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FROM REFRACTORIES TO DIMENSION STONE: INDUSTRIAL MINERALS FIELD ACTIVITIES IN 1996

A.F. Howse
Mineral Deposits Section

ABSTRACT

A reconnaissance investigation for new sources of dimension stone was undertaken in west-central and eastern Newfoundland. In the Long Range inlier, west of White Bay, ubiquitous bodies of gabbro and diabase may have commercial value as memorial stone. Several prospective sites were identified in the newly logged Upper Humber region. On the Avalon Peninsula, occurrences of the Lower Cambrian Smith Point limestone rocks are widely distributed. Sites with building-stone potential were examined on the Cape St. Mary's peninsula, and on the eastern side of Trinity Bay.

Coarse sillimanite was identified in an outcrop of quartz feldspar gneiss in the northeast Gander Zone. The outcrop comprises a small hill within the community of Musgrave Harbour and is located near the contact with Deadman's Bay Granite; minor garnet is also present. The showing suggests the metamorphic rocks of the Gander Zone may be good targets for commercial concentrations of the sillimanite group of aluminum silicates (sillimanite, kyanite, andalusite). These minerals are particularly important in the refractory industry, but also find diverse uses ranging from ceramics to the aerospace industry.

DIMENSION STONE – LONG RANGE INLIER

INTRODUCTION

The Long Range Grenville inlier represents a relatively unexplored target for new sources of dimension stone. Recent logging operations along its southeast margin provide access to excellent exposures of a variety of rock types including granitic gneisses, gabbro, anorthosite, amphibolite, and marble. The present brief survey focused on a recently logged range of hills and ridges located about 7 km northwest of Silver Mountain (NTS 12H/11). Woods roads have exposed numerous diabase dykes and (or) bodies of fine-grained gabbro. At least five sites were identified as possibly warranting further work as possible sources of dimension stone for the memorial and (or) monument trade. The following is a brief description of some of the more notable occurrences.

Location and Access

Potential dimension-stone sites (Figure 1) are located in the Upper Humber River region, about 15 km west of the Sops Arm Highway. Excellent access from the highway to the area is provided by a main access road and a network of branching forest-access roads. The coastal communities of Hampden and Sops Arm are a farther 18 and 20 km, respectively, via paved routes 420 and 421.

The topography of the region is very rugged, consisting of a number of heavily wooded hills, the flanks of which have been the focus of recent pulp-wood harvesting. It is these activities and the accompanying road construction that have uncovered most of the showings described in this report.

Previous Work

The Long Range Inlier has been relatively unexplored for its dimension stone. Poor accessibility accounts for much of this, especially along the seabound, unpopulated eastern shore of the Great Northern Peninsula. However, pulpwood logging and hydroelectric development particularly in the southeast part of the inlier have greatly improved access and are attracting some attention to its industrial mineral potential. Deposits of possible commercial merit include the Silver Mountain marble prospect (Howse, 1993) (white filler and dimension stone) and granitic gneiss particularly in the Sop's Arm–Cat Arm region (Meyer, 1995). The regional geological studies and maps produced by Erdmer (1984, 1985) and Owen (1986) provide a good geological database for mineral and dimension-stone exploration in the region.

Geological Setting

The study area is located within the Precambrian terrane of the Long Range Mountains, generally considered to be an inlier of the Grenville Province. The rocks dominantly consist

