littered with large abandoned cut blocks.

Structure

The development of joints is irregular and difficult to predict. One main set strikes east and has a near-vertical dip. It is recognized both in the quarry and in outcrop to the south. A flat set strikes north and dips 30 degrees west but joints are irregular and not well defined.

Joint and fracture intensity varies within the plug. Along a 110-metre section of outcrop south of the quarry (A-A', Figure 4-8-2) over 79 per cent of vertical joints are spaced greater than 50 centimetres apart and over 64 per cent are spaced more than 100 centimetres apart. Seventy-five per cent of horizontal joints and fractures are spaced wider than 50 centimetres (Figure 4-8-3). Along a 30-metre section of outcrop near the southern contact of the syenite plug (B-B', Figure 4-8-2), 66 per cent of vertical and 83 per cent of horizontal joints and fractures are spaced less than 50 centimetres apart.

Discussion

Changes in joint and fracture density in different areas of the plug could be a reflection of the location of the section measured. Section A-A' measured near the centre of the plug was probably subject to less intense pressure than section B-B' located nearer the margin (Figures 4-8-2 and 4-8-3).

Physical Tests

Results of physical tests carried out on samples from the quarry are outlined in Table 4-8-2. The tests indicate that the stone does not meet American Society for Testing and Materials (ASTM) standards for modulus of rupture (traverse strength) for granite building stone, but does meet all other ASTM standards.

GRANODIORITE — THREE MILE POINT (82F/11W)

Introduction

An abandoned quarry (MI 82F-249) near Three Mile Point on the east shore of Kootenay Lake (Plate 4-8-2) provided stone for a number of prominent buildings and the Houston monument in Nelson (Parks, 1917).

Sample Description

The granodiorite, considered early Cretaceous in age, is part of the Nelson pluton (Little *et al.*, 1963). It is porphyritic, with scattered feldspar crystals up to 2 by 4.5 centimetres visible in places. The stone is medium to coarse grained, speckled with black blades of biotite (1 to 2 millimetres) and glassy grey to pink quartz crystals (1 millimetre to 1 centimetre) and has a light white to pink tone.

Minerals identified in thin section include plagioclase, orthoclase, quartz, biotite and minor magnetite. Parks (1917) reports small amounts of sphene although this mineral was not observed in thin section.

Exposed surfaces, such as the Houston monument in Nelson, appear fresh and retain the stone's attractive appearance.

Quarry Development

Three separate sites were worked along a ridge (Figure 4-8-4).

Site 1

Site 1 consists of three working faces developed in a series of steps. The faces, cut along northwest-striking, vertically dipping joints, measure 12.8, 7.9 and 17.6 metres in length and have maximum heights of 4.0, 1.3 and 3.5 metres. Vertical joints and fractures are spaced between 0.2 and 3 metres apart; flat joints, 0.2 to 1.3 metres apart, strike between 270 and 290 degrees and dip 35 to 40 degrees north.

Site 2

Site 2 consists of one working face, approximately 36.5 metres long by 7.5 metres high, which parallels a vertical joint striking 353 degrees. Irregularly spaced joints, striking 305 degrees and dipping 45 degrees north, are spaced approximately 1.3 metres apart although only a few are exposed. A second set of vertical joints strikes 270 degrees; joint spacing is irregular between 0.9 and 8.0 metres.

Site 3

The developed face at Site 3 measures 21.8 metres long by 20 metres high. It parallels a vertical joint which strikes 235 degrees. A few low-angle joints (averaging between 1.0 to 2.0 metres apart) strike 295 to 305 degrees and dip 40 degrees north.

Reserves

Limited outcrop between faces prevents a statistical analysis of the size of blocks available from the quarry. Measurements of cut blocks below each of the three sites suggest potential for large blocks.

Table 4-8-1 illustrates the size of blocks left on site. It is assumed that these were either too small or flawed and were rejected in favour of larger blocks. Excellent potential for quarriable granodiorite exists both along and between abandoned working faces and future development is possible to the east (Figure 4-8-4).

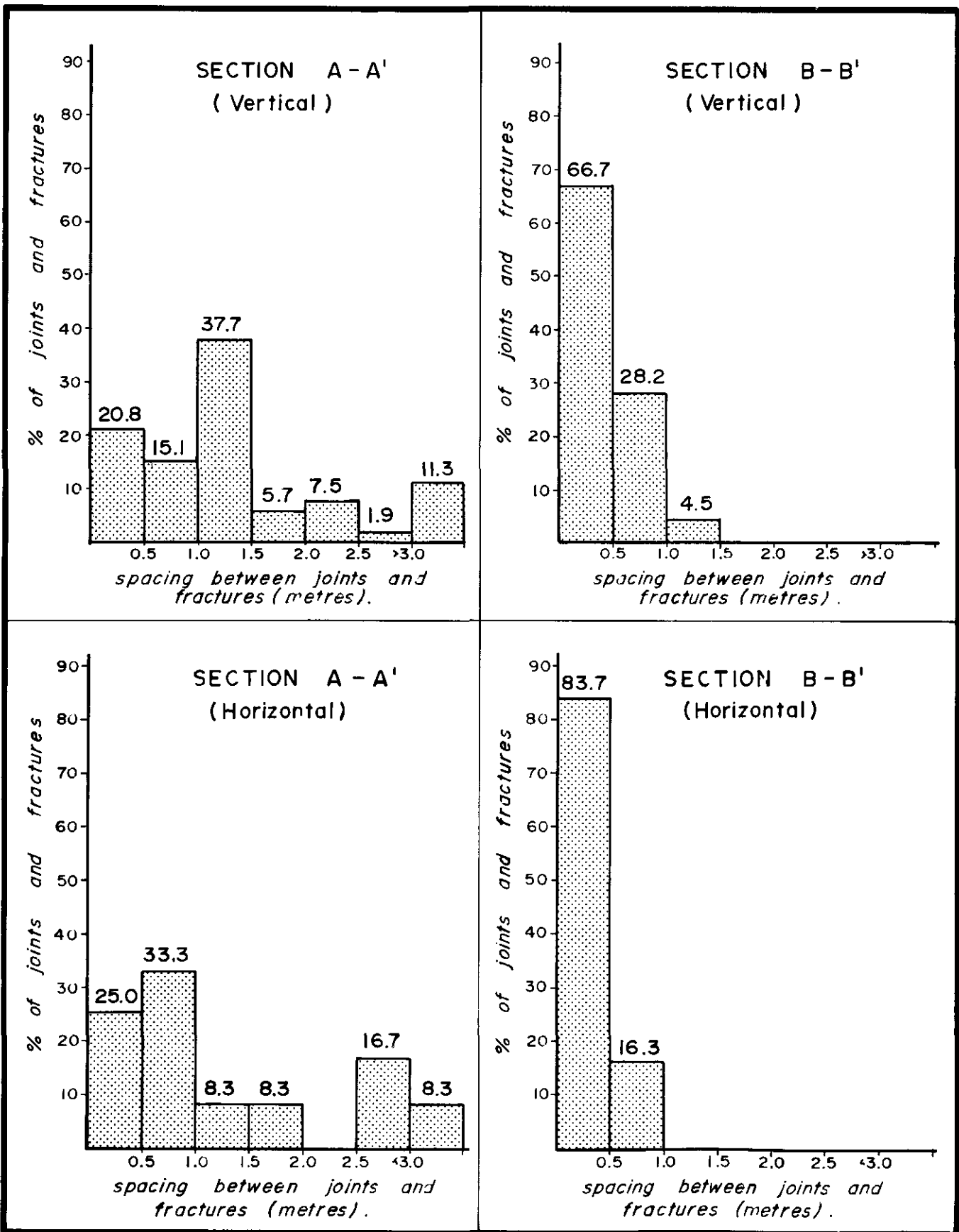


Figure 4-8-3. Ymir quarry histograms.

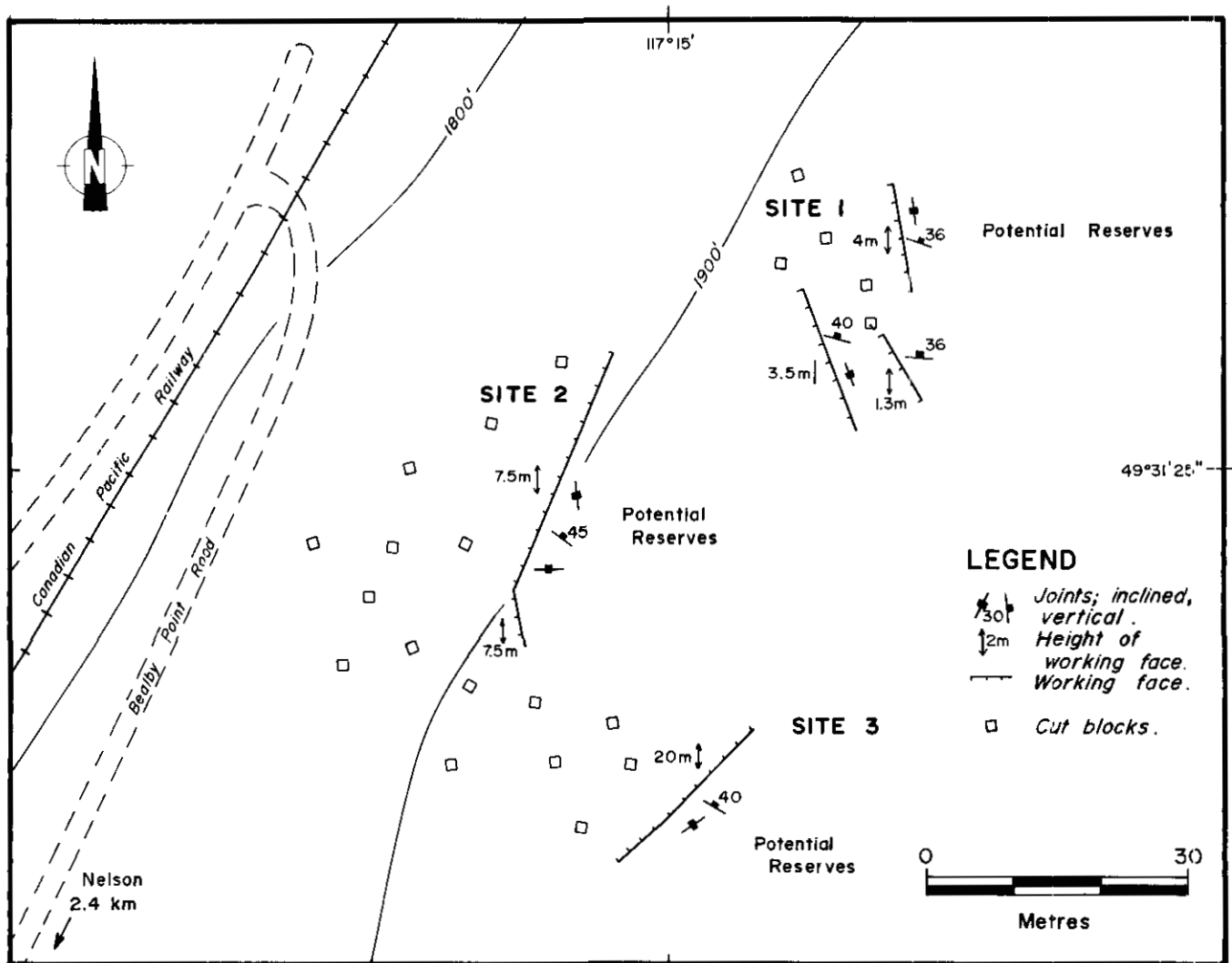


Figure 4-8-4. Three Mile Point quarry (82F/11W).

TABLE 4-8-1.
BLOCK SIZE, THREE MILE POINT QUARRY

Site*	Average Size of Cut Blocks (metres)
Site 1	0.99 × 0.62 × 0.35
Site 2	1.01 × 0.58 × 0.36
Site 3	1.11 × 0.62 × 0.50

* Based on 20 measurements at each site.

Physical tests reported by Parks (1917) on samples from this location indicate the stone meets ASTM standards for granite building stone (Table 4-8-2).

MARBLE — MARBLEHEAD QUARRIES (82K/7W)

Introduction

Four abandoned quarries (MI 82K-076), located approximately 3 kilometres north of the Meadow Creek bridge on Highway 31 south of Duncan Lake, produced white to grey-banded crystalline marble around the turn of the century. The marble was used in construction of a number of prominent buildings, including the attractive Bank of Commerce building in Nelson (Parks, 1917).

Quarry Development and Sample Description

All four quarries are located in crystalline limestone which crops out for about 1.5 kilometres north of Marblehead. The marble is part of the Lower Cambrian Badshot-Mohican Formation (Reesor, 1972).

