O T T A W A September 12th, 1941.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1091.

Gravity and Flotation Concentration of Manganese Ores from the Sussex Manganese Mining Company Limited, Sussex, New Brunswick.

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Shipment:

The shipment, received on June 25th, 1941, consisted of two barrels of ore, marked 'Main Vein' and 'Tunnel Sample', weighing 690 pounds and 510 pounds respectively. These samples from the Jordan Mountain mine at Sussex, New Brunswick, were submitted by M. E. Gough, President, Sussex Manganese Mining Company Limited, 80 Hammersmith Avenue, Toronto, Ontario.

Purpose of the Experimental Tests:

The tests on the two ores were run to determine what grade of concentrate could be produced and to determine the recovery of the manganese.

Characteristics of the Ore:

Four polished sections, prepared from the sample marked 'Main Vein', were examined microscopically for the purpose of determining the character of the ore.

In the polished surfaces the ore appears to be a breccia composed of a hard reddish-brown siliceous rock, cemented with fine-grained manganese oxide, largely pyrolusite and some manganite. This cement forms only a small proportion of the total mineral content of the sections.

A small percentage of manganese oxide also occurs within the angular rock fragments as sparsely disseminated, tiny particles, down to the limits of the microscope (about one micron) in size.

Sampling and Analysis:

The two samples were crushed to minus 5/8 inch for the gravity concentration tests and samples for analysis were cut from the heads. The analyses were as follows:

		Main Vein Per cent	Tunnel Sample Per cent
Manganese	-	19.03	9.51
Iron	-	1.34	1.90
Lead	-	Nil	Nil
Copper	-	0.034	0.03
Phosphorus	-	0.022	0.04
Sulphur	-	0.11	0.10
SiO_2	-	50.11	61.15

Experimental Tests:

The tests were run on both samples of ore using gravity concentration (where jigs and tables were used) and flotation.

(Continued on next page)

(Experimental Tests, cont'd) -

The results obtained on the ore by gravity concentration at coarse sizes were not good, as it was not possible to produce a metallurgical grade of product. Flotation tests produced a fairly good grade concentrate but as purchasers' requirements specify a maximum of 12½ per cent minus 20 mesh fines, the flotation concentrates would require a nodulizing or briquetting process which would increase the milling costs considerably. This difficulty is due to the fine size of the manganese oxide particles and their dissemination throughout the gangue, mentioned in "Characteristics of the Ore."

PART I. - MAIN VEIN SAMPLE.

Gravity Concentration.

Test No. 1.

In this test the ore which had been crushed to minus 5/8 inch was first screened to remove the minus 14 mesh material and then passed through a two-compartment laboratory Harz jig. The results are as follows:

Product	Weight, per cent	Assay, Mn, per cent	Distribution of manganese, per cent
Jig concentrate	23.9	32.72	39.12
Jig middling	33.8	18.50	31.28
Jig tailing	42.3	13.99	29.60
Feed	100.0	19.99*	100.00

* Calculated.

Test No. 2.

In this test the minus 14 mesh material from Test No. 1 was passed over the laboratory-size Wilfley concentrating table. The results are as follows:

(Continued on next page)

(Test No. 2, cont'd) -

Product	Weight, per cent	Assay, Mn, per cent	Distribution of manganese, per cent
1st concentrate	3.83**	43.26	12.21
2nd concentrate	2.76**	42.76	8.70
Middling	2.78	23.48	4.81
Sand tailing	87.08	10.57	67.85
Slime tailing	3.55	24.56	6.43
Feed	100.00	13.56*	100.00

* Calculated.

** Ratio of concentration (combined), 15.2:1.

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Test No. 3.

In this test the feed to the Harz jig was crushed to minus ¼ inch for the first pass, then the jig tailings were re-crushed to minus 6 mesh and rejigged. As the Harz jig was fitted with a 14-mesh bedding screen, the minus 14 mesh material in the feed passed into the hutches. This minus 14 mesh material was passed over the laboratory Wilfley table without further classification. The jig and table results were as follows:

Product	Weight, per cent	Assay, Mn, per cent	Distribution of manganese, per cent
1st jig conc.	23.8**	36.86	43.78
2nd jig conc.	10.8	22.61	12.18
Jig middling	19.5	10.53	10.24
Jig tailing	21.3	7.28	7.73
Table conc.	5.0**	43.98	10.97
Table middling	8.8	20.14	8.84
Table tailing	10.8	11.62	6.26
Feed	100.0	20.04*	100.00

* Calculated.