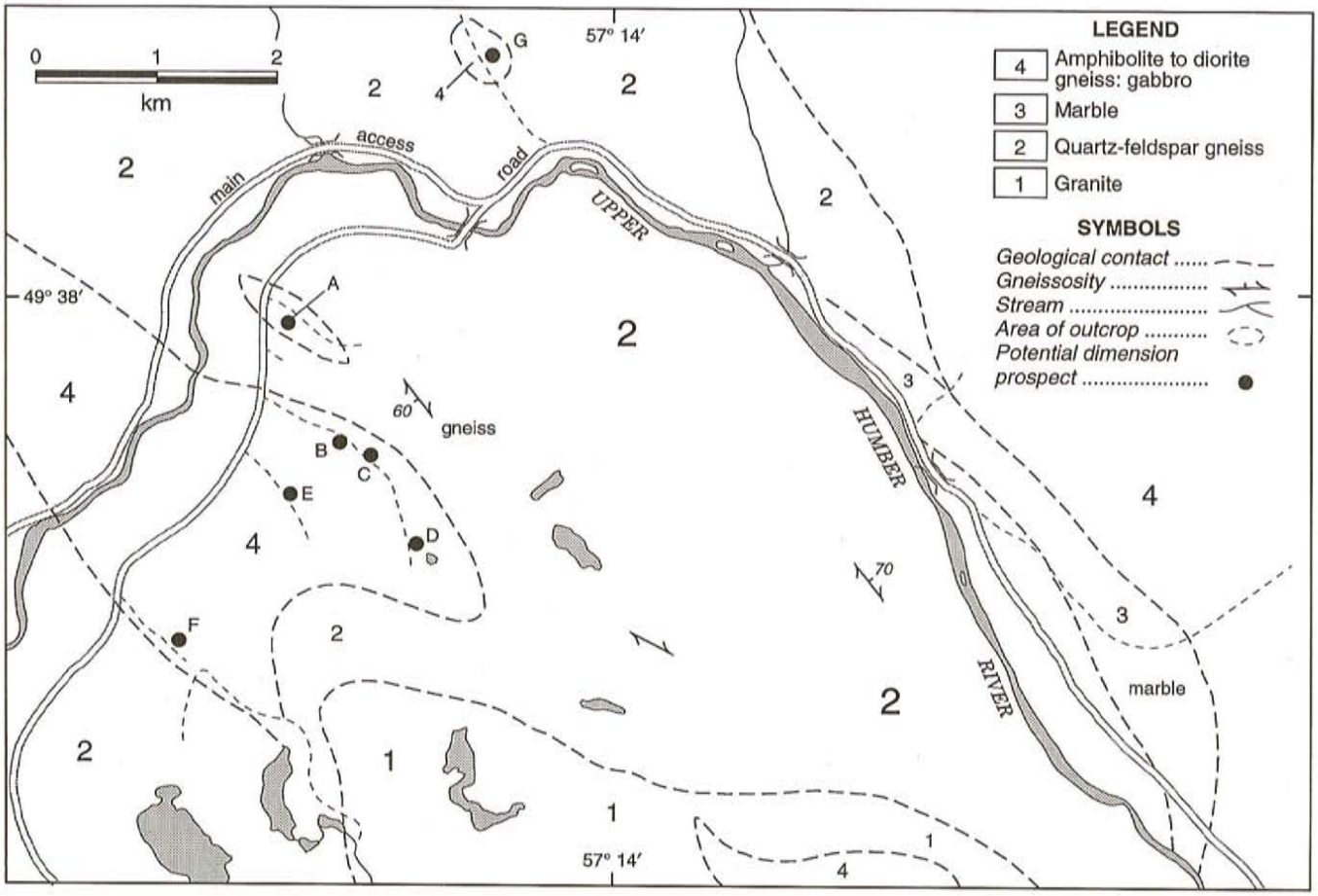


Figure 1. *Location of possible dimension-stone prospects in the Upper Humber region; overall potential includes Unit 3 (marble), which could be used for industrial filler and/or dimension stone.*

of quartzofeldspathic gneisse and granite to gabbroic plutons and diabase dykes.

DIMENSION-STONE POTENTIAL

Exposures of dark-green to black, massive to foliated gabbro were noted in a logged area located 1 to 2 km to the north and south of the Upper Humber River (Figure 1). They appear to be part of a lens-shaped diorite–gabbro unit mapped to the immediate north by Erdmer (1985). The following is a brief description of some outcrops (Figure 1) that may warrant further investigation of their dimension-stone potential.

Site A

A large outcrop of dark, medium-grained gabbro that straddles both sides of a short woods-access road is Site A (Figure 1). Exposed rock comprises a 60 by 60 m area and apparently represents the southwest, downhill extension of a small body of gabbro mapped by Owen (1986). No major joints were observed although some minor fractures were noted along the eastern edge of the outcrop. Obtaining monument-size blocks of stone from this site should not be difficult as evidenced by the presence of large rectangular blocks from road construction. A test face could easily be developed on the north side of the road where the relief is particularly suitable for such work.

