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INDUSTRIAL POTENTIAL OF THE SILVER MOUNTAIN MARBLE DEPOSIT, WESTERN NEWFOUNDLAND

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ABSTRACT

The Silver Mountain marble deposit is the largest documented carbonate deposit in the Long Range Precambrian inlier. It consists mainly of white, light blue-grey, cream, and grey-brown-green (colour-banded) marble. Some grey quartz-rich and graphitic zones are also present. Nearly all of the marble is coarsely crystalline consisting commonly of equigranular (2 to 4 mm) calcite. The main impurities are quartz, pyrite, epidote and chlorite. Geochemical analyses of representative chip samples from the white marble showed that dolomitic beds are also present. Reflectance tests for brightness and whiteness gave values in the low to mid ninety percent range. Both the chemical and physical tests showed that in order to meet specifications for premium quality filler, beneficiation would have to be carried out on the marble.

The marble, without processing, may be suitable for a number of industrial uses including some filler applications and as a source of dimension stone. It could also be a source of chips for terrazzo tiles and landscaping.

INTRODUCTION

The Silver Mountain marble is the largest carbonate deposit yet documented in the Long Range Grenville inlier. Although known since 1983, the deposit has received only cursory commercial assessment. The focus on Newfoundland's lower Paleozoic platformal marble deposits, as potential sources of industrial filler and building stone, and the comparative difficulty in accessing the Upper Humber region, might explain the lack of assessment follow-up, on marble showings in the in the Long Range inlier.

The purpose of this paper is to discuss the industrial potential of the Silver Mountain marble in the light of marked improvement in access to the deposit, and the current high level of interest in Newfoundland marble for industrial applications such as filler, building stone and other uses.

LOCATION, ACCESS AND LAND STATUS

The Silver Mountain marble deposit is located along the north bank of the Upper Humber River about 12 km west of the Sops Arm Highway (Figure 1; Plate 1). Excellent access from the highway to the deposit is provided by 12 km of upgraded gravel road (Plate 2). The coastal communities of Hampden and Sops Arm are a farther 18 km and 20 km respectively via paved routes 420 and 421. Both communities are located on good harbours that are capable of accommodating large ships although adequate port facilities are presently lacking. From December to June, shipping is restricted by frozen harbours and bays and heavy arctic drift ice. Ice-breaking capabilities of the Federal Department of Transport can prolong shipping activities along the coast.

The Silver Mountain deposit marble is presently partly encompassed by a Quarry Exploration Licence for dimension stone, held by M. Verbiski of St. John's, Newfoundland.

GEOLOGICAL SETTING

The study area is located west of White Bay on the southeast side of the Long Range Grenville inlier. This part of the inlier (a strip between Taylor's Brook and Western Brook Pond) was mapped by Erdmer (1984) prior to his 1:100 000-scale mapping of the Precambrian terrane of the Long Range Mountains (Erdmer, 1985). The dominant rocks of the area consist of an Helikian or older basement gneiss complex, part of which is metasedimentary, intruded by gabbro–anorthosite and granitic rocks. The marble of this report comprises a 4.5-km-lens-shaped sliver, interlayered with gneiss, and flanking a large gabbro body (Taylor's Brook gabbro complex of Erdmer, 1985) on its southwestern margin.

PREVIOUS WORK

The Silver Mountain marble deposit (named after a prominent hill near the deposit) was discovered by Doug Reusch in March, 1983. He carried out preliminary geological mapping and laboratory work on the marble, and established a single claim on a zone that he considered easily accessible and well located for quarrying (Reusch, 1985). He also extracted a sample of white marble, which was ground and sieved to various size fractions (coarse gravel, sand, fine sand). Samples of white and light blue-grey marble were pulverized to fine powders, and additional samples of white, blue-grey, and cream samples were slabbed and polished. He concluded from his results that the white marble chips were

