ONTARIO

DEPARTMENT OF MINES

BUILDING STONES OF ONTARIO

PART III

MARBLE

By

D. F. HEWITT

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BUILDING STONES OF ONTARIO

will be issued in five parts:

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II	Limestone
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PART III: MARBLE

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ACKNOWLEDGMENTS

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BUILDING STONES OF ONTARIO

PART III: MARBLE

By D.F. Hewitt[1]

INTRODUCTION

In the building stone trade, the term marble is used for any limestone, dolomite or serpentinized dolomite which will take a polish. Geologically the term marble is reserved for limestone and dolomite which has been recrystallized by heat and pressure during a period of metamorphism in the earth's crust. The rock consists of a crystalline aggregate of calcite or dolomite. Most commercial Ontario marbles are crystalline limestone or dolomite belonging to the Grenville series of Precambrian age and have been recrystallized during the Grenville period of mountain building which took place about 1,000 million years ago. Paleozoic limestones which have not been recrystallized have been quarried commercially as marble at St. Albert Station (Silvertone black marble) and Longford (Rama stone).

Composition:

Pure marbles are composed of calcite (calcium carbonate) or dolomite (calcium magnesium carbonate). A marble formed by recrystallization of a high calcium limestone is termed calcitic marble and consists largely of calcium carbonate,

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$CaCO_3$, composed of 56 percent CaO and 44 percent CO_2. A marble formed by the recrystallization of dolomite is termed dolomitic marble and consists principally of calcium magnesium carbonate $(Ca,Mg)CO_3$, composed of 54.35 percent $CaCO_3$ and 45.65 percent $MgCO_3$ or 30.4 percent CaO, 21.7 percent MgO and 47.9 percent CO_2. All gradations of marble from 100 percent calcite to 100 percent dolomite occur. The classification of marbles by calcite and dolomite content is given in the accompanying table:

Classification of Calcitic and Dolomitic Marbles

		CaO percent	MgO percent	CO_2 percent	$CaCO_3$ percent	$MgCO_3$ percent
Calcite	$CaCO_3$	56	0	44	100	0
Dolomite	$(Ca,Mg)CO_3$	30.4	21.7	47.9	54.35	45.65

	Calcite percent	Dolomite percent	CaO percent	MgO percent	CaO:MgO* percent
Calcitic marble	100-50	0-50	56-43.2	0-10.8	4:1
Dolomitic marble	50-0	50-100	43.2-30.4	10.8-21.7	4:1

* The CaO and MgO limits are only true when dealing with a pure marble; if impurities such as silicates are present the CaO:MgO ratio can be used for classification.

Nearly all marbles carry some mineral impurities usually in the form of silicates, oxides or sulphides. Among the more common silicate minerals found in marble are diopside, tremolite, wollastonite, actinolite, hornblende, muscovite, phlogopite, biotite, serpentine, olivine, chondrodite, scapolite, garnet, epidote, sphene, feldspar, tourmaline, zoisite and zircon.

Common oxide and sulphide impurities include quartz, hematite, limonite, magnetite, spinel, apatite, pyrite, marcasite, pyrrhotite, galena, sphalerite, and molybdenite. If carbonaceous material is present it usually crystallizes as graphite. Mineral impurities generally form veins, bands, streaks or cloudings and are not always objectionable since they may add to the colour and pattern of the marble. Many verde antique marbles, for example, consist almost entirely of serpentine.

Chemical analyses of some typical Ontario and foreign marbles are given in the accompanying table:*

TABLE

Sample No.	CaO percent	MgO percent	Insolubles percent	Ignition Loss percent
8	28.60	21.00	6.52	43.96
28	52.30	2.78	1.76	42.97
30	22.58	18.90	22.70	34.88
34	29.88	21.18	4.26	44.83
22	30.84	21.62	1.00	46.54
11	30.10	13.80	26.42	29.35
12	26.90	16.02	29.84	26.81
66	54.40	0.70	1.26	43.10
67	30.58	21.40	1.40	45.88
68	52.68	0.90	3.74	41.84
14	45.40	1.28	15.40	36.11
37	53.72	0.74	2.00	42.70
9	43.78	6.56	7.49	40.45
37A	39.92	0.72	21.60	31.82
40	38.90	1.64	25.54	31.96
15	45.04	0.90	15.12	35.94
80	55.77	0.43	0.24	44.47
26	55.03	0.47	0.35	43.6
90	Tr	35.27	50.28	7.2

* Chemical analyses of Ontario marbles were carried out by Temiskaming Testing Laboratories.

Sample No.	Description
8	White fine-grained dolomitic marble, Hastings Marble Products.
28	White coarse calcitic marble, W.F. Bonter & Company.
30	White fine dolomitic marble, Canada Talc Industries.
34	White coarse dolomitic marble, Madoc Marble Quarries.
22	Buff fine dolomitic marble, Stoklosar Marble Quarries.
11	Green fine calcitic marble, Stoklosar Marble Quarries.
12	Green fine calcitic marble, Madoc Marble Quarries.
66	Pink calcitic marble, Madoc Marble Quarries.
67	Pink fine dolomitic marble, Hastings Marble Products.
68	Pink coarse calcitic marble, Stoklosar Marble Quarries.
14	Black fine calcitic marble, Hastings Marble Products.
37	Black fine calcitic marble, Madoc Marble Quarries.
9	Brown Black River limestone, Stoklosar Marble Quarries.
37A	Brown Black River limestone, Hastings Marble Products.
40	Brown Black River limestone, Stoklosar Marble Quarries.
15	Brown Black River limestone, Madoc Marble Quarries.
80	Italian Carrara white marble.
26	Georgian Cherokee marble, Tate, Georgia.
90	Verde Antique marble, Georgia.

Colour:

The colour of marble is extremely variable. While pure marble is generally white, minor impurities will produce red, pink, brown, buff, black, yellow, green, blue and grey marbles. Red, pink, brown, and buff colourations are frequently due to iron oxides or manganese oxides. Serpentinized marbles and marbles containing chlorite or diopside are generally green or yellow. In the Madoc area white, black, buff, green, red and brown marbles are now being quarried.

While minor impurities may colour the calcite or dolomite of the marble rather uniformly, if the colouration is due to the presence of mineral impurities such as serpentine, diopside or phlogopite, the colouration may show veined or banded effects patterning the marble. Colour banding of this type may be due to original compositional differences between beds in the limestone and banding may follow bedding planes. Where there has been marble flowage during recrystallization, extremely varied banding may be produced. When a marble is fractured and brecciated, mineral colouration may be introduced along veins and fractures and the breccia fragments may be white while the matrix is coloured. This is true in the case of the Bancroft brecciated marbles which consist of fragments of white fine-grained marble in a matrix of brown micaceous marble.

Grey or black colouration is frequently due to carbonaceous matter in the marble. Blue grey or black "Hastings-type"

marbles present in the Madoc area of Hastings county on recrystallization frequently become white, with the carbonaceous material recrystallized as minute flakes of graphite.

Texture:

The size, shape, arrangement and regularity of grains in a marble define its texture. Grain size or crystallinity is classified as follows:

Coarse crystalline: over 5 millimetres (average)

Medium crystalline: 1-5 millimetres (average)

Fine crystalline: 0.2-1 millimetre (average)

Aphanitic: under 0.2 millimetre

(individual grains not detected with the naked eye).

An aphanitic marble may be classified as microcrystalline if grains average 0.05 to 0.2 millimetres in diameter and can be detected with a 10 power hand lens, or cryptocrystalline if grains average less than 0.05 millimetre in diameter and are only measureable under microscopic examination.

Marbles may be termed even-grained or equigranular if the grains are of uniform size and irregular-grained if of diverse grain size. Calcite or dolomite grains may be equant or elongated. If elongated in one direction it is likely that the calcite grains of the marble will show a preferred mineral orientation. In some marbles which have undergone deformation the calcite grains may be oriented with their C-crystallographic

axes pointing all in one direction. This mineral orientation can be determined by a petrofabric analysis which will statistically plot the orientations of C-axes in a thin section cut from the marble. A pronounced preferred mineral orientation may affect the durability of the marble depending on the direction in which the marble is cut (Bain 1940, p. 7).

In petrographic examination of the texture of a marble the number of grains per square centimetre can be measured to give a measure of the crystallinity. Bain (1940, p. 8) recommends that the coefficient of irregularity of the marble be measured: he states "grain contacts so irregular that grain holds grain as the clasps hold a gem in a ring are desirable in marble that is to be exposed to rigorous attack of frost and ground water. It has been found that the length of contact between grains on any surface divided by the square root of the number of grains exposed on that surface is approximately 1.8. This is called the coefficient of irregularity and may be 2.1 for marbles with very irregular grain borders and only 1.65 in smooth types. No old monument or glaciated ledge examined (showing favourable weathering characteristics) has had a coefficient below average and no badly disintegrated surface in unpolluted atmosphere has been above average."

Weight:

The specific gravity of calcite is 2.71 and that of dolomite

2.8 to 2.9, indicating that dolomitic marbles are slightly heavier than calcitic marbles. Bulk specific gravities of marbles range from 2.60 to 2.85 depending on the porosity. Marbles range from 150 to 182 pounds per cubic foot in weight.

Porosity and Absorption:

The porosity of recrystallized marbles is generally quite low ranging from 0.01 to 0.50 percent. In serpentine marbles porosity may be somewhat higher ranging up to 2 percent. Absorption (48-hour) is generally low ranging from 0.005 to 0.2 percent. In serpentine marbles of higher porosity, absorption may be as high as 1.5 percent.

Figures for bulk specific gravities, weight per cubic foot and 48-hour absorption for some Ontario and foreign marbles are given in the accompanying table:

TABLE 2

Sample No.	Description	Bulk Sp.Gr.	Wt. per Cu.Ft.	Absorption
8	White f.g. dolomitic marble (HMP)	2.84	177	0.10
28	White c.g. calcitic marble (WFB)	2.73	170	0.03
30	White f.g. dolomitic marble (C.Talc)	2.86	178	0.07
34	White c.g. dolomitic marble (MMQ)	2.86	178	0.10
22	Buff f.g. dolomitic marble (SMQ)	2.87	179	0.05
36	Buff f.g. dolomitic marble (MMQ)	2.84	177	0.11
46	Buff f.g. dolomitic marble (HMP)	2.84	177	0.10
11	Green f.g. calcitic marble (SMQ)	2.66	166	0.04
12	Green f.g. calcitic marble (MMQ)	2.64	165	0.04
81	Green f.g. calcitic marble (HMP)	2.72	169	0.06
66	Pink m.g. calcitic marble (MMQ)	2.71	169	0.05
67	Pink f.g. dolomitic marble (HMP)	2.85	178	0.05
68	Pink c.g. calcitic marble (SMQ)	2.72	169	0.08
13	Black f.g. calcitic marble (SMQ)	2.67	167	0.09
14	Black f.g. calcitic marble (HMP)	2.73	170	0.05
37	Black f.g. calcitic marble (MMQ)	2.72	169	0.10
9	Brown Black River limestone (SMQ)	2.73	170	0.05
37A	Brown Black River limestone (HMP)	2.72	169	0.37
40	Brown Black River limestone (SMQ)	2.61	163	0.30
15	Brown Black River limestone (MMQ)	2.66	165	0.61
80	White Carrara calcitic marble, Italy	2.71	169	0.16
26	White Georgia Cherokee calcitic marble	2.70	168	0.14
25	White Georgia Golden Vein calcitic marble	2.71	169	0.13
5	White m.g. calcitic marble, Danby, Vt.	2.71	169	0.13
	White Calacatta marble, Italy	2.72	169	0.15

HMP = Hastings Marble Products.
WFB = W.F. Bonter & Company.
C. Talc = Canada Talc Industries.
MMQ = Madoc Marble Quarries.
SMQ = Stoklosar Marble Quarries.

f.g.= fine-grained.
m.g.= medium-grained.
c.g.= coarse-grained.

Hardness:

Calcite has a hardness of 3 in Moh's scale of hardness and dolomite has a hardness of 3.5 to 4. The abrasive hardness of a marble will depend on its mineral composition, grain size, percentage of impurities and granularity. Some marbles are friable and relatively soft due to poor bonding between grains, while others are much harder due to closely interlocking intergrowths of grains. The abrasive hardness of a marble will be of primary importance in evaluating durability of marble for terrazzo flooring.

The abrasive hardness of marbles is measured by ASTM test C241-51 using a standard U.S. National Bu·eau of Standards abrasion machine. Marbles tested in this program ranged from a very soft 9 to a very hard 125 in the abrasive hardness scale. To be suitable for flooring in areas of heavy traffic it is generally considered that the abrasive hardness should exceed 15 to 18.