Site B

This area (Figure 1) was first noticed because of black, sheet-like slabs of gabbro that lie adjacent to the bedrock from which it was blasted (Plate 1). The rock is medium grained, even-textured material having a shiny blackness that suggest use for memorial stone The outcrop is extensively exposed along the southwest side of a hill that has a 30 to 35° slope thus affording a good location for test blocks. A sample of the stone was shown to stone workers in the Buchans fabrication plant and drew positive comments.

Sites C and D

Outcrops of diorite and dioritic gneiss were noted at three sites (Figure 1). A distinctive feature common to these exposures of dioritic gneiss is the banded and swirly pattern

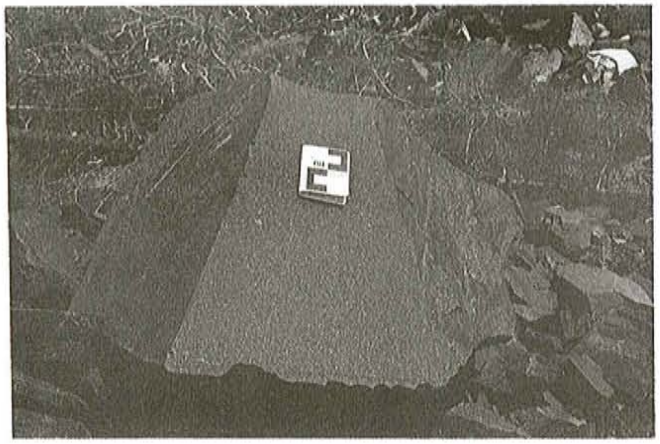


Plate 1. *Block of gabbro from road construction in the Long Range inlier. This type of rock may have potential as a source of memorial stone.*

(cm scale) defined by lighter feldspar minerals against a background of dark minerals. This could suggest potential use as a decorative stone or in tile panels.

Sites E and F

Pulpwood cutting along the northeast and southwest flanks of a large hill has exposed outcrops of massive black gabbro (Sites E and F). The latter site comprises the most attractive stone consisting of dense, fine- to medium-grained, shiny black gabbro. The stone, although massive, has a sheeted structure because of subhorizontal jointing. However, the wide spacing of the joints would allow the removal of adequately sized test blocks. The outcrops are exposed for more than 100 m along the hillside, which slopes 35 to 40°, giving good relief for quarry-face development.

Site G

This occurrence at Site G (Figure 1) is marked by a rock-cut on a woods road that branches northward from the Upper Humber River. The rock is a dark-green to black, fine- to medium-grained, amphibole-bearing gabbro; it weathers white and rusty brown. The latter is probably due to the presence of finely disseminated pyrite (noticed in one sample), which could be a matter of concern for some applications. The fresh surface looks distinctly black because of the presence of clean amphibole crystals.

The outcrop extends for about 35 m along the east side of the road, but is traceable for just a few metres back from the road before being obscured by tree-covered overburden. The maximum rock-cut height is approximately 5 m. Two sets of joints were noted, the attitudes of which are 82°/80°N and 105°/60°S but spacings are wide enough to provide adequately sized test blocks.

Other Prospects

Other rock types that show good promise in terms of aesthetics and quarrying potential have been identified along the southeast margin of the Long Range Inlier. A large Precambrian inlier of coarse-crystalline marble (Silver Mountain Deposit) comprises a variety of marbles including white, light blue-grey, and grey-brown-green banded stone. The massive nature of this stone indicates excellent quarriability potential (Howse, 1994). Also, trial blocks of Precambrian granite gneisses from western White Bay have received very positive market response at trade shows (Meyer, 1995).

DIMENSION STONE–AVALON PENINSULA

INTRODUCTION

Selected parts of the Early Cambrian Smith Point limestone were examined for potential uses as dimension and decorative stones. Well-documented outcrops of the unit are widely distributed on the Avalon Peninsula. In the past, some of these occurrences were examined for industrial use, especially as agricultural limestone to neutralize the natural acidity of the local soils. Generally, the deposits have proved to be too impure for such applications and too small for other possible uses such as cement stone. DeGrace (1974) gives an account of the early industrial investigations of these deposits.

