O T T A W A January 10, 1945.

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ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1776.

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Concentration Tests on a Sample of Manganese Ore from the Steep Rock Iron Mines Limited, Steep Rock Lake, Ontario.

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Concentration Tests on a Sample of Manganese Ore
from the Steep Rock Iron Mines Limited,
Steep Rock Lake, Ontario.

Shipment:

A sample of float-manganese ore, weighing about 50 pounds, was received on August 25, 1944. The sample was submitted by Mr. M. W. Bartley, Production Engineer, Steep Rock Iron Mines Limited, Atikokan, Ontario.

Location of Property:

The property from which this sample was taken is located at Steep Rock Lake, near the town of Atikokan, Fort Frances mining division, northwestern Ontario.

Sampling and Assaying:

No head sample was cut for assay from the shipment since all of it was needed at a coarsely crushed size for a sink-and-float test, but head sample assays calculated from the products of a test are as follows:

(Continued on next page)

(Sampling and Assaying, cont'd) -

		Per Cent
Manganese (Mn)	-	28.56
Silica (SiO_2)	-	43.14
Alumina (Al_2O_3)	-	0.87
Loss on ignition	-	6.90
Iron oxide (Fe_2O_3)	-	6.35

Experimental Tests:

Attempts were made to concentrate the ore by sink-and-float and by ordinary flotation. The ore can be beneficiated considerably by sink-and-float alone but the sink product will carry 20 per cent or more of silica. By flotation it was found possible, with a certain reagent combination, to float the silica while the manganese was depressed with dextrine. In this way about 90 per cent of the manganese could be recovered in a product assaying from 50 to 54 per cent manganese and less than 5 per cent silica.

CONCLUSIONS:

The tests indicate that the ore can be beneficiated by sink-and-float but this process alone will not bring the silica down low enough to produce a marketable manganese concentrate. Indications are that with the feed to sink-and-float in the size range of -5/8"+8 mesh a product assaying 45.8 per cent manganese and 18.2 per cent SiO_2 would come direct from the operation.

Roasting to remove water of crystallization would bring these assays up to 50 per cent manganese and 19.9 per cent SiO_2. This seems to be the best that can be expected from sink-and-float alone.

This product, however, or the ore direct, could be ground in a ball mill and treated by flotation to remove the greater part of the silica and to give a product that would meet market requirements. So far this has only been accomplished by floating the silica away from the manganese, which

(Conclusions, cont'd) -

was depressed by dextrine. When attempts were made to float the manganese it was found that too much silica floated with it, and so far an efficient silica depressant has not been found.

Character of the Ore:

No microscopic examination was made of the ore, since all of it was needed for the sink-and-float test after crushing to minus 1 inch.

The sample, however, contained pyrolusite in a siliceous gangue carrying some carbonates. Quite a bit of siliceous material was fine and intimately associated with the manganese minerals.

DETAILS OF INVESTIGATION:

Test No. 1. - Sink-and-Float.

The ore was crushed to pass through a screen with 1-inch square openings. The -1" material was then fractionated on a series of screens at 1/8-inch intervals as follows: 7/8", ¾", 5/8", ½", 3/8". The next screen used was 8 mesh. The material finer than 8 mesh could not be treated by sink-and-float but was used for flotation tests that will be described later.

Density separations were then made on each of the screened fractions in a galena-water suspension. Three separations were made on each size fraction, the sink from the first separation being re-treated at a higher density and this procedure repeated once more to give an original float, two intermediate products and a final sink for each fraction. The products of these separations are given in the following size-density analysis:

(Continued on next page)