Figures for abrasive hardness are given for the 20 Madoc marbles tested in this program with comparative figures for some Italian, and Georgian marbles in the accompanying table:

TABLE

Grain Size, Abrasive Hardness and Compressive Strength of Marbles

Sample No.	Description	Avg. Grain Size in mm.	Abrasive Hardness	Compressive Strength, p.s.i. Max.	Min.	Average
8	HMP white	0.2	28.8	25575	16650	20491
28	WFB white	1.0	26.4	13050	11625	12308
30	CT white	0.3	76.3	29500	26150	27966
34	MMQ white	5.0	19.2	20250	6500	13458
22	SMQ buff	0.05	31.8	37350	27250	32300
36	MMQ buff	0.1	33.6	26000	17625	22375
46	HMP buff	0.2	25.9	35300	28475	31783
11	SMQ green	0.1	125.0	46125	34325	39191
12	MMQ green	0.3	79.2	41875	30375	37830
81	HMP green	0.3	73.1	33500	33000	33250
66	MMQ pink	0.7	23.1	14750	11500	12783
67	HMP pink	0.2	22.9	30025	16400	23725
68	SMQ pink	0.7	26.1	14250	11875	12875
13	SMQ black	0.3	45.6	28500	12875	20687
14	HMP black	0.1	35.3	22750	17125	19591
37	MMQ black	0.2	22.0	16000	9600	13081
9	SMQ brown	0.01	59.6	36875	32500	34680
37A	HMP brown	1.0	44.3	21750	20500	21117
40	SMQ brown		42.6	22625	18500	20750
15	MMQ brown	0.01	40.3	20000	18250	19125
80	Carrara white	0.2	19.2	15800	12575	14800
26	Georgia white	1.2	17.4	13375	10250	11875
25	Georgia white	1.2	15.9	12525	9950	11050

HMP = Hastings Marble Products.
WFB = W.F. Bonter & Company.
CT = Canada Talc Industries.
MMQ = Madoc Marble Quarries.
SMQ = Stoklosar Marble Quarries.

Strength:

"The strength of marble is a measure of its capacity to resist stresses and depends partly on the rift and cleavage of the grains and partly on the degree of cohesion, interlocking of grains, and nature of any cementing material present. Compressive, transverse, tensional or cohesive and shearing strength all affect use, but compressive strength is the quality commonly tested. Usually marble is stronger across the bed than parallel to it," (Bowles 1958, p.5). Compressive strengths of marbles vary from 6,000 to about 40,000 pounds per square inch, indicating that commercial marbles can withstand much more compressive stress than they are likely to be subjected to. Bowles (1958, p.5) states that "most marbles can also withstand any transverse or shearing stresses to which they may be subjected; however some brecciated or veined marbles are too weak to sustain heavy loads."

Soundness and Durability:

Sound marbles should be free from joints, cracks and lines of weakness which may cause failure under stress. Seams, hairlines, cracks or shears may adversely affect durability and soundness. Jointing may be so closely spaced that it is impossible to quarry mill blocks. The presence of dikes or shear zones may adversely affect quarrying.

When a marble weathers under the effects of moisture, freezing and thawing, the marble increases in volume and

absorption increases. The durability of a marble is indicated by ASTM test C218-48, "Combined effect of temperature cycles and weak salt solution on natural building stone." After 30 cycles of heating and cooling and subjection to weak gypsum solution the increase in volume and percent absorption is measured.

Iron-bearing impurities such as pyrite, which may rust and cause discolouration on surfaces of stone subject to weather, are undesirable in marble used for exterior work.

ONTARIO MARBLE DEPOSITS

In 1962 and 1963 there has been increased interest in prospecting for commercial marble deposits in southeastern Ontario. Marble was quarried in 1962 and 1963 at Tatlock and Marble Bluff, north of Perth, by Omega Marble Tile and Terrazzo Limited and by Angelstone Limited. The latter company also quarried marble in Oso township near Sharbot Lake. Exploration work was carried out near Ompah, Actinolite and in Cashel township.

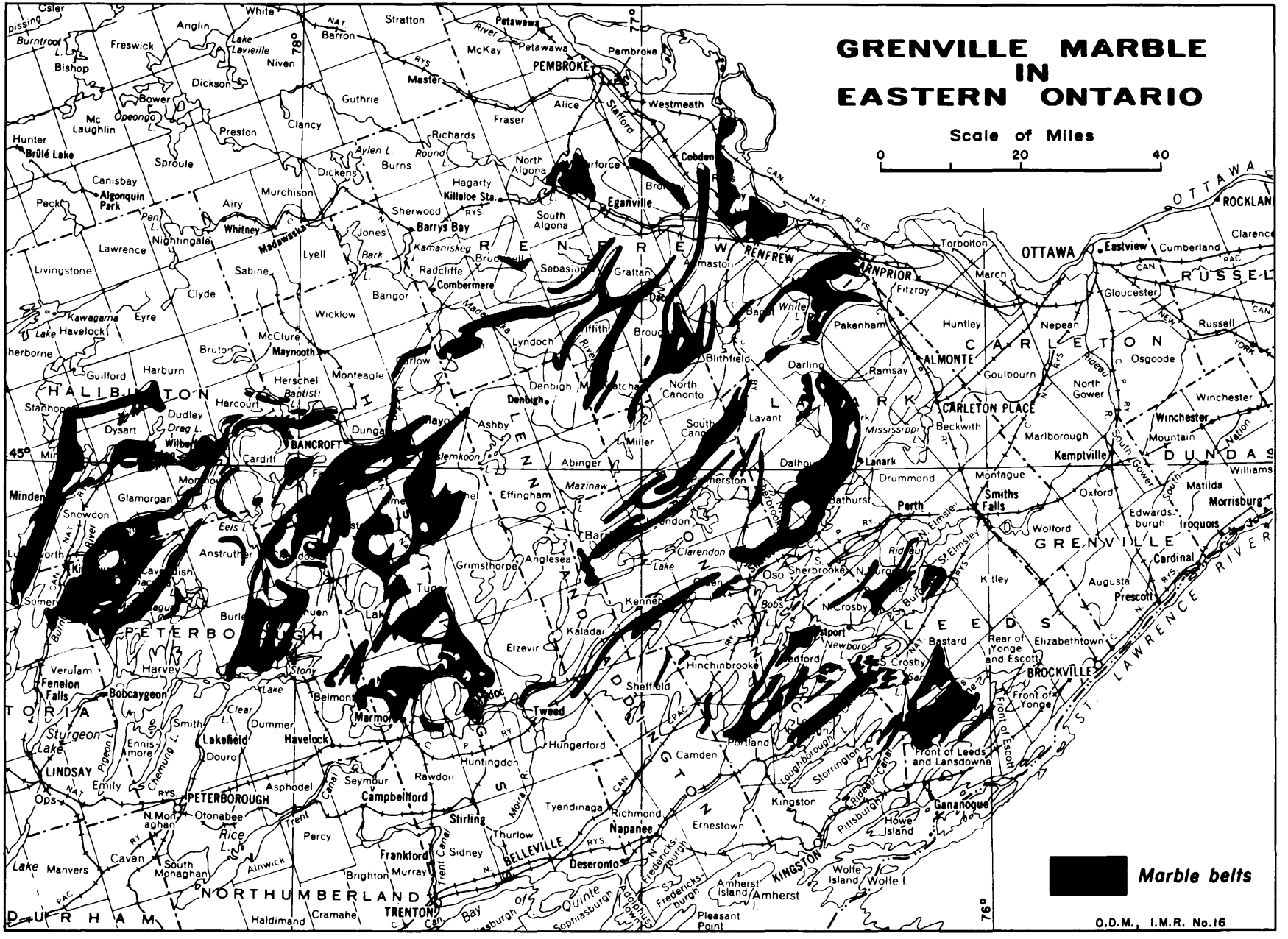
Marble quarrying for the production of marble chips and man-sized blocks is carried on at Madoc, Malone, Eagle Lake, Haleys and Renfrew. Marble chips of various colours are produced for terrazzo. Lump dolomite is shipped mainly to pulp and paper mills.

The distribution of marble in southeastern Ontario is shown in the accompanying figure. Marble underlies more than one hundred square miles.

Haliburton County

Haliburton

Bolender Brothers formerly operated a marble quarry in Block W, Haliburton village, Dysart township for the production of poultry grit, terrazzo chips, stucco dash and artificial stone. Goudge (1938, p.84) states that "the quarry, which is 160 feet long, has been worked back 120 feet into the north


GRENVILLE MARBLE
IN
EASTERN ONTARIO
Scale of Miles
0
20
40
Marble belts
O.D.M., I.M.R. No.16
PETERBOROUGH
HALIBURTON
BANCROFT
RENFREW
ALMONTE
CARLETON PLACE
OTTAWA
GRENVILLE
LEEDS
BROCKVILLE
KINGSTON
BELLEVILLE
PETERBOROUGH
NORTHUMBERLAND
DURHAM
LINDSAY
TRENTON
ST. LAWRENCE RIVER

side of a hill of coarsely crystalline white dolomite in which are numerous elongated masses of diopside, streaks of serpentinous limestone, and zones in which many flakes of black and brown mica are present. The dolomite band has an exposed width of 250 feet. It strikes N.80°E. and dips southerly into the hillside at an angle of 30 degrees."

A chemical analysis of the crushed Grenville dolomite from the bins is given by Goudge (1938, p.88):

SiO_2	7.30
Fe_2O_3	0.53
Al_2O_3	0.55
$CaCO_3$	52.82
$MgCO_3$	41.82
Total	103.02

Eagle Lake

Bolender Brothers operate marble quarries in lot 25, concession IV, Guilford township, north of the road one quarter mile west of Eagle Lake village. Three quarries have been opened in the west face of a high ridge of white crystalline dolomite. The southernmost quarry was being worked in 1962. The rock is a white medium to coarsely crystalline dolomitic marble with some black amphibolite inclusions and boudins floating in the dolomitic marble. Among the minor minerals noted were dicpside, phlogopite, pyrite, tremolite, serpentine and actinolite. The face is

largely composed of pure white dolomitic marble. The formation strikes north and dips 40°W. The face is 50 feet in height.

Several hundred feet to the north a small quarry has been opened on the hillside in banded white quartzite and white diopside rock. This material is used for insoluble chicken grit.

Petrographic examination of the marble indicates that it is composed of an aggregate of coarse, regular, equant dolomite grains averaging about 6 to 7 mm. in diameter. Grain boundaries are smooth and regular. Some tremolite and mica are present.

Physical properties of the marble (No. 47) are as follows:

Compressive strength, p.s.i., maximum: 13000;
minimum: 12250;
average: 12625;

Absorption, 0.13 percent;

Bulk specific gravity, 2.84;

Weight per cubic foot, 176.4 pounds;

Abrasive hardness, 20.5.

The mill consists of jaw crusher, rolls, triple deck screen, a second set of rolls, conveyors and bins. Principal products are poultry grit, terrazzo chips, stucco dash and marble sand. Considerable amounts are sold for surfacing driveways.

Lutterworth Township

Adams and Barlow (1910, p.213) state that "a band of beautiful serpentine limestone occurs on lot 13, concession XIV,

Lutterworth township, in the bed of a little stream which runs through the length of this lot. It is flanked on either side by a bed of the rusty weathering sedimentary gneiss so often associated with the Laurentian limestones, and at the point where the road traversing this lot crosses the stream, is exposed for a width of 30 yards.... The serpentine occurs in grains, lumps and masses, the largest masses being as much as 2 feet in diameter..... A block of this limestone was obtained and sent to the Forsyth granite works in Montreal, where it was sawn and polished. The stone presented a very fine appearance after polishing, and was reported by the Company to be easily worked, and of excellent quality, and in their opinion of great beauty."

"Much of the crystalline limestone in the township of Lutterworth constitutes a veritable marble, as on lot 19 of concessions IV and V and on lot 20 of concession V. This limestone would yield excellent lime, and would afford a fine material for building stone" (Adams and Barlow 1910, p.391).

Glamorgan Township

Adams and Barlow (1910, p.195) report that a small marble quarry was opened on lot 2, concession VI, Glamorgan township near the railway line. Some of the marble was used for tombstones in the cemetery at Gelert. The stone is said to have a good appearance being pure white in colour and coarse in grain. Some pyrite is present in the stone.

Peterborough County

Belmont Township

Concession VI, Lot 31

Bonter Marble Company has quarried white fine crystalline Grenville marble on lot 31, concession VI, Belmont township, north of Little Whitney Lake.

Hastings County

Bancroft

Bancroft was formerly an important marble quarrying centre and for about thirty years after their opening in 1908, there was intermittent production of marble from four small quarries south of Bancroft. These are the McMillan quarry in lot 28, concession X of Dungannon township; the Stewart quarry in lots 29 and 30, concession X of Dungannon township and the two Barker quarries in lots 41 and 42, Hastings Road west, Faraday township. These Bancroft quarries supplied much of the marble used for interior trim in the east block of the Parliament Buildings in Toronto; the Royal Ontario Museum in Toronto; the Parliament Buildings at Ottawa; the Vancouver court house and Canadian government buildings in Hamilton and Windsor.