** Ratio of concentration (combined), 3.5:1.

It may be seen from the above results that a higher-grade product was made when treating the finer size of feed both in the jigging and tabling.

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Test No. 4.

In this test the ore was crushed to minus 14 mesh, the minus 24 mesh fraction was screened out from this product, and both screen fractions were tabled separately with no further classification. The results of treating the two sizes were calculated together (the No. 1 product in each case represents the -14+24 mesh fraction and the No. 2 product the minus 24 mesh fraction) as follows:

Product	Weight, per cent	Assay, Mn, per cent	Distribution of manganese, per cent
1st table conc.	8.75◆◆	39.95	17.65
2nd table conc.	14.55◆◆	40.88	30.01
1st table middling	15.13	15.80	12.06
2nd table middling	24.44	13.94	17.19
1st table sand tailing	13.46	8.05	5.46
2nd table sand tailing	14.45	9.75	7.11
Combined slimes	9.22	22.61	10.52
Feed	100.00	19.81◆	100.00

◆ Calculated.

◆◆ Ratio of concentration (combined), 4.3:1.

It may be seen that in this test the grade of the concentrate was quite high and the recovery approached 50 per cent.

Flotation.

Tests Nos. 5 and 6.

In these tests ore at minus 14 mesh was ground at 57 per cent solids to 56.9 per cent minus 200 mesh and 61.8 per cent minus 200 mesh in Tests Nos. 5 and 6 respectively. The ground pulp was transferred to a laboratory flotation cell and floated at 44 per cent solids.

(Continued on next page)

(Tests Nos. 5 and 6, cont'd) -

The reagents used were as follows:

		Test No. 5. Lb./ton	Test No. 6. Lb./ton
Grinding:			
Kerosene	-	1.0	0.2
Sodium silicate	-	2.0	1.0
Soda ash	-	2.0	1.0
Oleic acid	-	---	0.28
Roughing:			
Sodium silicate	-	1.0	---
Oleic acid	-	0.84	1.12
Frother B-23	-	0.05	---
Cleaning:			
Oleic acid	-	0.14	---
Sodium silicate	-	---	0.4

The screen tests on the flotation tailings were as follows:

Mesh		Test No. 5. Weight, per cent	Test No. 6. Weight, per cent
+65	-	2.1	1.7
+100	-	8.0	7.2
+150	-	16.8	15.0
+200	-	16.2	14.2
-200	-	56.9	61.8
		100.0	100.0

Test No. 5:

Product	Weight, per cent	Assay, Mn, per cent	Distribution of manganese, per cent
Concentrate	24.84◆◆	45.66	55.27
Middling	13.57	25.49	16.85
Tailing	61.59	9.29	27.88
Feed	100.00	20.52◆	100.00

◆ Calculated.

◆◆ Ratio of concentration, 4.0:1.

Test No. 6:

Product	Weight, per cent	Assay, Mn, per cent	Distribution of manganese, per cent
Concentrate	25.02◆◆	42.75	54.76
Middling	13.88	29.58	21.02
Tailing	61.10	7.74	24.22
Feed	100.00	19.53◆	100.00

◆ Calculated. ◆◆ Ratio of concentration, 4.0:1.

(Tests Nos. 5 and 6, cont'd) -

From these two tests it may be seen that a fairly high grade of concentrate may be produced with a fair recovery. The insoluble in the concentrate in both these tests was approximately 22 per cent.

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Test No. 7.

In this test ore at minus 14 mesh was ground at 57 per cent solids, to 78.8 per cent minus 200 mesh. The ground pulp was transferred to a laboratory-size flotation cell and the rougher flotation carried out at 44 per cent solids. The rougher flotation concentrate was cleaned twice in an endeavour to produce a high-grade concentrate with a low insoluble content.

