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ASSESSMENT OF A TRAP ROCK FROM MONTREAL FOR USE AS A CONCRETE AGGREGATE

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

A trap rock submitted by Miron Company Limited was identified as an altered phonolite, known in the trade as Miroc.

Physical tests indicated that it was suitable for use in concrete.

Firing tests to determine its reaction to heating at temperatures between 300° and 1100°C indicated that the soundness of the rock was unimpaired up to 900°C. Fusion with vitrification resulted above this temperature.

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INTRODUCTION

A request was made by Mr. Charles Beique, Director of Research of Miron Company Limited Montreal for assistance in assessing a trap-like rock for use as a concrete aggregate. Suitably prepared aggregate chips and a few large fragments of rock were provided by the company. Miron Company Limited is a supplier of large quantities of crushed limestone rock in the Montreal area. The trap rock is an intrusive body within the confines of the operating quarry at St. Michel and would create a serious quarrying problem if found to be deleterious. The acceptability of the trap-rock for use as a concrete aggregate would be of value to the company. This product is known as Miroc.

Normal physical acceptance tests and a petrographic study were made. Chips of the rock were fired to determine the rock's soundness at elevated temperatures because the rock was found by petrographic study to be an altered phonolite. During a previous investigation on a trachytic phonolite from the Montreal area, similar tests proved its unsoundness when unfavourable expansion and disintegration resulted.

SAMPLE PREPARATION AND TESTS

Crushed Aggregate

Crushed aggregate conforming to Standard size, grading and weight specifications are shown in Table 1.

TABLE 1

Aggregate Submitted

Weight of Sample	Screen Size
6 lb	-1 1/2 in. + 1 in.
5 "	-1 " + 3/4 "
11 "	-3/4 " + 1/2 "
10 "	-1/2 " + 3/8 "
6 "	-3/8 " + 1/4 "
12 "	-1 1/2 " + 1/4 "
6 "	-1/4 " + 4 mesh
1 "	-3/8 " + 4 "

The following tests were made:

(a) Specific gravity and absorption
(b) Los Angeles abrasion ("A","B", and "C" gradings)
(c) Sulphate soundness (magnesium)

Uncrushed Rock

A large block and smaller fragments of rock provided cores, chips and blocks for the following tests:

d) Toughness test
e) Resistance to abrasion
f) Firing at elevated temperatures
g) Petrographic study and X-ray analysis

Samples one inch in diameter and one inch in length were cored in three directions, at right angles to each other, from the large block. A total of nine test pieces were prepared, three for each plane, to provide the samples for the toughness test.

Three 2 x 2 x 1 in. blocks were cut by diamond saw and honed to provide samples for resistance to abrasion tests.

Chips averaging 3/4 inch were used for the firing tests. The chips were prepared by crushing fragments of the rock in a laboratory model jaw crusher.

Material for petrographic study was taken from a depth of 4-5 in. within the large block.

STANDARD TEST PROCEDURES

Procedures conformed to the following:

a) Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate, ASTM Designation C127-42.

b) Standard Method of Test for Abrasion of Coarse Aggregate by Use of the Los Angeles Machine, ASTM Designation C131-55.

c) Tentative Method of Test for Soundness of Aggregates by Use of Magnesium Sulphate, ASTM Designation C88-56.

d) Standard Method of Test for Toughness of Rock, ASTM Designation D3-52.

e) Standard Method of Test for Abrasion Resistance Stone Subjected to Foot Traffic, ASTM Designation C241-51.

f) Sagger trays containing eight (8) aggregate chips were heated in a Glo-bar furnace with an electrically heated 12 x 20 inch hearth.

