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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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MINES BRANCH INVESTIGATION REPORT IR 60-49

FOUNDRY POTENTIALITY OF TEN SAND SAMPLES SUBMITTED BY RIO TINTO MINING CO. OF CANADA LTD.

by

A. E. MURTON

PHYSICAL METALLURGY DIVISION

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SUMMARY OF RESULTS

Nine samples of crushed Potsdam sandstone and one of beach sand from Prince Edward Island were submitted for test to determine their suitability for use as foundry moulding sands.

The beach sand was found to be suitable for use as an iron and non-ferrous core sand. It contains about 95% quartz, but the mineral impurities make it unsuitable for use as steel foundry sand. The screen distribution is too narrow for use as a base for iron foundry synthetic moulding sand.

Compound and cracked grains in the crushed sandstone samples make them somewhat angular and brittle. In this condition they are inferior to the imported Ottawa and New Jersey sands now in use, although the inherent grain shape of the Potsdam sandstone is probably satisfactory. Selection of a suitable method of reduction would probably result in a suitable grade of foundry sand.

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INTRODUCTION

In a letter dated April 11, 1960, Mr. R. P. Ehrlich, P. Eng., Consulting Metallurgist for Rio Tinto Mining Co. of Canada, Ltd., 335 Bay Street, Toronto, Ontario, advised that he was shipping for foundry suitability tests eight samples of sand prepared by crushing Potsdam sandstone from two separate deposits. Samples S-1 to S-4 inclusive, from the first deposit, were sized material, and samples A, B, D-1, and D-2, from the second deposit were unsized.

Subsequently, two additional samples were submitted for test. Of these, S-5 was another sample of crushed Potsdam sandstone, and W-1 was a beach sand from Prince Edward Island.

MINERALOGICAL EXAMINATION AND SINTERING POINT

A small quantity of sample W-1 was sent to the Mineral Sciences Division of the Mines Branch for a mineralogical examination. They reported that the sample contained about 95% quartz, 4% feldspar, and 1% ferromagnesium minerals. This is about the same constitution as some of the better imported lake sands from the U.S.A., such as Juniata and Muskegon. These sands are used by non-ferrous and iron foundries as core sand and a base for synthetic sand systems. Their mineral impurities cause them to sinter at too low a temperature to be suitable for steel.

Sample W-1 had a "B" sintering point of about 2650°F. This compares with about 2400°F for imported lake sands. The higher sintering point would not be a great advantage, because it is not enough to make the sand suitable for steel.

The crushed sandstone samples were not tested for mineralogical content or sintering point, because after these sands have been scrubbed sufficiently for moulding, they are high enough in quartz content to make them suitable for steel.

MICROSCOPIC EXAMINATION

Photomicrographs of representative sand samples are shown in Figures 1-8 inclusive. Included are photomicrographs of sample D-2 after having been scrubbed for 30 minutes wet (about the consistency of beach sand) in a laboratory sand muller. Also included are photomicrographs of an Ottawa, Illinois sand, and a Muskegon, Michigan lake sand.

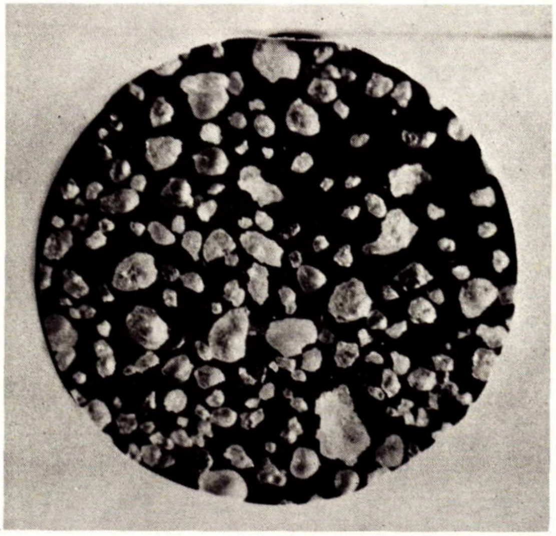

Figure 1 - (Sample B; X20)
Compound grains; a few fractured grains.

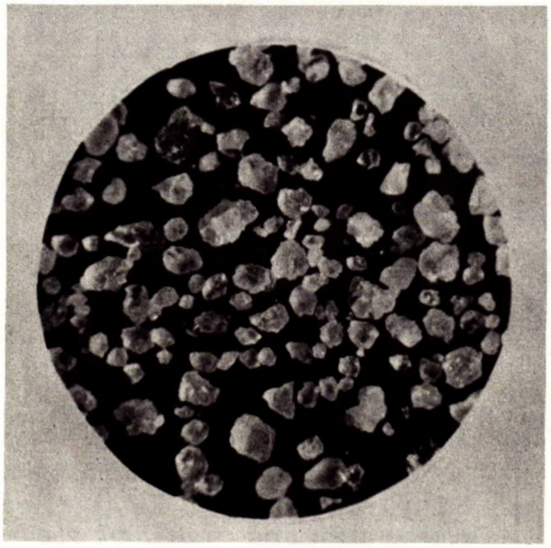

Figure 2 - (Sample D-2; X20)
Compound grains.