Quarry 1

Quarry 1 is located 3.1 kilometres north of the Meadow Creek bridge, adjacent to Highway 31 (Figure 4-8-5 and Plate 4-8-3). The working face, 28.1 metres long, has a vertical height of 10.1 metres: the north and south walls are 10.4 metres and 12.7 metres long respectively.

The marble varies from an attractive milky white to bluish-grey in colour. At the quarry, the white variety dominates and the blue-grey marble occurs in distinct individual bands up to 18 centimetres wide within a 2.75-metre band near the base of the quarry. Both the light and dark marble, referred to as "Light Kootenay" and "Dark Kootenay" by Parks, are medium grained (1 to 4 millimetres) and contain no visible sulphides or other impurities.

In thin section the euhedral grains are seen to be interlocked and consist entirely of calcium carbonate. No other minerals were observed.

Remnant bedding, visible along the quarry walls, strikes 320 degrees and dips 35 to 40 degrees to the northeast. One set of joints strikes parallel to bedding and dips 45 to 55 degrees to the southwest. A second set, measured south of the quarry, strikes 190

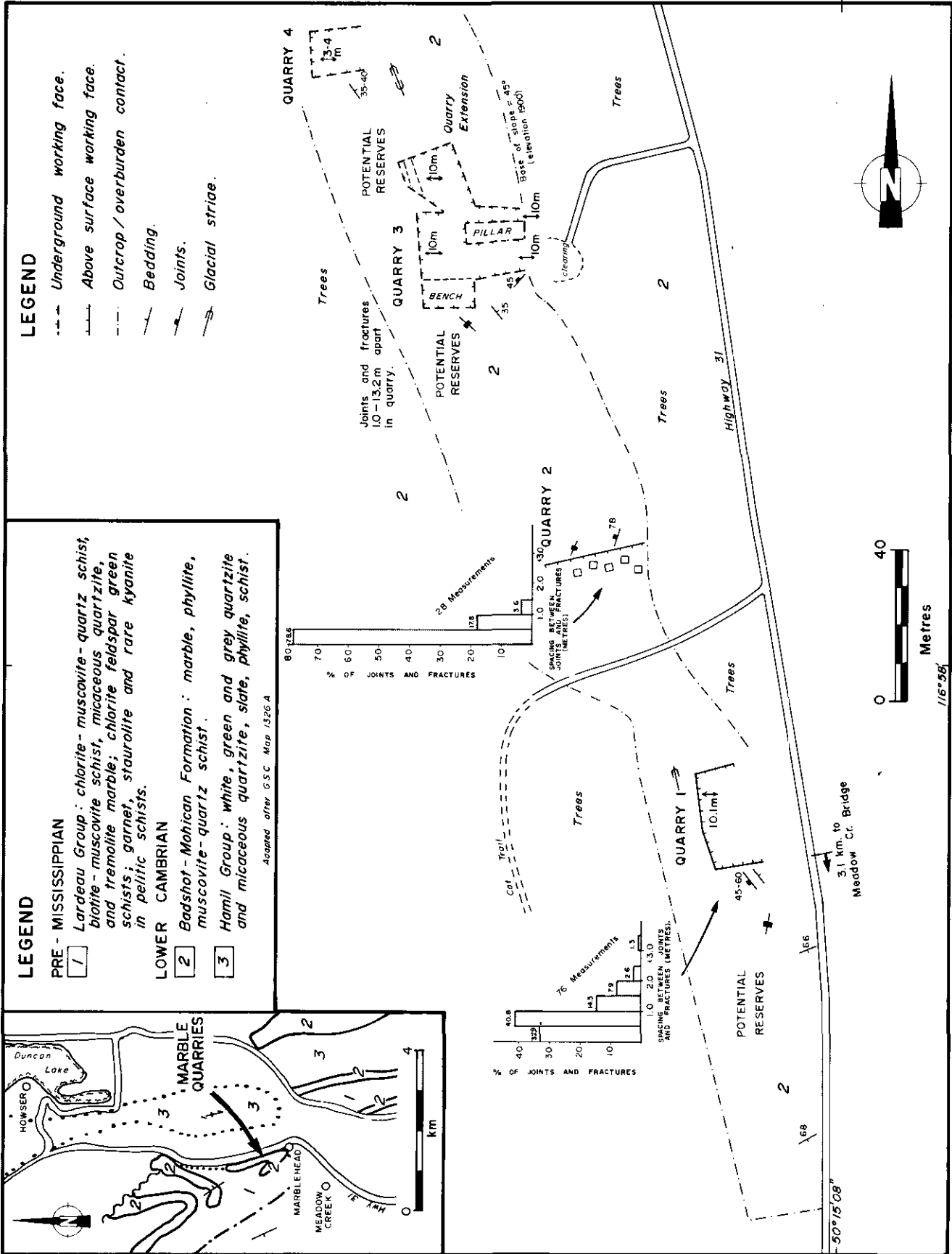


Figure 4-8-5. Marblehead quarries (82K/7W).

TABLE 4-8-2.
DIMENSION STONE QUARRIES IN BRITISH COLUMBIA, PHYSICAL PROPERTIES

Commodity	Quarry Name	NTS	Specific Gravity	Density		Absorption by Weight (per cent)	Compressive Strength		Traverse Strength (Modulus of Rupture)		
				lb/ft ³	kg/m ³		PSI	MPa	PSI	MPa	
GRANITE ^A	Ymir ²	82F/6E	2.69*	167.83*	2688*	0.35*	7,581 – 8,514	52.27 – 59.00	1,594 – 1,808	10.99 – 12.46	
	Three Mile Point ¹	82F/11W	2.656	163.63	2621	0.407	29,406	203	1,708	11.78	
	Beaverdell	82E/6E	2.61*	162.63*	2605*	0.50*	8,110 – 9,543	55.92 – 65.80	1,151 – 1,460	7.94 – 10.07	
	Vernon	82L/3	2.67	164.30	2632	0.354	24,791	171	1,968	13.57	
	Nelson Island ¹	92F/9E	2.657	164.82	2640	0.175	34,823	240	2,871	19.79	
	Hardy Island ¹	92F/9E	2.703	167.56	2684	0.177	32,288	223	1,453	10.01	
	Kelly Island ¹	92F/9E	2.681	166.33	2664	0.178	35,144	242	3,521	24.28	
	Knight Inlet		3.05	—	—	0.113	—	—	4,075	28.10	
	MARBLE ^B	Marblehead	82K/7W	2.718	168.70	2702	0.179	12,486	86	2,127	14.67
		Kaslo	82F/15W	2.752	171.36	2745	0.99	13,987	96	1,254	8.65
Nootka Sound		92E/15E	2.721	169.39	2713	0.073	18,992	131	2,349	16.20	
Texada Island (Anderson Bay)**		92F/9E	2.712	169.00	2707	0.052	18,518	128	2,466	17.00	
ANDESITE	Haddington Island**	92L/11E	2.67	143.41	2297	3.79	18,428	127	1,160	8.00	

PHYSICAL REQUIREMENTS — AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)									
GRANITE (See Definition)		N/A	160 (min)	2560 (max)	0.40 (min)	19,000 (min)	131 (min)	1,500 (min)	10.34 (min)
MARBLE (Calcite) (See Definition)		N/A	162 (min)	2595 (max)	0.75 (min)	7,500 (min)	52 (min)	1,000 (min)	7.00 (min)

* Average of three tests.

** Report published in Exploration in British Columbia, 1985, Part B.

¹ Granodiorite.

² Pulaskite.

GRANITE^A (Commercial Definition) — a visibly granular, igneous rock generally ranging in colour from pink to light or dark grey and consisting mostly of quartz and feldspars, accompanied by one or more dark minerals. The texture is typically homogeneous but may be gneissic or porphyritic.

MARBLE^B (Commercial Definition) — a crystalline rock composed predominantly of one or more of the following minerals: calcite, dolomite or serpentine and capable of taking a polish.

Source: 1984 Annual Book of ASTM Standards.

Conversion Factors:

PSI → MPa = # × 6.894 757 × 10⁻³

lb/ft³ → kg/m³ = # × 1.601 846 × 10

Physical Tests: Ymir and Beaverdell tests; B.C. Ministry of Transportation and Highways (Geotechnical and Materials Branch).

All other tests results, Parks (1917).

degrees and has a vertical dip. Parks describes the marble as "free from flaws and cracks and so unbroken that blocks can be taken out in size up to any dimension", however vertical fractures measured along the abandoned working face range between 0.25 and 3.1 metres apart. As illustrated in Figure 4-8-5, 67 per cent of cut blocks south of the quarry will be greater than 50 by 50 by 50 centimetres in size.

Quarry 2

This site is located approximately 80 metres northwest of Quarry 1 (Figure 4-8-5). No well-defined quarry exists at this location; it appears that small amounts of highly fractured grey marble were selectively removed in an unsuccessful attempt to find a more competent stone. A 27-metre section of dark grey, medium-grained crystalline limestone was examined. Joints and fractures have an average strike of 20 to 22 degrees and dip steeply to the west. Spacing between fractures is 10 to 70 centimetres, with an average spacing of 35 centimetres. Nearly 80 per cent of fractures are less than 50 centimetres apart (Figure 4-8-5).

Quarry 3

Quarry 3 lies 0.75 kilometre north of Quarry 1 along Highway 31 (Figure 4-8-5). This quarry, an underground operation (Plate 4-8-4), has the following dimensions:

South Portal: 14 metres long, 8 metres wide and approximately 10 metres high.

North Portal: 14.8 metres long, 3.5 metres wide and approximately 10 metres high.

Main Quarry: 24.9 metres long, 11.3 metres wide and approximately 10 metres high.

Quarry Extension: 11.1 metres long, 11.2 metres wide and approximately 10 metres high.

Bedding strikes 320 degrees, dipping between 35 and 40 degrees to the northeast and joints are not uniformly spaced. The entrance to the south portal is intensely fractured for the first 3 metres with fractures spaced 20 to 40 centimetres apart. Underground, joints and fractures measured along the south and west walls of the quarry are widely spaced, ranging between 1.0 and 13.2 metres apart.

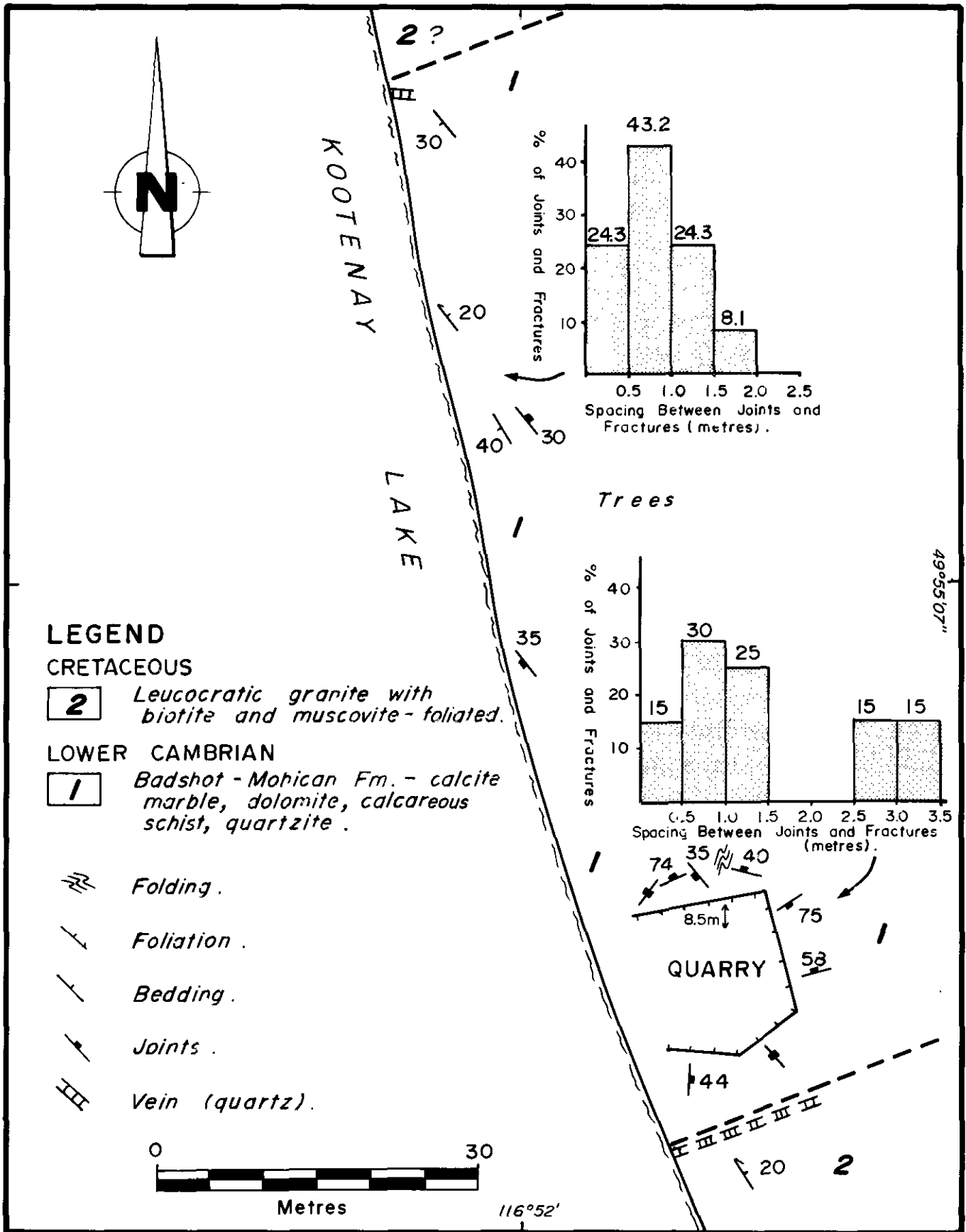


Figure 4-8-6. Kaslo quarry (82F/15W).

