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MINES BRANCH INVESTIGATION REPORT IR 63-94

CONCENTRATION OF AN IRON ORE FROM YUKON TERRITORY, FOR CREST EXPLORATION LIMITED

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

Laboratory tests on this ore showed that gravity concentration by jigging at various sizes from 6 to 28 m yielded combined concentrates assaying about 60% Fe with recoveries in the neighbourhood of 80% of the iron in the original feed. In one test, the crude ore was crushed to 14 m and jigged at 14, 20, and 28 m. The combined concentrates assayed 59.3% Fe with a recovery of 81.6% of the iron in the feed. Ratio of concentration was 1.58:1. A higher grade concentrate was obtained by jigging the crude ore at -6 m. The -6 m jig concentrate assayed 64.53% Fe with 0.17% P and 5.28% SiO_2. Recovery was only 47.8% of the iron in the original feed. More iron could be recovered at a lower grade by jigging the 6 m tailing at sizes down to 28 m.

Magnetizing roasting tests were done on the combined jig concentrates. The best result was obtained at 650°C for a 40 minute roast using city gas on a concentrate assaying 59.5% Fe containing 81.6% of the original iron. After grinding the roast product to 94% minus 325 m, the magnetic concentrate assayed 65.72% Fe with 0.15% P and 6.09% SiO_2 at a recovery of 72.6% of the iron in the original feed. Ratio of concentration was 1.90:1. The results of various flotation tests are also reported.

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INTRODUCTION

The purpose of the investigation was to determine if the ore could be concentrated to make pellets of premium grade for blast furnace feed.

Shipments

Five samples, each containing approximately 100 lb of ore, were received at the Mines Branch on September 13, 1962. The samples were submitted by Dr. C.D.A. Dahlstrom, General Manager, Operations, of Crest Exploration Limited, an exploration subsidiary of the California Standard Company, Calgary, Alberta. The samples were said to be representative of the four basic types of iron ore at the Snake River property.

A further sample of 400 lb was received at the Mines Branch on January 30, 1963. This sample was collected at section IF 37 and was said to be representative of large tonnages of the orebody. The section was cut as a 400 foot long channel across the orebody as it outcropped at the surface.

Description of Property

The Snake River iron prospect is a bedded hematite-jasper deposit. The thickness of the iron-bearing zone is said to vary from zero to over 350 feet and in the area of prime interest it is approximately 100 to 150 feet. The total reserve is said to be many billions of tons. The location of the property is in the Yukon Territory approximately 350 miles northeast of Whitehorse.

Sampling and Analysis

The original 5 samples were sampled and assayed for iron and silica with the results shown in Table 1. Each head sample was given a spectrographic analysis. Phosphorus was present in sufficient amounts to have a possible deleterious effect in the pellets.

TABLE 1

Head Sample Analyses of Preliminary Shipment

Sample	Analysis %	
	Sol Fe	SiO_2
A	48.16	23.11
B	46.24	22.43
C	40.12	35.37
D	37.04	31.00
E	37.35	29.91

*From Internal Report MS-AC-62-1195

As soon as the IF 37 Section sample had been received, a representative 20 lb sample was cut from it. The results of a screen analysis on this sample are shown in Table 2.

TABLE 2

Screen Analysis on I.F. 37 Head Sample

Size	Weight %	Analysis % Sol Fe	Distn % Sol Fe
+4 m	27.7	46.57	28.6
-4 +10 m	38.1	45.51	38.4
-10 +14 m	12.4	43.97	12.1
-14 +20 m	7.2	43.07	6.9
-20 +28 m	2.7	43.40	2.6
-28 +35 m	2.2	43.07	2.2
-35 +48 m	2.0	41.61	1.8
-48 +65 m	1.5	45.67	1.5
-65 +100 m	1.2	43.72	1.3
-100 +150 m	1.0	41.80	1.4
-200	4.0	41.77	3.2
Total	100.0	45.05	100.0

In a letter it was stated that the sample contained 25.86% silica and 0.30% phosphorus.

