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MINES BRANCH INVESTIGATION REPORT IR 68-13

INVESTIGATION OF A QUARTZITE DEPOSIT ON THE McGREGOR BAY INDIAN RESERVE AT BIRCH ISLAND, ONTARIO

by

F.E. HANES

MINERAL PROCESSING DIVISION

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INTRODUCTION

On September 27, 1967, Dr. A.B. Irwin, Head of the Mineral Resources Section, Indian Affairs Branch, Indian Affairs and Northern Development Department, Ottawa, telephoned Mr. H.M. Woodrooffe, Chief of the Mineral Processing Division, Mines Branch, Ottawa, requesting technical assistance in assessing quartzite being quarried on Birch Island, Manitoulin area, Ontario.

The writer and Dr. Irwin motored to the McGregor Bay Indian Reservation, between Whitefish Falls and Little Current, on October 25, 1967. The Chief, Mr. Arthur Nahwegahbow, showed us outcrops, and several quarries being operated by Indians under his direction. Samples of quartzitic rock were collected for investigation, and the quarrying methods were reviewed at a Council meeting in the Community Hall.

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GEOLOGY OF THE GENERAL AREA

A description of the geology of the area appears on the Ontario Department of Mines Preliminary Geology Map No. P.442, Bay of Islands-McGregor Bay Area, McGregor Bay Sheet (West Half), Districts of Sudbury and Manitoulin. Faults and folds are characteristic structures in the area in which quarrying has taken place.

The rock investigated is Precambrian, belonging to the Huronian age, and is designated "3e" in the lithological legend on the map (Appendix 1, excerpt of Legend). It is identified as a ferruginous, muscovitic quartzite and classified as a Huronian metasediment. Dr. J. A. Soles* identified samples of this rock as micaceous quartzite with iron staining. The staining is quite evident in all samples of the rock and is prominent on cleavage planes.

Occurrence of the 3e rocks is shown on the west side of the map, which covers an area just east of the actual quarries. The quarry area does not appear on the map because the western limit of the mapped area, longitude 81°45'00", is the eastern boundary of the quarry area investigated.

The geological map (interpreted by K. D. Card and assistants, 1967) pin-points various types of occurrences, one of which, the Birch Island quarry rock, is referred to as a cleaved quartzite.

The area is largely rock with occurrences of coniferous and deciduous trees, much low underbrush composed of spruce, birch and willow shrubs, and thinly growing grass. Overburden is relatively thin, or absent, on most of the massive rock outcrops.

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*Mineralogist, Ore Mineralogy Section, Mineral Processing Division, Mines Branch, Ottawa.

DESCRIPTION OF OUTCROPS

Upon our arrival at the community hall, headquarters of the Reservation, the Chief conducted Dr. Irwin and the writer on a tour of the various quarrying operations in the area.

One outcrop visited was located on a small hill behind the Chief's house, not far from the community hall. Figure 1 shows this small quarry and clearly shows considerable cleavage on the outcrop surface. The shallow pit in which Dr. Irwin stands indicates the degree to which this outcrop has been quarried. Cleavage in the rock is not a continuous feature.

Note the outcrop shown in Figure 2, where no indication of cleavage appears; massive blocks can be recovered by selective quarrying from this type of outcrop. According to the Chief, a small local demand exists for this type of block.

An example of sporadic cleavage is visible on the outcrop shown in Figure 3, where, over a large area in the vicinity of the two figures, only a spot at the Chief's left foot shows the characteristic cleavage.

Not all cleaved rock was found suitable for use. Some of the rock-surface showing in the foreground of Figure 1 was weathered, with the result that some of the exposed surface crumbled readily. Not all occurrences of cleavage on the outcrops showed weathering, however; in fact, most of the rock outcropping in the area is quite sound. A selection of quartzitic slabs gathered from the above quarry was stockpiled between the quarry and the Chief's house. All of the slabs were sound and were 3/8 to 5/8 inch thick.