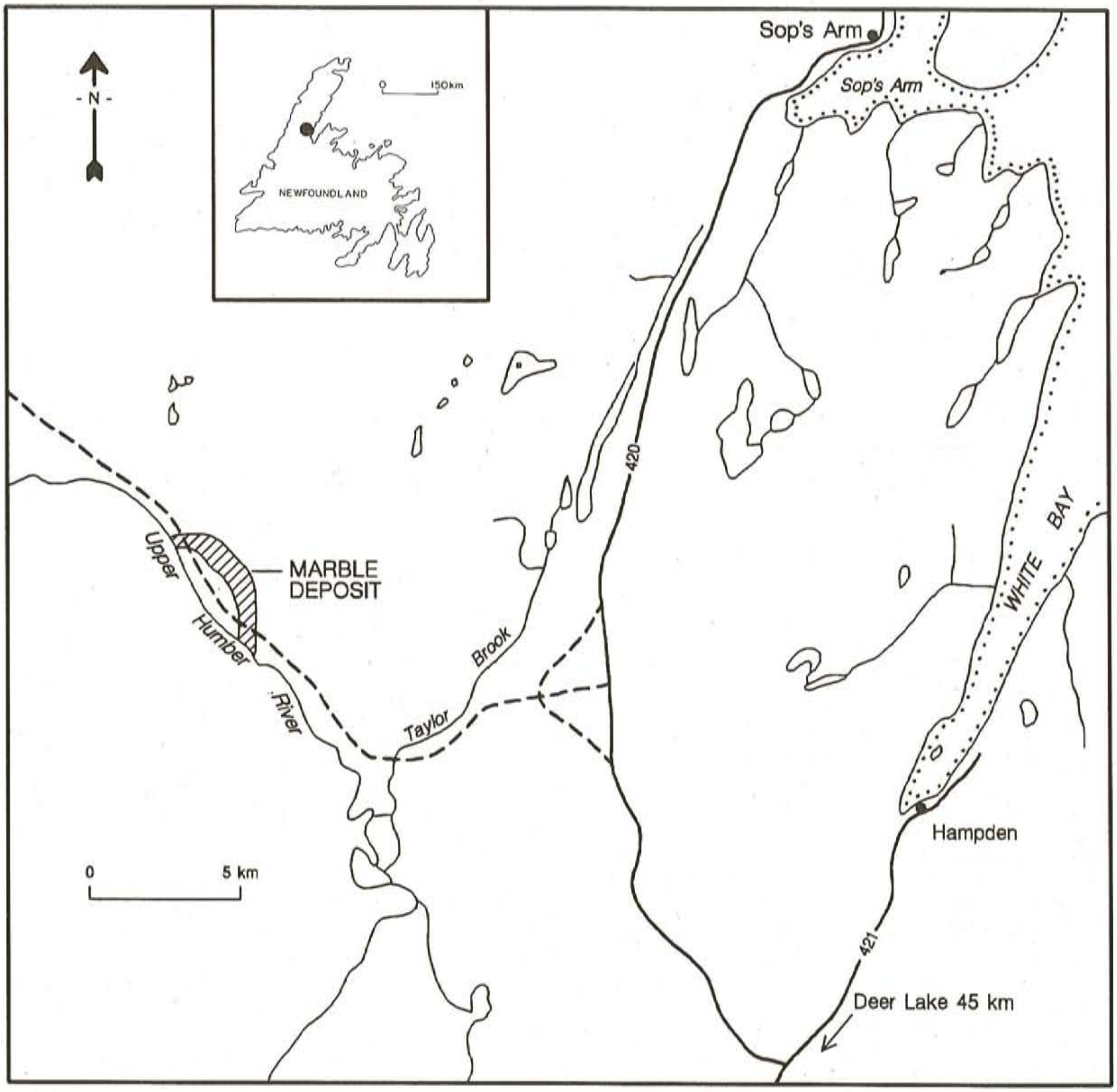

Figure 1. *Location of the Silver Mountain marble deposit showing main access road (dashed line), paved highways (routes 420 and 421) and potential shipping ports.*

superior in quality to those used locally in construction, and he believed that the calcitic sand is equivalent or superior in quality to similar imported material. The results from the polished slabs were also very promising in that all three colours had an attractive appearance when polished.