Descriptions of the operations of these quarries are given by Parks (1912,pp.321-6) and Goudge (1938,pp.106-108).

McMillan Quarry

Dungannon Township, Concession X, Lot 28

The McMillan quarry is located on a 30-foot hill on the south side of the concession road a mile east of No. 62 highway, near the C.N.R. line which crosses the road just to the east of the quarry. The rock is a pure white to mottled buff and white medium-crystalline dolomitic marble which strikes east-west and dips 85°N. Some knots of white tremolite were observed standing up on weathered surfaces.

The marble band is flanked on the north by mica schist containing biotite metacrysts. This schist shows a pronounced lineation on bedding surfaces plunging 60°W. The marble band is 60 feet wide and is flanked by amphibolite on the south side.

The quarry measures 60 feet in width across the band in a north-south direction and 120 feet in length. The pit is 40 feet deep and is water-filled. There are horizontal joints evident in the quarry.

A chemical analysis of the stone is given by Goudge (1938, p.109) as follows:

SiO_2	1.88
Fe_2O_3	0.86
Al_2O_3	1.08
$Ca_3(PO_4)_2$	0.02
$CaCO_3$	54.39
$MgCO_3$	42.51
Total	99.89

Petrographic examination of the marble indicates that it is composed of a medium-grained aggregate of regular equant dolomite grains averaging 0.6 mm. in diameter. Silicates are scarce.

Physical properties of the marble (No.41) are as follows:

Compressive strength, p.s.i., maximum: 20850;
minimum: 11125;
average: 15608;

Absorption, 0.07 percent;

Bulk specific gravity, 2.86;

Weight per cubic foot, 177.6 pounds;

Abrasive hardness, 15.8.

Stewart Quarry

Dungannon Township, Concession X, Lots 29 and 30

The Stewart quarry is located on the boundary between lots 29 and 30, concession X, Dungannon township, about 3/8 of a mile southwest of the McMillan quarry and 1/8 mile south of the concession road. There is an old road leading to the property $\frac{3}{4}$ of a mile east of highway No. 62. A mill was formerly operated on this property but is now dismantled. The Stewart quarry consists of a shallow cut, 160 feet long and 80 feet wide into the southeast side of a low marble ridge. The maximum quarry face on the north side of the opening is about 12 feet. A second opening 3 to 7 feet deep in the quarry floor measures 70 by 40 feet. The marble strikes N.70°-80°E. and

dips vertically. The sequence across the strike from the south side of the quarry is described by Goudge (1938, p. 107) as follows:

"120-foot band of light blue, medium-grained, rather siliceous dolomite veined with white.

33-foot band of fine-grained, banded, brownish pink dolomite containing less siliceous material than the blue marble.....

30-foot band of pale, clouded green, fine-grained dolomite also siliceous; this is adjoined to the northeast by fine-grained serpentinous green, micaceous dolomite which yields what is known as the "Imperial Green" marble. Occasional narrow bands of pink calcium marble are present in this zone. The outcrops of green marble are very rough."

Feathery rosettes of green tremolite are common in the green marble, and siliceous streaks and nodules stand out on weathered surfaces throughout the quarry area. Brown magnesian tourmaline (dravite) occurs in the micaceous facies of the marble. Joints are widely spaced.

A chemical analysis of the "Banded Pink" marble from the 33-foot band is given by Goudge (1938, p.109) as follows:

SiO_2	5.70
Fe_2O_3	1.08
Al_2O_3	1.08
$Ca_3(PO_4)_2$	0.04
$CaCO_3$	51.87
$MgCO_3$	41.17
Total	100.94

There are inclusions and bands of rusty paragneiss and amphibolite.

Petrographic examination of a specimen of the marble indicates that it is composed of fine to medium dolomite grains from 0.3 to 0.6 mm. in diameter. Some silicates are present.

Physical properties of the marble (No.43) are as follows:

Compressive strength, p.s.i., maximum: 24175;
minimum: 16025;
average: 20983;

Absorption, 0.10 percent;

Bulk specific gravity, 2.87;

Weight per cubic foot, 178.4 pounds;

Abrasive hardness, 32.8.

Barker Quarries

Faraday Township, Hastings Road, Lots 41 and 42 West

The Barker marble quarries are located in lots 41 and 42 west, Hastings Road, Faraday township, on the northeast side of L'Amable Lake, about $\frac{1}{4}$ mile west of highway No. 62. A great variety of marble is available on this property including several beautiful marble breccias.

The south quarry is in the side of a high dolomite bluff and measures 26 by 43 feet, with a 17-foot face on the east

side. The white, buff to grey fine-grained marble strikes east-west and dips vertically. Silicate knots to 12 inches in size were noted. The "Laurentian Buff" marble was obtained from this quarry.

The main north quarry is in a brecciated marble zone 15 to 20 feet wide consisting of angular fragments of grey to white marble in a brownish micaceous matrix. The marble strikes N.75°E. and dips vertically. The quarry opening measures 88 by 18 feet and runs at S.85°E. parallel to the strike of a 12-inch trap dike which dips 60°N. The "Laurentian No. 10" marble was quarried from this band; considerable brecciated marble remains. Adjoining this to the north is a 120-foot band of pink and rose marble of medium crystallinity from which the "Laurentian Rose" marble was obtained.

One hundred feet northwest of the rose marble opening another small opening has been made in brecciated marble in which the fragments are tinted green and brown. The marble was known as "Laurentian No. 14."

Physical properties of the brecciated marble (No.44) are as follows:

Compressive strength, p.s.i., maximum: 25275;
minimum: 18900;
average: 21808;

Absorption, 0.19 percent;

Bulk specific gravity, 2.93;

Weight per cubic foot, 182 pounds;

Abrasive hardness, 22.9.

Physical properties of the rose marble (No.44A & B) are as follows:

Compressive strength, p.s.i., maximum: 23625;
minimum: 12625;
average: 15956;

Absorption, 0.10 percent;

Bulk specific gravity, 2.71;

Weight per cubic foot, 169.2 pounds;

Abrasive hardness, 35.9.

Faraday Township

Concession XII, Lot 2

White medium crystalline dolomitic marble is exposed on the south side of a 100-foot metagabbro ridge on lot 2, concession XII, Faraday township. The dolomite marble is pure white in colour and contains minor amounts of scattered tremolite. The strike is N.70°E. and dip 70° southward. Occasional horizontal joints are apparent. Some blasting on the hillside was done in 1953 and 1954 but little work has been done on the deposit. The marble band is over 100 feet wide and is in contact with metagabbro on the north side. Increased amounts of silicates could be expected near the metagabbro.

Cashel Township

Concessions VI and VII, Lot 19

Grenville Marble Company

A deposit of black and white fine-grained calcitic marble

was staked in Cashel township, Hastings county, in 1962 by W.A. Gallagher. In 1963, several blocks of marble were quarried from the property and shipped to Port Hope.

The quarry is just east of the Weslemkoon Lake road at the northwest end of Horse Lake. Several acres have been stripped on the east side of a marble ridge and a quarry face of 30 feet is being developed in the hillside. The marble strikes N.5°E. and dips 65-75°W.

The fine-grained black marble is veined with medium-grained white marble. It takes a good polish. Petrographic examination indicates the marble is composed predominantly of calcite with minor amounts of graphite, quartz, phlogopite and feldspar. The chemical analysis indicates 5.5 percent of quartz and 1.0 percent of other silicate minerals, in this case mica and feldspar. Finely disseminated graphite dust is responsible for the black colour of the marble. In places, it displays a delicate banding which shows crenulation. Most of the calcite is fine-grained with a granular mosaic texture of grains averaging about 0.05 mm. This groundmass is cut by veinlets of coarser grained calcite from 0.5 to 1.5 mm. in grain size. Graphite is absent in these recrystallized veinlets, which are white.

Chemical analysis of a sample of the black marble was carried out by the Ontario Department of Mines Laboratory with the following results:

	percent
Silica (quartz)	5.52
Other silicates	0.98
Fe_2O_3	0.87
Al_2O_3	0.61
CaO	47.40
MgO	3.55
CO_2	40.80
Total	99.73

	percent
$CaCO_3$ (calculated)	85.01
$MgCO_3$ (calculated)	7.42
Total carbonate	92.43

Physical properties of specimens of the black marble are as follows:

Compressive strength, p.s.i., maximum: 24500;
minimum: 16500;
average of 3 cubes: 21250;

Water absorption, (48 hour), 0.076 percent;

Bulk specific gravity, 2.73;

Weight per cubic foot, 170.4 pounds;

Abrasive hardness, 40.0.

Marmora

Bonter Marble and Calcium Company Limited

Marmora Township, Concession IV, Lot 9

The marble quarry formerly operated by Bonter Marble and Calcium Company is located one mile north of Marmora on the

east side of the Crowe River on lot 9, concession IV, Marmora township. White fine to medium crystalline white calcitic marble was formerly quarried for building stone and for marble chips. A large pit measuring 80 by 40 feet is water-filled. It has a 28-foot face. The marble band strikes westerly and dips vertically. Goudge (1938, p. 98) states that it is 70 to 80 feet wide. There are some inclusions of paragneiss and amphibolite and a 3-foot trap dike strikes west and dips vertically. There is prominent horizontal and vertical jointing. The vertical jointing strikes east-west. The white marble grades to grey in the north part of the pit. Pink hematite staining occurs along some joints.

Goudge (1938, p.109) gives an analysis of the calcitic marble from the Bonter pit as follows:

SiO_2	0.80
Fe_2O_3	0.15
Al_2O_3	0.15
$Ca_3(PO_4)_2$	0.02
$CaCO_3$	95.10
$MgCO_3$	3.60
Total	99.82

Madoc Area

Over 20 small marble quarries have been operated in the Madoc area, principally for the production of marble terrazzo chips. The four companies producing terrazzo chips in the

Madoc area are Stoklosar Marble Quarries, Madoc Marble Quarries Company, Hastings Marble Products Limited and Canada Talc Industries Limited. W.F. Bonter & Company Limited at Malone produces crystalline calcitic marble principally for the pulp and paper trade.

Deloro

Marmora Township

Concession VIII, Lot 6

There are 4 small quarry openings in lot 6, concession VIII, Marmora township, half a mile south of No. 7 highway. These have been operated by Stoklosar Marble Quarries to produce white and green marble for terrazzo chips. One small quarry in coarsely crystalline white calcitic marble has an 8-foot face. The west portion of the quarry exposes aphanitic grey-green marble.

The white calcitic marble consists of carbonate grains up to 2 mm. in diameter intergrown with bladed wollastonite. Physical properties of the stone (No. 16) are as follows:

Compressive strength, p.s.i., maximum: 20750;
minimum: 14100;
average: 17366;

Absorption, 0.07 percent;

Bulk specific gravity, 2.80;

Weight per cubic foot, 174.9 pounds;

Abrasive hardness, 51.6.

Malone

Marmora Township

Concession X, Lot 17, Southeast Quarter

Hastings Marble Products Limited have operated a small green marble quarry at Malone on the southeast quarter of lot 17, concession X, Marmora township. Grey-green banded aphanitic calcitic silicated marble strikes N.15°E., dips vertically. There is some colour mottling. Some sulphides are present in the marble. The quarry measures 80 feet by 25 feet by 12 feet deep.