Chemical analyses in this investigation were made, where stated, by the Analytical Chemistry Sub-Division, Mineral Sciences Division, Mines Branch. Other iron determinations were done by the writer using the "Lerch" method, a stannous chloride-potassium dichromate procedure.

Characteristics of the Ore*

A small sample of each of the original five lots of ore was submitted for microscopic examination. This examination showed that the ore consisted essentially of hematite-rich and jasper-rich bands. These bands varied between 0.3 and 15 mm in width and appeared to separate readily by mechanical means. The hematite occurred as minute crystals and grains ranging from 1 to 30 microns in diameter. The crystals and grains in the high-hematite bands tended to form aggregates up to 0.5 mm in diameter.

*W. Petruk. Mineralogical Examination of an Iron Ore From the Snake River Area in Yukon Territory For Crest Exploration Limited. Investigation Report IR 62-83, Mineral Sciences Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

OUTLINE OF INVESTIGATION

From the results of the mineralogical examination it appeared that some form of gravity separation on feed sized from 1/4 in. to 35 mesh would yield beneficial results. It was apparent that any gravity concentrate produced would not contain much more than 60% iron so that a further stage of concentration would be necessary to produce a concentrate to meet premium grade pellet specifications. Since other laboratories had been approached to conduct beneficiation studies, it was decided to try to concentrate the ore at the Mines Branch using either heavy media separation or jigging.

Once a suitable gravity concentrate had been obtained it was proposed to try to upgrade it further by flotation or magnetizing roasting procedures.

RESULTS

Tests on Preliminary Samples

Gravity separation tests were first done on all 5 samples using the same procedure on each sample. The sample was crushed and screened so that three size fractions were made. The minus 1 in. plus 1/4 in. fraction by heavy-media separation using a galena medium; the minus 1/4 in. plus 20 m fraction was treated by jigging; and the minus 20 m fines were treated by tabling. The results of heavy-media separation are shown in Table 3.

The float product at a medium specific gravity of 3.45 was re-treated at 3.25, and the float product at 3.25 was re-treated at 3.10.

The results of the jigging tests are shown in Table 4.

TABLE 3

Results of Heavy-Media Separation (1/4 to 1 in. fraction)

Product	Ore A			Ore B			Ore C**			Ore D			Ore E		
	Weight %	Sol Fe %	Distn % Sol Fe	Weight %	Sol Fe %	Distn % Sol Fe	Weight %	Sol Fe %	Distn % Sol Fe	Weight %	Sol Fe %	Distn % Sol Fe	Weight %	Sol Fe %	Distn % Sol Fe
Sink at 3.45	79.5	54.25	86.5	51.1	55.29	59.0	44.4	60.2	63.3	37.6	50.46	52.5	64.3	50.62	74.5
Sink at 3.25	11.2	37.75	8.5	46.3	40.64	39.3	-	-	-	18.7	35.73	18.5	14.4	37.34	12.3
Sink at 3.10	3.4	33.80	2.3	1.3	36.30	0.9	-	-	-	17.3	29.05	13.9	12.0	34.04	9.3
Float at 3.10	5.9	23.26	2.7	1.3	28.81	0.8	55.6	27.77	36.7	26.4	20.68	15.1	9.3	18.19	3.9
Feed*	100.0	49.9	100.0	100.0	47.9	100.0	100.0	42.13	100.0	100.0	36.1	100.0	100.0	43.7	100.0

*Calculated.

**Sink-float done only at a sp gr of 3.45.

TABLE 4

Results of Jig Tests (20 m to 1/4 in. fraction)

Product	Ore A			Ore B			Ore C			Ore D			Ore E		
	Weight %	Sol Fe %	Distn % Sol Fe	Weight %	Sol Fe %	Distn % Sol Fe	Weight %	Sol Fe %	Distn % Sol Fe	Weight %	Sol Fe %	Distn % Sol Fe	Weight %	Sol Fe %	Disnt % Sol Fe
Jig conc	37.0	60.36	46.3	31.6	61.63	40.3	64.4	58.59	86.8	28.8	50.38	41.1	38.1	54.89	53.8
" tail	40.3	32.27	26.9	48.3	36.86	36.8	24.3	13.28	7.7	49.4	24.95	34.9	39.7	20.76	21.2
" bed	22.7	57.06	26.8	20.1	55.05	22.9	11.3	20.44	5.5	21.8	38.71	24.0	22.2	43.94	25.0
Feed*	100.0	48.3	100.0	100.0	48.4	100.0	100.0	43.3	100.0	100.0	35.3	100.0	100.0	38.9	100.0

*Calculated.