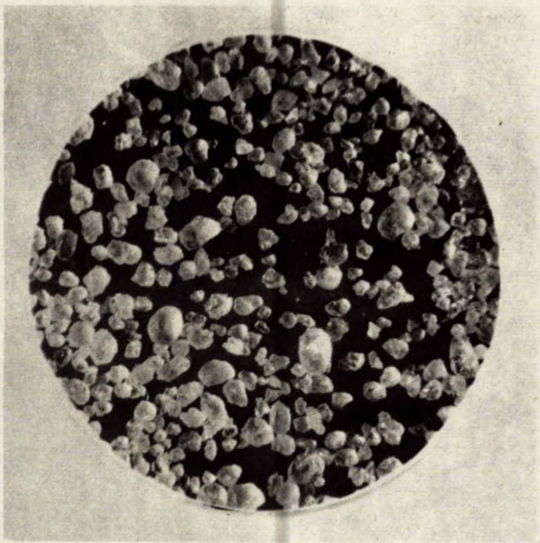

Figure 3 - (Sample D-2 scrubbed; X20)
A few compound grains left.

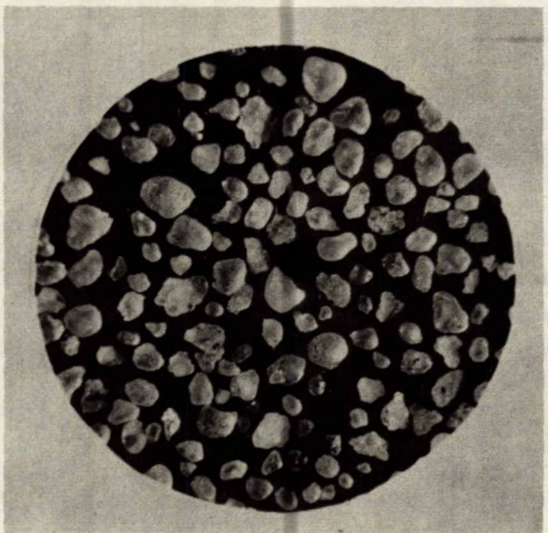

Figure 4 - (Sample S-2; X20)
Some compound and fractured grains.

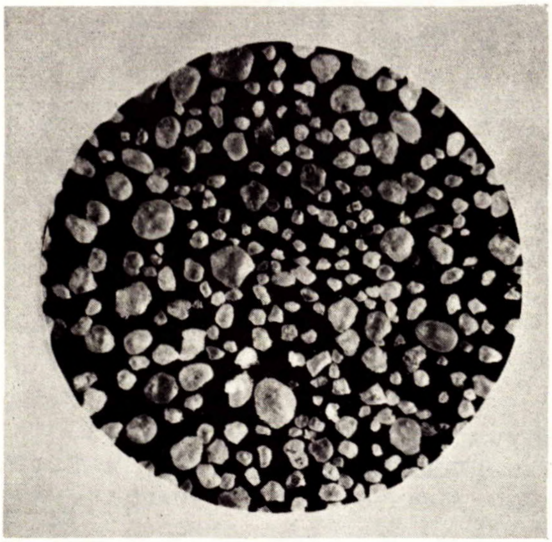

Figure 5 - (Sample S-5 - washed; X20)
A few compound and fractured grains.

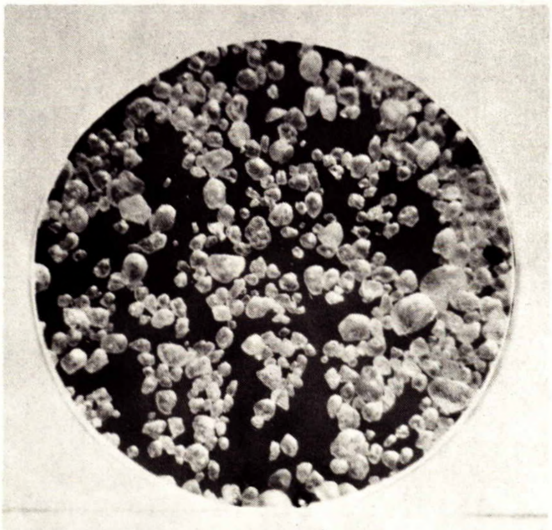

Figure 6 - (Ottawa "45"; X20)
Rounded grains.