The large outcrop shown in Figures 4 and 5 illustrates a quarrying operation where a considerable volume of cleavable rock is available. Figure 4, showing the overturned picnic table, gives some idea of the size of the slabs that can be recovered. Figure 5 illustrates an ideal working face for this type of quarry operation; slabs can be readily removed from left to right in succession. The degree of fracturing visible in the general area suggests, however, that the recovery of large, unbroken or crack-free slabs will be minimal. This quarry is ideal for substantial production of slabs ranging in thickness from 1/4 inch up to blocks of 12 inches and greater. Figure 5 shows thicker slabs, in place, that could be quarried for heavier building blocks or thick-dimensioned building stones. Slab thickness varies greatly, as can be seen from waste pieces lying near the quarries and from exposed rock in situ, illustrated in Figures 1, 3, 4 and 5.

Most of the quarries visited were surface openings of small extent; however, the main quarry proved to be rather extensive and showed evidence of considerable past activity. Figures 4 and 5 show the upper part of a large quarry operation, whereas the surface type of operation can be seen in Figures 1 and 3. Numerous limited attempts have been made to open up new quarries; for example, waste rock on one of the ridges shown in the background of Figure 3 illustrates the nature of preliminary work necessary in exploring potential deposits of suitable rock.

The one important structural characteristic of this rock, essential to the success of the operation by the Band, is the cleavage of the quartzite. This structure must be sufficiently evident in a deposit before further development can proceed.

COUNCIL MEETING OF THE BAND

A Council meeting arranged by Chief Nahwegahbow took place at the community hall after our return from inspecting the quarries.

Present, with the Chief in the Chair, was one of the Band's councillors, Mrs. McGregor, to make a quorum for the tribe. Because many problems concerning the Band's livelihood in the area were being discussed, others were present at the meeting. Besides Dr. Irwin and the writer, Mr. H. Toogood, Head of the Community Planning Unit, and Mr. V.G. Ulrich, Water and Sewer Engineer for Indian Affairs, from the Department of Indian Affairs and Northern Development, Ottawa; Mr. Eric Mulligan, Technical Building Supervisor of the Sudbury District Office of Indian Affairs; and Mr. Parsons, Assistant Superintendent, Manitoulin Island Indian Agency, Manitowaning, Ontario, were present, as also was a Mr. Powell, a consultant from Sudbury, Ontario.

Dr. Irwin and the writer were asked for comments, and at the suggestion of Dr. Irwin the writer reported on the inspection made earlier in the field.

The difficulty of finding adequate surface indications of cleavable rock in this type of terrain was pointed out. Because most of the cleaved rocks seen in the area were dipping at a very steep angle (cleavage planes in most cases were nearly vertical), great difficulty would be encountered