The results of the table tests are shown in Table 5.

TABLE 5

Results of Tabling Tests (minus 20 m)

Product	Ores B and E			Ores A and D			Ore C		
	Weight %	Sol Fe %	Distn % Sol Fe	Weight %	Sol Fe %	Distn % Sol Fe	Weight %	Sol Fe %	Distn % Sol Fe
Table conc	42.2	58.43	59.5	10.7	60.85	15.0	45.1	57.98	68.8
" midd	37.2	26.80	24.0	55.5	46.52	59.5	40.8	19.64	20.3
" tail	20.6	33.24	16.5	33.8	33.84	25.5	14.1	30.99	10.9
Feed*	100.0	41.5	100.0	100.0	43.4	100.0	100.0	38.5	100.0

*Calculated.

Due to the small amount of feed, samples B and E and samples A and D were combined in proportion and then tabled. A high proportion of the iron in the table tailing was lost as slime.

The proportion of the feed weights for each separation were calculated for each ore and the results are shown in Table 6.

TABLE 6

Proportion of Feed Weights

Operation	Ore A Weight %	Ore B Weight %	Ore C Weight %	Ore D Weight %	Ore E Weight %
H.M.S.	86.3	85.2	75.2	88.4	85.8
Jigging	11.0	12.1	17.7	9.6	11.5
Tabling	2.7	2.7	7.1	2.0	2.7
Total	100.0	100.0	100.0	100.0	100.0

A series of phosphorus determinations were done on several of the "sink" products with the results shown in Table 7.

TABLE 7

Results of Phosphorus Determinations on Sink Products

Sample	Sink at 3.10 % P*	Sink at 3.20 % P*	Sink at 3.25 % P*	Sink at 3.45 % P*
A	-	-	0.71	0.54
B	1.00	-	-	0.78
C	-	0.33	-	0.34
D	0.42	-	0.41	0.34
E	-	0.32	-	0.30

*From Internal Report MS-AC 63-160.

A sample of "sink" rejects from sample C were ground to 90% minus 325 m and treated by a Jones high intensity wet magnetic separator to discover if an acceptable grade and recovery could be made. The results of this test are shown in Table 8.

TABLE 8

Jones Separator Test on Sample C "Sink" Rejects

Product	Weight %	Analysis % Sol Fe	Distn % Sol Fe
10 amp conc	37.2	63.11	39.8
" " midd	30.8	56.09	29.3
" " tail	32.0	57.06	30.9
Feed*	100.0	59.02	100.0

*Calculated.

Jigging Tests on Head Samples

Due to the encouraging preliminary results from jigging, two jig tests were done on head samples of A and B ores. In these and subsequent jig tests, the jig used was a Denver Laboratory Mineral Jig. Approximately 4000 g of feed was used in each test, the feed rate being 1500 g/hr. Both samples A and B were crushed separately to minus 10 m and jigged using a 10 m screen. The results obtained are shown in Tables 9 and 10.

TABLE 9

Results of Jigging Sample A (10 m)

Product	Weight %	Analysis % Sol Fe	Distn % Sol Fe
Jig conc	39.9	63.67	50.0
" tail	46.6	40.94	37.6
" slime tail	7.8	52.23	8.0
" bed	5.7	39.49	4.4
Feed*	100.0	50.8	100.0

*Calculated.

TABLE 10

Results of Jigging Sample B (10 m)

Product	Weight %	Analysis % Sol Fe	Distn % Sol Fe
Jig conc	45.2	58.83	54.5
" tail	40.8	39.33	32.9
" slime tail	9.1	49.32	9.2
" bed	4.9	34.09	3.4
Feed*	100.0	48.8	100.0

*Calculated.