Features of the Smith Point limestone that indicate possible use as dimension stone are its deep red-pink colour and the presence of algal structures and interesting depositional textures. The biggest challenge is to find accessible sites having a low degree of jointing and fracturing necessary for the removal of competent test blocks. The most promising sites visited this summer are in the Heart's Delight–Heart's Desire area of Trinity Bay and on the Cape St. Mary's peninsula between Cuslett and St. Bride's.

CUSLETT–ST. BRIDE'S

The Smith Point limestone beds outcrop extensively in the St. Bride's–Cuslett area (Figure 2). The most exposures, in terms of areal distribution, are located within the community of St. Bride's itself (Plate 2). In many instances, the limestone underlies private and community property and therefore was examined only briefly during the present investigation. The more accessible deposits are located just south of Cuslett and about 2.5 km east of St. Bride's on the road to Branch and these were the main focus of attention. There are good cliff exposures of Smith Cove limestone between St. Bride's and Cuslett (north side of Perch Cove in particular) but access is difficult.

A description of the Smith Cove limestone, applicable to all outcrops examined, is as follows. The weathered surface

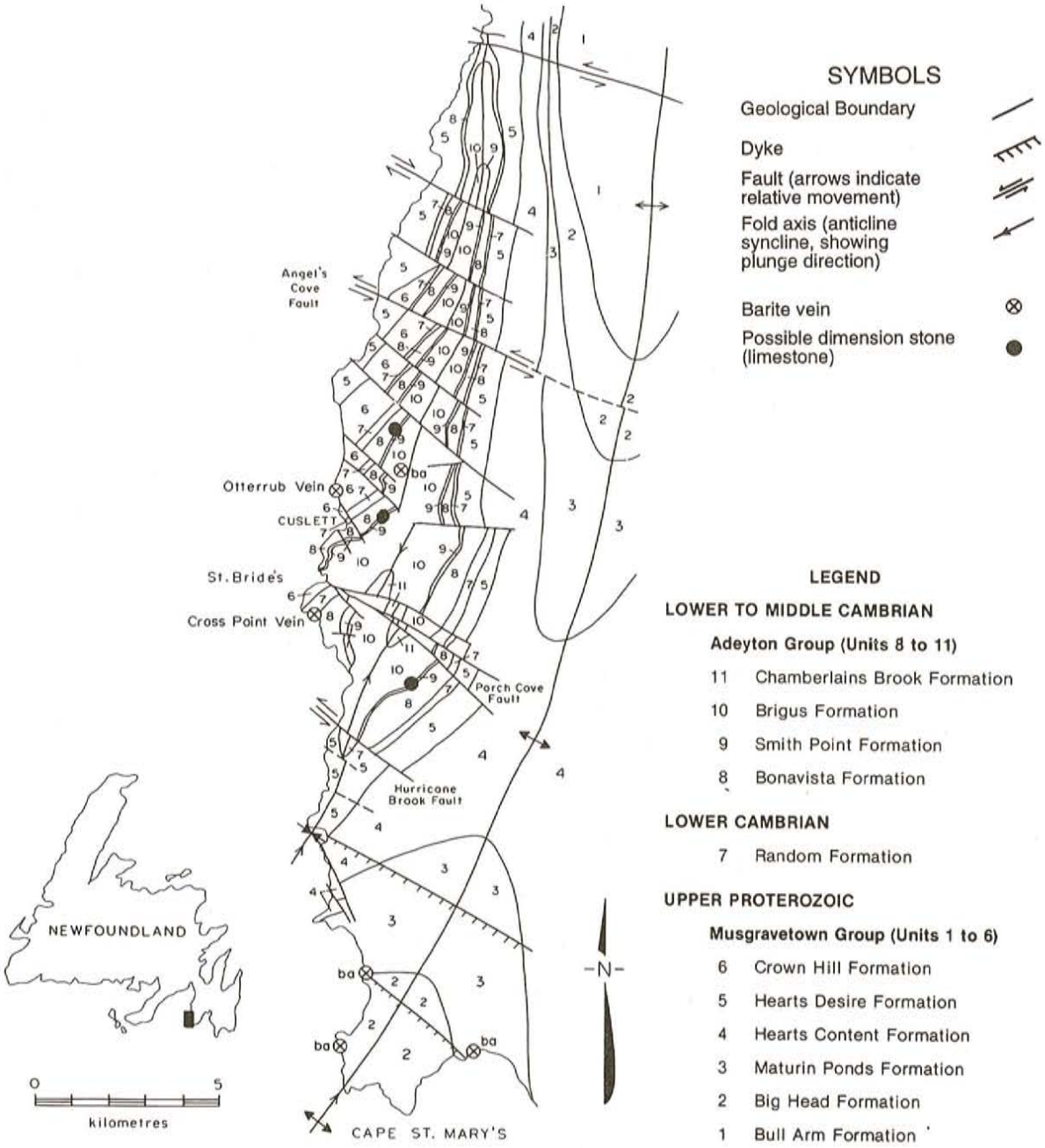


Figure 2. *Geology of the Cape St. Mary's peninsula showing location of some Smith Point limestone outcrops having possible dimension-stone potential.*

has a hackly appearance and is maroon red with a characteristic orange cast. The fresh stone is maroon with a faint bluish cast. It is a dense, hard and resistant rock. Minute stringers of crystalline calcite are common; in some instances the stringers are barite. The limestone is interbedded with shale up to 20 cm in width. The shale is a darker shade of red and is calcareous to slightly calcareous and constitutes about 25 percent of the Smith Point strata.

At the Cuslett site, the limestone dips into a north-facing hill at about 20° south but the dip steepens farther inland, east of the highway. A resistant knob of outcrop near the road could provide test blocks of this stone. The thickness of the limestone is approximately 6 m consisting of 1 to 1.5 m beds separated by limy nodular shale. The limestone unit can be traced for significant distances along strike and other, possibly more suitable sites may be present.

Plate 2. *Attractive red limestone of the Smith Point Formation is extensively exposed in the Cuslett–St. Bride's area of southeastern Newfoundland. The above outcrop is one of many in and around the community of St. Bride's.*