The marble is dominantly white, similar to the stone described at Quarry 1. Smaller amounts of the blue-grey banded variety are present and could be selectively worked.

Quarry 4

Quarry 4, located approximately 65 metres northwest of the south portal of Quarry 3, is an underground opening measuring 13.9 metres along its south and north walls, 12.2 metres along the working face and between 3 and 4 metres high.

Marble near the entrance is generally white, similar to marble described at Sites 1 and 3. Approximately 7 metres into the opening, the marble darkens to a grey colour and is cut by white calcite stringers, up to 18 centimetres wide, but averaging 1 centimetre in width. The grey marble is medium grained, banded, and not as attractive as the white variety.

On the south and west faces fractures spaced between 0.35 and 1.4 metres apart show no regular pattern. Remnant bedding appears to strike 320 degrees dipping 35 to 40 degrees to the northeast.

Reserves

Potential reserves of white to grey marble lie north, south and west of Quarry 1 (Plate 4-8-3). Preliminary results suggest cut blocks greater than 50 by 50 by 50 centimetres may be obtained from this area. Grey-banded marble from Quarry 2 will be restricted to blocks less than 50 by 50 by 50 centimetres in size. Large cut blocks of white to grey-banded marble, up to 13 metres long, are potentially available immediately adjacent to Quarry 3. Limited quantities of white marble and small blocks of grey marble are potentially available adjacent to Quarry 4.

There is excellent potential for reserves of dimension stone west of all four quarries although a heavy forest cover prevents detailed observation of this marble.

Physical testing of the marble, reported by Parks in 1917, indicates both varieties of white and grey marble meet ASTM standards for marble building stone (exterior) (Table 4-8-2).

MARBLE — KASLO (82F/15W)

Introduction

Crystalline limestone from a small quarry located on the east shore of Kootenay Lake opposite Kaslo (Lot 2278), was used to construct the Nelson City Hall (formerly the courthouse) and other buildings around the turn of the century (Parks, 1917). Recent examination of the site has outlined reserves of attractive white to grey marble, suitable as dimension stone (Figure 4-8-6 and Plate 4-8-5).

Sample Description and Quarry Development

Crystalline limestone, considered part of the Badshot-Mohican Formation of Early Cambrian age (T. Höy, personal communication, 1986) varies in colour from white to blue-grey. The stone is coarse grained (greater than 5 millimetres), with individual crystals up to 16 millimetres in size. Parks observed "the stone is charged with tremolite" and has a "tendency to turn yellow, and later brown" on weathered surfaces. Examination of the Nelson City Hall and the government building in Kaslo confirms this observation. Samples from the quarry tested by Parks indicate the marble meets ASTM standards for marble building stone (exterior) (Table 4-8-2).

The quarry has a horseshoe shape and is approximately 13 metres long by 14 metres across by 8.5 metres high (maximum).

Structure

Joints are irregular, striking between 0 and 90 degrees with dips varying from 60 to 90 degrees northwest. Remnant bedding strikes 320 degrees and dips 35 to 40 southwest towards the lake (Figure 4-8-6).

Eighty-five per cent of joints and fractures measured are spaced more than 50 centimetres apart. North of the quarry approximately 75 per cent of joints and fractures are spaced wider than 50 centimetres.

Reserves

Potential reserves of marble, similar to stone in the quarry, are outlined north of the opening on the shore of the lake. Although more intensely fractured than stone in the quarry, preliminary results indicate the marble is suitable as a dimension stone (Figure 4-8-6).

East of the quarry the marble is covered by heavy second growth forest and was not examined in detail. To the south, a well-defined granite/marble contact marks the limit of the Badshot-Mohican Formation (Figure 4-8-6).

SUMMARY — KOOTENAY QUARRIES

- (1) Physical tests on samples from the Ymir quarry indicate the stone does not meet ASTM standards for modulus of rupture. Stone from the Three Mile Point, Marblehead and Kaslo quarries meet all ASTM requirements for granite and marble building stone.
- (2) Based on the measurements of cut blocks at the Three Mile Point quarry and fracture density surveys at the Ymir, Marblehead and Kaslo quarries, a significant proportion of potential reserves could be cut into blocks suitable for dimension stone applications.
- (3) Stone from the Ymir and Three Mile Point quarries is suitable for building and ornamental purposes while marble from Marblehead and Kaslo could be used to produce facing stone and terrazzo tiles.

INTERIOR QUARRIES

GRANITE — BEAVERDELL QUARRY (82E/6E)

Introduction

A brief geological description of the Beaverdell granite quarry (MI 82E-169), 14 kilometres south of Beaverdell, was published in *Exploration in British Columbia, 1985, Part B* (White, 1986). Recent examination indicates reserves of dimension stone are located north of the worked face (Plate 4-8-6).

Sample Description

Granite examined north of the quarry is considered part of the Valhalla intrusive complex of Mesozoic age (Little, 1961). The stone has a pink tone and is coarse grained and porphyritic with phenocrysts of pink orthoclase feldspar (3.5 by 6 centimetres) common. Other minerals include plagioclase, quartz, biotite and hornblende. Immediately north of the working face the granite is cut by at least one biotite-feldspar porphyry dyke 5 to 10 metres wide (Figure 4-8-7).

Structure and Reserves

Fracture intensity appears to increase northwest of the quarry (Figure 4-8-7), where 42 per cent of joints and fractures are spaced less than 50 centimetres apart and 67 per cent are spaced less than 100 centimetres apart.

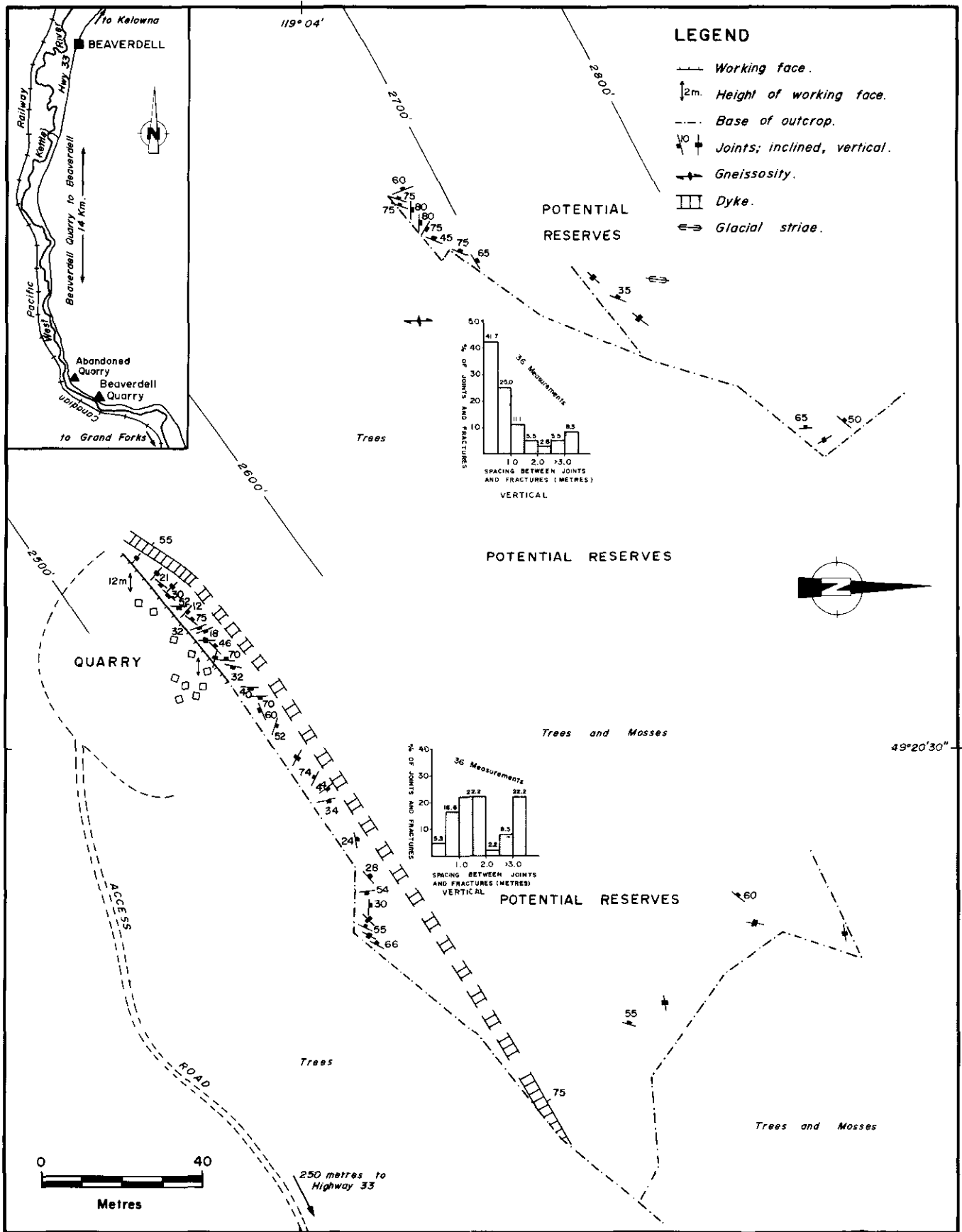


Figure 4-8-7. Beaverdell quarry (82E/6E).

Northeast of the quarry, over 94 per cent of joints and fractures are spaced more than 50 centimetres apart and 78 per cent are spaced wider than 100 centimetres.

Physical Tests

Samples tested do not meet ASTM standards for granite building stone. The results listed in Table 4-8-2 indicate the rate of absorption is higher than the 0.40 per cent standard. The compressive strength of the three samples tested was below the standard 19,000 pounds per square inch (131 MPa) minimum limit and two of the three samples were below the minimum standard of 1500 pounds per square inch (10.34 MPa) for modulus of rupture.

Further testing of stone is required to confirm the modulus of rupture test as these results are based on only three samples rather than six, as recommended.

GRANITE — OKANAGAN SUNSET QUARRY (82L/3W)

Introduction

A granite quarry (MI 82L-068) approximately 4.4 kilometres northeast of Ellison Provincial Park on the east shore of Okanagan Lake is described in *Exploration in British Columbia, 1985, Part B* (White, 1986; Plate 4-8-7). Field examination during 1986 confirmed reserves of dimension stone to the northeast of the abandoned face (Plate 4-8-8).

Sample Description

The granite is part of the Nelson intrusive complex of Mesozoic age (Okulitch, 1979). Fresh stone has an attractive pale pink tone, is medium to coarse grained and contains pink orthoclase feldspar crystals up to 8 millimetres in length. Weathered surfaces are light to dark grey with occasional yellow iron stain. Similar stone from the Vernon quarry (82L/3W), used to build the Vernon courthouse, remains fresh and attractive after more than 60 years, attesting to the quality of the granite.

Potential Reserves

A well-defined ridge of granite, 80 metres long, 25 metres wide and up to 20 metres high (Figure 4-8-8), extends northeast of the abandoned working face. Joints measured along the ridge strike north-northwest and dip 70 degrees west to vertical. A second set, measured at both ends of the ridge, strikes east and dips between 55 and 90 degrees to the north while less steeply dipping, irregular joints along the southern margins of the outcrop strike northwest and dip 30 to 40 degrees southwest.

Spacing between joints and fractures measured along the ridge is irregular although 48 per cent are spaced greater than 50 centimetres apart. Horizontal fractures, visible only on the exposed face, are widely spaced, between 1.0 and 6.0 metres apart. Fractures measured along the margin of the outcrop are closely spaced, between 10 and 30 centimetres apart (Figure 4-8-8).

GRANITE — VERNON QUARRY (82L/3W)

Introduction

A granite quarry (MI 82L-087) on the east shore of Okanagan Lake, 200 metres south of Ellison Provincial Park, provided dimension stone for the Vernon courthouse (Parks, 1917) (Plate 4-8-9).