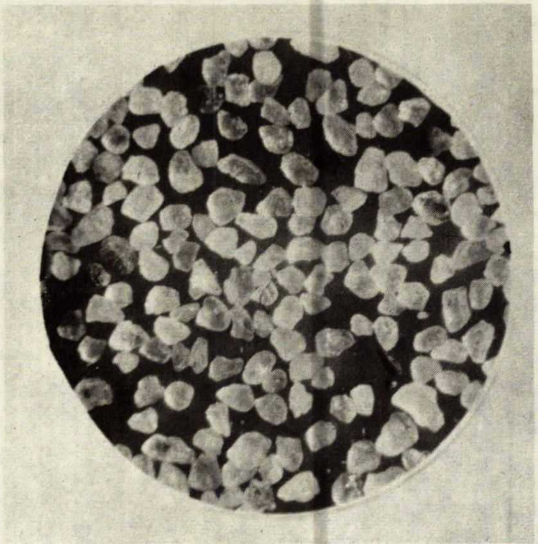

Figure 7 - (Sample W-1: X20)
Subangular grains. A few ferro-magnesium (black) minerals.

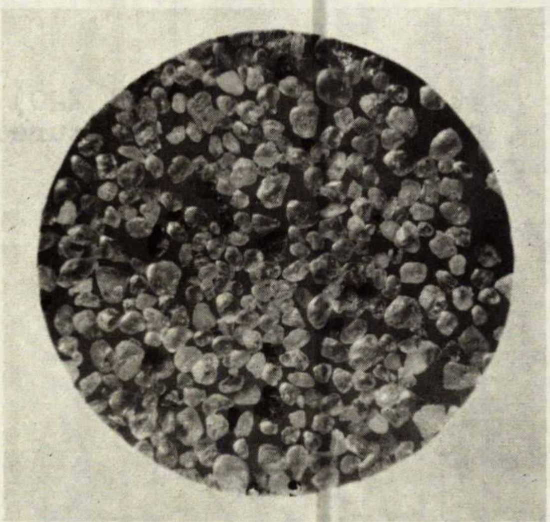

Figure 8 - (Muskegon X20)
Rounded grains. A few ferro-magnesium (black) minerals.

Screen Distribution

The screen distribution of the samples tested is shown in Table I.

TABLE 1 - Screen Distribution of Sand Samples

Per Cent Retained

U.S. Screen No.	A	B	B, Fines Removed	D-1	D-2	D-2; Scrubbed, Rewashed	S-1	S-2	S-3	S-4	S-5*, Washed	Composite S-1, 2, 3 Scrubbed Washed	W-1	Ottawa "45"
30	0.2	2.3	0.6	0.1	1.7	0.5	6.3	0.4	0.0	0.0	2.4	0.8	0.1	0.0
40	4.3	14.8	10.7	4.0	11.4	3.0	30.5	3.9	0.2	Trace	15.1	9.0	3.3	1.3
50	26.6	30.2	35.0	26.7	27.2	24.6	44.4	23.1	2.5	1.0	28.4	26.0	54.8	14.4
70	29.7	26.7	32.7	33.8	27.1	33.8	15.9	38.8	12.7	2.3	23.7	28.7	41.0	40.1
100	24.8	17.0	18.2	26.1	20.5	28.2	2.5	27.3	35.8	10.6	18.3	24.1	0.6	32.6
140	10.8	5.3	2.7	6.2	7.0	8.9	0.3	5.2	31.5	34.0	5.6	10.6	0.1	8.7
200	3.2	2.6	Trace	2.8	4.0	1.0	Trace	1.0	14.3	34.5	3.6	0.7	Trace	2.1
270	0.2	0.7	0.0	0.3	1.0	Trace	Trace	0.1	2.3	13.9	0.3	Trace	Trace	0.5
Pan	Trace	0.1	0.0	0.0	Trace	Trace	0.0	Trace	0.6	3.6	0.1	0.0	0.0	0.2
A.F.S. Fineness No.	60	53	49	58	57	58	38	56	90	130	53	56	44	62

*2.3% clay removed in washing.

MOULDING SAND PROPERTIES

The following mixture was used:

2500 g Sand

125 g Western Bentonite

25 g Cereal

Moisture to temper

Mulled 1 min dry, 6 min wet in laboratory sand muller

The properties obtained with the sands tested with this mixture are shown in Table 2. It will be seen that the Ottawa and New Jersey sands have the best combination of properties. The jolt test, which was made on three of these mixtures, is said by foundrymen to be related to the brittleness of the sand. By this test the New Jersey sand was the best, and sample S-5 (the best of the sandstone samples submitted) was much the worst. This test appears to corroborate the opinion of foundrymen that the New Jersey sand is best for moulding, although it is inferior to Ottawa sand for core-making.