Test blocks of Smith Point limestone could be taken from a number of northeast-trending showings, located on the north side of the highway to Branch, about 3 km east of St. Bride's. About 5 m of limestone are present and the proportion of interbedded shale is lower than in other sites. The limestone dips about 38° to the northwest, paralleling the slope of a hill. The limestone can be traced in a northeast direction for about 300 m.

The greatest commercial value for the limestone would lie in the construction field either as decorative chips or as dimension stone. Harris (1962) concluded that the stone would make excellent road "metal" or aggregate, and further observed that "the compact and unfractured nature of the limestone renders it suitable as a crude building stone, and it might even be a good quality building stone" (Harris, 1962, page 53). This author, while essentially agreeing with that assessment, also notes that it is the upper part of limestone sequence that has the best potential for building stone. There, it is possible to find metre-wide limestone beds and a minimum of shale, a consistent feature in all of the examined outcrops.

HEART'S DELIGHT–HEART'S DESIRE

Outcrops of Smith Point limestone are well documented on the eastern side of Trinity Bay and some have been investigated in the past for potential agricultural and cement use. However, the limestone's high level of impurities, particularly silica, has generally ruled it out as a suitable neutralizing additive for acidic soil, and although approaching cementstone in composition (the ideal balance of silica, alumina, and calcium carbonate needed for Portland cement making), the small size of the deposit reduces that possibility. Possible use as a building stone or other related applications has not yet been fully investigated.

The Smith Point limestone usually forms the crests of hills in which it outcrops because it is resistant to erosion compared to associated sedimentary rocks. This feature is well illustrated in the hills between Heart's Desire and Hopeall and offers good targets for those who are interested in testing its dimension-stone possibilities.

Perhaps one of the best places to obtain test blocks is located just east of Route 80 about halfway between Heart's Delight and Heart's Desire (Figure 3). A developed face about 6 m high is already present in the limestone and exhibits such desirable aesthetic features as a striking colour ranging from pink to brick-red, fossil fragments, and algal structures (Plate 3). The best limestone in terms of structural competency is found in the lower part of the face with increasing shale content upward. The limestone unit, which strikes in a northeast direction and dips between 35 to 65° to the west, was traced for 800 m along strike by Bogert (1939) during his pioneer investigations into the industrial potential of limestone in eastern Newfoundland.