Sample Description

The granite is part of the Mesozoic Nelson intrusive complex (Okulitch, 1979). It is coarse grained with a fresh light pink tone; minerals visible in hand specimen include orthoclase, plagioclase,

quartz, biotite and hornblende. Quartz stringers 2 to 3 centimetres wide by 3 to 4 metres long, cut the granite in the quarry face. Isolated patches of red iron stain are present on the outcrop.

Quarry Development and Structure

The working face, approximately 45 metres long by 10 metres high (Figure 4-8-9), was developed along prominent joints striking north to north-northeast and dipping steeply west. Other irregular north-striking joints dip moderately to steeply east. Well-developed east-west joints at the middle and south end of the face, dip steeply north. Flat joints exposed at the centre of the quarry strike northeast and dip gently south.

Spacing between vertical joints and fractures varies from 0.2 to 2.5 metres with no consistent pattern. Parks indicates blocks up to "15.6 by 3 by 2 feet" were selectively recovered although "great amounts of unmarketable material must be removed to obtain a limited amount of dimension stone". Documentation of joint and fracture spacing along the quarry face indicates nearly 60 per cent of recoverable blocks would be larger than 50 by 50 by 50 centimetres (Figure 4-8-9).

Reserves

Potential reserves of fresh granite extend 14 metres east of the abandoned working face along a prominent ridge (Figure 4-8-9). North of the quarry, granite crops out along the lakeshore within Ellison Provincial Park. Samples tested by Parks (1917) meet ASTM standards for granite building stone (Table 4-8-2).

SUMMARY — INTERIOR QUARRIES

- (1) Physical tests on selected samples from the Beavertell quarry indicate the granite does not meet ASTM standards for modulus of rupture and rate of absorption. Rock from the Vernon quarry meets all ASTM standards for granite.
- (2) Based on fracture density surveys and examination of exposed outcrop, potential reserves of granite at the Beavertell and Sunset quarries and limited reserves at the Vernon quarry have been documented. This stone is suitable for building and ornamental purposes.

COAST QUARRIES

GRANODIORITE — SWANSON QUARRY (92G/5W)

Introduction

A small quarry (MI 92G-008), approximately 1 kilometre west of Sechelt, produced paving stone prior to World War 1 (Figure 4-8-10; Parks, 1917). The quarry was opened in granodiorite of the Coast Plutonic Complex (Roddick *et al.*, 1979).

Quarry Development and Sample Description

The quarry (Plate 4-8-10), developed parallel to north-trending joints, has a maximum length of 75 metres along its north-south working face and 30 metres along its east-west face. A smaller face, approximately 25 metres north of the larger opening, is 25 metres long (Figure 4-8-10). The maximum height of developed faces is 3 metres.

The granodiorite is medium to coarse grained with a fresh appearance and a light tone. Exposed surfaces weather light grey and visible minerals include feldspar, quartz, biotite and hornblende. Occasional dark knots of mafic minerals and infrequent iron stains from weathered blades of biotite are visible on fresh surfaces. Pyrite and molybdenum were observed in one sample of float from near a "granite dyke", but neither mineral was found in place.

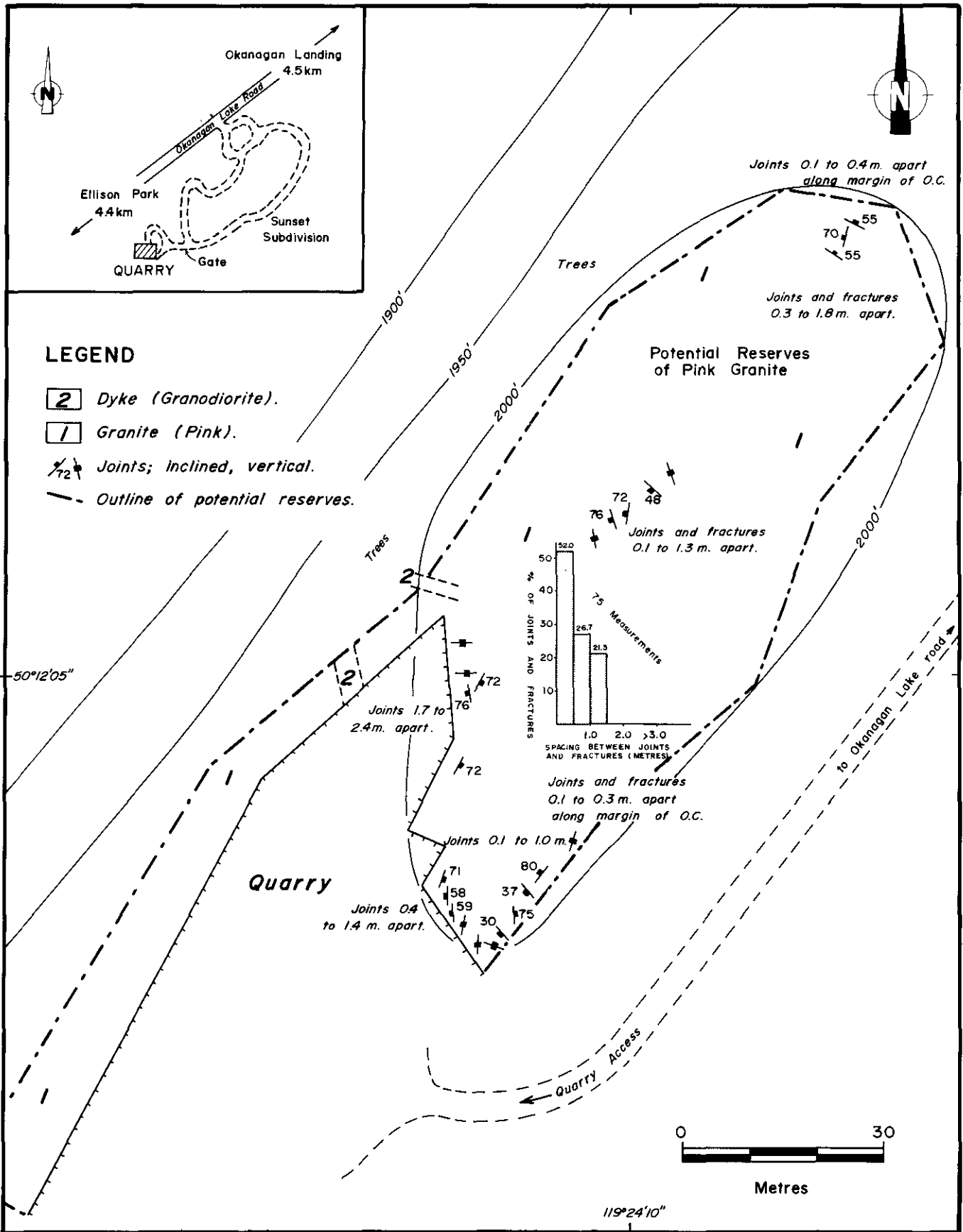


Figure 4-8-8. Sunset quarry (82L/3W).

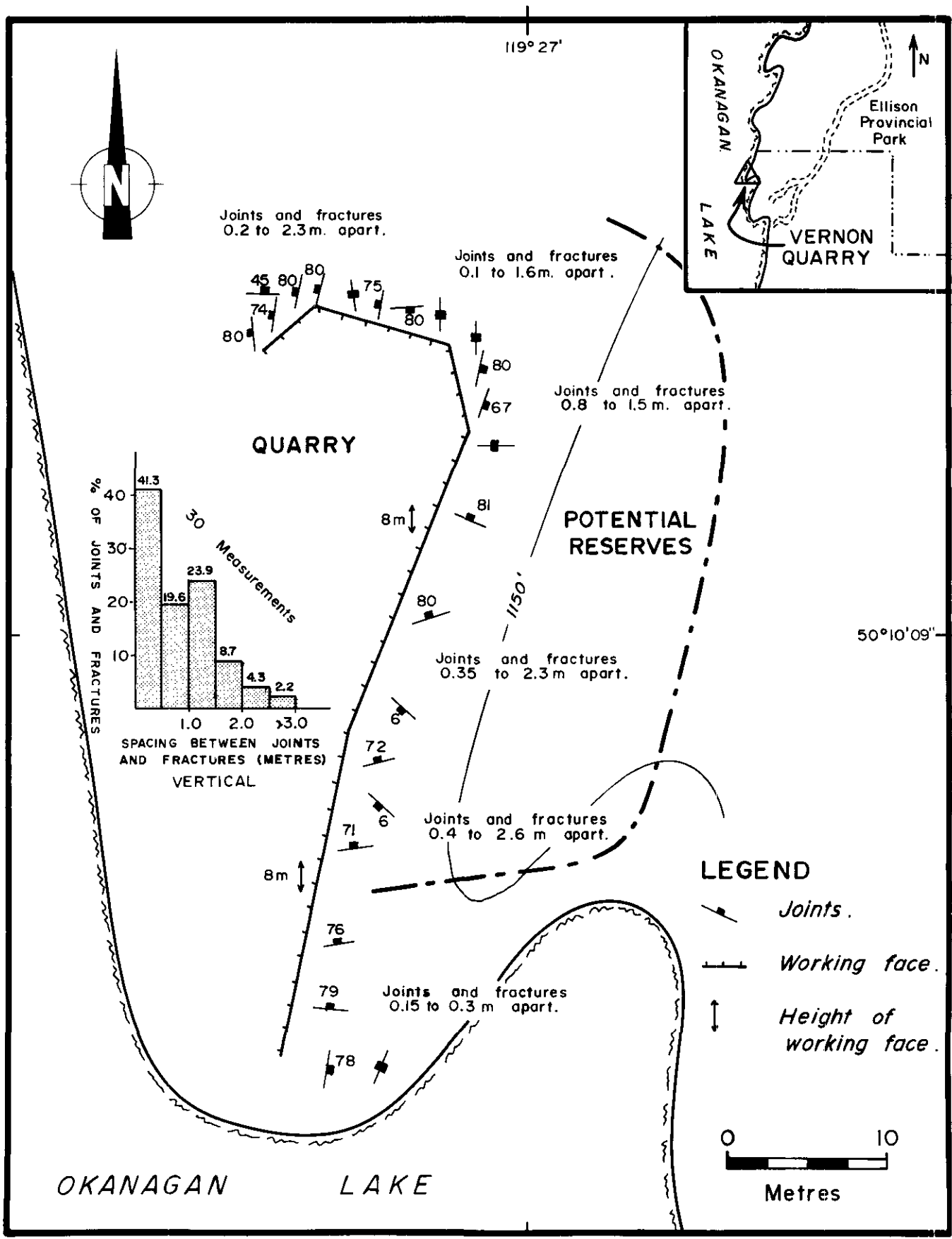


Figure 4-8-9. Vernon quarry (82L/3W).

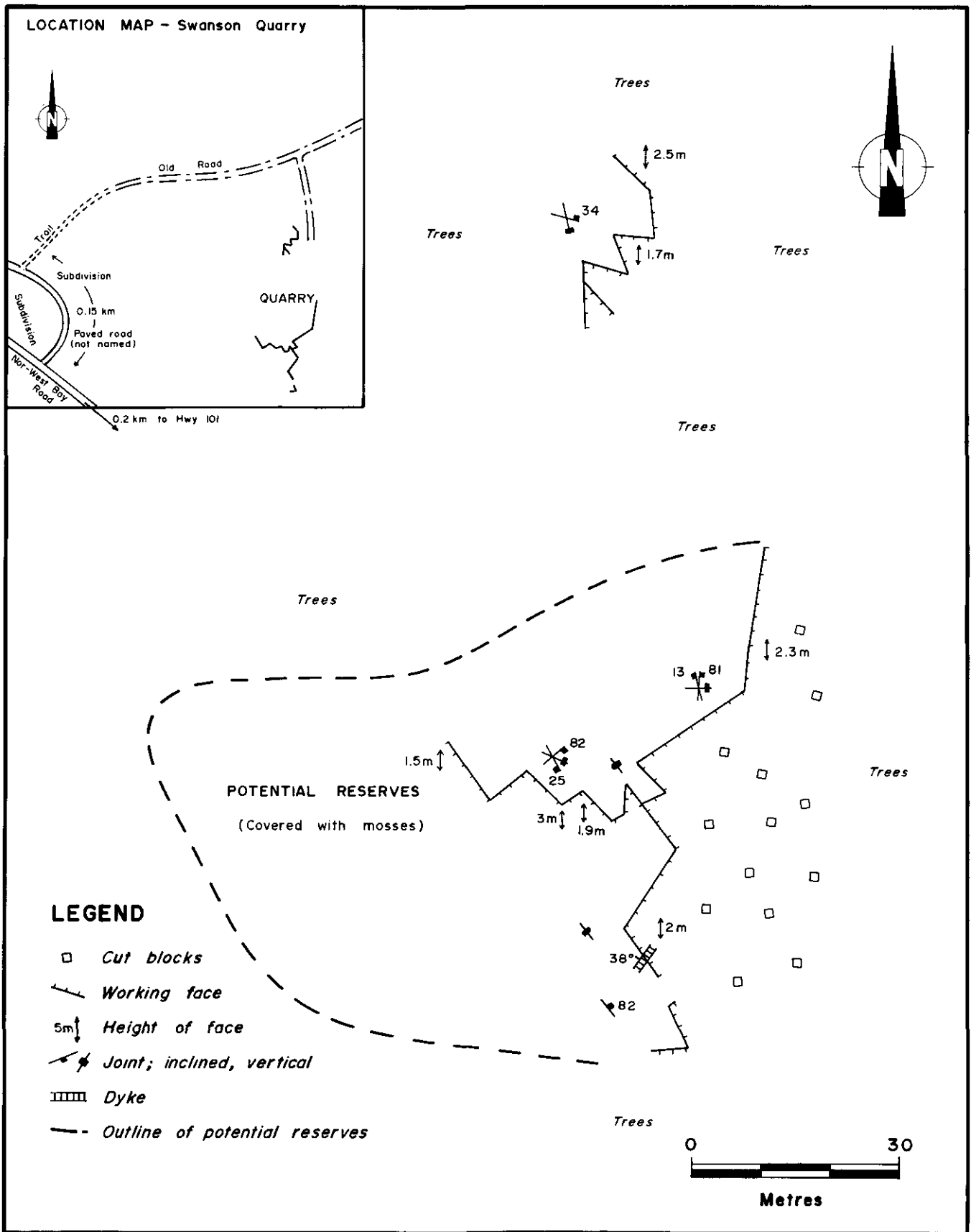


Figure 4-8-10. Swanson quarry (92G/5W).