CORE SAND PROPERTIES

The following mixture was used:

2000 g Sand

20 g Gelatinized corn flour

20 g AFS reference linseed oil

Water to temper

Mixed 1 min dry, 1 min with water, 5 min with oil in a laboratory paddle mixer

Baked $1\frac{1}{2}$ hr at $400^{\circ}F$.

TABLE 2 - Properties of Moulding Sand Mixtures

Sample	Moisture, per cent	Permeability	Green Compressive Strength, psi	Green Deformation, per cent	Green Tensile Strength, oz/in.^{2}	Dry Compressive Strength, psi	High Jolts to Break Overhang Specimen
A	3.4	163	7.4	3.65	12.6	158	-
B	3.3	178	7.2	3.45	11.6	96	-
B, fines out	3.3	243	7.2	3.8	13.2	89	-
D-1	3.4	198	8.3	3.0	13.2	104	-
D-2	3.4	193	7.7	3.8	13.4	105	-
D-2, scrubbed	3.5	151	7.9	4.0	15.0	137	-
S-1	3.5	417	6.7	4.3	14.8	114	-
S-2	3.5	198	7.1	4.8	15.8	176	-
S-3	3.6	88	6.6	4.6	12.2	230	-
S-4	3.8	61	6.6	3.8	11.0	221	-
S-5	3.5	185	8.0	3.9	15.0	130	129
W-1	3.5	151	7.9	4.25	15.2	113	-
Ottawa "45"	3.3	146	8.3	4.8	16.4	118	210
New Jersey "62"	3.5	134	8.1	4.5	19.0	169	245

The results obtained with this mixture are shown in Table III.

These results are similar to those obtained with the moulding sand mixture. The crushed sandstone samples are more brittle than the Ottawa and New Jersey sands, as is shown by the jolt test. Sample W-1 is also fairly sensitive to the jolt test, but it is likely that this result may be partly caused by the poor screen distribution.

PREPARATION OF SCRUBBED SAMPLES

Two samples were upgraded by scrubbing them for thirty minutes in a laboratory sand muller. For this test the samples were saturated with water, but had no excess moisture. This moisture content (about 10%) made them about the consistency of beach sand. The samples so treated were D-2, and a composite of S-1, S-2, and S-3. The improvement in properties effected by this treatment is evident in the photomicrograph (Figure 3) and Tables 2 and 3. About 10% of the material was lost in washing and screening.

DISCUSSION

The tests indicate that high quality moulding sands are not easily prepared from Potsdam sandstones. Compound grains, portions of small grains adhering to larger ones, and fractured grains make the sand in effect angular, although the inherent grain shape may be favourable. Many compound grains are quite fine, and it is difficult to break

Table 3 - Properties of Core Sand Mixtures

Sample	Green Compressive Strength, psi	Jolts to Break Overhang Specimen		Baked Tensile Strength, psi
		High Jolt	Low Jolt	
B, fines out	-	1	1	220
D-2	0.93	1	1	187
S-1	0.51	1	2	254
S-2	0.77	1	2	276
S-3	1.05	1	1	302
S-4	1.21	1	1	231
S-5	0.74	1.5	3.75	286
S-1, 2, 3 scrubbed	0.70	2	4	303
Ottawa "45"	0.82	3	7	362
W-1	0.53	1.5	3.75	260
New Jersey "62"	0.95	2.75	5.5	317

them up without fracturing larger grains which are also present.

It is probable that good foundry sands could be prepared from Potsdam sandstones by the use of suitable equipment. A scrubbing, abrasive action is required. Possibly a kent mill would be satisfactory, although it might be necessary to use rubber wheels and liners. Another possibility is the use of a periphally discharged rod mill. It may be necessary to have more than one unit in series. Preliminary crushing to about 16 mesh could be made on rolls.

Foundrymen's choice of sand is based on price and quality, and they would undoubtedly try to use an inferior sand if the price was lower.

CONCLUSIONS

1. The samples of crushed sandstone submitted for test are inferior to imported New Jersey and Ottawa sands now used. Compound and fractured grains have the effect of making the sand angular and brittle in moulding and core-making.
2. The inherent grain shape of the Potsdam sandstone is satisfactory, and, as this is brought out, the properties of the sand are improved. Probably a suitable method of preparation would produce a good foundry sand.

3. Sample W-1 is suitable for use as an iron foundry and non-ferrous core sand. It sinters at too low a temperature to be suitable for steel. It has too narrow a screen distribution to be suitable for a base for synthetic moulding sand.

AEM/KW