Petrographic examination indicates that the marble is sheared and mylonitized. Tremolite and serpentine are present. Average grain size is 0.2 to 0.4 mm. Physical properties of the stone (No.81) are as follows:

Compressive strength, p.s.i., maximum: 33500;
minimum: 33000;
average: 33250;

Absorption, 0.06 percent;

Bulk specific gravity, 2.72;

Weight per cubic foot, 169.8 pounds;

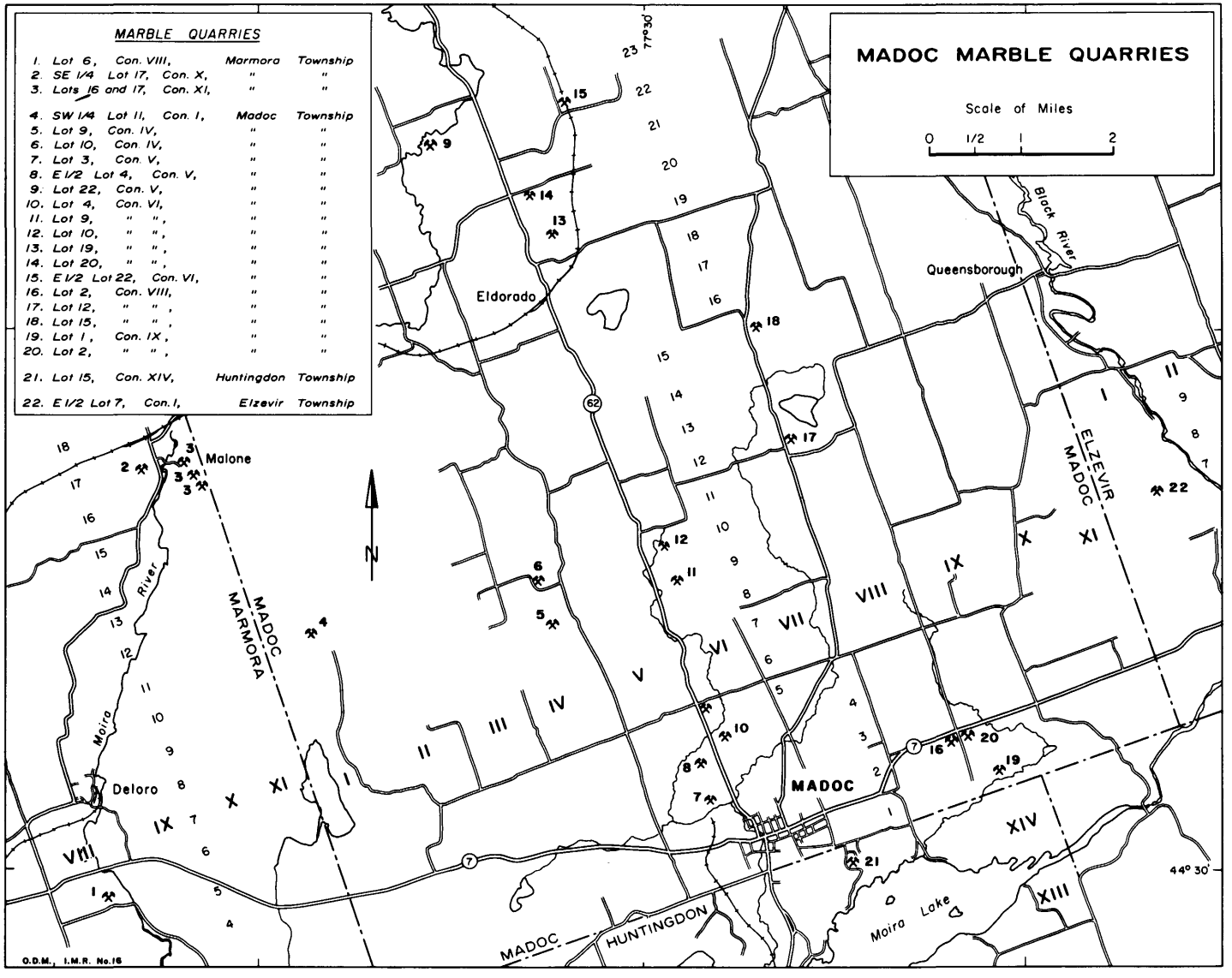
Abrasive hardness, 73.1.

W.F. Bonter & Company

Marmora Township

Concession XI, Lots 16 and 17

Six small white calcitic marble quarries have been opened


MADOC MARBLE QUARRIES
Scale of Miles
0 1/2 1 2
MARBLE QUARRIES
1. Lot 6, Con. VIII, Marmora Township
2. SE 1/4 Lot 17, Con. X, " "
3. Lots 16 and 17, Con. XI, " "
4. SW 1/4 Lot 11, Con. I, Madoc Township
5. Lot 9, Con. IV, " "
6. Lot 10, Con. IV, " "
7. Lot 3, Con. V, " "
8. E 1/2 Lot 4, Con. V, " "
9. Lot 22, Con. V, " "
10. Lot 4, Con. VI, " "
11. Lot 9, " " , " "
12. Lot 10, " " , " "
13. Lot 19, " " , " "
14. Lot 20, " " , " "
15. E 1/2 Lot 22, Con. VI, " "
16. Lot 2, Con. VIII, " "
17. Lot 12, " " , " "
18. Lot 15, " " , " "
19. Lot 1, Con. IX, " "
20. Lot 2, " " , " "
21. Lot 15, Con. XIV, Huntingdon Township
22. E 1/2 Lot 7, Con. I, Elzevir Township
Eldorado
Queensborough
Black River
Malone
Deloro
Moira River
MADOC MARMORA
ELZEVIR MADOC
MADOC HUNTINGDON
MADOC
Moira Lake
77°30'
44° 30'
O.D.M., I.M.R. No. 16

on lots 16 and 17, concession XI, Marmora township near the village of Malone by W.F. Bonter & Company. The quarries produce man-sized stone for pulp and paper mills, stone for terrazzo chips, chicken grit and dust. The dust is used as an additive to feed formula for poultry and livestock. The chicken grit is produced by crushing the calcitic marble in a jaw crusher and hammer mill and screening over a 3-deck 3- by 8-foot screen. The calcitic marble ranges from fine crystalline to medium crystalline, grey to white in colour. There are some dark amphibolite inclusions in places in the marble. The most northerly quarry is inactive and water-filled. A new quarry measuring 20 by 60 feet with a 12-foot face has been opened just east of the old quarry. The principal quarry now operated is a few hundred feet southeast of the mill in the west side of the marble ridge. The quarry measures 50 by 35 feet with a 20-foot face. Grey to white, fine to medium crystalline calcitic marble strikes north-south and dips vertically to steeply west. There are prominent closely spaced horizontal and vertical joints which make the stone unsuitable for building stone.

Petrographic examination indicates that the marble is coarse-grained, consisting predominantly of irregularly shaped calcite grains 0.3 to 2 mm. in size, averaging about 1.0 mm. in size. Twinning is common in the calcite grains. Physical properties of the stone (No.28) are as follows:

Compressive strength, p.s.i., maximum: 13050;
minimum: 11625;
average: 12308;

Absorption, 0.03 percent;

Bulk specific gravity, 2.74;

Weight per cubic foot, 171.1 pounds;

Abrasive hardness, 26.4.

A chemical analysis by Temiskaming Testing Laboratories of a specimen of the marble is as follows: insolubles, 1.76 percent; lime, 52.30 percent; magnesia, 2.78 percent; ignition loss 42.97 percent.

Madoc Township

Concession I, Lot 11, Southwest Quarter

Stoklosar Marbles Quarries operate a small quarry on the southwest quarter of lot 11, concession I, Madoc township. A 14-foot face of flat-lying brown to red-brown Pamelia limestone of the Lower Black River group is quarried in two seven-foot lifts. The limestone varies from microcrystalline to medium crystalline in texture. Shaly arkosic beds occur from 8 to 12 feet above the quarry floor. The arkosic limestone contains angular grains of quartz, feldspar and granite which are poorly bonded.

Petrographic examination of a specimen of the microcrystalline limestone indicates that the rock is a calcilutite composed of a very fine-grained matrix of carbonate with up to 10 percent of clastic quartz and feldspar grains up to 0.5 mm. in diameter. The red brown colour is due to fine hematite.

Physical properties of the microcrystalline limestone (No.9) are as follows:

Compressive strength, p.s.i., maximum: 36875;
minimum: 32500;
average: 34680;

Absorption, 0.07 percent;

Bulk specific gravity, 2.73;

Weight per cubic foot, 170.4 pounds;

Abrasive hardness, 59.6.

Physical properties of the medium crystalline limestone from another bed (No.40) are as follows:

Compressive strength, p.s.i., maximum: 22625;
minimum: 18500;
average: 20750;

Absorption, 0.30 percent;

Bulk specific gravity, 2.61;

Weight per cubic foot, 162.9 pounds;

Abrasive hardness, 42.6.

Chemical analysis of No. 9 limestone is as follows: insolubles, 7.49 percent; lime, 43.78 percent; magnesia, 6.56 percent; ignition loss, 40.45 percent.

Chemical analysis of No. 40 limestone is as follows: insolubles, 25.54 percent; lime, 38.90 percent; magnesia, 1.64 percent; ignition loss, 31.96 percent.

Analyses by Temiskaming Testing Laboratories.

Madoc Township

Concession IV, Lot 9

Hastings Marble Products operate a quarry on lot 9, concession IV, Madoc township. A 10- to 12-foot face of red-brown, flat-lying, medium to thin bedded, aphanitic to fine crystalline lower Black River limestone is quarried. Clastic shaly layers are rare. The face is approximately 30 feet long.

Petrographic examination of a specimen of medium crystalline limestone indicates that the rock is a clastic calcarenite composed of fragments and pellets of fine grained limestone in a clastic matrix of sparry calcite. Grain size ranges from 0.2 to 1.0 mm. There are some sparse quartz grains.

Physical properties of a specimen of medium crystalline calcarenite (No.37A) are as follows:

Compressive strength, p.s.i., maximum: 21750;
minimum: 20500;
average: 21117.

Absorption, 0.37 percent;

Bulk specific gravity, 2.69;

Weight per cubic foot, 167.9 pounds;

Abrasive hardness, 44.3.

Chemical analysis of limestone No. 37A is as follows: insolubles, 21.60 percent; lime, 39.92 percent; magnesia, 0.72 percent; ignition loss, 31.82 percent. Analysis by

Temiskaming Testing Laboratories.

Madoc Township

Concession IV, Lot 10

Madoc Marble Quarries operate a small roadside limestone quarry on lot 10, concession IV, Madoc township. A 10- to 12-foot face of red-brown, flat-lying, medium to thin bedded, aphanitic to fine crystalline lower Black River limestone is quarried in a pit measuring about 20 by 30 feet.

Petrographic examination of a thin section of microcrystalline limestone indicates that the rock is a very fine grained calcilutite composed of minute carbonate grains. There are up to 10 percent of clastic grains of quartz and feldspar averaging 0.2 mm. in size. Hematite dust gives the rock a red colouration.

Physical properties of the microcrystalline limestone (No.15) are as follows:

Compressive strength, p.s.i., maximum: 20000;
minimum: 18250;
average: 19125;

Absorption, 0.61 percent;

Bulk specific gravity, 2.66;

Weight per cubic foot, 166.1 pounds;

Abrasive hardness, 40.3.

Chemical analysis of limestone No. 15 by the Temiskaming Testing Laboratories is as follows: insolubles, 15.12 percent; lime,

45.04 percent; magnesia, 0.90 percent; ignition loss, 35.94 percent.

Madoc Township

Concession V, Lot 3

Madoc Marble Quarries Limited operate a small quarry in black calcitic marble 700 feet west of No. 62 highway on the edge of Madoc village in lot 3, concession V, Madoc township. The quarry which measures 30 by 20 feet with a 5-foot face is in black, aphanitic to fine crystalline, bedded Hastings calcitic marble. The marble strikes east-west and dips vertically.

Petrographic examination of the marble indicates that it is composed of an aggregate of equant to irregular calcite grains averaging 0.2 to 0.3 mm. in grain size. The black colour is due to graphite dust.

Physical properties of the marble (No. 37) are as follows:

Compressive strength, p.s.i., maximum: 16000;
minimum: 9600;
average: 13081;

Absorption, 0.10 percent;

Bulk specific gravity, 2.72;

Weight per cubic foot, 169.8 pounds;

Abrasive hardness, 22.0.

Chemical analysis of marble No. 37 by Temiskaming Testing

Laboratories is as follows: insolubles, 2.0 percent; lime, 53.72 percent; magnesia, 0.74 percent; ignition loss, 42.70 percent.

Madoc Township

Concession V, Lot 4, East Half

Hastings Marble Products Limited operate a small quarry in black calcitic marble 500 feet west of No. 62 highway in the east half of lot 4, concession V, Madoc township. The quarry which measures 30 by 20 feet with an 8-foot face is in black, aphanitic to fine crystalline, bedded Hastings calcitic marble which strikes N.30°E. and dips 50°S.E.

Petrographic examination of the marble indicates that it is composed of an aggregate of interlocking calcite grains averaging 0.1 mm. in diameter. There is about 10 percent clastic quartz grains. The black colouration is due to graphite dust. The grains show some preferential alignment.

Physical properties of the marble (No.14) are as follows:

Compressive strength, p.s.i., maximum: 22750;
minimum: 17125;
average 19591;

Absorption, 0.05 percent;

Bulk specific gravity, 2.73;

Weight per cubic foot, 170.4 pounds;

Abrasive hardness, 35.3.

Chemical analysis of marble No. 14 by the Temiskaming Testing

Laboratories is as follows: insolubles, 15.40 percent; lime, 45.40 percent; magnesia, 1.28 percent; ignition loss, 36.11 percent.

Madoc Township

Concession V, Lot 22

In 1963 Hastings Marble Products opened a small quarry in fine-grained yellow dolomitic marble on lot 22, concession V, Madoc township.