Structure

Three sets of joints are prominent at the site. A vertical set strikes east to southeast; a second set strikes northeast and dips southeast; and a third set strikes south-southeast and dips moderately to the west. Other irregular joints cut the rock with no apparent pattern.

Vertical joints are widely spaced with 70 per cent more than a metre apart. Approximately 50 per cent of vertical joints measured along the exposed working faces are more than 3 metres apart.

Flat-lying joints and fractures are closely spaced with 50 per cent less than a metre apart and 80 per cent less than 2 metres apart.

Reserves

Potential reserves of quarriable stone extend 45 metres west of the abandoned face (Figure 4-8-10) while north, south and east of the quarry heavy second growth forest restricts exposure.

A new housing subdivision is under construction approximately 60 metres west of the quarry. This will almost certainly place limitations on future quarry development.

JERVIS INLET QUARRIES

GRANODIORITE — NELSON ISLAND (QUARRY BAY) (92F/9E)

INTRODUCTION

Four quarries opened in granodiorite of the Coast Plutonic Complex (Roddick *et al.*, 1979) are located on Quarry Bay at the southern tip of Nelson Island (MI 92F-189). They have been operated periodically since the mid-1800s, providing stone for a number of buildings in Vancouver, Nanaimo and Victoria, most notably the Parliament Buildings in Victoria (Parks, 1917).

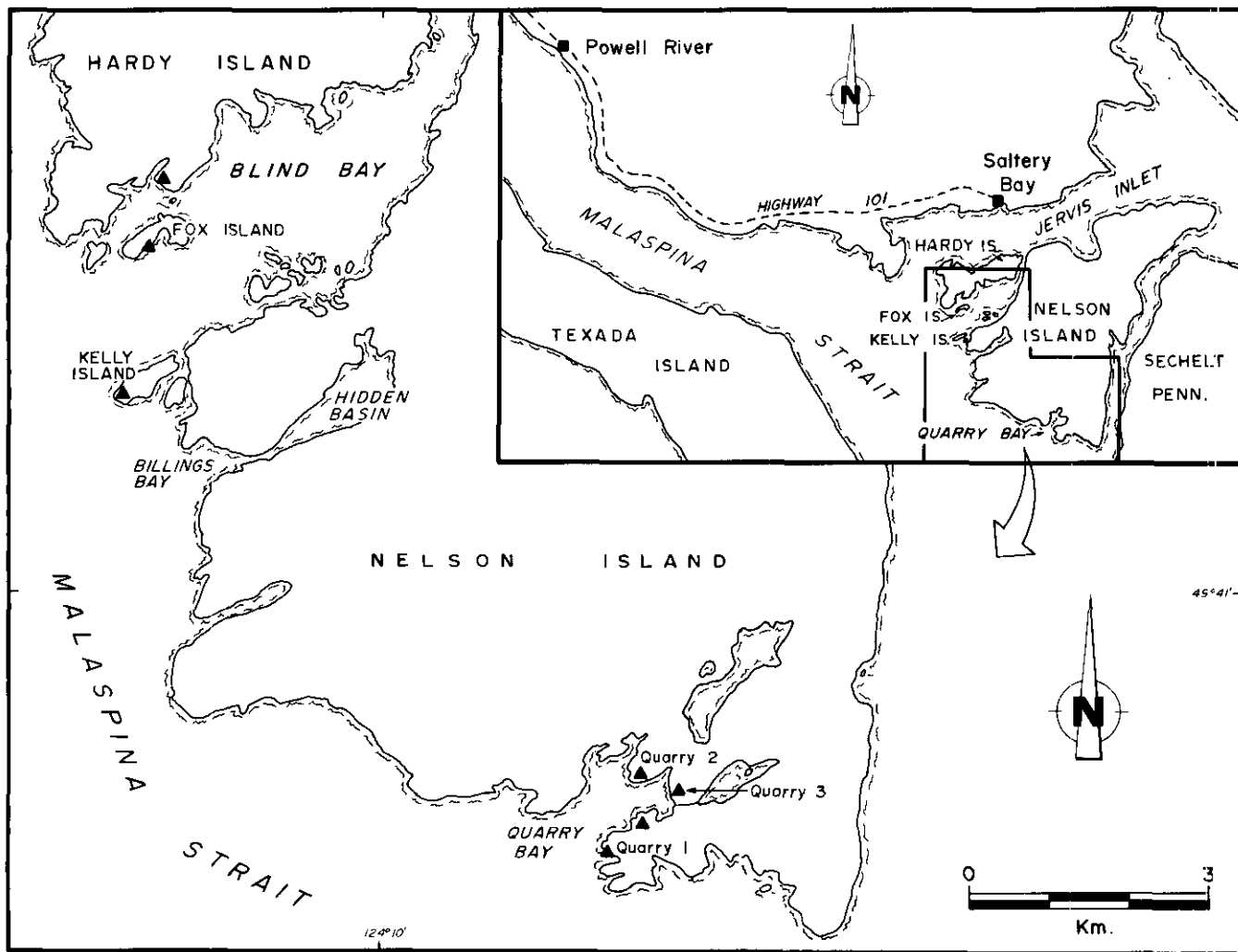


Figure 4-8-11. Location map, Jervis Inlet quarries.

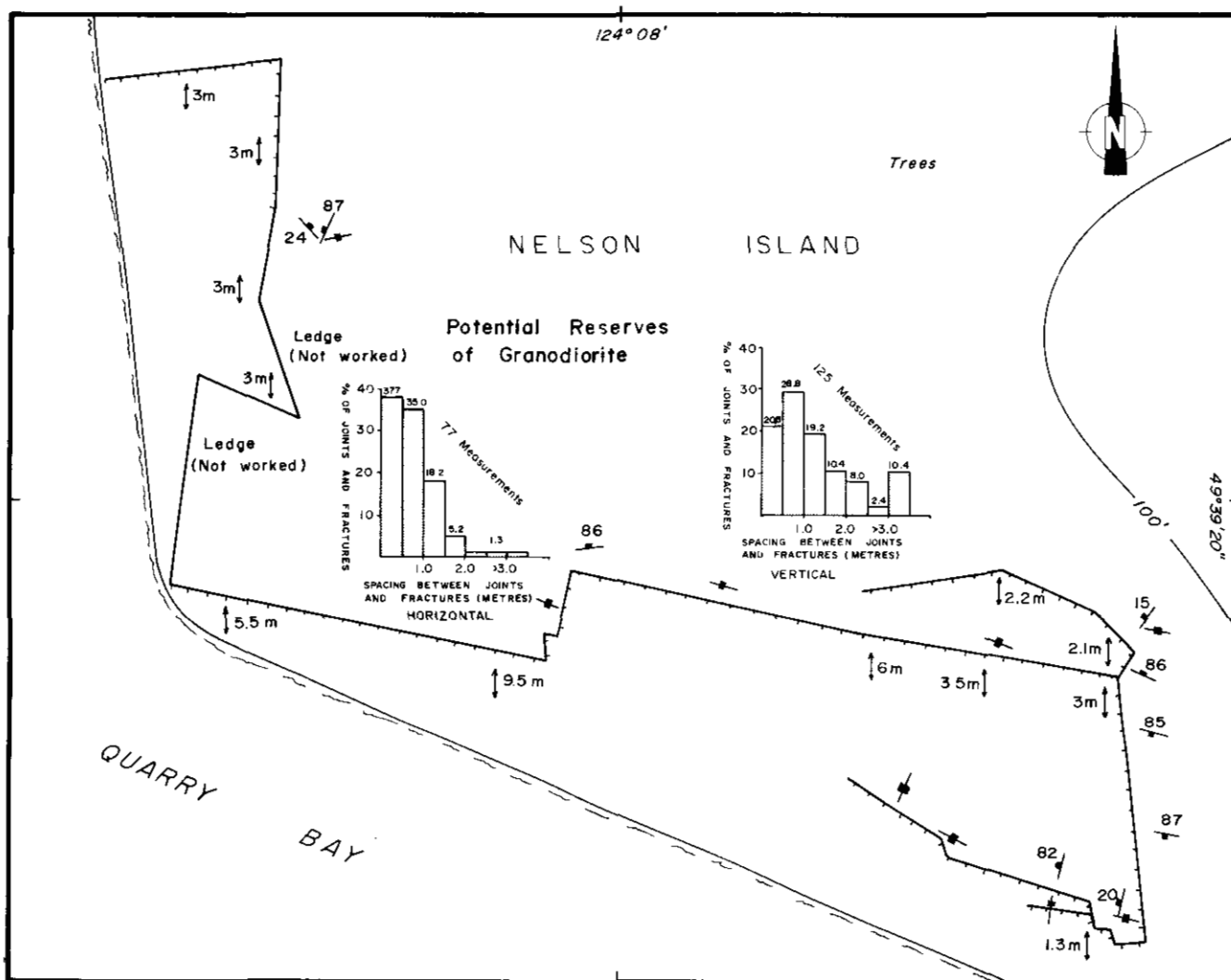


Figure 4-8-12. Nelson Island, Quarry 1 (92F/9E).

QUARRY 1

Quarry Development and Sample Description

Quarry 1 (Plate 4-8-11), situated on the north shore of a small inlet near the entrance of Quarry Bay, is approximately 185 metres long (Figure 4-8-12). Worked in benches, it was advanced north-eastwards a maximum of 45 metres from the shoreline, with working faces ranging from 3 to 9.5 metres in height.

The granodiorite has a light grey tone, medium texture and a uniform appearance on fresh surfaces. Black blades of biotite (1 to 10 millimetres) and occasional hornblende crystals contrast with the light grey feldspar and quartz matrix.

Scattered knots of mafic minerals (less than 1 per cent by volume), up to 3 centimetres wide by 10 centimetres long, are visible in outcrop. Isolated clusters of pyrite (individual crystals 1 to 2 millimetres in size) are also seen in places.

Structure

Figure 4-8-12 documents orientation and spacing between joints and fractures along the working faces. Almost 80 per cent of the vertical joints and fractures and over 60 per cent of the horizontal joints and fractures are spaced greater than 50 centimetres apart. Of these, 64 per cent of vertical and 27 per cent of horizontal joints and fractures are spaced more than a metre apart.

Reserves

Unworked benches provide additional reserves of stone. Granodiorite exposed north and northeast of the quarry is similar to stone in the working face and offers good reserve potential.

All rock from this quarry tested by Parks (1917) meets ASTM standards for granite building stone (Table 4-8-2).

QUARRY 2

Quarry Development and Sample Description

Quarry 2 (Plate 4-8-12) is located on a point at the north end of Quarry Bay (Figure 4-8-11). It consists of three working faces developed along the south and southeast shores of the point. The southern face, approximately 90 metres long and 2.8 to 10 metres high, has been advanced 15 metres from the shore. Face 2 is approximately 75 metres long by 3 to 4 metres high. Face 3, although not continuous, is approximately 45 metres long and 2 to 4 metres high.

The stone is similar in appearance to granodiorite in Quarry 1. Mafic minerals (biotite and hornblende) give it an attractive salt-and-pepper look, complementing the light grey feldspar and quartz matrix. The stone is medium grained with a few scattered black knots (up to 7 by 15 centimetres in size); rare occurrences of pyrite are localized along prominent joints.