For additional iron recovery, the jig tailing and bed of each sample were combined and re-jigged using a smaller stroke and a 28 m screen. For sample A, an additional concentrate was recovered at a grade of 58.2% Fe. The combined jig concentrate from sample A would assay 62.26% Fe at a recovery of 66.6% of the iron in the original feed. For sample B, an additional concentrate was recovered at a grade of 60.1% Fe from the jig tailing and bed. The combined jig concentrate from sample B would assay 59.06% Fe at a recovery of 67.7% of the iron in the original feed.

Tests on Composite Sample From Section IF 37

In order to avoid duplication of test work it was requested that a composite sample be submitted. Accordingly, a sample from section IF 37 was received and all subsequent tests were done on this sample.

Serial Jig Tests on Sample IF 37

From the preliminary test results it appeared that the ore was amenable to jigging and that a concentrate could be produced at a grade of about 60% Fe with a recovery of better than 70% of the iron in the crude ore. A 20 lb head sample was taken and, after analysis, crushed to minus 6 m. About 10 lb of the sample was then jigged on a 6 m screen, and the jig tailing re-jigged on a 10 m screen to recover additional concentrate. A considerable amount of fine iron present in the 10 m tailing was recovered by re-jigging on 14 m and 28 m screens. The plus 14 m particles were first screened out and rejected from the 14 m jig feed. The results of this test are shown in Table 11.

TABLE 11

Results of Serial Jigging at 6, 10, 14 and 28 m

Product	Weight %	Analysis %			Distn %
		Sol Fe	P**	SiO_2**	Sol Fe
6 m Jig conc	33.4	64.53	0.17	5.28	47.8
10 m Jig conc	10.0	61.75	0.22	-	13.7
14 m Jig conc	5.0	51.80	0.18	-	5.7
28 m Jig conc	0.9	63.14	0.35	-	1.3
Plus 14 m Jig tail	21.1	28.08	-	-	13.1
Minus 14 m Jig tail	27.5	27.30	0.45	-	16.7
Jig bed	2.1	36.85	-	-	1.7
Feed*	100.0	45.1			100.0

*Calculated.
**From Internal Report MS-AC-63-382.

The overall recovery from the 6, 10, 14 and 28 m concentrates was 68.5% of the iron in the original feed at a grade of 62.65% Fe. Weight recovery was 49.3% of the original feed. The result of a screen analysis on the 14 m jig tailing is shown in Table 12.

TABLE 12

Screen Analysis of 14 m Jig Tailing

Size Fraction	Weight %	Analysis % Sol Fe	Distn % Sol Fe
+20 m	14.5	17.26	9.1
-20 +28 m	12.5	18.32	8.4
-28 +35 m	16.5	20.91	12.7
-35 +48 m	11.5	22.89	9.6
-48 +65 m	10.0	26.74	9.8
-65 +100 m	8.5	29.34	9.1
-100 +150 m	7.0	35.42	9.1
-150 +200 m	6.0	40.68	9.0
-200	13.5	46.84	23.2
Total	100.0	27.3	100.0

*Calculated.

Magnetizing Roasting Tests

Two magnetizing roasting tests were done on samples of the combined jig concentrates. Two 500 g samples were roasted at 550°C for 15 minutes using city gas, and were then cooled in a nitrogen atmosphere. One sample was roasted without any size reduction; the other sample was first pulverized to 48 m. The roasted products were ground to about 94% minus 325 m and treated by a Jeffrey-Steffensen magnetic separator. The results are shown in Table 13.

TABLE 13

Results of Magnetic Separation of Roasted Jig Concentrate

Fraction	Product	Weight %	Analysis % Sol Fe	Distn % Sol Fe
6 m roast	Jeffrey conc	23.7	67.1	24.9
	" midd	16.9	66.86	17.7
	" tail	59.4	61.59	57.4
	Feed*	100.0	63.78	100.0
48 m roast	Jeffrey conc	46.8	66.78	49.6
	" midd	21.3	66.62	22.5
	" tail	31.9	55.19	27.9
	Feed*	100.0	63.05	100.0

*Calculated.