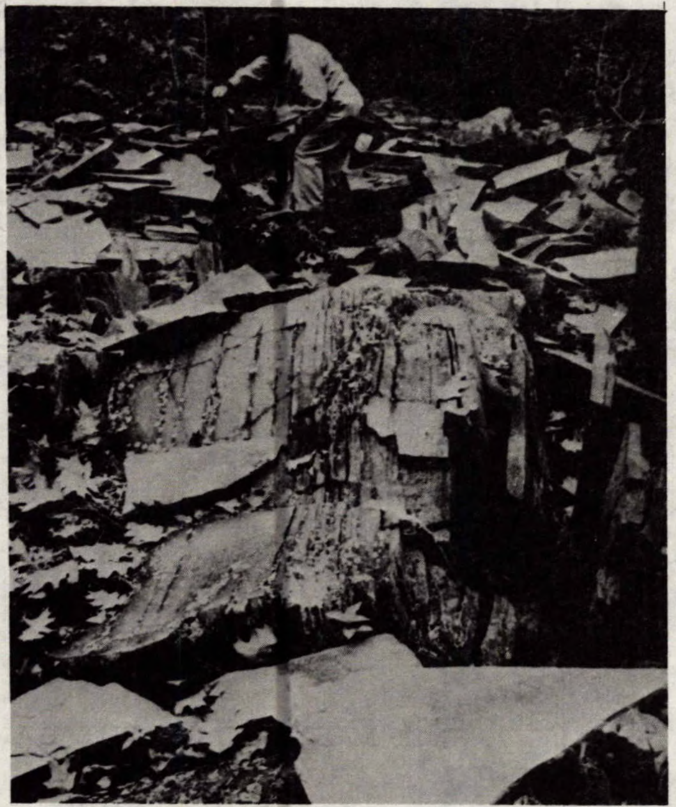

Figure 1. Shallow pit showing boulders with prominent cleavage. Dr. A. B. Irwin in background.

Figure 2. Beds of massive blocks lacking in orderly cleavage and showing irregular fracturing.

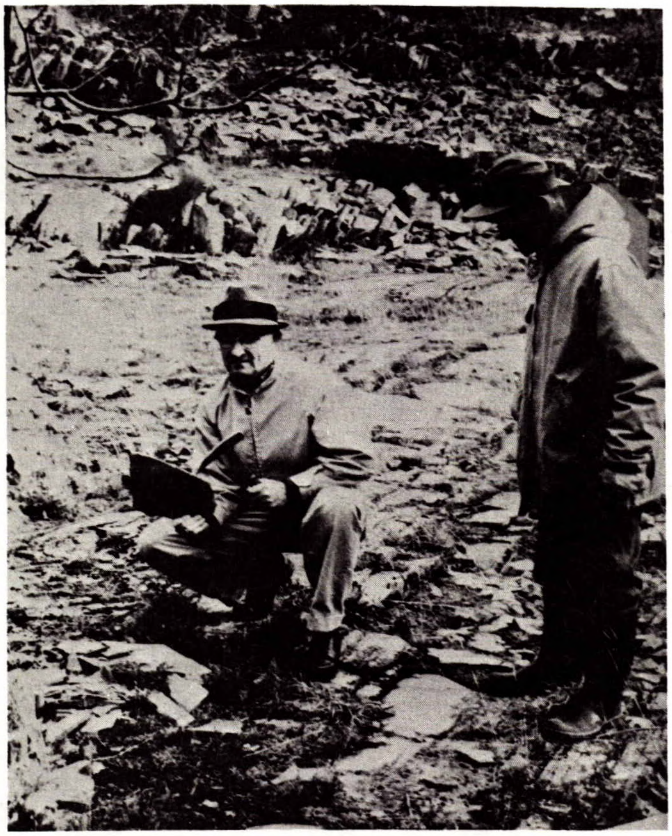

Figure 3. Chief Nahwegahbow (right) and Dr. A.B. Irwin examining a thin slab of quartzite. Note dip of quartzite slabs (cleavage planes) in background, and cleaved rock (surface indication) at the Chief's left foot.

Figure 4. View of cleavage characteristic of rock in the area. Large quarry (compare size of slabs with overturned picnic table).