TEST RESULTS

The following results were obtained from preliminary physical tests.

a) Specific gravity (aver. of 2) 2.79
Absorption per cent (aver. of 2) 0.20

a) Specific gravity	(aver. of 2)	2.79
Absorption per cent	(aver. of 2)	0.20

b) Percent wear for the three gradings "A", "B", and "C" were as follows:

"A"	(per cent)	12.2
"B"	(per cent)	13.3
"C"	(per cent)	13.0

c) The corrected percentage loss calculated from testing sizes of aggregate from 1½ inch to No. 4 mesh in magnesium sulphate solution was 0.32.

d) Average number of blows needed for testing toughness of three samples each in each of three directions amounted to 30. (individual sets of three required 44, 24 and 23 blows to shatter the material)

e) The abrasion resistance to foot traffic, Ha, (by Kessler's method) is 85.95.

f) Results of firing at elevated temperatures are best illustrated by reference to Figure 1, which shows aggregate chips in place in "sagger" plates. The figure above each tray refers to the temperature to which chips were fired. The tests commenced at 300°C with each following test at 100 degrees higher, to a maximum of 1100°C. Each sample was fired separately and allowed to saturate at its peak temperature for 1 hour. It was then removed from the furnace and cooled at room temperature. The original grey colour of the rock changed slightly to brown-grey and green-grey as it was heated through 700°, 800° and 900°C. At 1000°C the first sign of internal disruption was seen; surface fractures developed and the colour became more greenish-grey; the colour was still dull, non-vitreous in appearance at the 1000°C temperature. Fusion had advanced fully at 1100°C, with maximum disruption of the aggregate chips due to expansion of minerals; colour was more yellowish-green with darker areas where expanding minerals (probably feldspar) had broken out. The overall lustre of the rock had changed to vitreous.

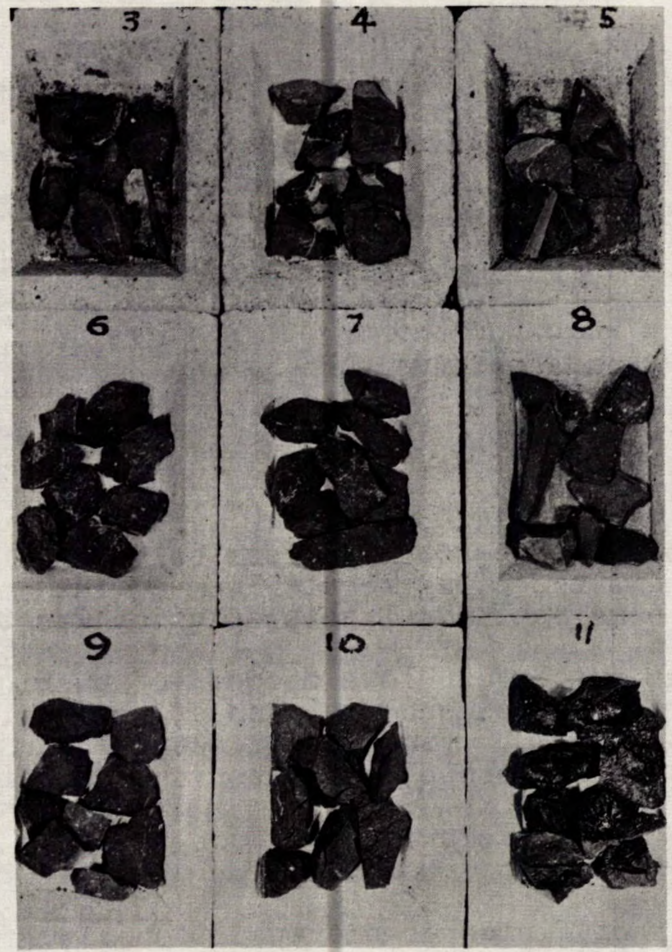


Figure 1. Sagger plates containing aggregate chips; numbers indicate 100°C of firing.

The following petrographic description, based on thin section study and X-ray diffractions analyses, was supplied by Dr. J. A. Soles of the Ore Mineralogy Section.

HCl treatment showed that the sample contains minor carbonate and grains which gelatinized. Specific gravity separations were made at densities of 2.85 and less to separate mafic and other heavy minerals from the lighter constituents; the various fractions were X-rayed. A thin section was stained to differentiate potassic and sodic minerals.