SIZE-DENSITY ANALYSIS

Product	Weight, per cent	Assays, per cent					Distribution, per cent				
		Mn	SiO_2	Al_2O_3	L.O.I.*	Fe_2O_3	Mn	SiO_2	Al_2O_3	L.O.I.	Fe_2O_3
-8 mesh fines	13.71	32.74	35.62	0.83	7.57	5.91	15.72	11.32	13.14	15.04	12.76
-6+8 mesh	1.65	22.75	50.11	0.81	6.58	6.22	1.31	1.92			
-4+6 mesh	1.74	15.43	59.98	1.18	5.56	7.23	0.94	2.42			
-3+4 mesh	1.74	11.53	67.30	1.19	5.05	7.32	0.70	2.72			
-3/8"+3 mesh	2.34	9.16	70.76	1.62	4.92	7.23	0.75	3.84			
-1/2"+3/8"	4.66	12.64	68.63	1.60	5.66	6.30	2.06	7.41			
-5/8"+1/2"	4.41	10.02	70.90	1.19	5.23	6.59	1.55	7.25			
-3/4"+5/8"	5.96	9.56	71.10	0.54	5.08	6.73	2.00	9.82			
-7/8"+3/4"	7.42	9.04	71.70	1.41	4.89	6.66	2.35	12.33			
-1"+7/8"	3.48	7.96	77.16	1.77	2.72	7.23	0.97	6.22			
Float @ 2.95	33.40	10.80	69.66	1.25	4.98	6.75	12.63	53.93	48.26	24.10	35.53
-6+8 mesh	0.46	33.37	35.36	0.91	7.40	5.61	0.54	0.38			
-4+6 mesh	0.45	30.84	39.46	0.93	7.03	6.52	0.49	0.41			
-3+4 mesh	0.53	27.20	45.56	0.79	6.52	7.12	0.50	0.56			
-3/8"+3 mesh	0.57	21.03	52.80	0.99	6.47	7.43	0.42	0.70			
-1/2"+3/8"	0.42	21.51	51.23	0.86	6.74	7.73	0.32	0.50			
-5/8"+1/2"	0.63	23.41	50.87	0.81	6.35	6.21	0.52	0.74			
-3/4"+5/8"	0.24	22.30	49.87	0.80	6.83	7.73	0.19	0.28			
-7/8"+3/4"	1.41	20.72	51.66	0.68	7.10	7.12	1.02	1.69			
-1"+7/8"	0.65	16.92	62.11	0.91	3.61	9.25	0.38	0.93			
Float @ 3.00; sink @ 2.95	5.36	23.32	49.82	0.83	6.26	7.20	4.38	6.19	5.11	5.00	6.08

* L.O.I. means per cent loss in weight on ignition.

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SIZE-DENSITY ANALYSIS (Continued)

Product	Weight, per cent	Assays, per cent					Distribution, per cent				
		Mn	SiO_2	Al_2O_3	L.O.I.	Fe_2O_3	Mn	SiO_2	Al_2O_3	L.O.I.	Fe_2O_3
-6+8 mesh	0.46	41.64	23.70	0.98	10.44	5.42	0.67	0.25			
-4+6 mesh	0.42	40.73	25.66	0.82	10.38	6.00	0.60	0.25			
-3+4 mesh	0.35	36.25	30.98	0.64	9.12	7.92	0.44	0.25			
-3/8"+3 mesh	0.27	35.01	32.10	0.71	9.00	8.05	0.33	0.20			
-½"+3/8"	0.32	29.98	38.70	2.85	7.68	9.07	0.34	0.29			
-5/8"+½"	0.48	29.98	38.72	0.71	8.90	8.05	0.50	0.43			
-¾"+5/8"	0.82	24.80	51.80	0.51	5.74	8.05	0.71	0.99			
-7/8"+¾"	0.88	25.65	47.06	0.35	8.50	6.15	0.79	0.96			
-1"+7/8"	0.70	25.10	53.16	0.85	5.64	7.17	0.62	0.86			
Float @ 3.00; sink @ 3.05	4.70	30.40	41.12	0.81	8.01	7.18	5.00	4.48	4.37	5.46	5.32
-6+8 mesh	0.72	45.55	16.77	0.49	8.72	4.55	1.15	0.28			
-4+6 mesh	1.29	46.97	15.69	0.68	8.65	4.70	2.12	0.47			
-3+4 mesh	2.49	47.29	15.83	0.39	8.83	5.23	4.12	0.90			
-3/8"+3 mesh	3.54	45.71	18.36	0.43	8.46	5.61	5.67	1.51			
-½"+3/8"	5.76	45.71	18.62	0.47	8.50	5.30	9.22	2.49			
-5/8"+½"	4.68	45.07	19.54	0.40	8.43	5.61	7.39	2.12			
-¾"+5/8"	9.19	40.17	26.65	0.66	7.89	5.76	12.93	5.68			
-7/8"+¾"	9.60	37.64	29.23	0.80	7.85	6.97	12.65	6.50			
-1"+7/8"	5.56	36.06	32.03	0.57	7.58	6.67	7.02	4.13			
Sink @ 3.05	42.83	41.52	25.02	0.59	8.12	5.98	62.27	24.08	29.12	50.40	40.31
Sink-and-float feed	86.29	27.89	44.34	0.87	6.79	6.42	84.28	88.68	86.86	84.96	87.24
Ore	100.00	28.56	43.14	0.87	6.90	6.35	100.00	100.00	100.00	100.00	100.00

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SUMMARY OF RESULTS OF SINK-AND-FLOAT SEPARATIONS.

(Size range of feed, -1"+8 mesh. Separating density, 3.05.)

