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IR 70-20 March 1970

ASSESSMENT OF A BLACK GRANITE ROCK FROM THE PERIBONKA AREA, P.Q., FOR USE AS MONUMENTAL AND BUILDING STONE

by

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Mineral Processing Division

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SUMMARY OF RESULTS

The fine-grained, microsyenite black granite quarried in the St. Ludger de Milot area, P.Q., reacted favourably to all physical tests; this indicates that the rock is suitable for use as building, ornamental, and monumental stone.

The rock dresses well with clean, sharp edges and takes a high, glossy polish. A hammered or otherwise worked surface shows excellent contrast with the polished surface. Aesthetically, the rock has a pleasing appearance, particularly for use as a monument die.

It is one of the acceptable, fine-grained rocks found in Canada which ranks competitively with imported rocks.

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Industriel Confidentiel

Rapport d'investigations IR 70-20 de la Direction des mines

ÉVALUATION D'UNE ROCHE GRANITIQUE NOIRE DE LA RÉGION DE PÉRIBONKA, P. Q., POUR UTILISATION COMME PIERRE MONUMENTALE ET DE CONSTRUCTION

par

F. E. Hanes*

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RÉSUMÉ DES RÉSULTATS

Le granite microsyenite noir à grains fins, extrait de la région de St-Ludger de Milot, P.Q., a réagi favorablement à tous les essais physiques; ceci indique que la roche est appropriée pour fins d'utilisation comme roche monumentale, ornementale et de construction.

La roche se taille bien, donnant des arêtes aigueës et bien définies, et prend aussi un bon poli brillant. Une surface, martelée ou travaillée autrement, présente un excellent contraste avec la surface polie. Esthétiquement, la roche possède une apparence agréable, particulièrement lorsqu'elle est utilisée comme pierre monumentale.

Elle est parmi une des roches à grains fins rencontrées au Canada qui, tout en étant acceptables, figurent compétitivement avec les roches importées.

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INTRODUCTION

Mr. E. Beaudin, Manager of the Beebe Granite Works, Beebe, P.Q., requested the assistance of the Mines Branch to assess the suitability of a black granite rock for use as a monumental and building stone. The rock, a fine-grained, microsyenite, black granite is quarried in the St. Ludger de Milot area approximately fifty miles northwest of Alma, P.Q. Alma is near the east end of Lake St. John, 140 miles north of Quebec City. This deposit is approximately 20 miles northwest of the coarse-grained, anorthositic black granite quarried on the Peribonka River.

The deposit, which was first quarried in August, 1963, extends for over a mile in a north-south direction. It is terminated on its northern end by a lake. The company selected samples of rock quarried from the most northerly part of the outcrop and prepared many of them for this investigation.

The writer visited the outcrop when the quarry first opened and, again, in 1969 after extensive quarrying had been done. Numerous photographs were taken of the deposit during both field trips to the area.

Scope of the Investigation

The usual preliminary tests and petrographic study were used for evaluating the rock for its suitability for use as a monumental and building stone; they are listed hereunder:

(1) petrographic study,

(2) specific gravity and absorption,

(3) compressive strength,

(4) flexural strength,

(5) toughness,

(6) temperature cycling in weak salt solution,

(7) abrasion resistance to foot traffic,

(8) Los Angeles abrasion,

(9) polishing and contrast.

Non-destructive tests such as measuring ultrasonic pulse velocity and measuring length and weight before and during exposure indicate the condition of the specimens without loss of specimens. Compressive strength tests were made on cubes at specific intervals of exposure.

SAMPLE PREPARATION

Many of the samples required for the tests were sawn and dressed by the company. Procedures used for tests followed prescribed standard methods of ASTM, as shown in Appendix A.

A slab of the rock was sawn and polished by hand with abrasives and buffing powder to assess its polishing characteristics.

TEST RESULTS

1. Petrographic Study*

The petrographic study consisted of microscopic examination of thin sections and megascopic study of the rock to determine its composition and nature.

Photomicrographs were made to illustrate textures and structural characteristics of the minerals.

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*Petrographic Study by Dr. J. A. Soles, Petrologist, Ore Mineralogy Section, Mineral Processing Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

The petrography, already reported to the Company, is included hereunder for record.

Market Name: Imperial Black

Company: Beebe Granite Works Ltd.