A Jones separator test was done on each sample of Jeffrey tailing to find out if additional iron could be recovered using a slightly higher field strength. The results are shown in Table 14.

TABLE 14

Jones Separator Tests on Jeffrey Tailing Samples

Fraction	Product	Weight % of orig. feed	Analysis % Sol Fe	Distn % of orig.feed Sol Fe
6 m roast tailing	3 amp conc	42.0	64.19	42.3
	3 amp midd	11.0	58.19	10.0
	3 amp tail	6.4	50.25	5.1
	Feed*	59.4	61.6	57.4
48 m roast tailing	3 amp conc	26.9	59.32	24.9
	3 amp midd	3.7	44.74	2.6
	3 amp tail	1.3	22.94	0.4
	Feed*	31.9	56.17	27.9

*Calculated.

Indications from this test were that a longer roasting time was required for more complete conversion to magnetite.

Jig Test on Screened Feed

A jig test was next run on a sample of the crude ore, screened into three size fractions. The ore was screened at 6 m and any oversize was crushed below this size. Three fractions were screened out and jigged separately; a minus 6 plus 14 m fraction, a minus 14 plus 28 m fraction, and a minus 28 m fraction. The sizes of jig screens used were, respectively, 6, 14 and 28 m. The results of this jig test are shown in Table 15.

TABLE 15

Results of Jigging of Screened Feed

Fraction	Product	Weight %	Analysis %			Distn %
			Sol Fe	SiO_2**	P**	Sol Fe
	Jig conc	28.6	64.06	7.12	0.24	40.0
-6 +14 m	" bed	5.2	38.96			4.4
	" tail	21.9	27.79			13.3
	" conc	12.7	57.86	12.24	0.30	16.1
-14 +28 m	" bed	1.6	19.48			0.7
	" tail	4.5	16.54			1.6
	" conc	8.2	61.21	9.12	0.35	11.0
-28 m	" bed	2.0	39.85			1.7
	" tail	15.3	33.41			11.2
	Feed*	100.0	45.8			100.0

*Calculated.
**From Internal Report MS-AC-63-534.

The overall concentrate recovery was 67.1% of the iron at a grade of 62.0% Fe. Weight recovery was 49.5% of the original feed. Since some of the iron lost in the jig bed would be recoverable at grade in a continuous plant, the results are comparable to those obtained with serial jigging. Additional jigging tests were done on samples of the tailing products, crushed to minus 48 m, to try to recover additional iron. No improvement in grade could be obtained in any of these tests.

Serial Jig Test on Minus 14 m Feed

In order to eliminate, if possible, any product screening that had been necessary in the other jig tests, it was decided to crush the original feed finer to minus 14 m and to jig at three sizes - 14, 20 and 28 m. The 14 m feed was first jigged on a 14 m screen, the jig tailing was re-jigged using the same bed on a 20 m screen, and the 20 m tailing was re-jigged on a 28 m screen using the original jig bed. The results of this test are shown in Table 16, and the jig settings for each separation are shown in Table 17.

TABLE 16

Serial Jigging of 14 m Feed

Product	Weight %	Analysis % Sol Fe	Distn % Sol Fe
14 m conc	40.6	61.59	54.7
14 m tail	59.4	34.93	45.3
20 m conc	14.1	57.22	17.6
20 m tail	45.3	28.12	27.7
28 m conc	8.4	51.47	9.3
28 m tail	36.9	23.07	18.4
28 m jig bed	-	26.55	-
Feed*	100.0	45.8	100.0

*Calculated.

The combined jig concentrates assayed 59.3% Fe with a recovery of 81.6% of the iron in the original feed.