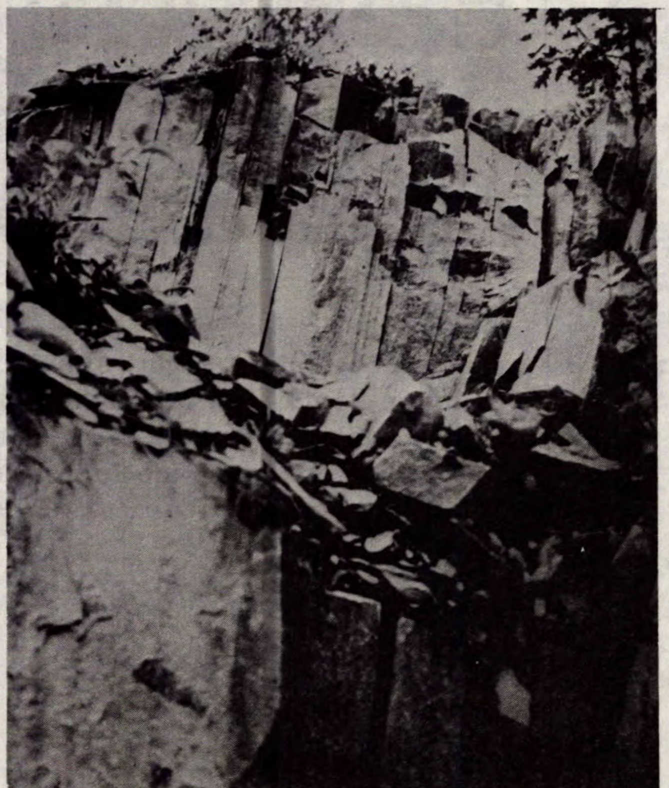

Figure 5. Upper portion of the large quarry, immediately above view in Figure 4. Well defined cleavage and massive slabs prominent.

in assessing the suitability or extent of any rock deposit simply from surface indications. Note the hopelessness of trying to assess the potential value of the cleaved rock shown at the Chief's left foot in Figure 3. It was pointed out that, in many areas, tremendous amounts of rock might have to be removed to recover small pockets of suitable material. Ridges, such as exist in the background of Figure 3, afford one means of visually locating pockets of suitable rock.

The possibility of exploring rock below the surface by diamond-drill core recovery was discussed, but it was suggested that this method was an unlikely means of exploration since fracturing in these folded and faulted rocks would make mapping of cleavage patterns impossible.

Probably the most suitable means of quarrying this type of rock would be to locate, in addition to indications of reasonably good cleavage, a deposit so structurally located that a face could be readily opened for quarrying, i.e. a side-hill exposure. Such a deposit is shown in Figures 4 and 5. It is evident that a large quantity of rock has been removed and that a large reserve remains available to quarrying.

The Chief stated that dynamite had been used to free masses of rock in the quarries. It was suggested that this practice be stopped because of the danger of increasing fracturing in the surrounding rocks. The use of small amounts of black powder to loosen key blocks or slabs was recommended. With one side of the deposit exposed, very little pressure with hammer and chisel would be required to dislodge slabs.

It was also suggested that the quarries be kept free of waste rock. More efficient quarrying would result if all rock quarried, both suitable and waste, were removed from the immediate quarry area.

The writer also recommended that an area be maintained where efficient grading of slabs and blocks could be made for stockpiling according to size, colour and type of slab or block.

DISCUSSION

The rock, which is a well-consolidated, micaceous quartzite, has adequate strength and durability to meet the necessary requirements for use. Sufficient corroborative evidence is available to establish a record of strength and durability. The material has been used with great success in the flooring of one of the central subway stations in Montreal's Metro. Panels of the material manufactured by a Montreal stone dealer (Mr. N. Braunsch of Terra Tile of Canada) have been obtained and are on view in the Construction Materials Section at the Mines Branch.

The rock can be used for flooring, patios, wall slabs and pre-cast panels for inside and outside applications, if a mottled, iron-stained surface is acceptable. Staining may increase under certain weathering conditions. Where this is not desirable, use of the stone must be restricted to inside locations. Care must also be exercised, in placing the slabs, to protect clothing which readily becomes soiled when in contact with the oxidized surfaces of the rock.

The rock's aesthetic quality is due to the staining, which is mottled in all shades of buff-yellow to deep brown-red. Added to the beauty of this mottling is the natural roughness of the cleavage surface. In some cases, outlines of the original bedding planes appear across the cleavage plane; these are visible as ridges across the face of the stone in sufficient relief to cast a shadow, depending on the direction of light (see Figure 6).