Erdmer (1984) briefly described the marble and identified the deposit as part of a unit of marble and calc-silicate rocks exposed in two slices within and at the margins of a body of gabbro–anorthosite. He described the marble as intelayered with basement gneiss and intruded by gabbro along the gneiss contact.

In 1985, the Silver Mountain deposit was briefly examined and sampled during a Newfoundland Department of Mines marble survey (Howse, 1986). Representative chip samples were collected from a cliff exposure of grey and white marble at the north end of the deposit for physical and chemical analyses. The main objective was to determine the suitability of the marble for industrial filler. The results were promising, but based on the overall results from the survey, priority follow-up was given to those deposits of the lower Paleozoic carbonate platform of northern Newfoundland (Howse, 1987).

PRESENT ASSESSMENT

The present work is aimed at acquiring more chemical and physical information on the Silver Mountain marble, and refocusing attention on its industrial potential. The field program extended the mapping to the northwest part of the deposit and included chip sampling of sections that are

Plate 1. *Typical topography looking in a northwesterly direction along the valley of the Upper Humber River.*

Plate 2. *Upgraded gravel road, which branches westward from paved route 420, has greatly improved access to the Upper Humber River region.*

exposed in roadcuts and outcrops (Figure 2). A total of 42 samples were collected for chemical analyses and these have been sent to the Newfoundland Department of Mines and Energy Geochemical Laboratory. Selected samples will be tested for brightness and whiteness. Some larger representative samples for cutting and polishing were also collected.

DESCRIPTION OF THE MARBLE

The deposit consists of a lens-shaped body of about 4.5 km long and 800 km wide at its maximum width. The marble is visible in outcrops along the river bank, in numerous exposures on the well-drained southeast-facing hills, and in roadcuts. The only significant overburden thickness is found on the lower flanks of the hills and near the river bank. The higher ground appears to have little glacial cover but like the rest of the property is well forested with spruce, fir and less commonly birch.

The marble is composed of mainly coarse-grained (2 to 4 mm), equigranular calcite. In its purest form, the stone is brilliantly white, examples of which can be seen in outcrops, float, and roadcuts, particularly at the north end of the deposit (Plates 3 to 5). Light blue-grey, and cream-coloured bands are also present. The yellowish cream colour may reflect a more dolomitic composition (and (or) the presence of trace amounts of iron?), and the blue-grey tints are likely caused by minute amounts of graphite.

A distinctive unit of thin-banded marble is widely exposed and is especially evident along the network of older woods roads that cover the interior of the deposit (Plate 6). The bands are defined by different shades of grey, brown, and pale-green. They may range in thickness from less than a centimetre to several centimetres and in some cases they grade into a more irregular, cloudy pattern dominated by very dark shades probably due to increased graphite content.

Impurities include minute (<1mm) widely scattered pyrite crystals, and minor amounts of quartz. Trace amounts of an epidote group mineral and chlorite may also be present. Erdmer (1984) reported that in at least two outcrops near the contact with the gabbro, the marble grades into a brown and green (diopside-bearing?) fine-grained rock a few metres thick.

The texture of the marble varies from massive, as in the lighter coloured stone, to gneissic as in the banded material. The gneissic fabric dips steeply, sometimes changing dip direction over a short distance. It has a northwest strike paralleling the general trend of the deposit. The main fabric is locally folded in outcrops by irregular asymmetric folds. Erdmer (1984) inferred banding in the marble to be transposed original bedding. Except where disturbed by blasting due to road construction, the marble is not notably fractured or sheared and joints are commonly widely spaced.

