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MINES BRANCH INVESTIGATION REPORT IR 59-40

CONCENTRATION TESTS ON A SAMPLE OF BEACH SANDS FROM NATASHQUAN RIVER, QUEBEC, SUBMITTED BY SOGEMINES CONSULTANTS, LTD.

by

J. D. JOHNSTON

MINERAL DRESSING AND PROCESS METALLURGY DIVISION

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CONCENTRATION TESTS ON A SAMPLE OF BEACH SANDS FROM THE MOUTH OF THE NATASHQUAN RIVER, QUEBEC, SUBMITTED BY SOGEMINES CONSULTANTS LTD., MONTREAL, QUEBEC.

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SUMMARY OF RESULTS

Small scale tests indicate that 53-54% of the iron present in the form of magnetite can be recovered without grinding, in a concentrate assaying about 65% iron.

Grinding the sands to 60% finer than 200 mesh will result in a concentrate assaying about 70% iron and containing about 48-49% of the iron present in the form of magnetite. This results in a loss of some iron in order to get the higher grade concentrate.

*Senior Scientific Officer, Mineral Dressing and Process Metallurgy Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

INTRODUCTION

A shipment of fifteen bags of beach sands, weighing 1465 lb, was received at the Mines Branch on July 9, 1958. This shipment was to be used for small scale testing. On July 30, 1958, a shipment of 24 tons arrived in 488 bags and was to be used for a larger scale test using semi-commercial equipment.

The shipments were submitted by Sogemines Consultants Ltd., 1980 Sherbrooke Street West, Montreal, Quebec.

It was requested that a magnetite concentrate be produced of as good grade as possible consistent with maximum recovery.

Location of Property

This material was taken from the beach of the Natashquan river at a point close to where the river empties into the Gulf of St. Lawrence.

Sampling and Analysis

A sample cut from the smaller shipment was assayed and reported as follows:

Iron	-	*18.5 %
Titanium dioxide	-	4.97 %
Phosphorus	-	0.08 %
Sulphur	-	0.069%
Acid insoluble	-	66.43 %
Silica	-	46.14 %

*Iron was determined by the Bi-sulphate method.

No bulk head sample was cut from the 24 ton shipment but it was sampled at regular intervals during the large scale runs made with it. These will be found in the section of this report dealing with the mill runs.

MINERALOGICAL EXAMINATION*

Procedure

A screen analysis was made of a head sample of the shipment. The individual screen fractions were then combined into +65 mesh and -65 mesh portions, and these were separated into their component minerals by a combination of heavy liquid and high intensity magnetic separations. The resulting mineral concentrates were examined microscopically to assess their purity and other characteristics: the transparent minerals in oil immersion under a petrographic microscope, and the opaque ones in polished sections under an ore microscope. This formed the basis for the mineral estimates shown below.

Results of Mineralogical Examination

The screen analysis of the sample of beach sand is shown in Table 1. The +65 and -65 mesh fractions total 49.0% and 51.0%, respectively.

TABLE 1

Screen Analysis of Head Sample

Mesh Size	Weight, %	
+28	0.2)	
-28 +35	2.0)	
-35 +48	13.3)	-49.0%
-48 +65	33.5)	
-65 +100	37.1)	
-100+150	11.0)	-51.0%
-150	2.9	
	100.0	

*From Mineralogical Investigation No. M-1615-E by E. H. Nickel, October 7, 1958.

The estimated mineral composition of these two fractions, determined according to the method noted above, is shown in Table 2.

TABLE 2

Estimated Mineral Composition of +65 and -65 Mesh Fractions

Minerals	+65 Mesh	-65 Mesh
Magnetite	2%	32%
Ilmenite + hematite	2	26
Quartz + feldspar	79	15
Hornblende	9	11
Pyroxene	5	9
Garnet	1.2	6
Sphene	0.6	1.1
Zircon	---	0.9
Rutile	---	Less than 0.1%
Monazite	---	Less than 0.1%

It is immediately evident from Table 2 that there is a striking difference in mineral composition between the +65 and -65 mesh fractions. The +65 mesh fraction consists largely of quartz and feldspar, with only 4% ore minerals (magnetite, hematite, and ilmenite). The -65 mesh fraction, on the other hand, consists of 58% ore minerals and only 15% quartz and feldspar. This size: density relationship, i.e. large grains with a low density occurring with small grains with a high density, is common in well-sorted beach sands.

The magnetite occurs largely as individual grains, and is not appreciably intergrown with other minerals, with the exception of some hematite, probably the result of partial oxidation of some of the magnetite grains. The ilmenite and hematite are intimately intergrown, and range from hematite lamellae in ilmenite to ilmenite lamellae in hematite. Some of the lamellae are only a few microns in diameter. The ilmenite-hematite relationships are very similar to those illustrated by Figure 1 in Mineragraphic Report M-1433-E, a copy of which is included in our report No. 828-OD.

All the other minerals present in the sample occur essentially as free grains.