Figure 7 shows a pre-cast panel 18 inches square. The different-sized dimensioned slabs used in its construction range from 1/4 to 5/8 inch in thickness and are placed on a mortar backing to make a panel having an overall thickness of 1 3/4 inches. The mottled staining is shown on the panel in this photograph, as well as on the 18-inch-long slab in Figure 6.

Single-thickness slabs of sound material should be used, in order to eliminate such defects as are shown in Figure 8 (a, b and c). The lower slab (a) shows a parting developing in what appeared to be an otherwise sound slab. The separation is along a less well-defined cleavage plane. Careful examination shows a potentially similar plane of weakness about one third of the slab's thickness from the bottom. The middle sample (b) shows a composite slab to illustrate the multi-layer characteristic often encountered in this outcrop (the cleavage planes have been accentuated by soaking the sample in water). Finally, the third slab (c) in Figure 8 illustrates the presence of oxidized iron-rich minerals interfingered between cleavage planes in the thin slab. Staining will continue to develop from these oxidized minerals as the surface is either worn or dressed to greater depth.

Figure 9 shows a polished, 1 1/2-inch-square sample cut from a deep brown-red oxidized slab. Zones or layers containing concentrated iron oxide can be seen outlined on the side of the larger sample of rock, at the corner near the number '359'. Numerous small spots of oxidized iron-rich minerals can be seen on the surface of the polished square, by binocular microscope or hand lens.

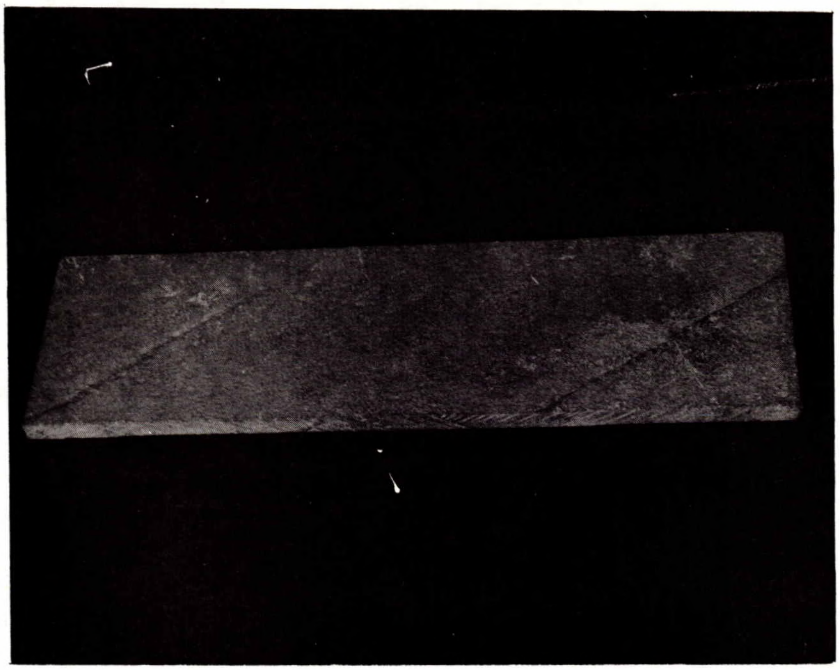

Figure 6. Bedding planes in relief on cleavage plane.

