O T T A W A March 20th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1178.

Magnetic Concentration of Magnetite from the Bessemer Mine, Hastings County, Ontario.

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(Copy No.___.)

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DESCRIPTION OF PROPERTY.

Location:

The Bessemer iron mine is located in Mayo township, Hastings county, Ontario. It is on a spur of the Central Ontario Railway, about twenty miles from Bancroft by road.

Mineralogy:

The ore consists of magnetite associated with pyrite, pyrrhotite, chalcopyrite, garnet, hornblende, and calcite. In places the magnetite is quite massive and fairly free of gangue

(Mineralogy, cont'd) -

minerals and in others the magnetite is intimately associated with the gangue minerals. There are two distinct ore bodies, the East Lens and the West Lens, separated by a diorite dike.

The East Lens consists mainly of a disseminated magnetite which is closely associated with the sulphide minerals. A large proportion of the sulphur in this ore body is in the form of pyrrhotite.

The West Lens contains much massive magnetite which grades into a disseminated variety on the boundaries of the ore body. The sulphur in this ore body is largely in the form of pyrite which appears to be more intimately associated with the gangue minerals than with the magnetite.

In both of these lenses the phosphorus content is quite low and is well below the Bessemer Grade maximum in the crude ore.

PROBLEM.

A study of this ore was made by coarse magnetic cobbing operations at various crushing sizes and also by fine grinding and wet magnetic separation methods. The tests were made under the following headings:

Series 1. - Fine Grinding and Wet Magnetic Separation.
Series 2. - Coarse Magnetic Cobbing. Preliminary Examination of Dump Ore.
Series 3. - Coarse Magnetic Cobbing. Preliminary Examination of Mine Samples.
Series 4. - Coarse Magnetic Cobbing. Possibilities in Obtaining Uniformity of Grade of Concentrate.
Series 5. - Coarse Magnetic Cobbing. A comparison of Results Obtained on the Dings Magnetic Pulley with Those on the Ball-Norton Type.
Series 6. - Coarse Magnetic Cobbing. Ore crushed to minus 5/8 inch and minus $\frac{1}{2}$ inch.
Series 7. - Coarse Magnetic Cobbing. Ore crushed to minus $\frac{1}{4}$ inch.

SUMMARY OF RESULTS.

Fine Grinding Tests:

A concentrate having a grade of 65 per cent soluble iron and containing not over 5 per cent silica can be made by grinding to minus 14 mesh and making a wet magnetic separation. The recovery of soluble iron in this concentrate will be 92 per cent at a ratio of concentration of 1.56:1. The sulphur content of the concentrate will be about 1.0 per cent but this will be reduced to a marketable percentage on sintering.

Coarse Magnetic Cobbing Tests:

East Lens: This ore body is not amenable to coarse magnetic cobbing operations. Due to the disseminated character of the magnetite it is difficult to obtain a satisfactory grade except at fine grinding sizes. The presence of pyrrhotite in this lens makes the final concentrate high in sulphur, requiring further treatment by sintering or nodulizing for its elimination.

West Lens: This ore reacts favourably to a coarse magnetic cobbing separation. Crushing to minus $\frac{3}{4}$ inch appears to give the most satisfactory results, although a satisfactory concentrate can be made from sizes ranging from minus $1\frac{1}{2}$ inch down to minus $\frac{1}{4}$ inch with each successively finer crushing size giving better results in grade and recovery. At minus $\frac{3}{4}$ inch a concentrate assaying 58 per cent iron, 0.10 per cent sulphur and about 6.5 per cent SiO_2, with a recovery of 90 per cent of the iron from a head assaying 48 per cent iron, can readily be made.

SHIPMENTS.

Test work on the Bessemer iron mine was begun on March 30th, 1941, at the Ore Dressing Laboratories of the Bureau of Mines, Ottawa, Ontario. The first sample was taken from the surface, as was also the second shipment. After dewatering the mine, further shipments of freshly broken ore from various drifts and cross-cuts were made. The latter samples did not exhibit the same physical characteristics as did the first two, so that results obtained on the mine samples were, on the whole, better than those obtained in the surface samples.