FUTURE WORK

The present work is an attempt to direct the attention of potential dimension-stone entrepreneurs toward some hitherto unexplored and/or overlooked sources of attractive stone. It is preliminary in scope and only indicates potential prospects. Except for some small representative rock samples for cutting and polishing, no testing has taken place. Follow-up work on any particular site would have to include detailed mapping and possibly drilling in order to prove the existence of reserves of consistent quality, and establish commercial value. Blocks would have to be taken initially in order to determine whether the rock meets the rigorous physical standards set by industry.

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" (56 by 61 by 76 cm). Blocks extracted for slabbing, to test the aesthetic qualities of the stone, should be as large as possible, or at least 1 m by 1 m by 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

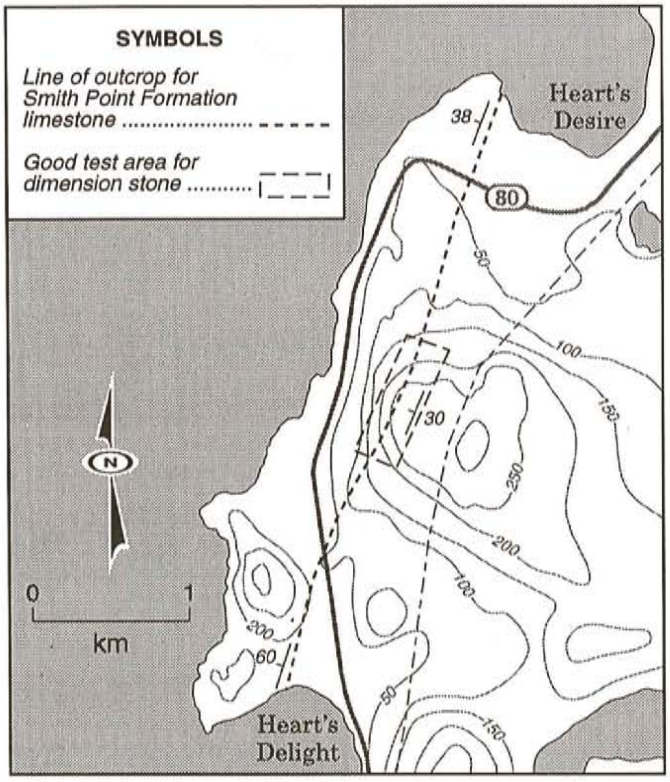


Figure 3. *Location of Smith Point limestone between Heart's Delight and Heart's Desire also indicating possible area for test-block excavation.*

Plate 3. *Red limestone of the Smith Point Formation exposed in a quarry located east of the highway between Heart's Delight and Heart's Desire.*

* Abrasion resistance; ASTM C 241
* Flexural strength; ASTM C 880

Dimension-stone deposits, like other mineral resources, are often found in scenic, sometimes populated regions. This underscores the need to minimize environmental damage when conducting any assessment or development. One way to help 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.