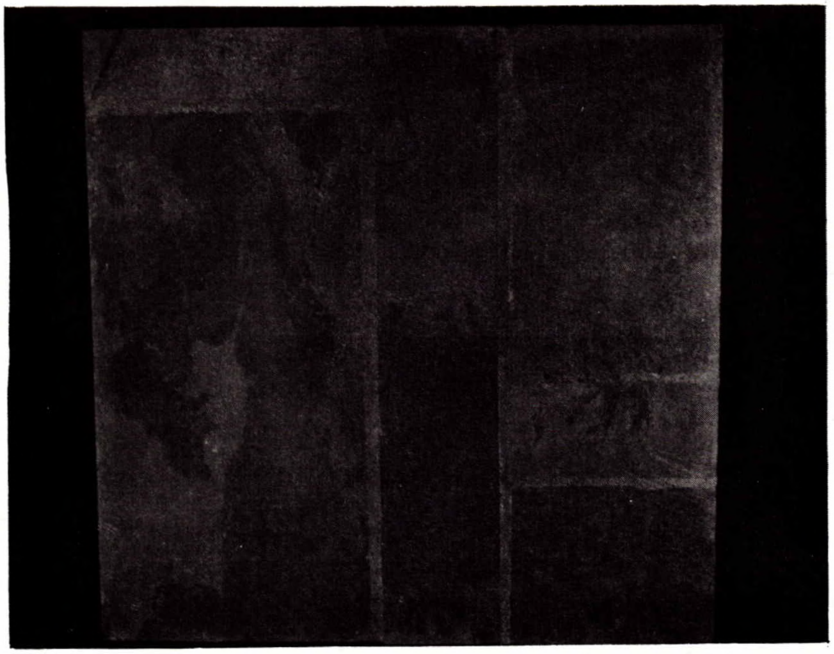

Figure 7. An 18-inch pre-cast panel made with dimensioned slabs of quartzite, backed with concrete.

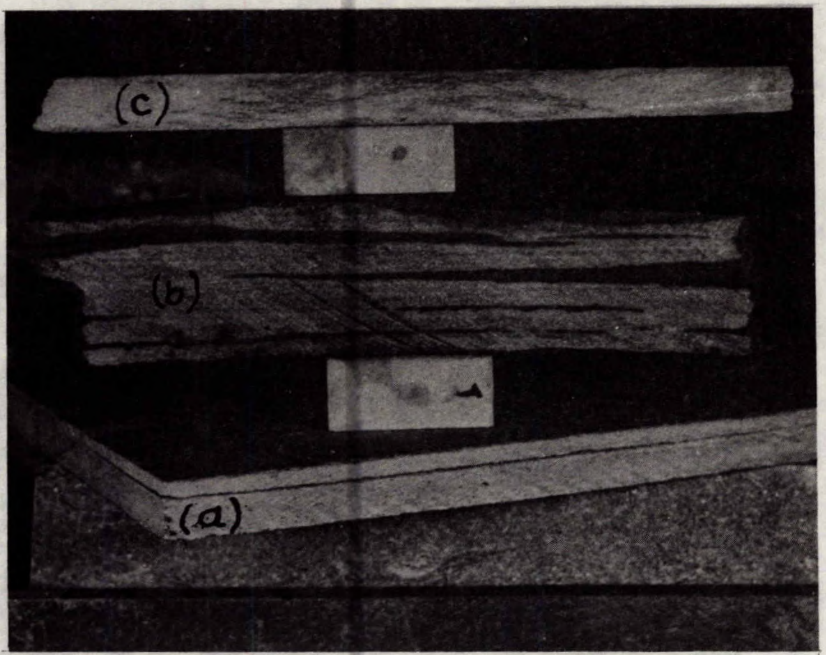

Figure 8. Three slabs showing (a) parting within a prepared slab, (b) multi-layer slab, (c) a zone of oxidized iron-rich minerals within a thin quartzite slab.