Structure

The orientation of joints and fractures is described in Figure 4-8-13. This figure illustrates the spacing between joints and fractures measured along the abandoned working faces. Almost 90 per cent of vertical joints and fractures and 70 per cent of horizontal fractures are spaced more than 50 centimetres apart. Approximately 70 per cent of all joints and fractures are more than a metre apart.

Reserves

Potential reserves of quarriable stone lie immediately northeast of Face 1 and northwest of Faces 2 and 3 (Figure 4-8-13). This stone is similar to granodiorite examined along the working faces and could be quarried by advancing the existing workings.

All rock tested by Parks (1917) meets ASTM standards for granite building stone (Table 4-8-2).

QUARRY 3

Quarry Development and Sample Description

Quarry 3 (Plate 4-8-13), the largest of the quarries, lies along a ridge on the east shore of Quarry Bay (Figure 4-8-11). An opening, approximately 40 metres long and up to 6 metres high, parallels the shoreline (Face 1, Figure 4-8-14). More extensive openings developed up the hill are designated Faces 2 to 4.

Face 2 is approximately 115 metres long and up to 18 metres high. Face 3, above and to the northeast of Face 2, is approximately 60 metres long with a working face 18 metres high. Face 4, located above and to the northeast of Face 3, is approximately 80 metres long and has a working face 20 metres high.

Stone from the quarry is similar to the granodiorite examined at Quarries 1 and 2. It has a light grey tone and a medium-grained texture, with biotite blades (1 to 10 millimetres) and minor hornblende contrasting with a lighter feldspar and quartz matrix. Black knots and dark inclusions comprise less than 1 per cent of the total volume.

Rock sampled by Parks (1917) meets ASTM standards for granite building stone (Table 4-8-2).

Structure

Joints measured along the four working faces are illustrated in Figure 4-8-14. Greater than 80 per cent of vertical joints and fractures and over 74 per cent of horizontal joints are spaced more than 50 centimetres apart. Some 60 per cent of all structures are spaced wider than 100 centimetres.

Reserves

Additional reserves of building stone are available along all four working faces. The faces could be advanced northeast, in a series of benches up the ridge (Figure 4-8-14).

QUARRY 4

Quarry 4 (Figure 4-8-11), the smallest of the four, was located but not investigated. Cottages built on the old workings prevent access to the site.

GRANODIORITE — HARDY ISLAND (92F/9E)

INTRODUCTION

Two abandoned quarries on the southwest shore of Hardy Island (MI 92F-425) provided stone for breakwaters in Vancouver and Victoria (Parks, 1917) (Plate 4-8-14). The quarries, opened in granodiorite of the Coast Plutonic Complex (Roddick *et al.*, 1979), have good potential for further development.

LOWER QUARRY

Quarry Development and Sample Description

The lower quarry (Plate 4-8-15), located on the northwest shore of a small inlet off Blind Bay (Figure 4-8-11), has an opening approximately 100 metres long. Worked faces, ranging from 2 to 23 metres high, have been advanced northeast in benches from the shoreline (Figure 4-8-15).

The rock, similar in appearance to the granodiorite at Quarry Bay, weathers grey to black. It is medium to coarse grained with a uniform appearance and a light grey tone on fresh surfaces. Minerals seen in hand specimen include feldspar, quartz, biotite and hornblende. Black knots, up to 30 centimetres across, are common and pyrite and chalcopyrite are frequently noted.

Physical Tests

Physical tests carried out by Parks (1917) indicate the stone does not meet ASTM standards for modulus of rupture for granite (Table 4-8-2).

Structure

Orientation and spacing between joints and fractures are illustrated in Figure 4-8-15. Over 87 per cent of steeply dipping fractures are spaced more than 50 centimetres apart and 72 per cent over a metre apart. Almost 30 per cent of fractures are spaced more than 3 metres apart.

Flat-lying joints and fractures are well developed with more than 81 per cent spaced 50 centimetres apart and 65 per cent spaced a metre apart. A relatively large proportion, 22 per cent, are spaced more than 3 metres apart.

One large cut block on site measured 9.3 by 6 by 5 metres, an indication of the size of blocks potentially available.

UPPER QUARRY

Quarry Development and Sample Description

Approximately 35 metres west of the lower quarry a second opening, 95 metres wide by 5 to 18 metres high (Figure 4-8-15), has been advanced north along a northeast set of steeply dipping joints.

The stone, similar to the lower quarry, is light grey with a uniform appearance on fresh surfaces. Blades of biotite and occasional hornblende crystals contrast with a matrix of light grey feldspar and quartz. As at the lower quarry, large black knots (up to 30 centimetres across) are common and pyrite is common on joint planes. Exposed surfaces weather grey to black.

Structure

Prominent northeasterly striking joints dip south 75 degrees to vertical with more northerly striking joints dipping east 18 to 30 degrees. Irregular northwest-striking joints dip west at 16 degrees. Joint and fracture spacing, similar to the lower quarry, is illustrated in Figure 4-8-15.

RESERVES

Reserves of quarriable stone remain in undeveloped benches at both sites extending north-northeast from abandoned faces (Figure 4-8-15).

GRANODIORITE — KELLY ISLAND (92F/9E)

Introduction

Five quarries (MI 92F-196) opened in granodiorite of the Coast Plutonic Complex (Roddick *et al.*, 1979) on the southwest end of Kelly Island (formerly Granite Island) were developed around the

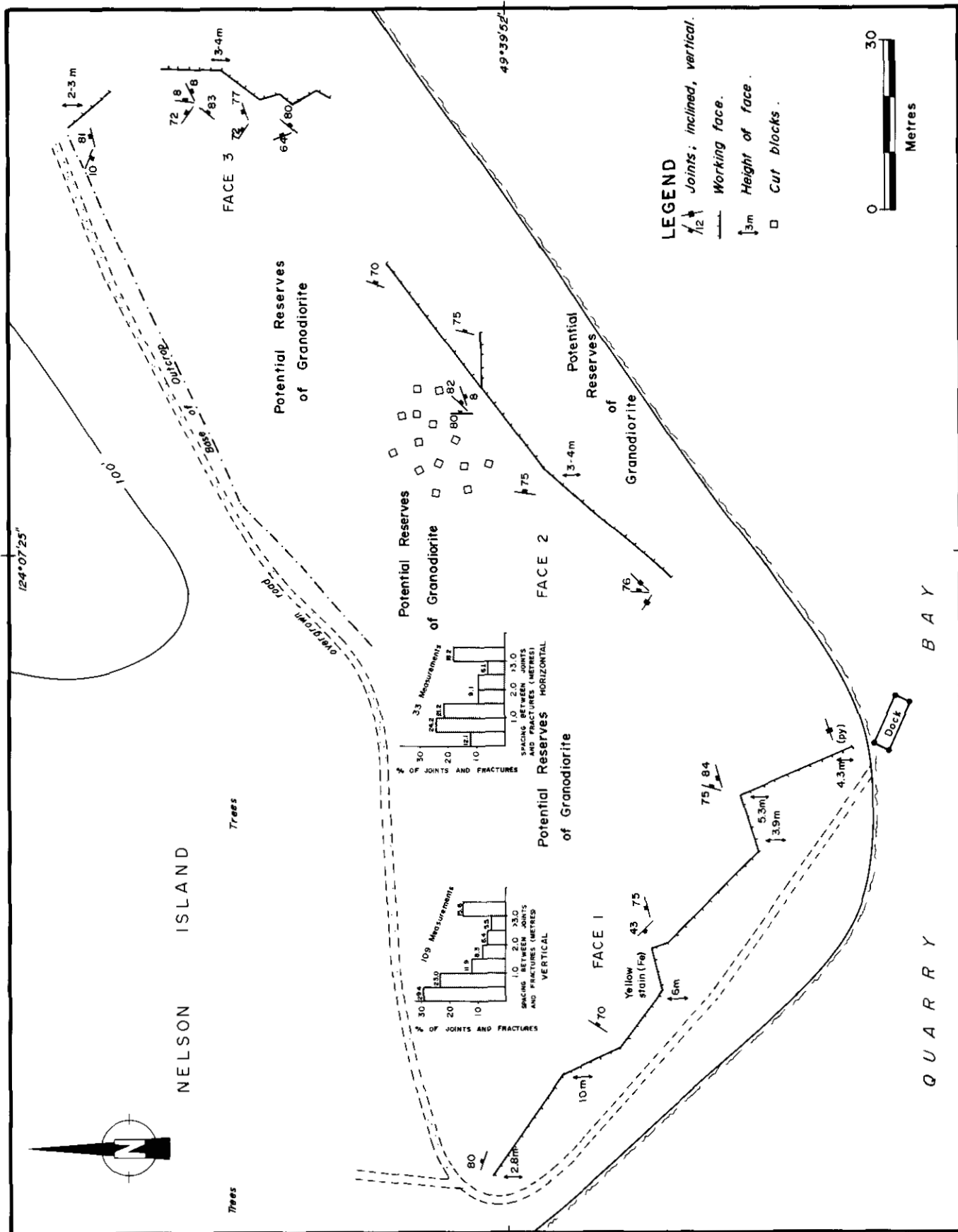


Figure 4-8-13. Nelson Island, Quarry 2 (92F/9E).

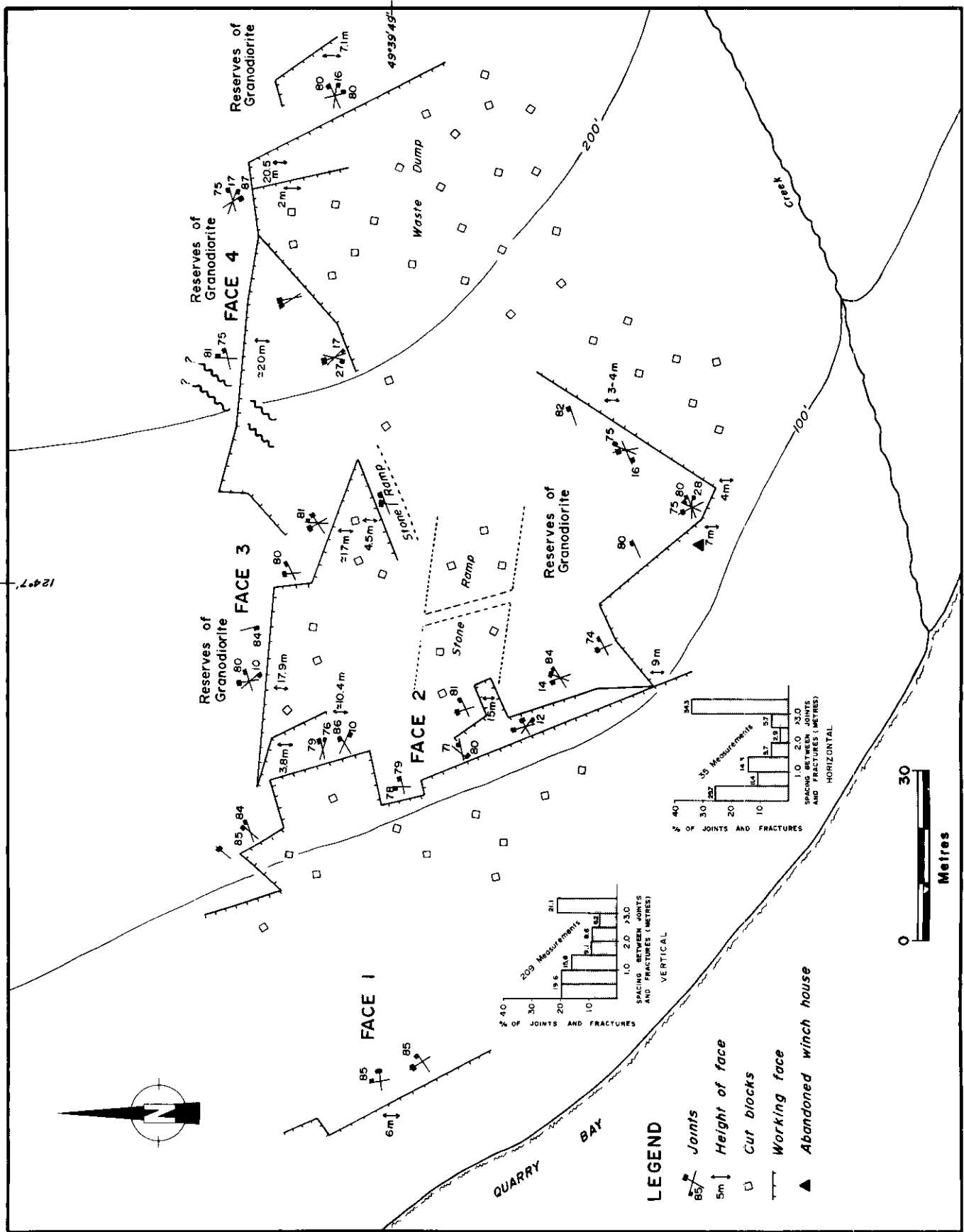


Figure 4-8-14. Nelson Island, Quarry 3 (92F/9E).