Madoc Township

Concession VI, Lot 4

Stoklosar Marble Quarries Limited operate a small quarry in black calcitic Hastings marble 300 feet east of No. 62 highway in lot 4, concession VI, Madoc township, a mile north of Madoc village. The quarry is on the north side of a low hill and measures 25 feet wide, 20 feet deep, with a 12-foot face to the south. The rock is well bedded, aphanitic to fine crystalline black Hastings marble which strikes N.40°E. and dips 55°S.E.

Petrographic examination of the marble indicates that it is composed mainly of equant calcite grains with smooth grain boundaries and 20 to 30 percent of quartz grains. Grain size ranges from 0.1 to 0.4 mm. averaging 0.3 mm. There is a pronounced alignment of grains, and some grain elongation.

The quartz grains tend to be smaller than the calcite grains. The presence of quartz grains contributes to the superior hardness of this marble.

Physical properties of the marble (No.13) are as follows:

Compressive strength, p.s.i., maximum: 28500;
minimum: 12875;
average: 20687;

Absorption, 0.09 percent;

Bulk specific gravity, 2.67;

Weight per cubic foot, 166.7 pounds;

Abrasive hardness, 45.6.

Madoc Township

Concession VI, Lot 9

Madoc Marble Quarries formerly operated a small quarry in green and white calcitic marble in lot 9, concession VI, Madoc township. The quarry is half a mile east of No. 62 highway. A 15-foot face has been opened up on the south side of a hill and the quarry measures 30 by 20 feet. White medium crystalline marble strikes north-south and dips vertically to 80°W. The marble is cut by a basic dike and adjacent to the dike the marble is altered to a greyish-green colour.

Madoc Township

Concession VI, Lot 10

Stoklosar Marble Quarries operated a small quarry in green

calcitic serpentinized marble in lot 10, concession VI, Madoc township just south of the road. Green and white aphanitic to fine crystalline calcitic marble dips 20°N. in part, but structure is irregular. The marble is intruded by rhyolite. Serpentine and tremolite are abundant in the marble in places.

Madoc Township

Concession VI, Lot 19

Pale buff fine-grained dolomitic marble is quarried by Stoklosar Marble Quarries on lot 19, concession VI, Madoc township. A ten-foot quarry face has been opened in the east side of a 40-foot hill.

Petrographic examination indicates the marble consists of very fine-grained dolomite grains with irregular grain boundaries. Grain size averages 0.05 mm. with a few larger grains to 0.3 mm. There is rare quartz.

Physical properties of the marble (No.22) are as follows:

Compressive strength, p.s.i., maximum: 37350;
minimum: 27250;
average: 32300;

Absorption, 0.05 percent;

Bulk specific gravity, 2.86;

Weight per cubic foot, 177.6 pounds;

Abrasive hardness, 31.8.

Chemical analysis of marble No. 22 by Temiskaming Testing Laboratories is as follows: insolubles, 1.0 percent; lime, 30.84 percent; magnesia, 21.62 percent; ignition loss, 46.54 percent.

Madoc Township

Concession VI, Lot 19

Hastings Marble Products Limited operate a small marble quarry in buff-coloured dolomitic marble on lot 19, concession VI, Madoc township. The quarry measures 20 by 80 feet with a 10-foot face. There is one to two feet of overburden. The fine crystalline to aphanitic banded buff marble strikes north-south and dips 70°E. It is highly jointed.

Petrographic examination indicates the marble is composed of an aggregate of equant dolomite grains averaging 0.2 mm. in size. There is some irregularity in grain size and minor quartz and feldspar are present.

Physical properties of the marble (No.46) are as follows:

Compressive strength, p.s.i., maximum: 35300;
minimum: 28475;
average: 31783;

Absorption, 0.10 percent;

Bulk specific gravity, 2.85;

Weight per cubic foot, 177.0 pounds;

Abrasive hardness, 25.9.

Madoc Township

Concession VI, Lot 20

Madoc Marble Quarries Limited operate a small quarry 300 feet south of the road in lot 20, concession VI, Madoc

township. The rock is a well banded, fine crystalline, pink, white and grey calcitic marble which strikes north-south and dips 80°E. There is a mineral lineation on the bedding surfaces plunging 60°N. There are prominent horizontal joints. The quarry measures 25 by 40 feet with a 10-foot face.

Petrographic examination of a specimen of this pink marble indicates that it is composed of a medium-grained aggregate of serrate, interlocking calcite grains averaging 0.7 mm. in diameter. The calcite is strongly twinned.

Physical properties of the marble (No.66) are as follows:

Compressive strength, p.s.i., maximum: 14750;
minimum: 11500;
average: 12783;

Absorption, 0.05 percent;

Bulk specific gravity, 2.71;

Weight per cubic foot, 169.2 pounds;

Abrasive hardness, 23.1.

Chemical analysis of marble No. 66 by Temiskaming Testing Laboratories is as follows: insolubles, 1.26; lime, 54.40 percent; magnesia, 0.70 percent; ignition loss, 43.10 percent.

Madoc Township

Concession VI, Lot 22, East Half

Stoklosar Marble Quarries have operated 4 small pink marble quarries east of the road on the east half of lot 22, concession

VI, Madoc township. The most southerly opening runs northward into the hillside consisting of white, grey and pink banded, fine crystalline calcitic marble that strikes north-south and dips 80°E. Fifty feet to the north there is a second opening on the west side of the 40-foot ridge. The quarry face is 25 feet high and exposes banded grey and white, medium to fine crystalline marble. Joints strike east-west and dip 65°S. A strong lineation plunging 60°N. is noted on bedding planes. Two other quarry openings to the north expose banded pink, white and grey, fine crystalline marble. Horizontal joints are closely spaced. Flat-lying Paleozoic limestone rests on the marble along the west side of the third quarry.

Petrographic examination of a specimen of pink marble indicates that it is composed of an aggregate of serrate interlocking calcite grains averaging 0.7 mm. in diameter. The calcite grains show twinning; sparse quartz is present. There is an incipient alignment of grains.

Physical properties of the marble (No.68) are as follows:

Compressive strength, p.s.i., maximum: 14250;
minimum: 11875;
average: 12875;

Absorption, 0.08 percent;

Bulk specific gravity, 2.72;

Weight per cubic foot, 169.8 pounds;

Abrasive hardness, 26.1.

Chemical analysis of marble No. 68 by Temiskaming Testing Laboratories is as follows: insolubles, 3.74 percent; lime,

52.68 percent; magnesia, 0.90 percent; ignition loss, 41.84 percent.

Madoc Township

Concession VIII, Lot 2

A small quarry has been opened in fine-grained pink marble by Hastings Marble Products on lot 2, concession VIII, Madoc township, just south of No. 7 highway. The pink marble band has been exposed over a width of 100 feet; it strikes east-west and dips 80°N.

Petrographic examination indicates the marble is composed of a fine-grained aggregate of equant dolomite grains averaging 0.2 mm. in size. Sparse quartz is present.

Physical properties of the marble (No.67) are as follows:

Compressive strength, p.s.i., maximum: 30025;
minimum: 16400;
average: 23725;

Absorption, 0.05 percent;

Bulk specific gravity, 2.85;

Weight per cubic foot, 177.0 pounds;

Abrasive hardness, 22.9.

Chemical analysis of marble No. 67 by Temiskaming Testing Laboratories is as follows: insolubles, 1.40 percent; lime, 30.58 percent; magnesia, 21.40 percent; ignition loss, 45.88 percent.

Madoc Township

Concession VIII, Lot 12

Stoklosar Marble Quarries formerly operated a small quarry in buff dolomitic marble at Hazzards Corners in lot 12, concession VIII, Madoc township. There are several small irregular openings on the east side of the road in strongly jointed, buff aphanitic marble. The buff marble grades to white in places.

Petrographic examination of the marble indicates that it is composed of a fine-grained mosaic of irregular dolomite grains averaging 0.1 to 0.2 mm. in diameter. There is a preferred alignment of grains. Minor quartz, mica and pyrite were noted.

Physical properties of the marble (No.69) are as follows:

Compressive strength, p.s.i., maximum: 43000;
minimum: 22750;
average: 29875;

Absorption, 0.13 percent;

Bulk specific gravity, 2.84;

Weight per cubic foot, 176.4 pounds;

Abrasive hardness, 46.6.

Madoc Township

Concession VIII, Lot 15

Madoc Marble Quarries Limited operate a small quarry in

buff dolomitic marble 1.2 miles north of Hazzards Corners in lot 15, concession VIII, Madoc township. The quarry which measures 35 by 20 feet with a 12-foot face is located on the east side of a hill 200 feet east of the road. Aphanitic white to buff marble showing strong jointing is exposed in quarry openings.

Petrographic examination indicates that the marble is composed of an aggregate of very fine equant grains of dolomite averaging 0.02 mm. Sparse pyrite, quartz and feldspar are present.

Physical properties of the marble (No.36) are as follows:

Compressive strength, p.s.i., maximum: 26000;
minimum: 17625;
average: 22375;

Absorption, 0.11 percent;

Bulk specific gravity, 2.84;

Weight per cubic foot, 176.4 pounds;

Abrasive hardness, 33.6.

Madoc Township

Concession IX, Lot 1

Bonter Marble Company quarried white medium to fine crystalline calcitic marble in lot 1, concession IX, Madoc township. The marble strikes N.50°E. and dips 75°N.W. Blue grey streaks up to 4 feet wide are present in the white marble and buff colouration is observed at places. The quarry opening measures 30 by 25 feet with an 8-foot face.

Madoc Township

Concession IX, Lot 2

A small quarry has been opened in fine-grained white dolomitic marble in lot 2, concession IX, Madoc township, just south of No. 7 highway by Hastings Marble Products. The marble strikes N.60°W. and dips vertically. A ten-foot quarry face had been opened in August 1963 when the property was visited by the author.

Petrographic examination indicates that the marble is composed of a mosaic of fine-grained equant dolomite grains with smooth mutual boundaries. Average grain size is 0.2 mm. There is some alignment of grains. Rare silicates and quartz are present.

Physical properties of the marble (No.8) are as follows:

Compressive strength, p.s.i., maximum: 25575;
minimum: 16650;
average: 20491;

Absorption, 0.10 percent;

Bulk specific gravity, 2.84;

Weight per cubic foot, 176.4 pounds;

Abrasive hardness, 28.8.

Chemical analysis of marble No. 8 by the Temiskaming Testing Laboratories is as follows: insolubles, 6.52 percent; lime, 28.60 percent; magnesia, 21.0 percent; ignition loss, 43.96 percent.

Rawdon Township

Concession XIV, Lot 1

A small quarry was opened in 1963 by Madoc Marble Quarries on the north side of the old Marmora road in lot 1, concession XIV, Rawdon township, Hastings county. The deposit is fine-grained green and white calcitic marble which strikes east-west and dips vertically. A 10-foot quarry face has been developed in the south side of a low ridge.

Petrographic examination indicates that the calcitic marble is composed of coarse and fine calcite grains 0.5 and 0.1 mm. in diameter, chlorite and serpentine. Average grain size is 0.3 mm. Grains have serrate irregular borders which contribute to high strength.

Physical properties of the marble (No.12) are as follows:

Compressive strength, p.s.i., maximum: 41875;
minimum: 30375;
average: 37830;

Absorption, 0.04 percent;

Bulk specific gravity, 2.64;

Weight per cubic foot, 164.8 pounds;

Abrasive hardness, 79.2.

This is a remarkably strong and hard marble.

Chemical analysis of marble No. 12 by Temiskaming Testing Laboratories gives the following results: insolubles, 29.84 percent; lime, 26.90 percent; magnesia, 16.02 percent; ignition

loss, 26.81 percent.

Huntingdon Township

Concession XIV, Lot 1

A small quarry in a green calcitic marble was operated in 1963 by Stoklosar Marble Quarries on the north side of the old Marmora road in lot 1, concession XIV, Huntingdon township, Hastings county. The 20-foot quarry face is at the east end of a hill of vertically dipping green and white marble which strikes east-west.

Petrographic examination of the marble indicates that it is composed of fine-grained calcite grains with very irregular serrate intergrown boundaries which gives the rock great strength. The calcite grains are intergrown with laths of chlorite, and serpentine which make up at least 10 percent of the rock. Grain size averages 0.1 to 0.2 mm.

Physical properties of the marble (No.11) are as follows:

Compressive strength, p.s.i., maximum: 46125;
minimum: 34325;
average: 39191;

Absorption, 0.04 percent;

Bulk specific gravity, 2.64;

Weight per cubic foot, 164.8 pounds;

Abrasive hardness, 125.0.

This is a remarkably strong and hard marble.