DETAILS OF INVESTIGATION

Test No. 1 - Wet Magnetic Concentration

A sample of the sands as received was treated on a Crockett magnetic machine to produce a magnetite concentrate. The concentrate was re-run through the machine under the same conditions for cleaning purposes thus yielding a middling product.

The cleaned concentrate was screened and the fractions analysed while the middling and tailing were bulk sampled and analysed.

Screen Analysis of Concentrate

Size of Fraction	Weight, %	Assay, %		
		Fe	TiO_2	Insol
+48 mesh	1.27	23.7	6.4	53.6
- 48+65 "	8.46	54.8	4.4	12.3
- 65+100 "	54.90	67.3	2.9	2.5
-100+150 "	30.80	69.2	2.1	1.4
-150 "	4.57	70.2	1.1	1.4
Average Conc. (cal.)	100.00	66.44	2.74	3.63

Results of Test No. 1

Product	Weight, %	Assay, %			Distribution, %		
		Fe	TiO_2	Insol	Fe	TiO_2	Insol
Concentrate	14.56	66.44	2.74	3.63	53.76	8.23	0.81
Middling	0.62	42.4	6.3	31.3	1.46	0.80	0.30
Tailing	84.82	9.5	5.2	76.2	44.78	90.97	98.89
Feed (cal.)	100.00	17.99	4.85	65.36	100.00	100.00	100.00

A good elimination of gangue has been obtained. The iron in the tailing product is mostly hematite and is intimately associated with ilmenite.

Test No. 2

A sample of the sands was ground about 60% finer than 200 mesh and treated on a three drum Jeffrey-Steffensen magnetic concentrating machine with all three drums at full intensity. Three products were obtained.

Screen Analysis of Concentrate

Size of Fraction	Weight, %	Assay, %		
		Fe	TiO_2	Insol
+ 100 mesh	2.49	55.9	7.78	8.64
-100 + 150 "	10.51	65.6	4.49	2.32
-150 + 200 "	25.91	69.4	1.60	2.20
-200 "	61.09	70.6	0.65	0.72
Average Conc. (cal.)	100.00	69.4	1.48	1.47

Results of Test No. 2

Product	Weight, %	Assay, %			Distribution, %		
		Fe	TiO_2	Insol	Fe	TiO_2	Insol
Concentrate	12.89	69.4	1.48	1.47	47.67	4.00	0.31
Middling	2.82	28.4	5.92	47.00	4.27	3.50	2.16
Tailing	84.29	10.7	5.23	70.92	48.06	92.50	97.53
Feed (cal.)	100.00	18.77	4.77	61.29	100.00	100.00	100.00

Again there has been a good elimination of gangue along with a somewhat better grade of concentrate than that produced in test No. 1.

Test No. 3

This test was similar to test No. 2 except that the amperages on the drums were dropped successively from 2.2 to 1.7 to 0.70, the final concentrate being taken off at the last drum. Three products were obtained.

Screen Analysis of Concentrate

Size of Fraction	Weight, %	Assay, %		
		Fe	TiO_2	Insol
+ 100 mesh	0.97	50.5	12.18	10.76
-100 + 150 "	8.76	66.4	4.19	1.00
-150 + 200 "	27.89	70.2	1.16	0.40
-200 "	62.38	71.4	0.65	0.24
Average Conc. (cal.)	100.00	70.42	1.21	0.45

Results of Test No. 3

Product	Weight, %	Assay, %			Distribution, %		
		Fe	TiO_2	Insol	Fe	TiO_2	Insol
Concentrate	12.24	70.42	1.21	0.45	49.89	3.27	0.09
Middling	3.09	41.80	5.70	29.48	7.48	3.89	1.46
Tailing	84.67	8.70	4.97	72.64	42.63	92.84	98.45
Feed (cal.)	100.00	17.28	4.53	62.47	100.00	100.00	100.00

In this case a still better grade of concentrate has been produced than in tests 1 or 2 but a higher middling loss has reduced recovery in the concentrate.

Test No. 4

In this test a sample of sands as received was treated on a Crockett machine to remove a magnetite concentrate. The concentrate was repassed for cleaning purposes and then the non-magnetic and middling portions were combined, dried and treated on a Stearns high intensity separator to remove the intimate mixture of ilmenite and hematite. The products were assayed for Fe, TiO_2 and insoluble.