Product	Weight, per cent	Assays, per cent					Distribution, per cent				
		Mn	SiO_2	Al_2O_3	L.O.I.	Fe_2O_3	Mn	SiO_2	Al_2O_3	L.O.I.	Fe_2O_3
-8 mesh fines	13.71	32.74	35.62	0.83	7.57	5.91	15.72	11.32	13.14	15.04	12.76
Sink @ 3.05	42.83	41.52	25.02	0.59	8.12	5.98	62.27	24.08	29.12	50.40	40.31
Sink and fines to further treatment	56.54	39.39	27.01	0.65	7.99	5.96	77.99	35.40	42.26	65.44	53.07
Float @ 3.05	43.46	14.46	64.12	1.15	5.49	6.86	22.01	64.60	57.74	34.56	46.93
Ore	100.00	28.56	43.14	0.87	6.90	6.35	100.00	100.00	100.00	100.00	100.00

(Size range of feed, 1"+8 mesh. Separating density, 3.00.)

Product	Weight, per cent	Assays, per cent					Distribution, per cent				
		Mn	SiO_2	Al_2O_3	L.O.I.	Fe_2O_3	Mn	SiO_2	Al_2O_3	L.O.I.	Fe_2O_3
-8 mesh fines	13.71	32.74	35.62	0.83	7.57	5.91	15.72	11.32	13.14	15.04	12.76
Sink @ 3.00	47.53	40.50	25.93	0.61	8.11	6.09	67.27	28.56	33.49	55.86	45.63
Sink and fines to further treatment	61.24	38.70	28.10	0.66	7.99	6.05	82.99	39.88	46.63	70.90	58.39
Float @ 3.00	38.76	12.53	66.91	1.19	5.18	6.82	17.01	60.22	53.37	29.10	41.61
Ore	100.00	28.56	43.14	0.87	6.90	6.35	100.00	100.00	100.00	100.00	100.00

(Size range of feed, 1"+8 mesh. Separating density, 2.95.)

Product	Weight, per cent	Assays, per cent					Distribution, per cent				
		Mn	SiO_2	Al_2O_3	L.O.I.	Fe_2O_3	Mn	SiO_2	Al_2O_3	L.O.I.	Fe_2O_3
-8 mesh fines	13.71	32.74	35.62	0.83	7.57	5.91	15.72	11.32	13.14	15.04	12.76
Sink @ 2.95	52.89	38.68	28.35	0.63	7.94	6.21	71.65	34.75	38.60	60.86	51.70
Sink and fines to further treatment	66.60	37.46	29.84	0.67	7.86	6.15	87.37	46.07	51.74	75.90	64.46
Float @ 2.95	33.40	10.80	69.66	1.25	4.98	6.75	12.63	53.93	48.26	24.10	35.54
Ore	100.00	28.56	43.14	0.87	6.90	6.35	100.00	100.00	100.00	100.00	100.00

(Test No. 1, cont'd) -

Looking at the size-density analysis, it will be noted in the fractions of Sink @ 3.05 that in the sizes coarser than 5/8" the manganese assays drop while the SiO_2 assays go up. This would indicate that if the feed to sink-and-float were in the size range -5/8"+8 mesh a better grade of product would be obtained. From the figures in the table, average grade of Sink @ 3.05 in the size range -5/8"+8 mesh would be 45.84 per cent manganese and 18.15 per cent SiO_2 as produced. After roasting to drive off water of crystallization, the assay would be 50.13 per cent manganese and 19.85 per cent SiO_2. This is believed to be the maximum grade obtainable by sink-and-float alone.

Test No. 2. - Flotation.

Flotation tests were conducted on samples of the products of the sink-and-float test, Float @ 2.95 and Sink @ 3.05, and also on the -8 mesh fines which was the nearest approach to the original ore that was available after the sink-and-float test had been made. Since there was only about 3,000 grams of -8 mesh fines, the greater part of the experimental flotation work was done on the rejects from the sink-and-float test. These tests were very encouraging and proved beyond doubt that the silica could be separated from the manganese. So far this has been possible only by floating the silica while the manganese is depressed by dextrine. It was not found possible to effectively depress the silica when attempts were made to float the manganese.

The results of a typical test carried out under the most ideal conditions thus far known are given below:

The sample was ground about 85 per cent finer than 200 mesh in a ball mill, with dextrine added at the

(Test No. 2, cont'd) -

rate of 4.0 pounds per ton and duPont 243 at the rate of 0.20 pound per ton. The silica was then floated with an additional 0.20 pound per ton of duPont 243 added to the cell. The pH value of the pulp was about 7.5. The concentrate was cleaned once.

Summary of Results:

Product	Weight, per cent	Assays, per cent			Distribution, per cent		
		Mn	Fe	Insol.	Mn	Fe	Insol.
Concentrate	28.3	4.44	3.03	89.80	3.52	21.56	71.76
Cleaner tailing	12.0	20.73	5.90	55.16	6.96	17.76	18.64
Flotation tailing	59.7	53.44	4.04	5.69	89.52	60.68	9.60
Feed (cal.)	100.0	35.66	3.98	35.41	100.00	100.00	100.00

In treating an ore of this type that is very low in manganese, a preliminary beneficiation by sink-and-float would appear to be good practice. Ore of the grade submitted can be treated by flotation alone.

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