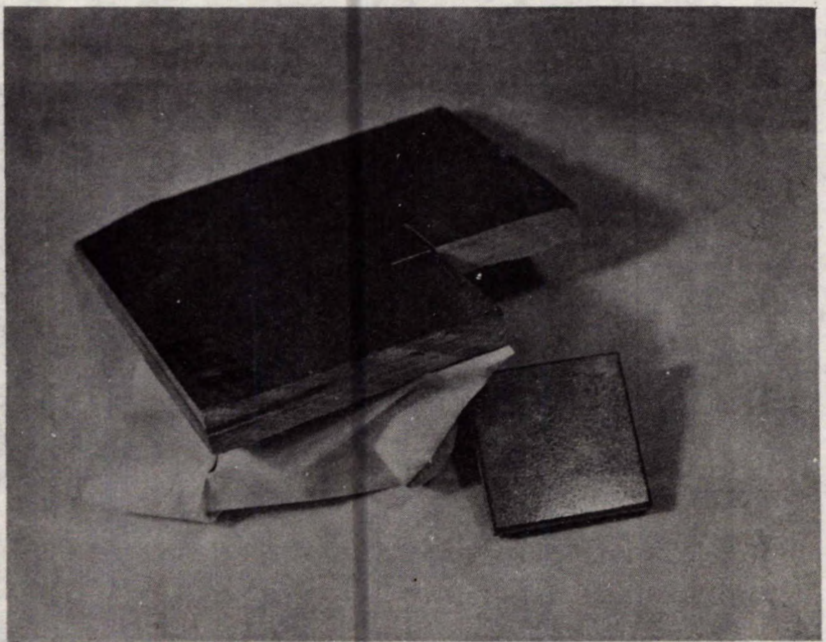

Figure 9. A 1 1/2-inch square cut from a thin, highly oxidized brown-red slab and polished to a high gloss (note glare from light on the small sample).

CONCLUSIONS

The rock discussed in this report, when carefully selected, is satisfactory for use for both inside and outside applications in patios, walks, walls, and ornamental architectural installations. Its value as a manufactured product in slabs and panels has been amply tested by past performance.

It has a distinct aesthetic quality that is mainly due to its mottled, iron-stained appearance and to the natural, rough-finished surface of the cleavage planes. The cleaved surfaces also impart a partially shiny appearance, due to the presence of fine micaceous particles throughout the stone.

Defects and features to be guarded against have been discussed and illustrated. Some difficult quarrying problems were also pointed out. Systematic good quarrying procedure and a stockpiling plan were advocated for efficient exploitation of this rock.

Finally, there is included, as appendix 2 of this report, a summary of a meeting held in the Mineral Processing Division at Ottawa, on November 7, 1967, to discuss the problem at greater length.

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ONTARIO DEPARTMENT OF MINES

PRELIMINARY GEOLOGICAL MAP No. P. 442

BAY OF ISLANDS-McGREGOR BAY AREA

McGREGOR BAY SHEET (WEST HALF)

DISTRICTS OF SUDBURY AND MANITOULIN

Scale 1 inch to 1/4 mile

N.T.S. Reference: 41 I/4
G.S.C. Aeromagnetic Map: 1522G

LITHOLOGIC LEGEND

Bay of Islands - McGregor Bay Area

CENOZOIC
PLEISTOCENE AND RECENT
Sand, gravel, clay
Unconformity

PALEOZOIC
ORDOVICIAN

8
- 8a Limestone, dolomite
- 8b Shale
- 8c Conglomerate, sandstone

Unconformity

QUARTZITE

3
- 3a White, medium- to coarse-grained quartzite
- 3b White, fine-grained quartzite
- 3c Feldspathic quartzite, arkose
- 3d Biotitic quartzite, protoquartzite, subgreywacke
- 3e Ferruginous, muscovitic quartzite
- 3f Green, muscovite quartzite

CONGLOMERATE

2
- 2a Polymictic paraconglomerate, protoquartzite matrix
- 2b Polymictic paraconglomerate, greywacke matrix
- 2c Polymictic paraconglomerate, laminated argillite matrix
- 2d Polymictic orthoconglomerate
- 2e Oligomictic quartz pebble conglomerate
- 2f Quartz-jasper pebble conglomerate

PELITE

1
- 1a Muscovitic and chloritic metapelite
- 1b Biotitic metapelite
- 1c Chloritoid metapelite
- 1d Garnet metapelite
- 1e Siltstone, argillite
- 1f Laminated argillite