TABLE 17

Jig Settings For 14 m Serial Jigging

Separation	Stroke	Water
14 m	1/4 to 1/8 in.	0.55 gpm
20 "	1/8 "	0.22 "
28 "	1/4 to 1/8 "	0.10 "

Roasting Tests on Jig Concentrates

Three roasting tests at 650°C were done using city gas on combined samples of the jig concentrates. Roasting time was varied from 20 to 60 minutes. No grinding was done before roasting. After roasting, each product was ground separately to about 94% minus 325 m and treated using a low intensity Jeffrey-Steffensen magnetic separator. One magnetic concentrate sample was treated in a laboratory hydroseparator at an upflow rate of 50 ft/hr to try to eliminate additional gangue. The results of these tests are shown in Tables 18 and 19.

TABLE 18

Roasting Tests of Combined Jig Concentrates

Roast time (min)	Product	Weight % of orig. feed	Analysis %			Distn % of orig. feed
			Sol Fe	SiO_2**	P**	Sol Fe
60	Jeffrey conc	52.4	65.87	6.08	0.15	72.5
	" midd	2.6	62.64			3.5
	" tail	8.1	34.11			5.6
	Feed*	63.1	61.67			81.6
40	Jeffrey conc	52.6	65.72	6.09	0.15	72.6
	" midd	1.8	61.18			2.3
	" tail	8.7	36.90			6.7
	Feed*	63.1	61.60			81.6
20	Jeffrey conc	48.1	65.80			66.5
	" midd	3.3	62.24			4.3
	" tail	11.7	43.70			10.8
	Feed*	63.1	61.50			81.6

*Calculated.
**From Internal Report MS-AC-63-907.

TABLE 19

Hydroseparator Test on Jeffrey Concentrate from 40 min Roast

Product	Weight % of orig. feed	Analysis %			Distn % of orig. feed Sol Fe
		Sol Fe	SiO_2**	P**	
Hydrosep. o'flow	0.7	58.9			0.9
" spigot	51.9	66.05	6.06	0.15	71.7
Feed*	52.6	65.9			72.6

*Calculated.
**From Internal Report MS-AC-63-907.

A specific surface determination was done on the hydroseparator spigot product and showed it to be 3514 cm^2/gm.

Flotation Tests on Jig Concentrates

Two flotation tests were done on a sample of composite jig concentrate using a cationic flotation procedure for floating siliceous gangue. The feed was first ground for 25 minutes to 100 m. Results were unsatisfactory with regard to both grade and recovery and are shown in Table 20.

TABLE 20

Flotation Test Results on Combined Jig Concentrates

Conditions	Product	Weight %	Analysis % Sol Fe	Distn % Sol Fe
Neutral pH	Froth	21.4	56.41	20.3
	A midd froth	7.0	59.32	6.9
	A midd	9.7	60.46	9.8
	Concentrate	61.9	60.62	63.0
	Feed*	100.0	59.6	100.0
ph 10.5	No. 1 froth	10.9	53.31	9.7
	No. 2 froth	15.4	59.97	15.4
	Concentrate	73.7	60.95	74.9
	Feed*	100.0	60.0	100.0

*Calculated

Jig Test on Minus 20 m Feed

A further jig test was done on a sample of crude ore, crushed to 20 m, to find out the effect on grade and recovery. The results, which are shown in Table 21, were not as good as obtained in previous jig tests. However, it was significant that a good grade concentrate could be produced on the coarse fraction by simple alteration of the jig variables.

TABLE 21

Results of Jigging Minus 20 m Feed

Product	Weight %	Analysis % Sol Fe	Distn % Sol Fe
No. 1 Jig 20 m conc	26.2	65.67**	37.7
No. 2 " " "	10.5	53.68	13.5
20 m slimes	2.6	53.25	3.0
Screened + 28 m tail	14.0	25.19	7.7
28 m Jig conc	5.3	57.2	6.6
28 m slimes	1.8	44.4	1.8
48 m Jig conc	8.8	36.4	7.0
" " tail	14.9	41.4	13.5
-28 +48 m Jig tail	8.5	21.9	4.1
Jig bed	7.4	31.8	5.1
Feed*	100.0	45.7	100.0

*Calculated

**Assayed 6.28% SiO_2 and 0.18% P. From Internal Report MS-AC-63-1046.

Magnetic Separation and Flotation of a Roasted Concentrate

A comparison between magnetic separation and anionic and cationic silica flotation was made on a sample of roasted jig concentrate, ground first to about 65% minus 325 m. Half the ground sample was treated by a magnetic separator, while the other half was kept for flotation. The results of magnetic separation are shown in Table 22.