Source: St. Ludger de Milot, Que. (20 mi.N.of Lake St. John)

Sample No.	Sections, Mounts	Photos
ESR-104 (CM-191)	TS-150-63	P925, P926

Megascopic Description:

The rock is grayish black on a rough surface, fine-grained, and rarely fractured. A polished surface reveals abundant, small magnetite crystals scattered randomly through the lighter-coloured matrix. A few coarse particles of pyrite (to 1 mm) are present, and small pyrite grains are commonly with the magnetite.

Microscopic Description:

The rock texture is hypidiomorphic granular; anhedral to cuhedral crystals of the constituent minerals interpenetrate along common boundaries. The approximate mineralogical composition is as follows:

Minerals	Proportions	Grain Sizes
Albite ($Ab_{90}An_{10}$)	50%	1.0-3.0 mm
Pyroxene (Augite)	15	0.1-1.5 mm
K Feldspar	10	0.1-0.5 mm
Hornblende (Uralite)	5	0.1-1.0 mm
Biotite	6	0.2-0.7 mm
Magnetite	10	0.05-0.5 mm
Chlorite	<1.5	Sm
Quartz	<1	0.05-2 mm
Apatite	<1	0.5-3 mm
Pyrite	<0.5	0.05-1 mm

Albite is present as randomly oriented prismatic to irregular crystals, simply to complexly twinned in the centers, which are clouded by an alteration product. The potassic feldspar is mostly interstitial to, and occasionally coextensive with, the plagioclase crystals. The pyroxene is euhedral to subhedral, uralitized here and there to an amphibole; and chlorite in polycrystalline masses appears to be the alteration product of ferro-magnesian minerals, both pyroxene and amphibole.

Biotite, apatite, magnetite, and rare quartz are anhedral to euhedral, scattered, and apparently primary. Pyrite is similarly distributed, the smaller grains most commonly are found with magnetite.

The rock is a microsyenite.