LIST OF OCCURRENCES, BAY OF ISLANDS - McGREGOR BAY AREA

1. Wallace mine - nickel, copper
2. Iroquois Island occurrences - copper, cobalt
3. McGregor Island - north shore occurrences - sulphide
4. McGregor Island, east channel occurrences - sulphide
5. McGregor Island, south shore occurrences - sulphide
6. High Island trap rock occurrence
7. Birch Island quarry - cleaved quartzite

APPENDIX 2

Meeting, November 7, 1967

A meeting was held in the writer's office at 40 Lydia Street, Ottawa. Mr. H.M. Woodrooffe, Chief of the Mineral Processing Division, personnel of the Department of Indian Affairs and Northern Development, Chief Nahwegahbow, Mr. N. Braunsch of Terra Tile of Canada, Montreal, and the writer were in attendance. Indian Affairs personnel included Dr. A.B. Irwin, Mr. V. Robinson, Superintendent of the Manitoulin Indian Agency, and Mr. P. Hare, Development Officer for the Regional Office, Toronto. No representative of the Department of Trade and Commerce was able to attend this meeting.

The writer showed a number of colour transparencies illustrating the quarrying operation and the appearance of the rock outcrops in the Whitefish River Indian Reserve area. Many problems concerning quarrying, manufacturing and marketing were discussed between the Chief of the Indian Band, the Department of Indian Affairs personnel, and Mr. Braunsch; little participation on the part of the Mines Branch personnel was necessary.

The writer pointed out, however, that if exclusive rights were granted to one purchaser for part of the product, quarrying would be jeopardized, inasmuch as only a small fraction of the total product might be marketed. The most efficient operation would result from the creation of markets for as much of the quarried rock as possible. Waste in this type of operation is excessively high even under the most favourable circumstances. Mr. Braunsch assured the group he did not expect exclusive purchase rights.

The writer commented upon the adverse effects of the new shipping rates for stone products in Quebec and Ontario, effective since the CPR took over Smith Transport Company. According to Mr. H. Weimer, a stone dealer at North Bay, the old rate from River Valley to North Bay was 17 to 20 cents per 100 lb. The current minimum rate is 32 cents per 100 lb, applicable only to shipments weighing over 40,000 lb. For a 5-ton shipment, the rate is $1.23 per 100 lb, literally six times the previous charge. Thus, small operations are seriously affected.

Current shipping rates from Sudbury to Toronto and to Montreal, obtained from Smith Transport Company in February 1968, are shown in the accompanying Table. Note that for less-than-truck-lot shipments of under 5 tons there is a market differential in rates for rough stone (unfinished) and manufactured products. Furthermore, manufactured products are considerably heavier; for example, the weight of the 18-inch patio tile of Figure 7 (43 lb) is almost exactly double that of an equivalent-size stone slab.

The following list shows the relationship of charges for rough and finished materials between Sudbury and Toronto and Sudbury and Montreal.

TABLE 1

Transport Rates ($) Per 100 lb from Sudbury, Ontario						
Toronto, Ontario			Montreal, P.Q.			
	Rough	Finished		Rough	Finished	Weight (lb)
A	2.63	3.32	A	2.68	3.35	0 to 499
B	2.39	2.63	B	2.68	3.17	500 to 999
C	2.14		C	2.68	2.39	1000 to 1999
D	1.74		D	2.68	2.75	2000 to 4999
E	1.51		E	2.52		5000 to 9999
12 ton*	1.13		F	2.26		10000 & over
15 ton*	0.97		15 ton*	1.45		
20 ton*	0.85		20 ton*	1.45		

*Rates charged on shipments up to five (5) short tons are given in five categories (by weight intervals) for Ontario and six for Quebec trucking. Additional quantities are classified as truck loads. Charges on truck loads are for maximum loading. A Tariff Bureau Association administers commodity regulations for different provinces; rates may vary according to local conditions. Any errors in the above table may be due to the writer's interpretation of the information given, or may be due to lack of knowledge of local regulations.

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