The Silver Mountain marble is in contact with black garnetiferous metaquartzite, quartzofeldspathic gneiss and gabbro. The marble is considered to be interlayered with the gneiss and intruded by gabbro, the main body of which flanks the east side of the deposit. The marble is also cut by diabase dykes, part of the ubiquitous swarm found throughout the Long Range inlier. In at least three outcrops near its southwestern margin the marble is in contact with a conglomeratic rock consisting of subangular dark fragments varying from pebble size to cobble size, in a carbonate matrix. Reusch (1985) noted that the marble locally grades into metaquartzite via a transitional zone containing psammitic boudins and Erdmer (1984) observed that near the contact with the gabbro the marble grades into a brown and green (diopside-bearing?) fine-grained rock several metres thick.

Unlike the generally fine-grained, white marble deposits that have been identified in Newfoundland's lower Paleozoic platformal sequences, the Silver Mountain marble is coarse grained in texture. Reusch (1985) correlated the marble in a general way with the crystalline Grenville marbles of Ontario and New York.

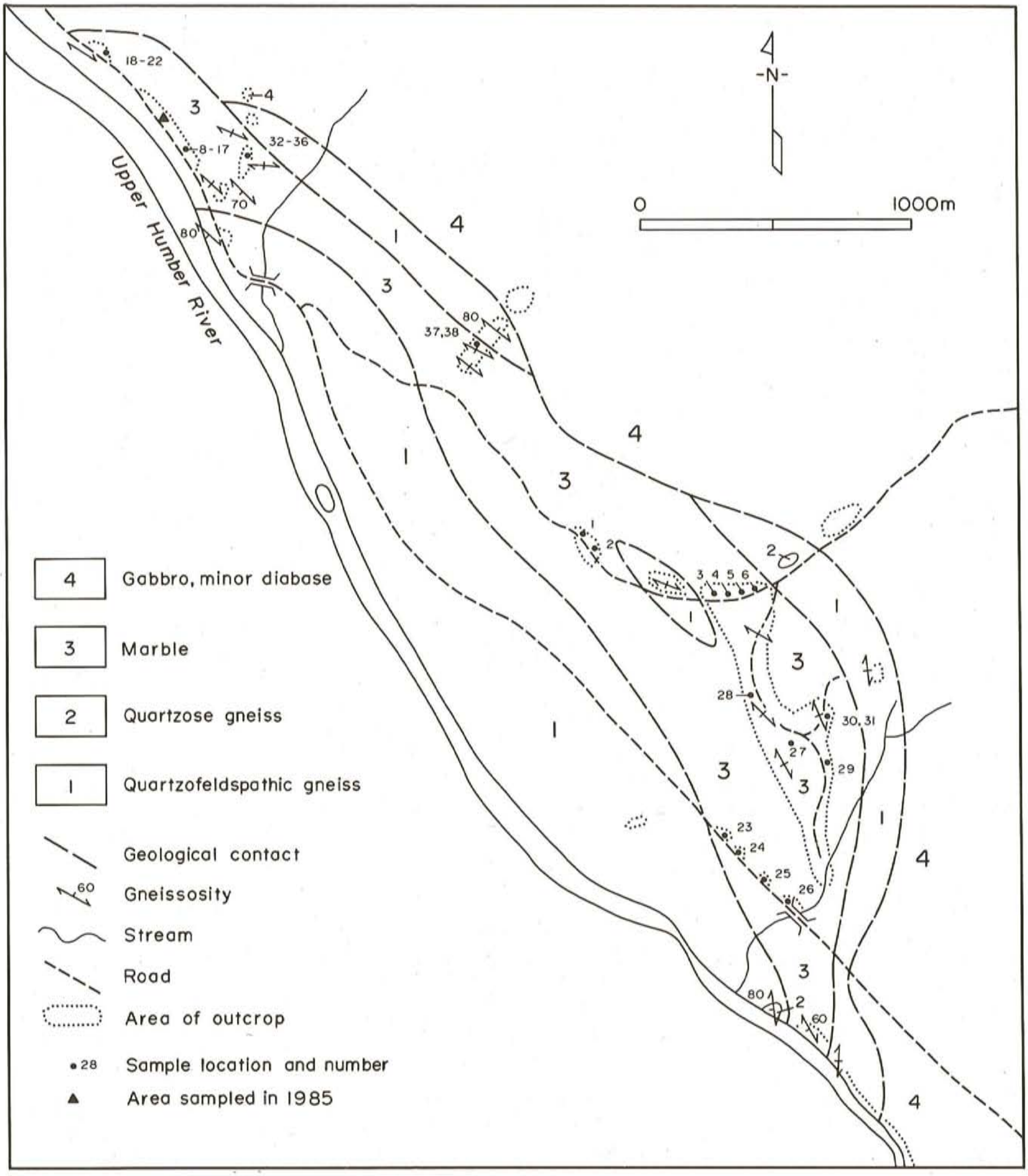

Figure 2. *Geology of the Silver Mountain marble deposit; data by Reusch (1985) and Howse (1993).*

POTENTIAL INDUSTRIAL USES

FILLERS