TABLE 22

Magnetic Separation of Roasted Product

Product	Weight %	Analysis % Sol Fe	Distn % Sol Fe
Jeffrey conc	76.9	62.80	90.1
" midd	2.7	50.6	2.5
" tail	20.4	19.3	7.4
Feed*	100.0	53.6	100.0

*Calculated

Half of the remaining sample was treated by cationic silica flotation using 0.5 lb of dextrine WW82 per ton, and 0.5 lb/ton each of RADA and POA. The results are shown in Table 23.

TABLE 23

Cationic Flotation of Roasted Product

Product	Weight %	Analysis % Sol Fe	Distn % Sol Fe
Concentrate	79.0	58.8	88.1
Froth No. 1	7.6	21.7	3.1
" " 2	3.9	31.1	2.3
" " 3	4.1	32.2	2.5
" " 4	5.4	38.8	4.0
Feed*	100.0	52.7	100.0

*Calculated.

The concentrate was upgraded in a hydroseparator at an upflow of 50 ft/hr to 60.1% Fe with a loss of 6.3% of the iron in the original feed.

On the remaining fraction of roasted concentrate, a test was done using an anionic silica flotation method. The ore was pulped and conditioned with 0.5 lb/ton of dextrine WW82. The pH was raised to 11.5 with 1 lb of NaOH per ton. A total of 1 lb of $CaCl_2$ per ton was added, and after conditioning, a froth was floated using 1 lb of oleic acid No. 4 per ton as collector. After flotation was completed, the froth was reground and refloated using only a small amount of additional collector. The results are shown in Table 24.

TABLE 24

Anionic Flotation of Roasted Product

Product	Weight %	Analysis % Sol Fe	Distn % Sol Fe
Regrind froth	15.0	31.7	8.9
" tail	35.0	49.2	32.1
Concentrate	50.0	63.3	59.0
Feed*	100.0	53.6	100.0

*Calculated.

A hydroseparator test raised the grade of concentrate very slightly to 63.4% Fe. From the results of these tests, it seems that magnetic separation will yield a higher grade concentrate at a better recovery than either flotation methods.

CONCLUSIONS

From the results of this investigation it seems possible to produce premium grade iron concentrates if the phosphorus content of about 0.18% is acceptable. The crude ore can be upgraded by jigging, after crushing to about 6 m, to yield concentrates at various sizes down to 28 m. The best grade of concentrate by jigging contained less than 6% silica at the coarse size with a ratio of concentration of about 3:1. This concentrate would make ideal sinter feed provided the phosphorus content of 0.17% is acceptable. The remaining jig concentrates could be combined and magnetically roasted. After fine grinding, a product containing about 7% silica could be produced and pelletized. Due to the fine particle size of the hematite grains extremely fine grinding to 500 m or finer would be required to lower the silica content in a magnetic concentrate much below 6%. At a grind of about 94% minus 325 m, a magnetic concentrate containing about 7% silica was filtered and the cake contained 15% moisture. Previous experience* indicates that artificial magnetite concentrates containing this amount of moisture in the filter cake can be balled successfully in the production of green pellets.

Apart from jigging, the only other method that might produce comparable results at the same size range would be heavy-media cycloning. Reports indicate that this method might be cheaper than jigging due to the large unit capacity and lower maintenance costs. It is proposed to investigate heavy-media cycloning as well as jigging on a larger scale during a pilot plant run at a later date.

On the whole, the flotation results obtained were not encouraging, and did not compare favourably with other methods. A proposed flowsheet is shown in Figure 1. More information will be learned in the pilot plant test and it is possible that heavy-media cycloning might replace jigging as a more attractive process.