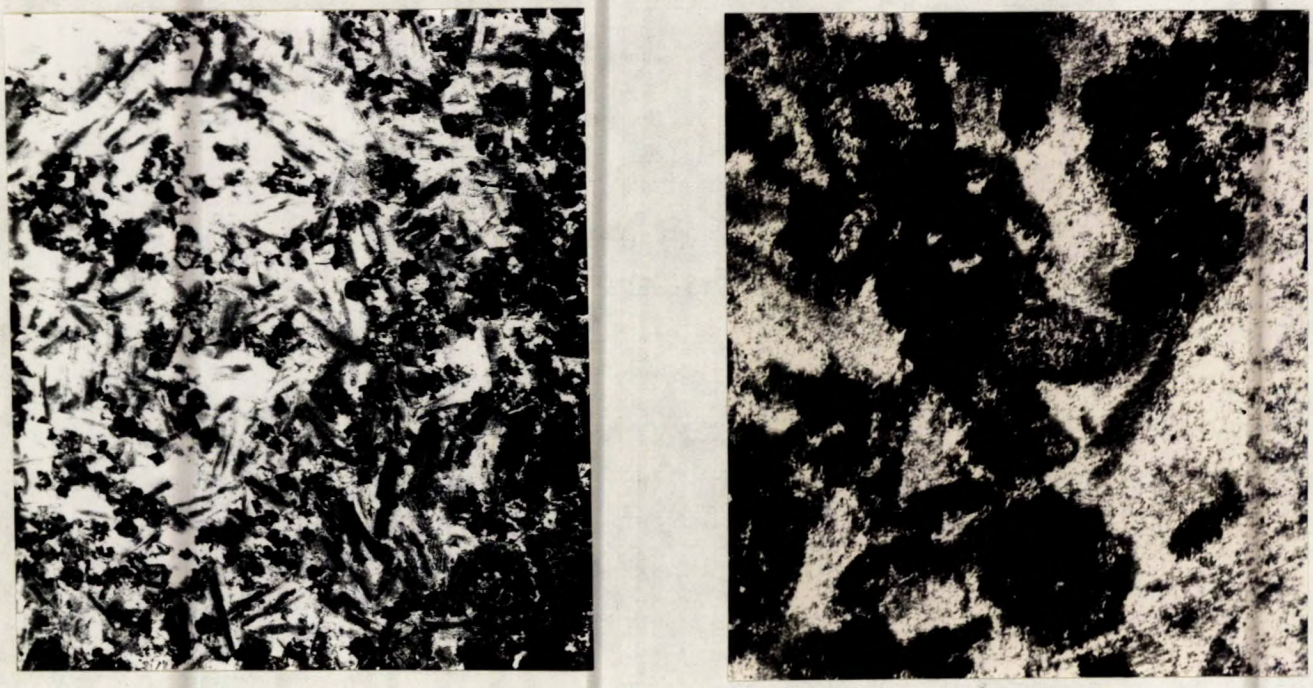

Figure 1: Photomicrograph of microsyenite CM 191 showing: LEFT, prismatic, cloudy albite and K-feldspar crystals, megnetite (black) and pyroxene (high relief) altering to uralite; RIGHT, enlarged view showing uralitized pyroxene. Magnifications x12 and x 30.

2. Specific Gravity and Absorption (Appendix A-a)

Specific Gravity: average of two tests = 2.98

Absorption: average of two tests = 0.086%

3. Compressive Strength (Appendix A-b and c)

The results shown in Table 1 were obtained on samples exposed as follows:

a) control specimens (dry) - no freeze-thaw cycling,
b) samples after 354 cycles of freeze-thaw cycling,
c) " " 634 " " " " " ,
d) " " 30 cycles of temperatre cycling in weak salt solutions.

TABLE 1

Comparison of Compressive Strength Results

Type of Test	Values of Compression (psi) Sample Specimen Number in Bracket(x)			Average
Standard Oven-Dry	(1) 46,075	(2) 45,500	(3) 44,500	45,358
After 30 cycles of Temp and Weak Salt Sol'n	(4) 29,200	(5) 31,125	(6) 38,425	32,917
After 354 Freeze-Thaw Cycles	(7) 33,050	(8) 31,125	(9) 34,750	32,975
After 634 Freeze-Thaw Cycles	(10) 32,725	(11) 23,300	(12) 21,625	25,883

4. Flexural Strength (Appendix 1-d)

Values shown in Table 2 are the results of flexural (rupture) strength tests on three samples for each of dry and wet conditions.

TABLE 2

Flexural Strength Results (psi)

Samples	Dry	Wet
1	9,700	8,880
2	8,500	8,640
3	9,800	9,200
Average	9,330	8,910

5. Toughness (Appendix A-e)

Because of the fine-grained texture of this rock, orientation of samples could only be according to the two planes of a slab of the rock. Six of the test samples were cored parallel to the surface of the slab and three were cored at right angles to the first six cores. Results of the test are shown in Table 3.

TABLE 3

Results of Impact Load Test
(number of blows)

Samples	Number of Blows (average) or (distance of final blow, cm)
6 specimens	27
3 "	28

6. Temperature Cycling in Weak Salt Solution (Appendix A-f)

Increase in absorption, per cent = nil.

Increase in volume, per cent; two specimens (average) = 0.075;

one specimen = nil

7. Abrasion Resistance to Foot Traffic (Appendix A-g)

This method of determining the resistance to abrasion caused by rubbing was devised by Kessler. The empirical value thus obtained is used for comparative assessment with other rocks. Average values obtained by testing three samples in three different positions were applied in Kessler's formula to calculate the resistance to abrasion H(a).

Kessler's Formula =

$$H(a) = \frac{10G\ (2000 + Ws)}{2000\ Wa}$$

where H(a) = resistance to abrasion

G = specific gravity

Ws = average weight of sample before and after test (grams)

Wa = loss in weight (grams)

Result (average) - Resistance to Abrasion

$$H(a) = 101.91$$

8. Los Angeles Abrasion (Appendix A-h)

This test was made to assess wear or breakdown on a rock by another method of measuring its resistance to abrasion.

A Los Angeles Abrasion, Grade 'A' test on a coarse crushed product of the rock resulted in a loss in weight of 15.13 per cent.

9. Polishing and Contrast

An excellent, shiny, polished finish can be obtained by dressing the stone using various grades of carborundum abrasives and by buffing with a tin oxide powder.

Excellent contrast is obtained between the polished and bush-hammered or sand-blasted surface when carving or lettering the rock.

DISCUSSION

Results of tests made on this microsyenite rock indicate that it is suitable for use as an ornamental and/or dimension stone.

Its ability to take a high polish and the excellent contrast between polished and hammered surfaces makes it an ideal rock for the manufacture of ornamental and monumental stone.