Finely ground and pulverized calcium carbonate is used as a filler in various products. Generally, its source is limestone, chalk, marble, and less commonly vein calcite. In industrialized countries, the ground and pulverized form may outrank dimension stone as much as 40 times by tonnage, and twice by value (Harben and Bates, 1990). Deposits of white marble, though scarce, are the most common sources of carbonate mineral fillers.

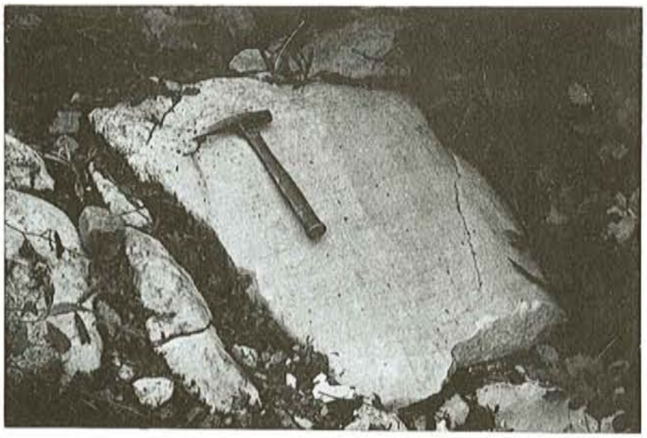

Plate 3. *Coarsely crystalline, white marble of the Silver Mountain deposit.*

Plate 4. *Typical exposed area of marble near the centre of the deposit.*

Plate 5. *Marble exposed in roadcut located in the northwest area of the Silver Mountain marble deposit.*

The original purpose of a filler was to replace a more expensive commodity, such as titanium dioxide in paint, or polymer in plastics or rubber. Now its role has expanded into

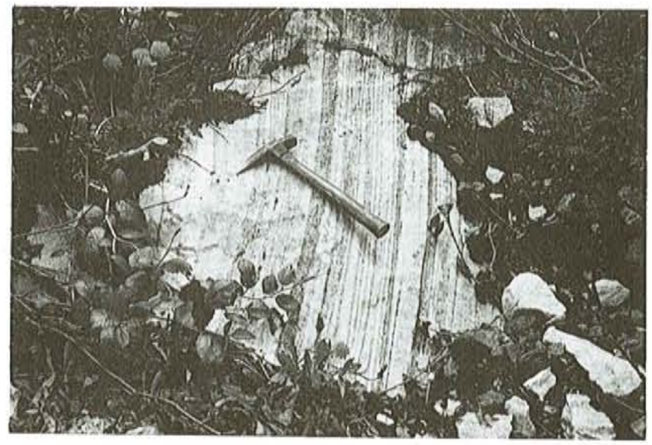

Plate 6. *Attractive multi-coloured banded marble.*

more functional aspects such as adding colour, stiffness, opacity or other desirable attributes to a product. The expanded role of fillers has escalated prices so that they are no longer considered cheap materials. Calcium carbonate competes with numerous other industrial minerals as a filler, including kaolin, talc, mica, wollastonite, and nepheline syenite.