The reagents used were as follows:

		Lb./ton
Grinding:		
Kerosene	-	0.2
Quebracho*	-	1.0
Soda ash	-	1.0
Oleic acid	-	0.28
Roughing:		
Oleic acid	-	1.12
1st Cleaning:		
Quebracho*	-	0.4
Oleic acid	-	0.14
2nd Cleaning:		
Quebracho*	-	0.2
Oleic acid	-	0.07
Pine oil	-	0.05

* Quebracho is a crude tannic acid extract.

The screen tests on the final tailing gave the following results:

Mesh	Weight, per cent
+ 65	-
+100	3.0
+150	10.5
+200	7.7
-200	78.8
	100.0

(Test No. 7, cont'd) -

Results:

Product	Weight, per cent	Assay, Mn, per cent	Distribution of manganese, per cent
Concentrate$^{\Phi\Phi}$	16.50$^{\#}$	45.67	38.95
Middling	25.95	30.80	41.32
Tailing	57.55	6.63	19.73
Feed	100.00	19.34$^{\Phi}$	100.00

$^{\#}$Ratio of concentration, 6.1:1.

$^{\Phi}$ Calculated.

$^{\Phi\Phi}$ Insoluble - 20.73 per cent.

From a comparison of the results obtained in this test with those of Tests Nos. 5 and 6, it appears that there is a certain maximum grade of concentrate that may be obtained when treating this ore. The second stage of cleaning used in this test did not raise the grade materially, and it did lower the manganese recovery somewhat. The extremely close association between the manganese oxide and the gangue, as mentioned under the heading "Characteristics of the Ore," does not allow a complete separation of the mineral particles within the economic limits of grinding.

PART II. - TUNNEL SAMPLE.

Gravity Concentration.

Test No. 8.

For this test the feed to the laboratory Harz jig was crushed all minus 6 mesh. The ore was passed through the jig twice. The product from the first pass was called the concentrate and that from the second pass was called the middling. The material passing into the hutch

(Test No. 8, cont'd) -

through the 14-mesh bedding screen was tabled on a Wilfley laboratory table. The results of the test were as follows:

Product	Weight, per cent	Assay, Mn, per cent	Distribution of manganese, per cent
Jig concentrate	9.8	22.55	23.9
Jig middling	10.9	9.17	10.8
Jig tailing	47.9	3.58	18.6
Table concentrate	4.3◆◆	46.80	21.8
Table middling	4.0	22.70	9.9
Table sand tailing	21.9	5.28	13.0
Table slime tailing	1.2	15.75	2.0
Feed	100.0	9.23◆	100.0

◆ Calculated.

◆◆ Ratio of concentration, 23.3:1.

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Test No. 9.

For this test the ore was crushed all minus 20 mesh and passed over the Wilfley laboratory table without further classification. The results are as follows:

Product	Weight, per cent	Assay, Mn, per cent	Distribution of manganese, per cent
Table concentrate	15.38◆◆	39.98	50.38
Table middling	11.34	11.73	10.89
Table sand tailing	58.97	4.75	22.95
Table slime tailing	14.31	13.47	15.78
Feed	100.00	12.20◆	100.00

◆ Calculated.

◆◆ Ratio of concentration, 6.5:1.

Tests Nos. 8 and 9 indicate that it is possible to make a fairly high grade of concentrate with a fair recovery if this low-grade ore is crushed to a fine size. The slime loss involved in this fine crushing is, however, a difficult problem to overcome as well as the fact that a

(Test No. 9, cont'd) -

fine concentrate must be nodulized or briquetted. Flotation will recover the slimes, though briquetting is still necessary.

Flotation.

Tests Nos. 10 and 11.

In these tests the ore at minus 14 mesh was ground at 57 per cent solids to 42.6 and 59.6 per cent minus 200 mesh for Tests Nos. 10 and 11 respectively. The ground pulp was transferred to a laboratory flotation cell and the rougher flotation carried out at 44 per cent solids. The cleaning was at 7 per cent solids.