The following is a list of the samples and their analysis:

Date 1941	Description	Weight, tons	Percent Fe	Percent S	Percent P	Percent Insol.
Mar. 30	Surface	5	52.40	0.23	0.016	12.38(SiO_2)
July 8	"	2	45.88	0.19	0.017	25.91
Oct. 1	161 x-cut	1	51.35	0.17	0.018	19.70
	163 x-cut	1	54.61	0.22	0.012	17.56
	165 x-cut	1	54.57	0.22	0.015	17.98
	161 Drift, East Face	1	44.35	1.56	0.024	29.47
Nov. 22	161 Drift, East Face	1	39.31	1.20		35.07
	161 Drift, South Rib	1				
	West Drift Face	1	37.63	Tr.		34.17
	161 x-cut	1	55.66	0.17		16.49
	163 x-cut	1	53.93	0.05		18.36
	165 x-cut	1				
Dec. 2	East Lens, Bulk	3	41.93	1.49		32.91
	West Lens, Bulk	3	50.28	0.15		21.32

The last two samples represent fairly well the run-of-mine from each lens. The two samples that were not used were 161 Drift, South Rib, which would correspond fairly closely to the sample from the East Face, and No. 165 Cross-Cut, which should be similar to the previous sample from that area.

DETAILS OF TESTS.

Series No. 1. - Fine Grinding and Wet Magnetic Separation:

Two tests were run in this series. The first test was on ore from the surface and was reported in Investigation No. 1045, of July 5th, 1941. The ore from the second test was taken from freshly broken ore in the mine and was composed of equal proportions from the East Lens and the West Lens.

Test No. 1.

This lot of 5 tons was fed to a ball mill in closed circuit with a screen. The screen undersize was concentrated on a Roche wet magnetic separator. The middlings from this operation were dewatered in a Dorr classifier and returned to the ball mill. Three different screens were used in the fine grinding circuit to note the grade of concentrate obtained at various finenesses of grinding.

Product	Determination	Screen size		
		13x3 mesh.	16x5 mesh.	24 mesh.
Feed	Iron (Soluble)	52.40	52.40	52.40
	Sulphur	0.23	0.23	0.23
	Phosphorus	0.016	0.016	0.016
	Silica	12.38	12.38	12.38
	Manganese	0.08	0.08	0.08
Concentrates	Iron (Soluble)	61.45	63.45	63.59
	Sulphur			0.15
	Phosphorus			0.01
	Silica			5.18
Tailing	Iron (Soluble)	5.09	5.93	4.33
Ratio of Concentration		1.21:1.	1.21:1.	1.21:1.

This ore requires grinding to minus 14 mesh to obtain a concentrate assaying over 60 per cent in iron.

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Test No. 2.

The ore for this test was freshly broken ore from the mine and comprised equal amounts from the East Lens and the West Lens. A three-ton lot was used in this test.

The ore was crushed to minus $\frac{3}{4}$ inch and treated on a Ball-Norton suspended magnet separator. The non-magnetics from this treatment were discarded and the magnetics delivered to a ball mill in closed circuit with a 16x5 mesh screen. The undersize from the screen was delivered to a Roche wet-magnetic separator, the middling being dewatered in a Dorr classifier and returned to the ball mill for further grinding.

Coarse Cobbing.

	Weight, per cent	ASSAYS, per cent				RECOVERIES, per cent			
		Fe	S	P	Insol.	Fe	S	P	Insol.
Heads	100.0	46.04	0.919	0.015	26.10	100.0	100.0	100.0	100.0
Concentrates	79.5	54.43	0.918	0.012	19.45	94.0	79.6	63.4	59.2
Tailing	20.5	13.44	0.919	0.027	52.14	6.0	20.4	36.6	40.8

Ratio of concentration 1.26:1.

Fine Grinding.

Heads	100.0	54.43	0.919	0.012	19.45	100.0	100.0	100.0	100.0
Concentrates	80.4	66.52	0.938	0.002	6.04	98.2	82.0	13.4	25.0
Tailing	19.6	4.93	0.864	0.053	74.38	1.8	18.0	86.6	75.0

Ratio of concentration 1.24:1.

Overall Results.

Heads	100.0	46.04	0.919	0.015	26.10	100.0	100.0	100.0	100.0
Final Concentrate	63.9	66.52	0.938	0.002	6.04	92.4	65.3	8.5	14.8
Final Tailing	36.1	9.71	0.880	0.038	61.46	7.6	34.7	91.5	85.2

Ratio of concentration 1.56:1.

(Continued on next page)

(Test No. 2, cont'd) -

Analysis of Concentrates.