The most significant features of carbonate fillers that determine their suitability for industrial applications are particle size, brightness (whiteness), and mineralogical and chemical purity.

Products such as paper, paints and plastics require very bright fillers. Depending on the method used to measure light reflectance, minimum brightness specifications may range from 94 to 96 percent. Other products such as asphalt roofing and sealers, carpet backing, jointing compounds and some plastics, are less demanding and permit the use of off-white to grey calcium carbonate, provided other specifications are met.

Table 1 lists the primary uses and general specifications for carbonate fillers.

With regard to mineralogical and chemical purity, the main requirement is to have the maximum calcium carbonate content possible. It is desirable to have a minimum of acid insoluble minerals such as quartz, or any hard, abrasive minerals. The presence of dark minerals adversely affects the colour of the filler thus limiting its commercial value. It is possible to remove such contaminants by magnetic separation, electronic colour sorting, froth flotation, and manual sorting of the crude rock. The limited assessments carried out to date on the Silver Mountain marble deposit show that the marble has potential for use as an industrial filler in a number of applications. Brightness tests (Table 2) gave values that are borderline between good and excellent. Processing in the form of flotation or magnetic separation would be required in order to meet brightness specifications required for a premium quality filler of the kind used in paper, paints and plastics. However, the stone could be considered for a wide variety of products requiring good whiteness as shown in Table 2.

Table 1. Primary uses for carbonate fillers (modified after Guillet and Kriens, 1984)

Application	Function	General Specifications
Paint	Extender of prime pigments	High whiteness, 44 to 8 microns top size; acid insoluble 0.2 % max.
Plastics	As a resin extender in a wide range of polymer systems	High whiteness; controlled particle size 30 to 5 microns top size; acid insoluble 1.0 % max.
Paper	Filler for paper coatings, partial replacement for kaolin	High whiteness; low abrasion; particle size 10 to 4 microns; acid insoluble 1.0 % max.
Putty, Caulking Sealing	Filler and sealant	White; 90-99% passing 325 mesh (44 microns); $CaCO_3$ content of joint cements can reach 80 %
Vinyl Floor Covering	As a filler in vinyl tile	Coarse granular (-40 mesh) to fine (-325 mesh); good white colour
Carpet Backing	To provide body and weight	White to grey colour, 90-99% passing 325 mesh
Asphaltic Products	Filler in roofing materials and asphalt sealers	Off colour, buff to grey, coarse ranging from 80% passing 325 to 80% passing 200 mesh
Rubber	Filler pigment in footwear, car goods non-reinforced rubber, wire and cable coatings	White to off-colour; fine to medium fine products
Construction	Filler in jointing compounds for gypsum board	Lower grade white products; 90-95% passing 325 mesh
Other	Reconstituted marble	White coarse products; 80-85% finer than 200 mesh, and granular grades
Coal mines	Coal dust suppressant	White to buff,coarse filler used in coal mining

Table 2. Chemical analyses and dry brightness tests for representative chip samples from the Silver Mountain marble deposit (white zone), Upper Humber River region, western Newfoundland

% Sample No.	% SiO_2	% Al_2O_3	% Fe_2O_3	% $MgCO_3$	% $CaCO_3$	% Brightness
5946016	3.09	0.97	0.47	15.32	80.72	94.7
5946017	1.63	0.39	0.19	15.05	82.82	93.4
5946018	1.02	0.17	0.09	1.27	95.62	94.9
5946019	1.70	0.45	0.15	1.94	94.11	91.1
5946021	1.72	0.42	0.15	3.26	93.91	93.3
Average	1.83	0.48	0.21	3.53	89.43	93.5

Chemical analyses by Newfoundland Department of Mines and Energy, Geochemical Laboratory. Brightness tests by I.M.D. Laboratories (1986).