The petrographic study showed that most of the iron in the sample consists of small magnetite crystals scattered randomly throughout the matrix; no staining will emanate from these small centers. Only a minimal (<0.5 per cent) amount of pyrite, a deleterious constituent, is present.

After many cycles of rapid freezing and thawing, no physical defects such as cracking or discolouration were evident. No increase in absorption and only a negligible volume change during temperature and weak salt solution cycling indicate the close-textured characteristics of this massive, fine-grained rock. The rock has a very low absorption value.

The three samples used for temperature/weak salt solution testing were crushed at the completion of the test. The loss in compressive strength amounted to 27.4 per cent (approximately) after 30 cycles of temperature and weak salt solution. The decrease is very much in line with the loss after approximately 350 cycles of freeze-thaw. ASTM test C 218 notes that correlation between the 30cycle test results and an exposure of 350 cycles of freeze-thaw testing is a possibility. It would appear from the results shown in Table 1 that this is verified. However, individual results of the 30-cycle (Temperature and Weak Salt) test are rather scattered.

A loss of almost 43 per cent in compressive strength occurs after 634 freeze-thaw cycles. The average value (25,883 psi) of compressive strength remaining at this point of cycling has not reached the minimum specified for Engineering Grade rock. The tentative ASTM Specification C 422-58T(see Appendix A-j) gives a minimum value of 25,000 psi for Engineering Grade and values from 16,000 to 28,000 psi for structures with life expectancy of less than fifty years.

Flexural strengths in both wet and dry conditions averaged between 9,000 and 9,300 psi and are acceptable for most practical structural applications.

This rock reacted favourably to tests designed to measure wearability, toughness, abrasion by rubbing, and resistance to abrasion in the Los Angeles machine. Values of 27 to 28 cm (or number of blows) in the toughness test compare favourably with stringent toughness requirements for curling stones that rate values of 31 or higher in all orientations of the test specimens. The Kessler's H(a) resistance number of 101.9 compares most favourably with typical granites whose values average between 80 to 90. A loss of only 15 per cent for any rock in an "A" grouping by the ASTM Los Angeles procedure is suitable for use as an aggregate in any application. The results of all three tests more than satisfy the strictest interpretation of the specifications.

Readings of volume change, length variation, and internal disruption were made on test samples in the freezing-thawing tests. All specimens, after initial absorption, varied only 0.001 cm in length measurements and showed no perceptible change in volume or in soniscope readings throughout the test.

CONCLUDING REMARKS

Results of physical tests made on this black granite rock indicate that it is suitable for ornamental, monumental, and dimension use.

Aesthetically, the rock has a pleasing appearance; it responds to dressing procedures and readily takes a high, glossy polish. A hammered surface shows good to excellent contrast with the polished surface.

It is one of the acceptable fine-grained rocks found in Canada and it should compete with similar types of imported rocks.

FEH/am

APPENDIX A

ASTM Standard Test Methods Used in this Investigation

a. Standard Methods of Test for Absorption and Bulk Specific Gravity of Natural Building Stone - ASTM Designation: C97-47.

b. Standard Method of Test for Compressive Strength of Natural Building Stone - ASTM Designation: C170-50.

c. Tentative Method of Test for Resistance of Concrete Specimens to Rapid Freezing in Air and Thawing in Water - ASTM Designation: C291-52T (adapted for testing 2in. cubes of stone by periodic tests for comparative study).

d. Standard Method of Test for Modulus of Rupture of Natural Building Stone - ASTM Designation: C99-52.

e. Standard Method of Test for Toughness of Rock - ASTM Designation: D3-18 (reapproved 1952).

f. Tentative Method of Test for Combined Effect of Temperature Cycles and Weak Salt Solutions on Natural Building Stone - ASTM Designation: C218-48T.

g. Standard Method of Test for Abrasion Resistance of Stone Subjected to Foot Traffic - ASTM Designation: C241-51.

h. Tentative Method of Test for Resistance to Abrasion of Small Size Coarse Aggregate by Use of The Los Angeles Machine - ASTM Designation: C131-64T.

j.* Tentative Specification for Structural Granite - ASTM Designation: C422-58T.

k.** Standard Definitions of Terms Relating to Natural Building Stones - ASTM Designation: C119-50.

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* Information of physical requirements where consideration may be given for specific structural (construction) uses.

**Comparison of definitions between the term 'black granite' when used in the scientific sense and in the commercial (building) granite sense.