Screen Analysis of Crockett Magnetite Concentrate

Size of Fraction	Weight, %	Assay, %		
		Fe	TiO_2	Insol
+48 mesh	1.57	20.08	5.05	56.08
- 48+65 "	9.07	52.50	4.80	17.12
- 65+100 "	49.79	66.50	2.38	1.72
-100+150 "	35.21	69.10	2.29	0.48
-150 "	4.36	69.90	1.16	0.80
Average Conc. (cal.)	100.00	65.58	2.56	3.49

Screen Analysis of Ilmenite-Hematite Concentrate

Size of Fraction	Weight, %	Assay, %		
		Fe	TiO_2	Insol
+48 mesh	7.06	9.00	4.19	71.32
- 48+65 "	23.29	19.00	10.15	53.28
- 65+100 "	43.13	37.00	19.90	23.68
-100+150 "	24.00	48.80	24.30	4.24
-150 "	2.52	52.90	21.00	1.68
Average Conc. (cal.)	100.00	34.06	17.60	28.72

Results of Test No. 4

Product	Weight, %	Assay, %			Distribution, %		
		Fe	TiO_2	Insol	Fe	TiO_2	Insol
Magnetite concentrate	14.18	65.58	2.56	3.49	51.84	8.17	0.78
Ilmenite-hematite concentrate	19.09	34.06	17.60	28.72	36.25	75.61	8.67
Tailing	66.73	3.20	1.08	85.80	11.91	16.22	90.55
Feed (cal.)	100.00	17.94	4.44	63.23	100.00	100.00	100.00

The concentrate produced on the Stearns high intensity machine contains such minerals as garnet, amphibole and ortho-pyroxene as well as ilmenite and hematite, all of which are magnetic in a high intensity circuit. A separation of the ilmenite and hematite from the other three minerals can be effected with the use of a Carpco high tension electrostatic machine as shown in the following test.

Test No. 5

A sample of ilmenite-hematite concentrate as produced in test No. 4 was treated on a Carpco high tension electrostatic machine for purposes of upgrading it to a high iron-high titanium product.

Results of Test No. 5

Product	Weight, %	Assay, %			Distribution, %		
		Fe	TiO_2	Insol	Fe	TiO_2	Insol
Concentrate	55.40	46.1	23.07	5.8	90.09	94.06	8.06
Tailing	44.60	6.3	1.81	82.2	9.91	5.94	91.94
Feed (cal.)	100.00	28.35	13.59	39.87	100.00	100.00	100.00

Test No. 6

Since a reasonably accurate estimate of the moisture content of the shipping product is desired, a figure for this was arrived at as follows:

A 500 g sample of dry magnetite concentrate was soaked in water for 30 min and drained for 20 min.

weight of dish + wet solids	825 g
weight of dish + dry solids	747 g
weight of water	78 g
weight of water + dry solids	578 g

$$\% \text{ moisture}, \frac{78 \times 100}{578} = 13.49\%$$

Tests 7 to 12 - Mill Runs

The 24 ton shipment was treated on a two-drum Dings magnetic concentrating machine in a series of six tests. Feed, concentrate and tailing were sampled at regular intervals during each test and were assayed for Fe, TiO_2 and insoluble. The concentrates were all saved and bulk sampled when all of the runs were finished. The bulk sample was also assayed for Fe, TiO_2 and insoluble. These runs were conducted with the purpose of obtaining maximum recovery even at the sacrifice of grade to some extent.

Results of Tests 7 to 12

Test No.	Feed rate, lb/hr	Product	Assay, % Fe	Assay, % TiO_2	Assay, % Insol	Recovery %	Ratio of concentration
7	1000	Feed	11.7	3.89	73.6		9.55:1
		Conc.	59.5	3.94	9.68	53.25	
		Tailing	6.11	3.44	80.7		
8	1440	Feed	12.6	4.00	72.3		9.79:1
		Conc.	58.2	4.32	10.5	47.20	
		Tailing	7.41	4.34	78.9		
9	1440	Feed	14.0	3.94	69.2		10.38:1
		Conc.	62.4	4.02	4.64	42.94	
		Tailing	8.84	4.90	71.2		
10	1000	Feed	15.0	3.74	70.2		7.16:1
		Conc.	60.6	3.84	11.8	56.39	
		Tailing	6.63	4.68	82.6		
11	1000	Feed	13.5	3.72	73.2		9.57:1
		Conc.	61.5	2.64	8.0	47.60	
		Tailing	7.9	4.24	83.2		
12	1000	Feed	19.4	4.56	62.8		5.20:1
		Conc.	62.7	2.48	7.30	62.11	
		Tailing	9.1	4.60	77.40		

In all, 4355 lb of concentrate was produced, the average assay of which was:

Fe^*	-	61.34%
TiO_2	-	3.77%
Insol	-	8.94%

The variation in recovery and ratio of concentration from test to test can only be accounted for by variations in grade of feed as well as varying proportions of magnetite and hematite in the feed. Although the feed rate changed from 1000 lb/hr to 1440 lb/hr the machine used had sufficient capacity to handle 4 to 6 times as much as this.

CONCLUSIONS

Tests conducted on this material show that magnetite concentrates of satisfactory grade for treatment in an electric furnace can be produced without grinding the feed. It was not possible to concentrate the ilmenite-hematite mixture in a wet circuit since no machine is available to do this. It could have been done in a dry circuit but this would not fit in with the proposed scheme of treating the sands.

Variations in grade of feed which may be extreme from time to time will no doubt interfere with the operation of a magnetic concentration plant unless some form of gravity concentration precedes magnetic concentration in order to level out the grade of feed.

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*Iron determinations were done by the Bi-sulphate method.

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