The reagents used were as follows:

		Test No. 10. Lb./ton	Test No. 11. Lb./ton
Grinding:			
Kerosene	-	0.2	0.2
Quebracho	-	1.0	1.0
Soda ash	-	1.0	1.0
Oleic acid	-	0.28	0.28
Roughing:			
Oleic acid	-	0.56	0.56

The screen tests on the final tailings gave the following results:

Mesh	Test No. 10. Weight, per cent	Test No. 11. Weight, per cent
+ 48	3.5	-
+ 65	9.0	2.5
+100	15.2	8.3
+150	17.3	14.4
+200	12.4	15.2
-200	42.6	59.6
	100.0	100.0

(Continued on next page)

(Tests Nos. 10 and 11, cont'd) -

Test No. 10:

Product	Weight, per cent	Assay, Mn, per cent	Distribution of manganese, per cent
Concentrate	11.08**	42.0	50.00
Middling	2.66	14.9	4.25
Tailing	86.26	4.95	45.75
Feed	100.00	9.32*	100.00

* Calculated.

** Ratio of concentration, 9.0:1.

Test No. 11:

Product	Weight, per cent	Assay, Mn, per cent	Distribution of manganese, per cent
Concentrate	13.98**	40.50	61.65
Middling	3.17	14.00	4.84
Tailing	82.85	3.74	33.51
Feed	100.00	9.19*	100.00

* Calculated.

** Ratio of concentration, 7.2:1.

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Test No. 12.

In this test the ore at minus 14 mesh was ground at 57 per cent solids to 36.2 per cent minus 200 mesh. The ground pulp was floated at 44 per cent solids and the rougher concentrates were cleaned at 30 per cent solids.

The reagents used were as follows:

		Lb./ton
Grinding:		
Kerosene	-	0.2
Quebracho	-	1.0
Oleic acid	-	0.35
Soda ash	-	1.0
Roughing:		
Kerosene	-	0.125
Oleic acid	-	0.42
Pine oil	-	0.037
Cresylic acid	-	0.044
1st Cleaning: Quebracho	-	0.25
2nd Cleaning: Quebracho	-	0.25

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(Test No. 12, cont'd) -

The screen test on the final tailing was as follows:

Mesh	Weight, per cent
+ 65	16.7
+100	17.5
+150	17.9
+200	11.7
-200	36.2
	100.0

Results:

Product	Weight, per cent	Assay, Mn, per cent	Distribution of manganese, per cent
Concentrate	8.96◆◆	44.44	45.26
Middling	9.49	15.52	16.74
Tailing	81.55	4.10	38.00
Feed	100.00	8.80◆	100.00

◆ Calculated.

◆◆ Ratio of concentration, 11.2:1.

This test indicates that by cleaning a rougher concentrate at a high density, a high-grade (44.4 per cent Mn) concentrate may be produced with a fair (45 per cent) recovery. The coarse grinding in this test somewhat lowered the recovery over that shown in Test No. 11.

Summary and Conclusions:

The various tests conducted on both the high-grade 'Main Vein' sample and the lower-grade 'Tunnel' sample indicate that some degree of concentration is possible.

Gravity concentration at the coarse sizes required for metallurgical manganese ore did not allow the production of a high-grade concentrate or a high recovery from either ore.

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(Summary and Conclusions, cont'd) -

In Test No. 3 the combined jig and table concentrates contained only 41.5 per cent manganese with a recovery of 54.75 per cent, while in Test No. 8 on the low-grade sample although the table concentrate contained 46.8 per cent manganese the recovery was only 21.8 per cent. The slime loss is high when treating these ores by gravity concentration methods.

Flotation allowed the production of concentrates containing 45.6 per cent manganese, with a recovery of 55 per cent of the mineral in Test No. 5 on the high-grade ore. On the low-grade ore, as in Test No. 11, the concentrate had a grade of 40.5 per cent manganese, containing 61.6 per cent of the total manganese. However, flotation requires that the ore be ground fine and this process is expensive as well as giving a product which is too fine to be accepted as furnace ore without a nodulizing or briquetting treatment.

It is doubtful whether the products from the treatment of ores such as those submitted would be of sufficient value to warrant any complicated treatment.

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OS:GB.

(Sussex Manganese Mining Co. Ltd.,)
(Investigation No. 1091.) -

Figure 1.

Photomicrograph showing fine-grained manganese oxide as the cementing material of a breccia and as tiny, sparsely disseminated particles within the rock fragments. The grade of ore pictured here is higher than the average represented by the four polished sections examined under the microscope.

Pyrolusite - white.
Gangue - grey.
Pits - black.

Magnification: 200X.

A 200-mesh grid is superimposed.

OS:PES.
(Nov./41)