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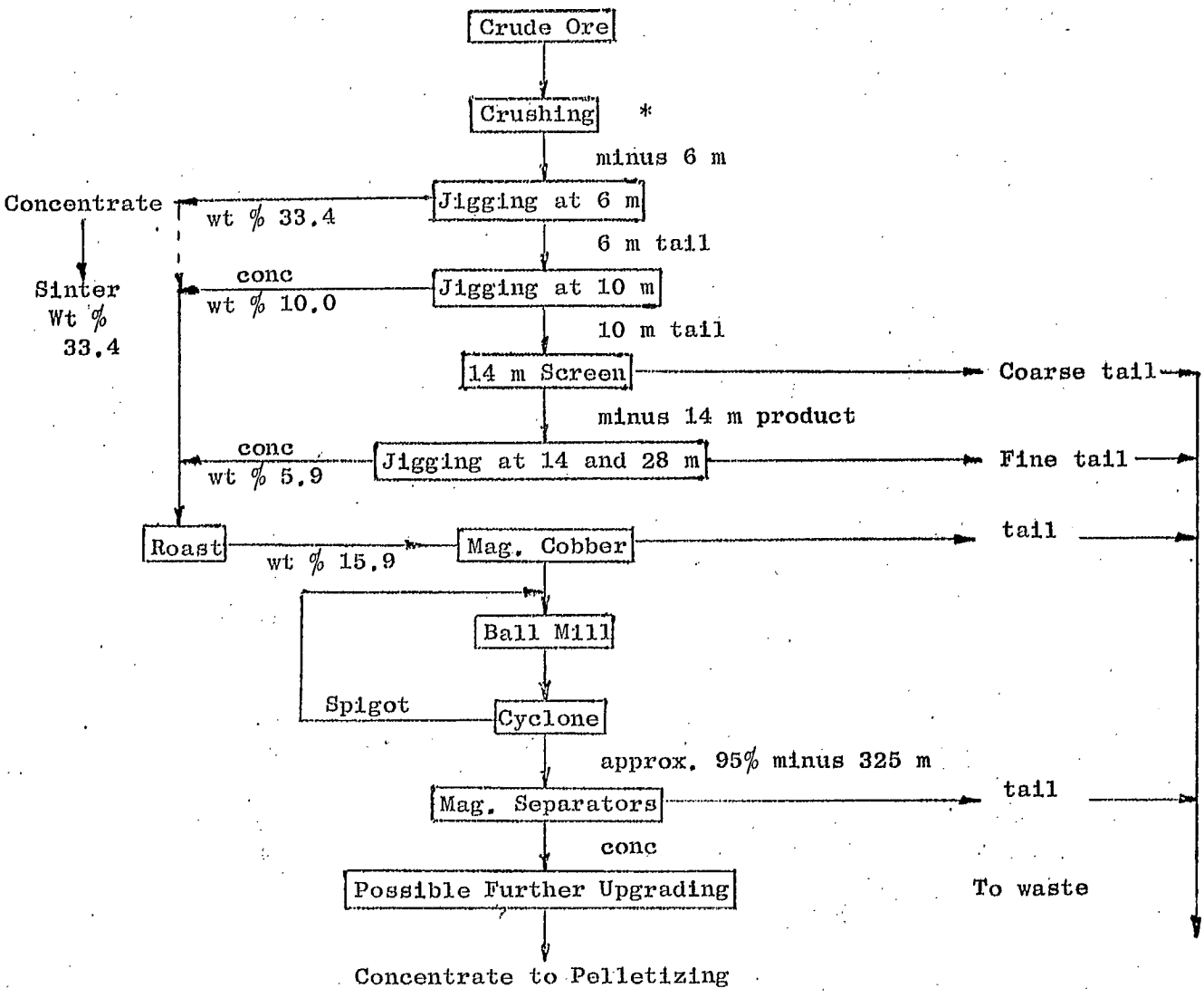
*International Nickel Co., Copper Cliff, p.c.

PDM/Jg



*Conventional or dry autogenous crushing.

Fig. 1. Suggested Treatment Scheme