Chemical analysis of marble No. 11 by Temiskaming Testing

Laboratories is as follows: insolubles, 26.42 percent; lime, 30.10 percent; magnesia, 13.80 percent; ignition loss, 29.35 percent.

Canada Talc Industries Limited

Conley Mine

Huntingdon Township, Concession XIV, Lot 15

Canada Talc Industries Limited mine white aphanitic dolomitic marble for terrazzo chips at the Conley mine in lot 15, concession XIV, Huntingdon township, Hastings county.

Petrographic examination of the marble indicates that it is composed of carbonate grains, with equant regular boundaries, averaging 0.3 mm. in diameter. Considerable tremolite and other silicates are present. Grain size is somewhat variable and there is a strong grain alignment.

Physical properties of the marble (No.30) are as follows:

Compressive strength, p.s.i., maximum: 29500;
minimum: 26150;
average: 27966;

Absorption, 0.07 percent;

Bulk specific gravity, 2.88;

Weight per cubic foot, 179.0 pounds;

Abrasive hardness, 76.3.

Chemical analysis of marble No. 30 by Temiskaming Testing Laboratories is as follows: insolubles, 22.70 percent; lime,

22.58 percent; magnesia, 18.90 percent; ignition loss, 34.88 percent.

Elzevir Township

Concession I, Lot 7, East Half

Bonter Marble Company operated a small quarry in pink aphanitic marble on the east half of lot 7, concession I, Elzevir township.

Actinolite

Elzevir Township

In 1963 Madoc Marble Quarries Limited opened a quarry in white medium to coarsely crystalline dolomitic marble on the south side of highway No. 7 east of Actinolite on lots 2 and 3, concession VI, Elzevir township, Hastings county. The marble strikes east-west and dips 40°S. A 15-foot quarry face has been developed at the west end of a low ridge. The white marble has some pink and green micaceous streaks.

Petrographic examination of the marble indicates that it is composed of large equant dolomite grains with smooth grain boundaries. There is abundant twinning. Average grain size is 4 to 5 mm. Less than 5 percent of tremolite and other silicates are present.

Physical properties of the marble (No.34) are as follows:

Compressive strength, p.s.i., maximum: 20250;
minimum: 6500;
average: 13458;

Absorption, 0.10 percent;

Bulk specific gravity, 2.86;

Weight per cubic foot, 177.6 pounds;

Abrasive hardness, 19.2.

Chemical analysis of marble No. 34 by Temiskaming Testing Laboratories is as follows: insolubles, 4.26 percent; lime, 29.88 percent; magnesia, 21.18 percent; ignition loss, 44.83 percent.

Actinolite

Hungerford Township

In 1962 and 1963, Vermont Marble Company carried out exploration and diamond drilling on marble properties on the east and west sides of the Moira river in Hungerford township a mile south of Actinolite.

On the Trudeau property on the east side of the river, drilling disclosed a 250 foot width of coarsely crystalline white calcitic marble. The marble strikes N.10°W. and dips 80 degrees east.

Petrographic examination of the calcitic marble on the east side of the river indicates that it is composed of a coarse interlocking mosaic of twinned calcite grains averaging about 5 mm. in diameter. No mineral impurities were noted in the thin section examined and the stone appears to be of high purity.

Physical properties of the marble (No.6) are as follows:

Compressive strength, p.s.i., maximum: 14250;
minimum: 9750;
average: 11291;

Absorption, 0.05 percent;

Bulk specific gravity, 2.74;

Weight per cubic foot, 171.1 pounds;

Abrasive hardness, 25.7.

Hungerford Quarry
Hungerford Township
Concession XIV, Lot 11

The Hungerford quarry located in lot 11, concession XIV, Hungerford township, near the village of Actinolite, was worked in the early 1900's for building stone. Coarsely crystalline white calcitic marble occurs in a band 500 feet wide and striking north-south. There are grey and green bands in places. Jointing is frequent and made it difficult to obtain large blocks.

The church at Actinolite was built of coarsely crystalline calcitic marble over 100 years ago, and it has weathered well.

Frontenac County
Mountain Grove

There is an outcrop of white and buff medium- to coarse-grained highly silicated marble on the east side of the

concession II/III road a mile north of No. 7 highway at Mountain Grove sideroad. A test block is reported to have been taken from a 5-foot face of this marble. The marble strikes N.70°W. and dips 20°S.

Mountain Grove

Olden Township

Concession II, Lot 18

Rideau Aggregates Limited have operated a quarry on the south side of No. 7 highway in lot 18, concession II, Olden township, Frontenac county. A ten-foot quarry face has been opened in a deposit of medium crystalline white dolomitic marble which strikes northeast and dips 20°S.E.

Petrographic examination of the marble indicates that it is composed of a coarse-grained aggregate of interlocking dolomite grains averaging 3 mm. in diameter. There are sparse silicates.

Physical properties of the marble (No.27) are as follows:

Compressive strength, p.s.i., maximum: 18000;
minimum: 14500;
average: 16275;

Absorption, 0.08 percent;

Bulk specific gravity, 2.86;

Weight per cubic foot, 177.6 pounds;

Abrasive hardness, 19.7.

Barrie Township

A band of fine crystalline pink and white dolomitic marble extends across lots 27, 28 and 29, concessions IX and X, Barrie township, Frontenac county. Two small building stone quarries were opened on these lots. The Report of Progress of the Geological Survey of Canada for 1863 (p.823) states that "a fine white marble is found in the township of Barrie, where the Laurentian (Grenville) limestones are said to be extensively developed on the twenty-seventh, twenty-eight and twenty-ninth lots of the ninth and tenth ranges. Blocks of considerable size have been brought from this locality, and show a fineness of grain and a strength equal to the best foreign statuary marbles. Grains and spots of tremolite, and more rarely of quartz, are however disseminated through this marble, and detract from its value. Specimens of an equally fine grained marble from the same locality, have a uniform pink or rose tint, and others are of a dove-grey colour."

Parks (1912, p. 215) describes the quarry as follows: "a quarry was opened on one of the fine grained white belts of marble about 40 years ago and a small quantity was shipped for monumental use..... The opening is of crescentic shape, about 50 feet wide, and exposes a face of 15 feet. Horizontal bedding (sheeting?) divides the face into layers of 4 feet, 2 feet, 1 foot, 2 feet and 3 feet in thickness. The main joints strike S.30°W. and dip 80° to the northwest. A second set of joints

strikes 5°S. of E. The general strike of the formation and the lamination of the marble correspond to the southwest jointing. The extent of the fine grained belt could not be determined, owing to overburden, but there is undoubtedly a very large amount available. I see no reason why very large blocks could not be obtained, in fact there are some pieces already quarried measuring 3 feet by 3 feet by 6 feet."

The Barrie marble is described by Parks (1912, p.315) as follows: "the base of this stone is pure white and finely crystalline, the individuals being about one-fourth of a mm. in diameter. This degree of fineness is not sufficient to give the dull effect of the finest statuary marble, as the stone presents minute glistening facets to the eye. The grain is coarser than in the Calabogie marble. Elongated crystals of tremolite, sometimes more than an inch in length, are scattered throughout the whole mass of the rock. On fresh fracture these crystals are not so disfiguring, but on short exposure they turn brown and seriously detract from the value of the stone. Should further prospecting reveal parts of this band free from tremolite, the township of Barrie would undoubtedly furnish the finest white marble hitherto found in the province."

"As the Barrie marble has so often been referred to in the literature of the subject, all the orginary tests were applied with the results given below:

Specific gravity	2.846
Weight per cubic foot	179.224
Pore space, percent	0.22
Ratio of absorption, percent	0.08
Coefficient of saturation	0.94
Crushing strength, lbs. per square inch	25018.
Transverse strength, lbs. per square inch	1858.

Ompah

Between Ompah and Plevna in Clarendon and Palmerston townships there is a wide band of dolomitic marble. Goudge (1938, p.74) reports that "in 1935 Mr. S.H. Orser of Verona shipped a trial carload of marble blocks to Toronto from a deposit of banded blue Grenville dolomite about 4 miles west of Ompah on the road to Plevna. A sample of the dolomite sent to the Bureau of Mines is medium-grained and is striped with alternate bands of light and dark blue. Visible impurities consist of small crystals of colourless quartz. The dolomite takes a good polish and large blocks are said to be easily obtained from the deposit, but it is 12 miles from Lavant Station on the Kingston and Pembroke branch of the Canadian Pacific railway, the nearest railway shipping point."

Sharbot Lake

Angelstone Limited

Sharbot Lake Quarry

In 1962 and 1963 Angelstone Limited quarried several

hundred tons of white and grey medium crystalline marble on lot 21, concession IV, Oso township, Frontenac county.

One quarry was opened 500 feet west of the farmhouse. White to grey medium crystalline marble strikes N.85°E. and dips 60°S. The quarry measures 30 by 30 feet by 6 feet deep. The marble was quarried by drilling out the blocks.

Petrographic examination of specimens of medium crystalline grey marble indicates that it is composed predominantly of dolomite grains averaging approximately 0.8 mm. in diameter. The carbonate grains show a preferred alignment. Approximately 8 percent silicate minerals are present including quartz, feldspar and mica.

Physical tests of the medium-grained grey marble (No.42) are as follows:

Compressive strength, p.s.i., maximum: 14250;
minimum: 6175;
average: 10210;

Absorption, 0.10 percent;

Bulk specific gravity, 2.84;

Weight per cubic foot, 176.4;

Abrasive hardness, 13.4.

A thousand feet east of the farmhouse a second small quarry was opened on the north side of a 25-foot ridge of marble. The marble strikes N.80°E. and dips 55°S. The marble is grey and white banded. This marble is being marketed under the trade name "Sharbot Wave".

Petrographic examination of specimens of the coarsely crystalline white and grey marble indicates that it is composed of an aggregate of calcite crystals averaging 4 to 6 mm. in diameter. Minor amounts of mica and quartz are present.

Physical properties of this marble (No. 10) are as follows:

Compressive strength, p.s.i., maximum: 9100;
minimum: 7250;
average: 8160;

Absorption, 0.11 percent;

Bulk specific gravity, 2.70;

Weight per cubic foot, 168.6 pounds;

Abrasive hardness, 18.5.

Lanark County

Lanark

A wide band of white and grey Grenville marble strikes northeast and dips steeply to the east through Lanark village, Lanark township. Many of the buildings in Lanark including the town hall are built of local marble which was quarried in the village. Banded white and grey calcitic marble quarried at Lanark is described by Parks (1912, p.331) as follows:

Specific gravity	2.772
Weight per cubic foot, lbs.	169.45
Pore space, percent	0.519
Ratio of absorption, percent	0.18

Coefficient of saturation	0.44
Crushing strength, lbs. per square inch	15343.
Transverse strength, lbs. per square inch	1394.

Tatlock

In 1962 marble exploration was carried out near Tatlock in Darling township by Omega Marble Tile and Terrazzo Limited, Angelstone Limited and Vermont Marble Company. Quarrying was begun by Omega marble and Angelstone Limited.

Darling Township
Concession IV, Lot 3
Guthrie Farm

Vermont Marble Company drilled and sampled the white medium crystalline calcitic marble on lot 3, concession IV, Darling township in 1962. The marble strikes N.10°E. and dips 70°E. A mill block was removed for testing in June 1962.

Angelstone Limited
Tatlock Quarry
Darling Township
Concession IV, Lot 5

In 1963 Angelstone Limited opened a white marble quarry on the Guthrie farm on lot 5, concession IV, Darling township,

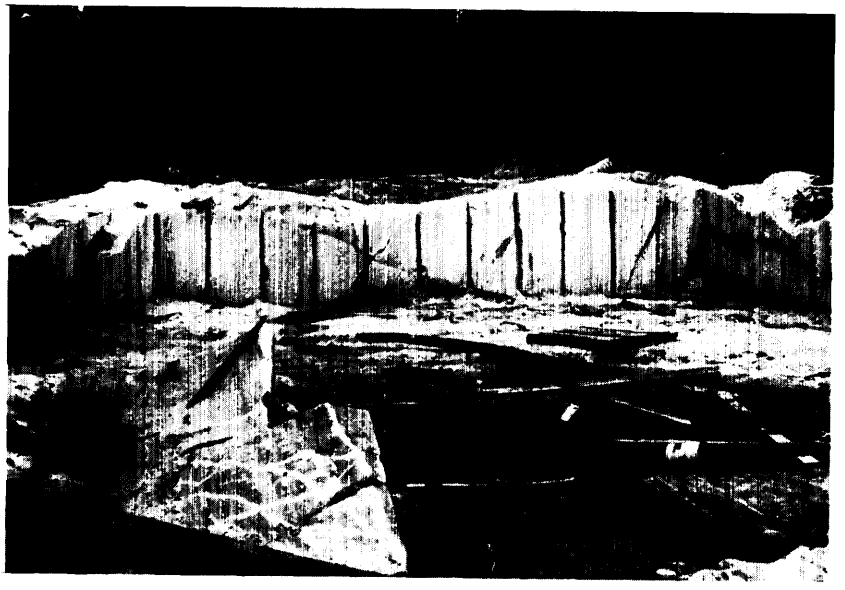
Lanark county. When visited by the author an area of 50 by 130 feet of white medium crystalline marble had been stripped. The marble strikes N.10°W. and dips 50°E. Bedding foliation is not prominent on the outcrop but some silicate bands may be seen. Relief is about 15 feet. Vertical jointing was observed striking east-west. Quarrying is carried out by drills mounted on a quarry bar. The opening in June 1963 measured 18 by 15 feet by 6 feet deep.