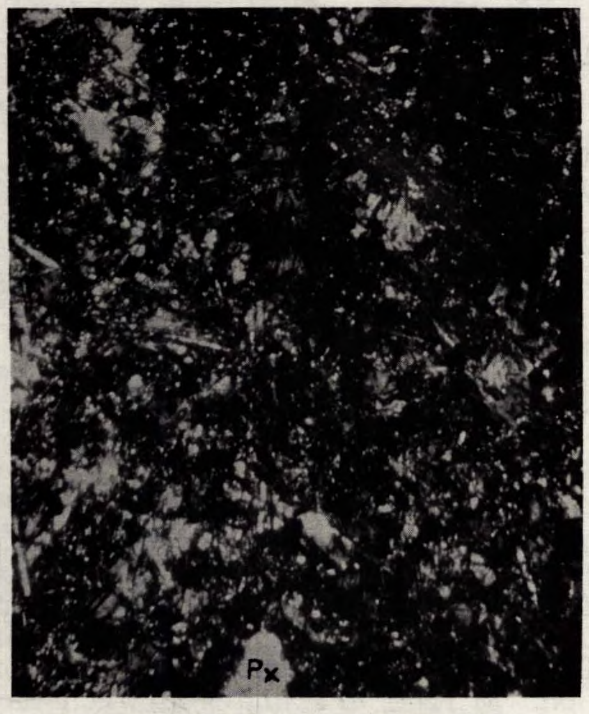
Thin section and X-ray study gave the following mineralogical composition:

Minerals		Percentage	Grain Sizes (mm)
Potassium Feldspar (Sanidine?)		30	5 - 70
Clinopyroxene (Augite):	large crystals	5	0.1 - 1
	small "	15	20 - 200
Analcite:	large "	10	0.1 - 2
	small "	20	5 - 50
Carbonate (Dolomite)		2 - 5	5 - 50
Magnetite		5 - 8	10 - 50
Apatite		1	5 - 50
Sulphide		Negl.	1 - 20
Mica		1	1 - 20
Unidentified (dark)		10	- - -

The rock texture is hypidiomorphic granular to porphyritic. A few large euhedral crystals of augite and apatite are scattered in a fine-grained matrix of potassium feldspar (sanidine?) and analcite. Dispersed large, rectangular grains of analcite suggest that alteration of another quartz-poor sodium silicate has taken place; the grains are charged with magnetite and carbonate dust (Figure 3). The rock is a strongly altered member of the sub-silicic group; its fine grain and porphyritic texture suggest it was a phonolite. It appears to be physically competent.

Figure 2. Photomicrograph of altered phonolite showing large crystals of augite (Px), apatite (Ap) and analcite (Ze) in a fine-grained matrix of potassium feldspar, analcite, dark needles of clinopyroxene and magnetite (black). Magnification X 50.

Polarized light



Crossed polaroids

Figure 3. As Fig 2, enlarged. Potassium feldspar in matrix appears anisotropic under crossed polaroids, analcite appears isotropic. Note analcite is charged with particles, of carbonate. Magnification X 75.

DISCUSSION

Results of all preliminary acceptance tests indicate that this rock is acceptable for use as a concrete aggregate. It is very fine grained and massive, and has an extremely low absorption (0.20%). Abrasion losses in the 12 to 13% range for gradings "A", "B" and "C" (allowable is 50% by ASTM Designation C33-54T) and a corrected percentage loss of 0.32 for the magnesium sulphate soundness test (allowable is 18% by ASTM Designation C33-54T) is sufficient evidence of its soundness.

A measurement of its toughness shown by the value of an average 30 blows is close to the value required for a quality of rock used for curling stone manufacture. The rock is unquestionably suitable for use in concrete based on a toughness test parameter.

Its abrasion resistance to foot wear is very good as indicated by its high Ha value of 86. Many granites of high quality fall in a range from 80 to 90. The Kessler value (Ha) is useful for comparative checks with rocks of known resistance to abrasion.

Petrographically the rock seems to be physically competent and contains no potentially deleterious minerals, indicating its suitability for use as an aggregate in normal concrete.

Unlike the high temperature instability experienced with a sample of trachytic phonolite, also from the Montreal area, only cracking developed in the aggregate chips at the temperature of fusion, approximately 1000°C, due to the fluxing action of the analcite. Very slight discolouration was the only evident change in the rock in temperatures below 1000°C.

CONCLUSIONS

By physical parameters, the altered phonolite from the St. Michel quarry of Miron Company Limited is well within specified values required for an aggregate for use in normal concrete.

The apparent competency of the rock and the lack of disintegration at temperatures up to 900°C further indicates its suitability.

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