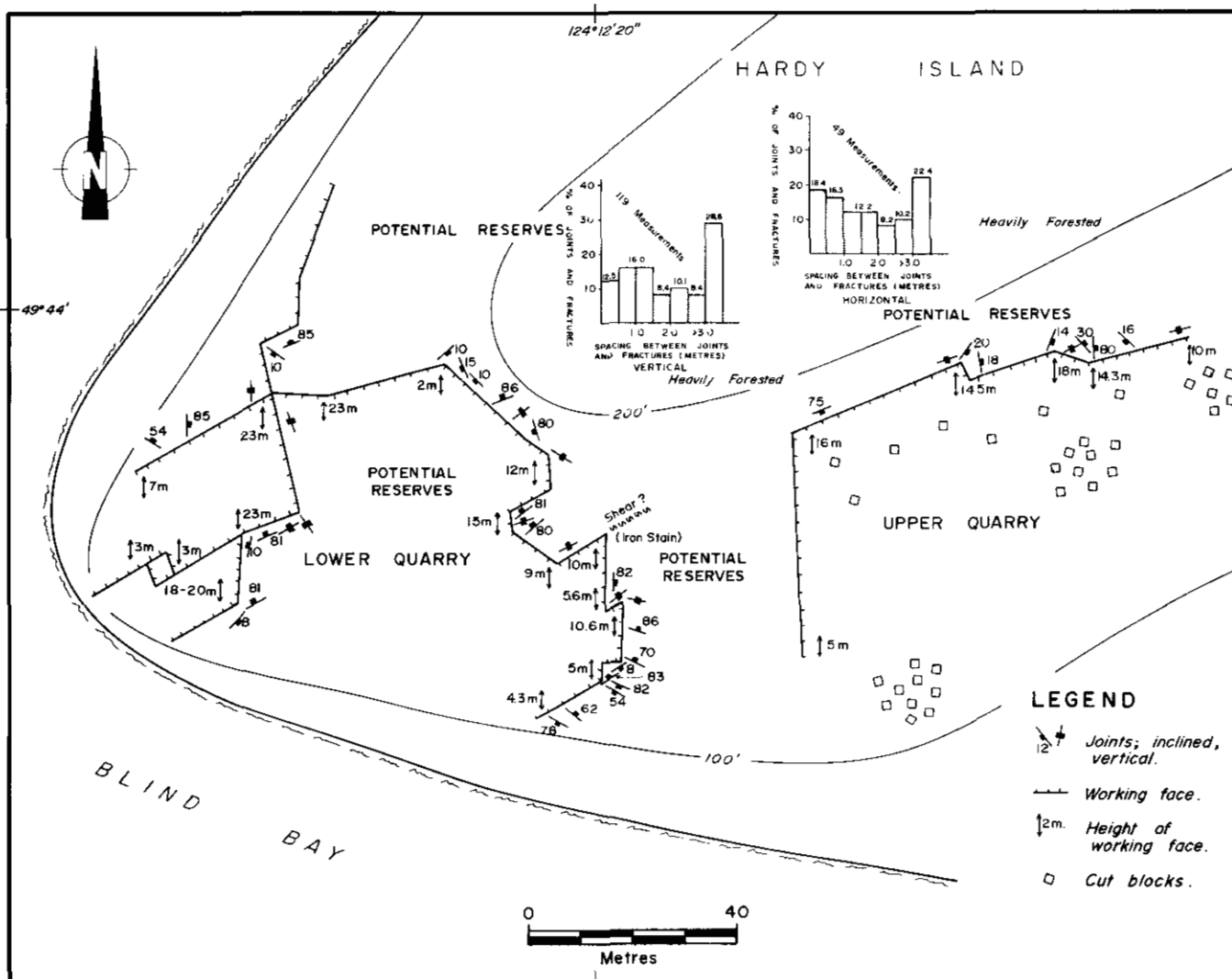


Figure 4-8-15. Hardy Island quarries (92F/9E).

turn of the century (Parks, 1917; Figure 4-8-11 and Plate 4-8-16). Recent examination of the sites outlined reserves of quarriable granodiorite.

Sample Description

Medium-grained granodiorite from all five quarries is similar in appearance but slightly darker than stone from Nelson and Hardy Islands (Parks, 1917), having more biotite. Patches of pyrite less than 1 centimetre in size and a few black knots (estimated to be less than 0.5 per cent of volume) are visible on the quarry face. The stone, used to construct the Victoria Harbour seawall, has an attractive fresh appearance after over a half a century of exposure.

Physical tests by Parks (Table 4-8-2) indicate the stone meets ASTM standards for granite building stone.

Quarry Development

Quarry 1

Quarry 1 is located 15 metres north of the shoreline on the southwest coast of the island (Figure 4-8-16). Its opening, 40 metres wide by 11 metres high, was developed along vertically dipping northwest-trending joints and south-dipping northeast-striking joints.

Quarry 2

Quarry 2 (Plate 4-8-17), the largest of the four sites, lies 35 metres northeast of Quarry 1. Developed along a prominent ridge, it is approximately 110 metres long and has a working face 12 metres high. Three sets of near-vertical joints strike northeast, east and southeast. Flat joints strike south-southeast and dip 8 to 10 degrees west (Figure 4-8-16).

Vertical joints and fractures measured along the face are widely spaced with over 91 per cent greater than 50 centimetres apart and nearly 60 per cent spaced over 100 centimetres apart (Figure 4-8-16). Horizontal joints averaged more than a metre apart.

Quarry 3

Quarry 3, approximately 55 metres long with benches 4 to 6 metres high, is 85 metres west of Quarry 1.

Four sets of prominent steeply dipping joints are recognized, with strikes ranging from northeast to south. Flat joints strike north-northeast and dip 10 degrees east. More than 94 per cent of joints and fractures are spaced greater than 50 centimetres apart with 77 per cent spaced over 100 centimetres apart and 16 per cent over 300 centimetres apart (Figure 4-8-16).

Quarries 4 and 5

Quarries 4 and 5, approximately 30 metres long by 3 to 5.2 metres high and 25 metres long by 4 metres high respectively, are 105 metres northwest of Quarry 2 on the northwest shore of Kelly Island.

The attitudes of three steeply dipping joint sets are: northerly, dipping west; northeasterly, dipping south; and southeasterly, dipping north. The attitudes of flat-dipping joints are variable. Over 91 per cent of joints and fractures are spaced greater than 50 centimetres apart and over 67 per cent are spaced wider than 100 centimetres. Flat joints are spaced more than a metre apart (Figure 4-8-16).

Reserves

Reserves of quarriable stone extend north-northeast of Quarries 1 and 2, north-northwest of Quarry 3 and south-southeast of Quarries 4 and 5 (Figure 4-8-16). Granodiorite north of Quarry 2 is more intensely fractured than stone at the quarry itself, however measurements indicate 75 per cent of potential reserves could be cut into 50-centimetre blocks.

GRANODIORITE — FOX ISLAND (92F/9E)

Introduction

Granodiorite of the Coast Plutonic Complex (Roddick *et al.*, 1979) was extracted from a small quarry (MI 92F-378) on the south shore of Fox Island around the turn of the century (Figure 4-8-11 and Plate 4-8-18). Examination of exposures north and west of the quarry indicates potential reserves of dimension stone.

Sample Description

The granodiorite is visibly lighter in appearance than Kelly Island stone and slightly coarser (Parks, 1917). It is medium grained, light grey in colour on fresh surfaces and weathers grey to black. Black knots of mafic minerals (biotite, hornblende) up to 10 by 20 centimetres are infrequent (less than 0.5 per cent of total volume) and small pyrite crystals (less than 1 millimetre in size) occur in isolated patches.

While no buildings constructed from the stone were examined, exposed quarry walls appear fresh.

Quarry Development

An opening approximately 30 metres long by 3.5 to 11 metres high was developed along the shore of Fox Island (Figure 4-8-17). A second small opening, 10 metres to the northwest, measures 10 metres long by up to 1.6 metres high.

Three sets of steeply dipping joints are recognized: east-northeast dipping north; east-northeast dipping south; and south-southeast dipping east. Two low-angle joints measured in the quarries strike 85 degrees dipping 10 degrees south and 135 degrees dipping 12 degrees southwest (Figure 4-8-17).

Spacing between joints and fractures, in the quarries and adjacent outcrops, indicates that large blocks are available (Figure 4-8-17). Over 90 per cent of all joints and fractures measured were greater than 50 centimetres apart, almost 80 per cent are spaced more than 100 centimetres apart and a significant proportion are spaced wider than 300 centimetres apart.

Reserves

Potential reserves of dimension stone extend north and west of the larger quarry, parallel to the shoreline, for at least 30 metres. Outcrops are covered by vegetation but limited examination of the rock suggests it is similar to the quarry exposures. Dense second growth forest cover prevented detailed examination north, west and east of the small quarry.

SUMMARY — JERVIS INLET QUARRIES

Dimension stone quarries on Nelson, Hardy, Kelly and Fox Islands have operated sporadically since the nineteenth century, supplying large volumes of stone to markets in the Lower Mainland and Vancouver Island. Examination of each site during July 1986 revealed:

- (1) Subtle differences in texture and colour exist between granodiorite from each of the islands. Specifically, stone from Fox and Hardy Islands is slightly coarser than Nelson or Kelly Island granodiorites. Kelly Island granodiorite is darker than stone from the other islands.
- (2) Joint and fracture density is highest at the three Nelson Island quarries with approximately 30 to 40 per cent spaced less than 50 centimetres apart. Joint and fracture density on Hardy, Kelly and Fox Islands is not as intense with approximately 10 to 20 per cent spaced less than 50 centimetres apart.
- (3) Black knots and minor amounts of sulphides are more frequently seen in Hardy Island quarries, but their total volume is still small.
- (4) Quarries 2 and 3 on Nelson Island and the quarries on Hardy and Kelly Islands have large potential reserves.

Three sites must remain available for development if British Columbia wishes to preserve a major source of Jervis Inlet granodiorite. These are Quarry 3 on Nelson Island and the quarries on Hardy and Kelly Islands.

MARBLE — NOOTKA SOUND

HISNIT INLET QUARRY (92E/15E)

Introduction

A small quarry (MI 92E-020), opened in crystalline limestone of Middle to Upper Triassic Quatsino Formation (Muller *et al.*, 1981), operated briefly on Hisnit Inlet from 1908 to 1909 (Plate 4-8-19). Examination of the quarry and surrounding area indicates limited potential for further development.

Sample Description

Marble examined in the quarry has an attractive white to light grey colour, is medium grained and similar in appearance to crystalline limestone from Marblehead. Parks (1917) determined the marble is 95.62 to 97.86 per cent calcium carbonate equivalent and physical tests indicate the rock conforms to modern ASTM standards for marble building stone exterior (Table 4-8-2).

Quarry Development and Structure

The quarry, developed in a poorly exposed outcrop 16.5 metres east of the shoreline, is rectangular in shape with sides 14.6 metres long by 12.1 metres wide by a maximum 6 metres high (Figure 4-8-18).

Remnant beds are thought to strike 60 to 80 degrees although attitudes are difficult to determine. Basalt dykes cut the marble along the north and east walls of the quarry; flooding prevented close examination of the south and east walls.

According to Parks, channellers removed slabs of marble "5 feet by 5 or even 6 feet, probably from blocks obtained at the bottom of the quarry". This is the best estimation of the size of blocks available as outcrop is covered by water in the quarry and by heavy second growth forest elsewhere.