Chemical analysis of the white marble (No.4) is as follows:

	Percent
Insoluble silica and silicates	11.33
Calcium oxide (CaO)	48.33
Magnesium oxide (MgO)	0.98
Carbon dioxide (CO_2)	39.00
Total	99.64

The insolubles include 7.22 percent silica (SiO_2); 0.01 percent ferric oxide (Fe_2O_3); and 3.56 percent alumina (Al_2O_3).

Petrographic examination indicates that the marble is composed predominantly of calcite in coarse irregular grains up to 6 mm. in diameter. Average grain size is 1.0 mm. The silicate minerals are principally quartz and tremolite which occur in random distribution through the section examined. Modal analysis indicates the following mineral composition for the marble: calcite, 89; tremolite 7; and quartz, 4 percent.



Sharbot Lake quarry of Angelstone Limited

Tatlock quarry of Angelstone Limited

Physical properties of this marble (No.4) are as follows:

Compressive strength, p.s.i., maximum: 10375;

minimum: 7475;

average: 10225;

Absorption, 0.15 percent;

Bulk specific gravity, 2.71;

Weight per cubic foot, 169.2 pounds;

Abrasive hardness, 24.6.

In November 1963 a second quarry was opened 1,000 feet southerly along the strike, right beside the Tatlock Road. Diamond-drilling at this location indicated that the bed had thickened to about 300 feet and was relatively free from heads and joints at least to a depth of 250 feet. The top seven foot layer was removed by blasting and systematic quarrying of sound blocks was commenced below this level. The company intends to concentrate future operations in this location, and the product is currently marketed under the trade name "Temple White".

Omega Marble Tile and Terrazzo Limited
Tatlock Quarry
Darling Township
Concession V, Lot 6, Southwest Half

A marble quarry was opened in the summer of 1962 north of the Tatlock road on the southwest half of lot 6, concession V, Darling township, Lanark county, by Omega Marble Tile and Terrazzo Limited. The quarry is approximately 13 miles north

of Lanark village and a mile east of Highway 511 which connects Perth and Calabogie.

Medium to coarsely crystalline banded silicated calcitic marble is exposed on a 35-foot ridge north of the road, over a strike length of 900 feet. Bedding foliation in the marble is pronounced and strikes N.30°W. with a dip of 60 - 70°E. The marble is exposed across strike for a width of 250 feet. The marble band is flanked on the northeast by amphibolite and metagabbro and on the southwest by amphibolite (hornblende gneiss). The strong bedding foliation of the marble is accentuated by layers of tremolite and diopside which stand up on weathered surfaces. Overburden on the hill is thin. White is the predominant colour of the marble on the property, but a band of azure blue marble is also quarried. Pink and fawn marble is available at the northwest end of the hill.

The initial quarry opening is located on the west side of the 35-foot hill. The face has been advanced to the northeast parallel to the direction of the bedding. Blocks of marble up to 35 feet in length are quarried by wire saw. Two wire saws, one 2,200 feet in length, and one 2,800 feet in length, are employed. Carborundum is used as the cutting abrasive and is fed to the wire at the cutting surface in the form of a slurry. Marble blocks quarried are 10 to 15 tons in weight.

In 1963 a second quarry face was opened at the northwest end of the ridge. At this quarry white, pink, green and brecciated marble have been quarried. Production of up to 150

tons of marble per week has been reported in 1963.

A chemical analysis of the white marble is as follows:

	Percent
Insoluble silica and silicates	8.93
Fe_2O_3	0.02
Al_2O_3	0.08
CaO	50.77
MgO	0.11
CO_2	39.2

Calcium carbonate content of this calcitic marble is 90.5 percent.

The "Rideau White" Omega Marble examined has the following modal analysis: calcite, 93.4; quartz, 3; diopside, 2.4; and tremolite, 1.2 percent. The silicates are fine-grained and white in colour and appear in streaks paralleling the bedding of the marble. Grain boundaries are irregular: average grain size is 1 to 1.5 mm. with a range from 0.2 to 3 mm. There are approximately 85 grains per square centimetre of marble in samples examined. Some variation in the percentage of silicate minerals was observed in different parts of the marble and silicates appear to range from 5 to 15 percent. Pyrite crystals were present in one place in the quarry.

Physical properties of the "Rideau White" marble are as follows:

Bulk specific gravity 2.73;

Weight per cubic foot 170.4 pounds;

Absorption 0.130 percent;

Apparent porosity 0.355 percent;

Tatlock quarry of Omega Marble Tile and Terrazzo Limited showing mill blocks cut by wire saw.

Tatlock quarry of Omega Marble Tile and Terrazzo Limited showing face cut by wire saw.

Compressive strength, p.s.i.,

normal to bedding: 11050;

parallel to bedding: 10100;

Abrasive hardness, 26.5;

Average light reflectivity, 67.63 percent.

Physical properties of pink marble (No.86) from the Omega quarry are as follows:

Compressive strength, p.s.i., maximum: 11100;

minimum: 9750;

average: 10775;

Absorption, 0.16 percent;

Bulk specific gravity, 2.71;

Weight per cubic foot, 169.2 pounds;

Abrasive hardness, 25.3.

Physical properties of Rideau blue marble (No.49) from the Omega quarry are as follows:

Compressive strength, p.s.i., maximum: 10600;

minimum: 6100;

average: 7843;

Absorption, 0.129 percent;

Bulk specific gravity, 2.72;

Weight per cubic foot, 169.8 pounds;

Abrasive hardness, 19.1.

Marble Bluff

Angelstone Limited

North Lanark Quarry

A small quarry was opened in the early 1900's by the North Lanark Granite and Marble Quarries Limited on the east side of the road in lot 7, concession IV, Darling township, Lanark county. The quarry cut measures 30 by 80 feet and is 12 to 15 feet deep. The stone is a white and green to white and buff medium crystalline serpentine marble. Banding is irregular. Parks (1912, p.336) has described the quarry during its period of operation. He states that "the main mass of marble extends across both lots (Lots 7, Concession III and IV) for a distance of about one-third of a mile with an average width of 500 feet. This belt strikes about 70°E. of N. and is flanked on the north side by a grey granite, while to the south succeeds a band of common whitish coarse crystalline limestone of variable width, followed by black hornblendic schists..... The valuable material is a true serpentine marble consisting of a medium-grained white or lavender coloured calcite marked by cloudings of green or buff serpentine. Although different types are recognized, there does not seem to be any distinct banding or arrangement of the various kinds, which appear to fade into one another."

Parks (1912, p.337) gives the following physical specifications for a specimen of the serpentine marble:

	Percent
Specific gravity	2.662
Weight per cubic foot, lbs.	164.38

Pore space, percent	1.06
Ratio of absorption, percent	0.406
Coefficient of saturation	0.51
Crushing strength, lbs. per square inch	16068.
Transverse strength, lbs. per square inch	1091.

Parks states that "the surface of the deposit where no work has been done shows a discouraging amount of irregular fracturing, but at a very limited depth this disappears and a comparatively strong series of joints parallel to the strike of the deposit is encountered."

In 1962 Angelstone Limited purchased this property.

During 1962-63 a few blocks of this serpentine marble were quarried for sampling and testing. The product is marketed under the trade name "Lanark Green" and future quarrying will be carried out as market requirements dictate.

Renfrew County

Arnprior

Building stone was quarried at Arnprior from blue-grey Grenville marble east of the town. Parks (1912, p.333) describes the quarry as follows: "this quarry was opened many years ago in the side of a ravine east of Arnprior. The limestone beds strike northeast and dip southeast at an angle of 30°. Parallel to this direction the stone is banded in white and greenish-grey layers. In places the banding is

irregular so as to constitute clouds rather than bands, in others the grey material is in excess so that it forms the base rather than the white part."

The marble was used in the Parliament Buildings at Ottawa. Parks (1912, p.333) gives the following specifications:

Specific gravity	2.741
Weight per cubic foot, lbs.	170.634
Pore space, percent	0.252
Ratio of absorption, percent	0.092
Coefficient of saturation	0.76
Crushing strength, lbs. per square inch	15100.
Transverse strength, lbs. per square inch	1677.

Renfrew

White to grey coarse crystalline Grenville marble has been quarried at Renfrew for building stone; the Renfrew post office and Roman Catholic church are built of Renfrew stone.

Horton Township

Concession III, Lot 13

Jamieson Quarry

The Jamieson quarries are described by Satterly (1945, p.104): "crystalline limestone, which forms a ridge in the northern part of lot 13, concession III, Horton township, has been opened up by four quarries, which are 2 miles by road

from Renfrew. The lot is owned by J.A. Jamieson, and one quarry is operated from time to time for foundation stone, monumental stone, and sills.... These quarries were first opened in 1922, and the stone was burnt for the making of lime for only one year, operations being transferred to the quarry in lot 5, concession II, Horton township."

"On the south side of the hill adjacent to a farm road an abandoned quarry, 150 by 60 feet with a 30-foot face, exposes blue-grey crystalline limestone containing grains of dolomite, flakes of phlogopite, scales of graphite, and silicate minerals. Material rich in the latter was discarded during operations, as indicated by piles of stone in the quarry. Immediately to the east of this quarry and near the top of the hill is a small abandoned quarry 75 by 50 feet with a 10-foot face. Some of this rock was quarried for building stone."

"A third quarry on top of the ridge faces north. It is irregular in shape, approximately 300 by 100 feet and from 4 to 6 feet deep. This quarry is operated for building stone when there is any local demand. The rock exposed is a blue-grey crystalline limestone striking east and dipping 40°N. Most of the rock shows no bedding planes and contains only a very minor amount of phlogopite and graphite. At the north edge of the quarry near one grey bed, a band rich in silicate minerals occurs parallel to the bedding. The minerals are green pyroxene, pale grey tremolite, amber vesuvianite and pyrrhotite. Grains of dolomite in the stone are sufficiently numerous to give the deposit almost the composition of magnesian limestone."

"The fourth quarry which has been abandoned for some time, lies just northwest of the third and nearer the road. It is about 500 by 100 feet in dimensions with a 10-foot face to the north."

A chemical analysis of the stone is given by Goudge (1938, p.178):

SiO_2	1.42
Fe_2O_3	0.43
Al_2O_3	0.25
$Ca_3(PO_4)_2$	0.09
$CaCO_3$	88.73
$MgCO_3$	8.82
Total	99.74

Three marble quarries which are now abandoned are described by Parks (1912, p.328). One was located 2 miles west of town, one behind the Catholic church in town and one on lot 9, concession II of Horton township. Physical specifications for the Renfrew marble are given by Parks (1912, p.329) as follows:

Specific gravity	2.758
Weight per cubic foot, lbs.	171.85
Pore space, percent	.016
Ratio of absorption, percent	.0057
Coefficient of saturation	0.58
Crushing strength, lbs. per square inch	14562.
Transverse strength, lbs. per square inch	2090.

Horton Township

Concession II, Lot 5

Jamieson Lime Company for many years operated a lime plant and quarry about 2 miles south of town on lot 5, concession II, Horton township. The stone is coarsely crystalline grey to white Grenville calcitic marble which strikes N.E. and dips 30°S.E.

Haley

Three small marble quarries have been operated for marble building stone east of Haley Station in Ross township.

Ross Township

Concession V, Lot 20

Gould Quarry

The Gould quarry on lot 20, concession V, Ross township is just west of the quarry of Dominion Magnesium Limited. The stone is a pure white coarsely crystalline dolomitic marble striking N.10°E. and dipping 50°E. An analysis of the stone is given by Goudge (1938, p.178):

	Percent
SiO_2	0.20
Fe_2O_3	0.10
Al_2O_3	trace

$Ca_3(PO_4)_2$	0.04
$CaCO_3$	55.82
$MgCO_3$	44.00
Total	100.16

The pure dolomite is flanked by siliceous dolomite.