DIMENSION STONE

Marble is a highly valued commodity in the construction industry, particularly for interior uses such as columns, floors and trim, but also as exterior facing on large buildings. The American market alone imports approximately $250 million of marble annually. Specifications require aesthetically pleasing colours and textures of consistent quality and in reliable amounts. The stone must have low amounts of joints and shears and other physical flaws. Impurities such as pyrite and biotite are undesirable because on oxidation they produce stains, a particular concern for exterior work.

The Silver Mountain marble has several features that recommend it for possible use as dimension stone. Joints are relatively widely spaced indicating that large competent blocks could be removed, and the level of impurities in some bands is low. Reusch (1985) concluded from his work on white, blue-grey, and cream marble from the deposit, that the rock has potential as a building stone because of its attractive colour and ability to take a polish. To these colours can be added the thin-banded grey–brown–green type, and mottled or cloudy grey marble exposed in the central areas of the deposit. Also a distinctive brown and green, fine-grained rock noted by Erdmer (1984) near the gabbro contact, may warrant assessment. The deposit could also be considered as a potential source of terrazzo chips and landscaping material.

RESERVE POTENTIAL AND DISCUSSION OF FUTURE WORK

To date, the data gathered on the Silver Mountain marble deposit indicates that a sizable deposit, comprising several colour varieties, is present. The marble has a strike length of nearly 5 km and an average width of approximately 400 m. Assuming a very modest quarryable depth of just 10 m, a tonnage of over 50 million tonnes is inferred (using a calcite density of 2.7 tonnes per cubic metre). Reusch (1985) estimated 175,000 tonnes of white marble on his claim block, which was calculated over a strike length of 500 m, width of 10 m, and depth of 10 m. He also suggested that the total could exceed that figure by two orders of magnitude. The present work suggests that for the white zone alone these are very conservative estimates and that the total tonnage in the northern portion of the deposit may amount to several million tonnes.

The assessment work done, to date, is a first step in evaluating the deposit's economic potential. Future evaluation should be aimed at identifying marble zones of specific economic interest within the deposit. The whiter stone at the north end of the deposit, for example, may be suitable for filler applications and (or) chips for landscaping. The banded marble exposed along roads in the interior may be suitable for dimension stone. Additional work consisting of more detailed mapping and possibly diamond drilling is required. If and when units with specific commercial potential are identified, efforts should be aimed at delineating reserves of consistent quality. Removal of blocks will be necessary for testing.

Harben and Purdy (1991) in a review of current procedures and standards for building-stone assessment, emphasized that the manner in which test blocks are excavated and handled is as critical in dimension-stone evaluation as in any other mining project. Blocks should be sawn rather than blasted, and maximum use made of natural attributes of cleavage and bedding. In practical terms the specimen block for technical testing should measure at least 22 by 24 by 30 inches (56 by 61 by 76 cm). Blocks extracted for slabbing, to assess the aesthetic qualities of the marble, should be as large as possible, or at least 1 m x 1 m x 1.5 to 2.0 m. The following standard ASTM tests are considered critical in the dimension-stone industry for estimating product potential:

* Water absorption/Bulk specific gravity; ASTM C 97
* Modulus of rupture; ASTM C 99
* Compression strength; ASTM C 170
* Abrasion resistance; ASTM C 241
* Flexural strength; ASTM C 880

The location of the deposit in the scenic region near the Upper Humber River, underscores the need to minimize environmental damage in conducting any assessment or development. One way to accomplish this would be to extract blocks without the use of explosives, wherever possible. This would also protect the stone from fractures that could negate its commercial value. The location of work sites, whether stripping sites or development quarries, in visually obscured areas would also be a prudent practice.

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Note: Geological Survey Branch file numbers are included in square brackets.