REFRACTORIES AND ABRASIVES

INTRODUCTION

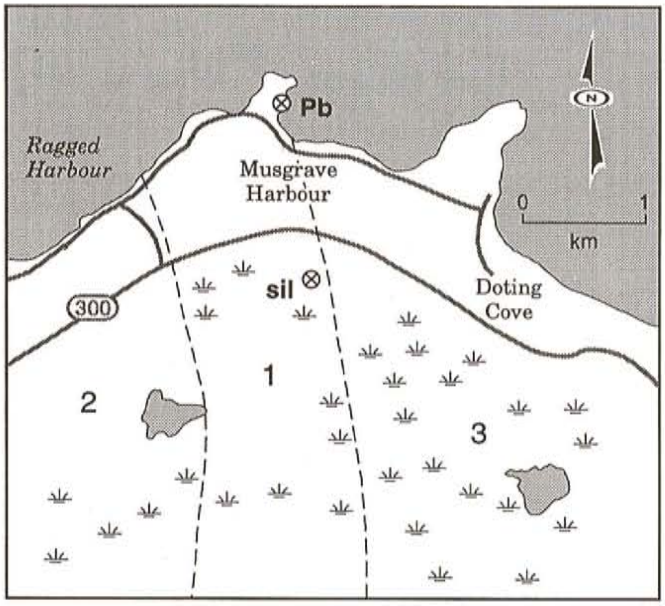
A school broadcast aired by CBC Radio (one of a series of lectures on Earth Science sponsored by the Newfoundland Department of Education during 1970 to 1971) recounted how students in Doting Cove, near Musgrave Harbour, had mistakenly identified mineral crystals on the surface of a local outcrop, as "fossillized bird tracks." The students brought their discovery to the attention of Memorial University of Newfoundland geoscientists who identified the "bird tracks" as randomly oriented crystals of the aluminum silicate mineral, andalusite. The showing was described as "the first large occurrence of andalusite known on the island." (Neale, 1972, page 70).

Intriguing stories like that, along with references by regional mappers to other sillimanite and related minerals in the northeast Gander Zone, prompted the present brief search in the Musgrave Harbour area for refractory and abrasive minerals. Although no andalusite was seen, an interesting sillimanite-rich zone in metamorphic rocks close to a granite contact was identified. Interestingly, its physical description bears a close resemblance to the "fossilized bird tracks" outcrop described by the Doting Cove students.

DESCRIPTION

The showing is located on the crest of a small hill just south of Route 330 about 1 km from the coast (Figure 4). Aggregates of sillimanite up to 15 cm in diameter were noted in gneissic rocks near its contact with the Deadman's Bay Granite. Individual crystals are bluish-grey, acicular shaped, and up to 2 cm in length. They have a distinctive random orientation that gives the bedrock-weathered surface a unique appearance (Plate 4). The outcrop slopes beneath bogland along its southward strike, but float containing similar mineralization was noted on this marsh several hundred metres south of the outcrop described above. Deformed and flattened garnets up to 1.5 cm in diameter are also present in some localized zones. The outcrop dimensions are 65 by 27 m and contains up to 20 percent or more sillimanite in some zones.

The presence of coarse sillimanite, including kyanite and andalusite in metamorphic rocks of the northeast Gander Zone have been noted previously (Neale, 1972; Jayasinghe, 1978), thus indicating that these rocks are a good target for economic concentrations of minerals used in the refractory



LEGEND

3	Deadman's Bay Granite: megacrystic biotite granite
2	Medium grained muscovite biotite granite
1	Gander Group: metasedimentary rocks

SYMBOLS

Geological contact ..... – – –
Mineral occurrence (sillimanite) ..... ⊗ sil

Figure 4. *Location of sillimanite showing at Musgrave Harbour, Newfoundland.*

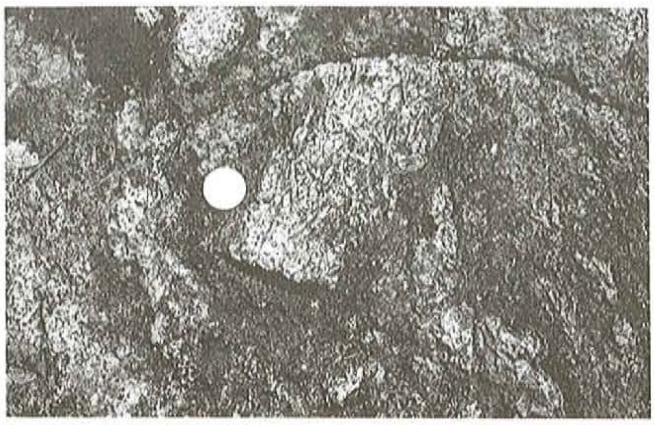


Plate 4. *Sillimanite-rich metasedimentary rocks of the Gander Group at Musgrave Harbour. Note the aggregates of randomly oriented sillimanite crystals.*

and abrasive industries. The most important commercial feature of the sillimanite minerals is its refractory properties and 90 percent of consumption is for refractory use (Skillen, 1996). Other industrial applications are found in abrasives, ceramics, and the aerospace industry.

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