Determination		Per cent
Fe (Soluble)	-	66.55
Sulphur	-	0.95
SiO_2	-	3.32
Al_2O_3	-	0.60
CaO	-	1.23
MgO	-	1.18
Phosphorus	-	0.002

Screen Analysis.

Mesh	Weight, per cent	Fe, per cent
+ 28	1.9	58.75
- 28+ 35	4.8	61.47
- 35+ 48	7.6	63.76
- 48+ 65	10.2	64.41
- 65+100	15.2	66.48
-100+150	14.6	66.80
-150+200	13.7	67.89
-200	32.0	69.63

The results on this test were somewhat better than in the previous test, indicating that the ore from the surface was more refractory.

It was necessary to grind to minus 14 mesh to obtain a concentrate assaying over 65 per cent in iron and having not over 5 per cent in silica.

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Conclusions from Series No. 1:

1. A concentrate assaying 65 per cent or better in iron can be made by grinding to minus 14 mesh.

2. The sulphur is somewhat high but this would be considerably reduced by the necessary sintering.

3. The extremely low phosphorus in the concentrates

(Conclusions from Series No. 1, cont'd) -

should make this a premium ore in this respect.

4. The second test should be more indicative of the results to be expected in actual practice than is the first test.

Series No. 2. - Coarse Magnetic Cobbing. Preliminary Investigation on Sample from the Surface.

This test was reported in Investigation No. 1064, August 9th, 1941.

In this series two tests were made, one by crushing to minus 4 inch and the other on material crushed to minus 1½ inch. In each case the ore was crushed and separated into screen sizes and each screen size treated separately.

Test No. 1. - Ore Crushed to minus 4-Inch.

	Weight, per cent	ASSAYS, per cent				RECOVERIES, per cent			
		Fe	S	P	Insol.	Fe	S	P	Insol.
Feed	100.0	46.17	0.18	0.017	26.04	100.0	100.0	100.0	100.0
Magnetics	87.2	49.10	0.16	0.016	23.38	92.8	75.9	82.7	78.3
Non-Magnetics	12.8	26.13	0.34	0.023	44.23	7.2	24.1	17.3	21.7

Ratio of concentration 1.12:1.

The ore at this size did not react very satisfactorily and to obtain grade the recovery would drop to around 70 per cent.

Test No. 2.

	Weight, per cent	ASSAYS, per cent				RECOVERIES, per cent			
		Fe	S	P	Insol.	Fe	S	P	Insol.
Feed	100.0	45.52	0.20	0.017	25.74	100.0	100.0	100.0	100.0
Magnetics	74.0	52.97	0.15	0.014	19.67	86.0	55.2	62.3	56.5
Non-Magnetics	26.0	24.38	0.35	0.025	42.96	14.0	44.8	37.7	43.5

Ratio of concentration 1.35:1.

(Test No. 2, cont'd) -

The ore by crushing to minus 1½ inch reacted reasonably well to this method of treatment. The tailings in this test were high but later results indicate that this sample was more refractory to handle than the average from the mine.

—

Conclusions from Series No. 2:

Crushing to minus 4 inch does not produce a suitable concentrate except at a considerable sacrifice of recovery.

At minus 1½ inch the ore will produce a concentrate of about 53 per cent iron with a recovery of 86 per cent of the iron.

This ore sample appears to be more refractory to treat than later samples, as the results obtained in later work were considerably better.

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Series No. 3. - Coarse Magnetic Cobbing. Preliminary Investigation of Samples Taken in the Mine.

The samples for this series of tests were freshly broken ore from some of the drifts and cross-cuts in the mine. All the samples were stage-crushed to minus 1½ inch and the separation made on the Ball-Norton suspended magnet separator. The maximum amperage of the machine was used in each case.

(See table on next page)

(Series No. 3, cont'd) -

Product	Determination, per cent	No. 161 X-Cut.	No. 163 X-Cut.	No. 165 X- Cut.	No. 161 Drift
		- P e r c e n t -			
Feed	Iron	51.83	53.94	54.67	44.90
	Sulphur	0.18	0.29	0.22	1.56
	Insoluble	20.55	17.67	17.85	28.87
Concentrate	Iron	57.66	60.50	58.90	50.90
	Sulphur	0.12	0.20	0.08	1.52
	Insoluble	14.25	10.64	13.76	23.16
	Fe, Recovery	98.3	96.9	97.2	94.0
	Weight "	88.3	86.4	90.2	82.9
Tailing	Iron	7.70	12.30	15.70	14.86
	Sulphur	0.68	0.94	1.41	1.80
	Insoluble	68.30	62.35	55.50	56.55
Ratio of concentration -		1.13:1.	1.16:1.	1.11:1.	1.21:1.