Dominion Magnesium Limited

Ross Township

Concession V, Lot 20

A large quarry is operated on the east half of lot 20, concession V, Ross township by Dominion Magnesium Limited for the production of magnesium metal from the dolomitic marble. The high purity coarse-grained dolomitic marble has an indicated width of 250 feet and has been traced for 3,500 feet. The main quarry is 50 feet deep. The marble strikes north-south and dips 60°E. Although most of the marble is white, there are patches of grey, buff and reddish marble. Some marble blocks were taken from this quarry for statuary by E.B. Cox.

Several hundred feet to the northeast of the main quarry a second quarry has been opened which measures 35 by 300 feet and is 25 feet deep. Some of this dolomitic marble was quarried by Canadian Dolomite Company.

Physical properties of a specimen of marble (No.48) taken from the main quarry by the writer are as follows:

Compressive strength, p.s.i., maximum: 23400;
minimum: 20250;
average: 21500;

Absorption, 0.04 percent;

Bulk specific gravity, 2.87;

Weight per cubic foot, 178.4 pounds;

Abrasive hardness, 17.6.

A chemical analysis of dolomitic marble from the Dominion Magnesium quarry was supplied by the company and is as follows:

	Percent
CaO	30.8
MgO	20.6
L.O.I.	47.0
Insoluble (SiO_2)	0.17
R_2O_3 (Fe_2O_3 + Al_2O_3)	0.12

Ross Township
Concession VI, Lot 19, East Half
McGinn Quarry

The McGinn quarry located on the E½ of lot 19, concession VI, Ross township was worked for marble from 1901 to 1907. The stone is a pure white coarsely crystalline dolomitic marble which strikes north-south and dips 50°E. The pure marble band is 250 feet wide and is flanked by impure siliceous dolomite with

amphibolite interbeds. There is some tremolite in the marble. The quarry which measures 40 by 80 feet and 5 to 10 feet deep is partially filled with water. An analysis of the dolomite is given by Goudge (1938, p.178).

SiO_2	0.36
Fe_2O_3	0.29
Al_2O_3	0.27
$Ca(PO_4)_2$	0.04
$CaCO_3$	55.40
$MgCO_3$	43.90
Total	100.26

One set of joints parallel the strike and dip while a vertical set strike N.75°W. Parks (1912, p.313) describes the marble as follows: "this stone must be regarded as the best example of the white coarsely crystalline limestones. The crystals average one-fourth of an inch in diameter and in consequence the polished surface presents a sheen due to the different ways the crystals are cut. Although this stone would be called white, it nevertheless possesses a slight creamy shade. The stone is dolomitic in composition..... In the best parts of the quarry no impurities are present except an occasional grain of chondrodite. The product of these quarries must be regarded as an extremely desirable material.

Specific gravity	2.878
Weight per cubic foot, lbs.	179.347

Pore space, percent	0.149
Ratio of absorption, percent	0.052
Coefficient of saturation	0.9
Crushing strength, lbs. per square inch	22595.
Transverse strength, lbs. per square inch	1745.

This stone may be seen in the Munroe block at Pembroke, a school in Sault Ste. Marie and in the Roman Catholic church at Douglas.

Physical properties of a specimen of this marble (No.38) taken by the writer in 1963 were as follows:

Compressive strength, p.s.i., maximum: 21750;
minimum: 19125;
average: 20500;

Absorption, 0.06 percent;

Bulk specific gravity, 2.86;

Weight per cubic foot, 177.6 pounds;

Abrasive hardness, 19.6

Ross Township

Concession VI, Lot 20, West Half

Cook Quarry

Parks (1912, p.315) reports marble at this property but little work had been done.

Canadian Dolomite Company

Ross Township

Concession VI, Lot 24

A small quarry has been opened on Smith's farm on lot 24, concession VI, Ross township by Canadian Dolomite Company for the production of marble chips. The stone is a white coarsely crystalline dolomitic marble with very few impurities. The pit measures 30 by 20 feet with an 8-foot face.

Calabogie

Grey and white fine crystalline Grenville marble is described by Parks (1912, pp.326-7) on lots 17 to 19, concession III, Blithfield township, near Calabogie.

Stormont County

Silvertone Black Marble Quarries Limited

The marble quarry operated by Silvertone Black Marble Quarries Limited is located one-quarter mile southwest of St. Albert station, on lots 8 and 9, concession XII, Finch township, Stormont County. The quarry was operated from 1931 to 1957 to produce marble mill blocks and terrazzo chips.

There is very little overburden on the low limestone ridge on which the quarry is located. The formation quarried is flat-lying, thick-bedded, aphanitic to fine-grained

crystalline black limestone of the Black River (Ottawa) formation. Much of the Black River limestone of the Ottawa-St. Lawrence lowland is black in colour. Since the stone is not recrystallized, geologically it is classified as a high calcium limestone. In the building stone trade the stone is classified as a marble because it takes an excellent polish. Flecks of coarsely crystalline grey calcite present in the fine crystalline black limestone impart a silvery sheen to the marble giving it the trade name "Silvertone Black." While most of the beds are black in colour, some of the beds are brownish-black, and careful selection of blocks is necessary to maintain the colour. There are occasional thin black argillaceous partings. Beds range from 12 inches to 39 inches in thickness with 18 inches being average. Major jointing systems run east-west (N.92°E.) and north-south, but joints are not closely enough spaced to affect quarrying of large blocks.

In 1950 when examined by the writer the quarry area measured 135 by 110 feet, with a depth of 34 feet. From 2 to 3 feet of thin-bedded limestone was stripped from the surface. Beneath this, eighteen quarriable beds of limestone were worked: bed thicknesses numbering from the surface downward were as follows:

Silvertone Black Marble Quarry.

Surface stripping, thin-bedded limestone, 2.6-3 feet.

	Feet	
Bed 1	1.3	
Bed 2	1.3	
Bed 3	1.0	
Bed 4	1.7	
Bed 5	1.2	
Bed 6	2.6	
Bed 7	1.8	
Bed 8	2.0	
Bed 9	2.3	
Bed 10	1.4	
Bed 11	3.3	(splits in 2 measuring 2 and 1.3 ft.)
Bed 12	1.7	
Bed 13	1.4	
Bed 14	0.8	
Bed 15	0.8	
Bed 16	1.1	
Bed 17	1.4	
Bed 18	1.4	
Total Thickness	31.1 feet quarriable stone	

The stone was quarried by close drilling and broaching. Blocks averaged three to six tons, and were limited in thickness by bed thicknesses.

	Percent
SiO_2	1.32
Fe_2O_3	0.54
Al_2O_3	0.82
$Ca_3(PO_4)_2$	0.04
$CaCO_3$	95.82
$MgCO_3$	1.09
Total	99.63
S	0.06
CaO	53.81
MgO	0.52

Crushing strength of the marble is 17,000 pounds per square inch normal to the bedding and 20,000 pounds per square inch parallel to the bedding (Goudge 1938, p.193).

Goudge (1938, p.193) states that "among the principal buildings in which Silvertone Black marble has been used for interior decorative purposes are the following: British Empire building, Rockefeller Centre, New York; Postal Terminal building and Notre Dame de Grace post office, Montreal; Ottawa Hydro Electric building, Postal Terminal building and the Justice building, Ottawa; Toronto Hydro Electric building and the T. Eaton Company store, Toronto; and in new Federal buildings in Hamilton, Guelph, Fort William, Winnipeg and Vancouver."

Physical properties of the marble (No.7) are as follows:

Compressive strength, p.s.i., maximum: 19250;
minimum: 10625;
average: 15250;

Absorption, 0.17 percent;

Bulk specific gravity, 2.70;

Weight per cubic foot, 168.6 pounds;

Abrasive hardness, 35.1.

Nipigon Area

A marble quarry was opened on the east shore at the mouth of the Nipigon River in limestone of the Sibley series. Tanton (1931, p.199) describes the locality as follows: "the limestone there is thinly interlaminated with red, purple and green shaly material. In a zone, about 20 feet wide, adjacent to a wide diabase dike, the rock has been slightly recrystallized and indurated. Prior to 1919 an ornamental building stone, known as Nipigon marble, was produced from a quarry on the east shore.

Cooke Point, Lake Nipigon

J.W. Lawrence opened a marble quarry on Cooke point, on the south shore of Lake Nipigon west of the Virgin Islands. The occurrence is described as follows by E.G. Pye[1]: "The Sibley

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1 Resident Geologist, Ontario Department of Mines, Port Arthur, Ontario.

sediments are exposed at the base of a diabase sheet for about a mile along the lakeshore and rise as much as 20 feet above lake level. They are gently folded, thin-bedded dolomitic limestones, either white or pale green in colour. In 1931 they were investigated by the late J.W. Lawrence as a source of building and ornamental stone. Several samples were forwarded to Nicholson Cut Stone Limited of Leaside, Ontario and according to Lawrence, were found to be acceptable as regards colour, texture and weathering properties. In 1948 an analysis was made of the dolomite indicating a silica content in excess of 20 percent:

	Percent
SiO_2	20.78
Al_2O_3	3.22
CaO	37.12
MgO	10.80
Fe	1.06
P	0.03
Mn	0.05
S	0.05
L.O.I.	22.83
Total	95.94

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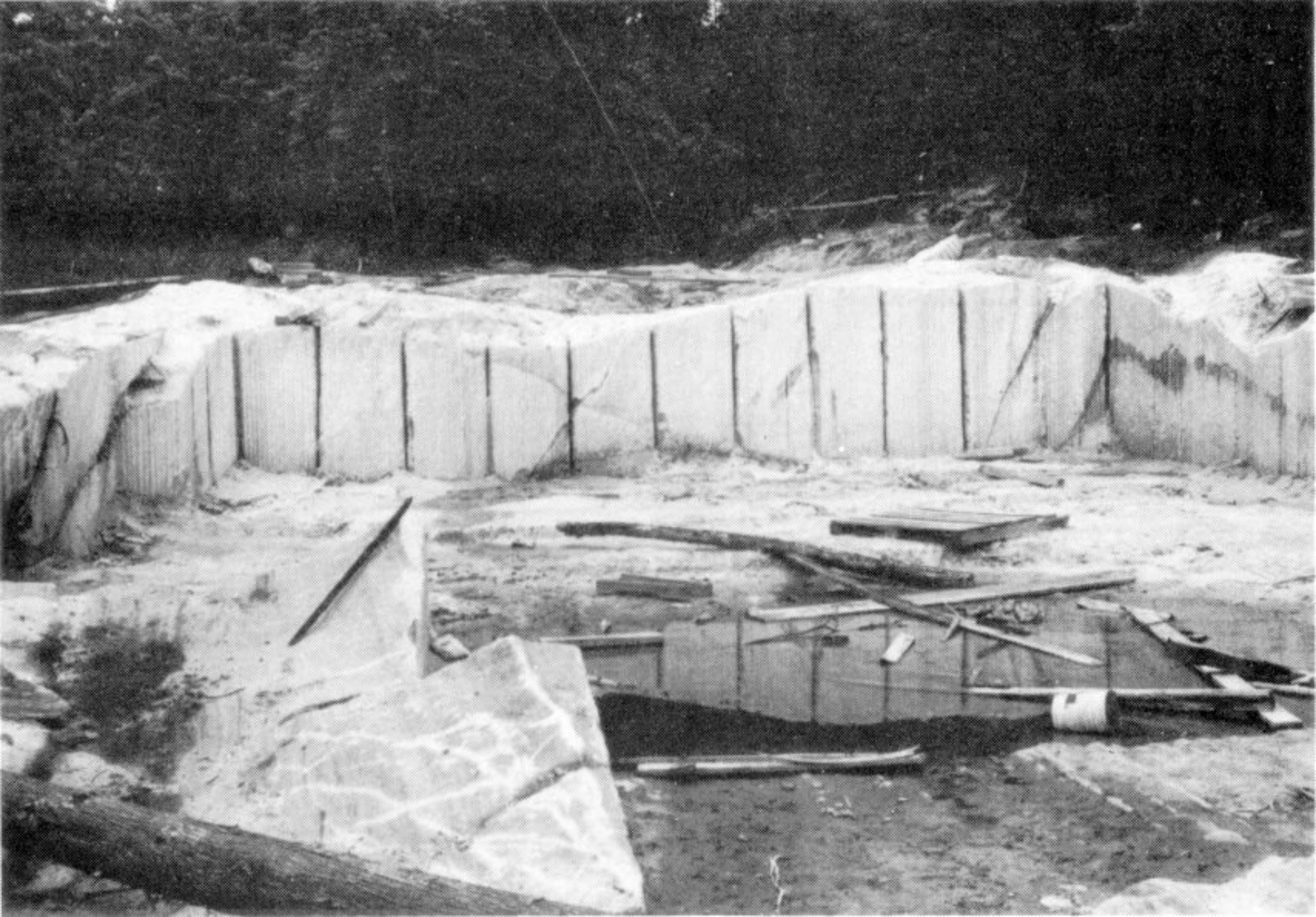

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