Reserves

Basalt dykes occupy 55 per cent of the north wall and 23 per cent of the east wall of the quarry (Figure 4-8-18). Heavy forest growth

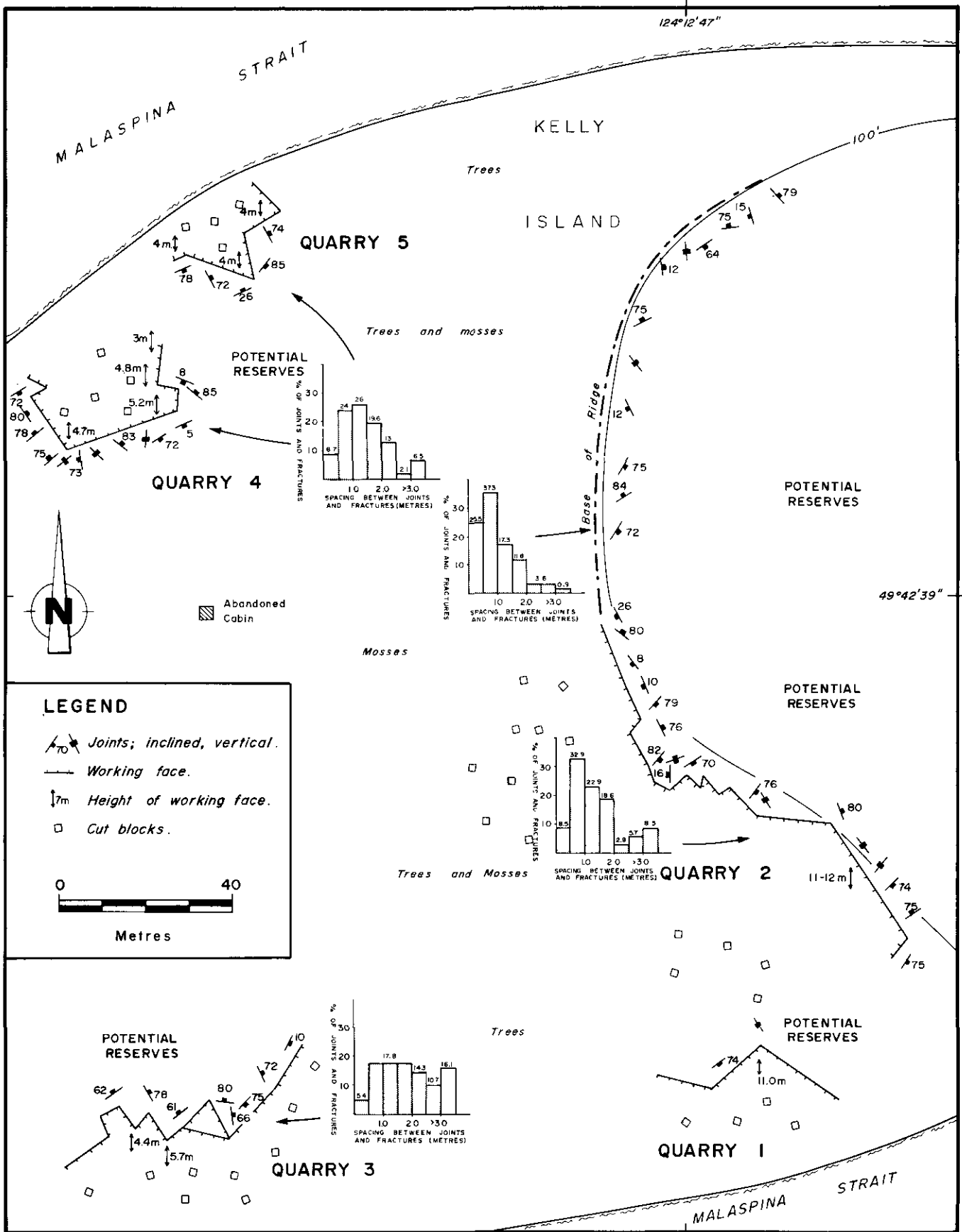


Figure 4-8-16. Kelly Island quarries (92F/9E).

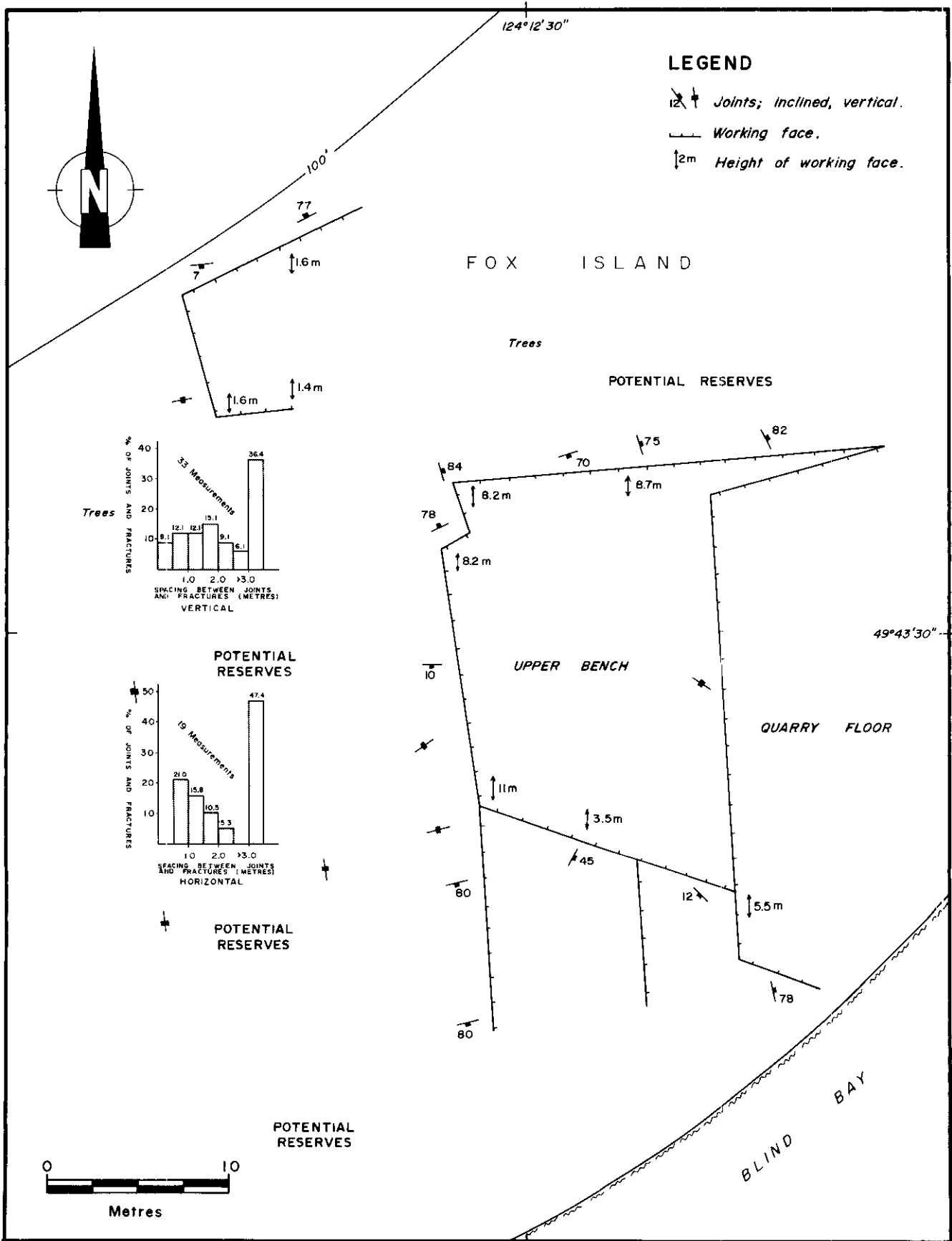


Figure 4-8-17. Fox Island quarry (92F/9E).

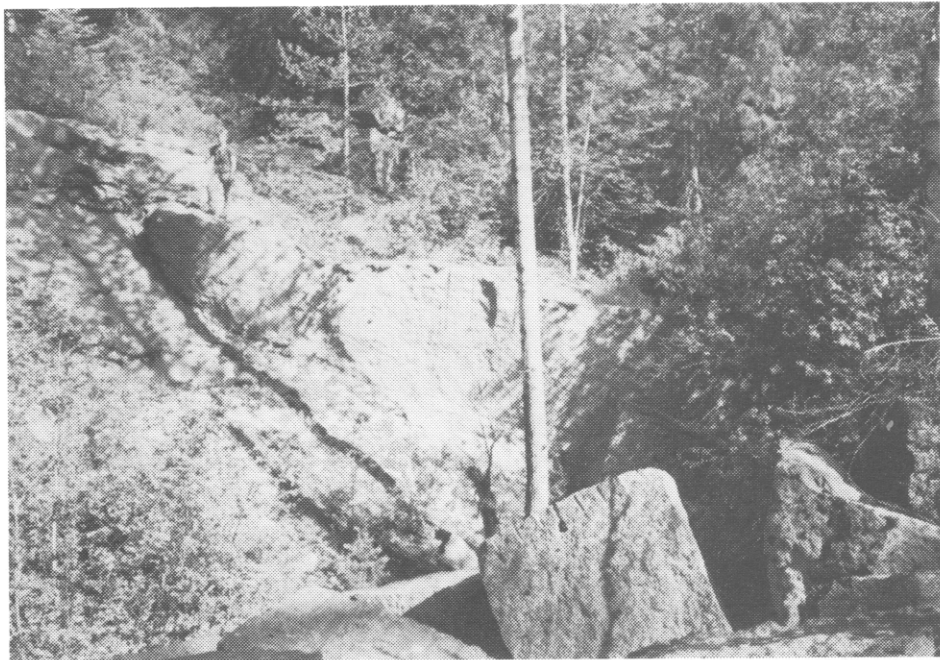


Plate 4-8-1. Northwest corner of Ymir quarry (92F/6E). Note $1.7 \times 1.6 \times 0.55$ -metre blocks left on site (foreground).



Plate 4-8-2. Three Mile Point quarry (82F/11W). Site 1. Note reserves of granodiorite and horizontal joints.



Plate 4-8-3. Marblehead (82K/7W). Quarry 1. Reserves of marble 3.1 kilometres north of Meadow Creek bridge, Highway 31.

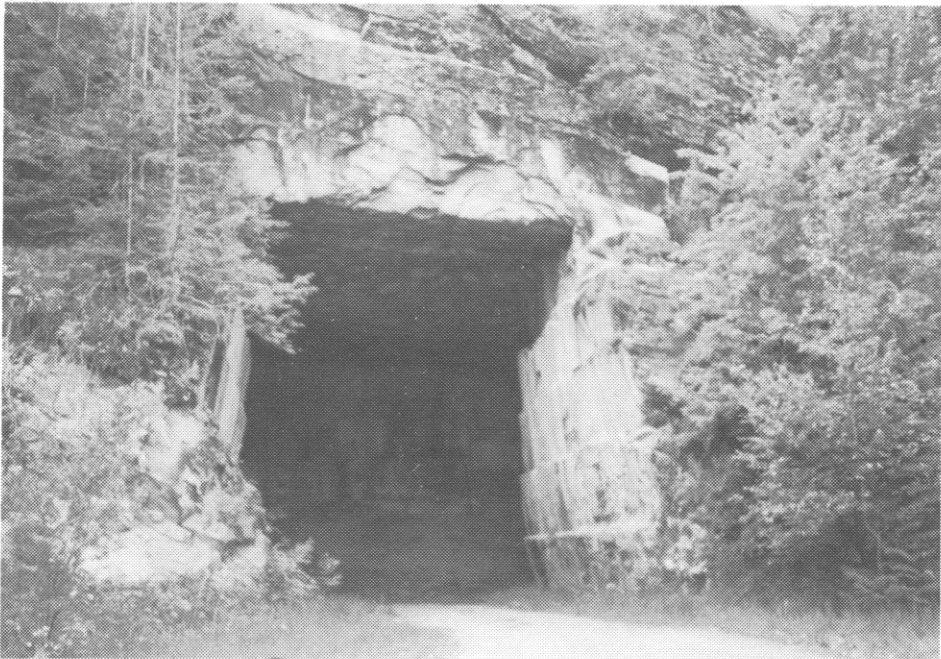


Plate 4-8-4. Marblehead (82K/7W). Quarry 3. South portal (approximately 10 metres in height).



Plate 4-8-5. Reserves of marble immediately north of the Kaslo quarry (82F/15W). Joints are spaced 2 to 3 metres apart.



Plate 4-8-6. Beaverdell quarry (82E/6E). Looking northeast with quarry in foreground and potential reserves of granite exposed along ridge.



Plate 4-8-7. Sunset quarry (82L/3W). Looking northeast of quarry working face.



Plate 4-8-8. Sunset quarry (82L/3W). Reserves of granite along a northeast-trending ridge approximately 40 metres northeast of worked face.



Plate 4-8-9. Vernon quarry (82L/3W). Note steeply dipping vertical joints. Looking north.



Plate 4-8-10. Swanson quarry, Sechelt (92G/5W). Abandoned working face — 2 metres high. Looking northwest.



Plate 4-8-11. Nelson Island, Quarry Bay (92F/9E). Looking north at abandoned face of Quarry 1.



Plate 4-8-12. Nelson Island, Quarry Bay (92F/9E). Looking north at face of Quarry 2.



Plate 4-8-13. Nelson Island, Quarry Bay (92F/9E). Looking northwest at abandoned faces of Quarry 3. Top bench is approximately 61 metres above sea level.



Plate 4-8-14. Hardy Island quarry (92F/9E). Looking northeast. Upper bench is approximately 50 metres above sea level.



Plate 4-8-15. Hardy Island, lower quarry (92F/9E).



Plate 4-8-16. Kelly Island quarry (92F/9E).



Plate 4-8-17. Kelly Island (92F/9E). Twelve-metre face — Quarry 2.



Plate 4-8-18. Fox Island quarry (92F/9E). Looking north.



Plate 4-8-19. Nootka Sound quarry (92F/15E).