The cross-cut samples were all from the West Lens and the sample from No. 161 Drift was taken from the East Lens.

The recoveries on all these samples were quite high, considering the type of work.

Recovery was good in all cases but there was quite a variation in the grade of concentrate. The East Lens does not concentrate satisfactorily, the grade being low and also containing considerable sulphur.

Series No. 4. - Coarse Magnetic Cobbing. Tests on the Production of a Uniform Grade of Concentrate.

It was thought that a uniform grade of concentrate could be made for a given size of crushing, despite a reasonable variation in the grade of feed sample, if the field strength of the magnets were held at a critical value.

Tests were made at minus $1\frac{1}{2}$ inch, minus 1 inch, and minus $\frac{3}{4}$ inch. The crushed ore was passed over the machine at a low amperage and a concentrate removed, the tailings from

(Series No. 4, cont'd) -

this operation were returned to the machine and formed the feed for the next higher amperage. This procedure was followed through to the maximum amperage of the machine, the weights and assays of the concentrate at each amperage being taken as well as those on the final tailing.

In these tests concentrates were made from 7 to 14 amps. inclusive, the 7 amps. being the lowest at which any concentrate was removed and the 14 amps. being the maximum of the machine.

In the table given below, the concentrate and tailing details for the 11 amp. concentrate only are given, as this appeared to be the critical amperage for the machine.

Sample:		161 X-Cut	165 X-Cut	West Drift	East Lens
Crushing Size:		-1½"	-1"	-1"	-1"
Product	Determination, per cent				
Feed	Sol. Iron	50.90	54.48	37.63	39.31
Concentrate	Sol. Iron	59.50	60.54	55.14	52.54
	Iron Recovery	90.5	92.4	44.1	62.7
	Weight "	72.5	83.1	53.1	46.9
Tailing	Sol. Iron	21.30	23.91	30.09	27.61
Ratio of concentration -		1.38:1.	1.20:1.	2.13:1.	1.88:1.

In comparing No. 165 X-Cut sample with the West Drift sample, the variation in the grade of concentrate is small in comparison to the large variation in the grade of feed.

The West Drift sample and the East Lens samples were used as being representative of the most difficult portions of the ore body to treat. Taking these factors into consideration the agreement in grade of concentrate is considered quite satisfactory.

(Continued on next page)

(Series No. 4, cont'd) -

Two further tests were run on ore crushed to minus $\frac{3}{4}$ inch. For these tests bulk samples from both the East Lens and West Lens were used. As these were samples of the entire lenses they will be indicative of the results to be expected in practice. The results on the West Lens are given in detail while only the 13-amp. concentrate for the East Lens is given. Both these tests were made in a manner similar to the previous tests in this series.

West Lens.

Per cent	7 Amps.	8 Amps.	9 Amps.	10 Amps.	11 Amps.	12 Amps.	13 Amps.	14 Amps.
Feed								
Fe	48.99	48.99	48.99	48.99	48.99	48.99	48.99	48.99
S.	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182
Insol.	21.10	21.10	21.10	21.10	21.10	21.10	21.10	21.10
Conc.								
Fe	61.82	61.33	59.11	58.84	58.67	58.42	58.25	58.05
S.	0.067	0.068	0.075	0.083	0.087	0.091	0.093	0.096
Insol.	10.56	11.17	11.63	12.11	12.35	12.66	12.84	13.03
Tailing								
Fe	46.73	42.61	37.10	30.55	26.11	22.17	19.60	17.67
S.	0.203	0.242	0.309	0.368	0.409	0.441	0.465	0.486
Insol.	22.98	26.26	32.28	37.98	41.85	45.19	47.41	49.08
Recovery								
Fe	18.92	42.70	65.22	78.30	84.17	88.24	90.43	91.92
S.	5.50	12.74	22.17	29.71	33.41	37.11	38.99	40.65
Insol.	7.49	18.04	29.76	37.38	41.09	44.35	46.24	47.87
Weight	15.0	34.1	54.0	65.1	70.3	74.0	76.1	77.6
Ratio of Conc.	9.94:1	2.93:1	1.85:1	1.53:1	1.42:1	1.35:1	1.31:1	1.29:1

This test indicates that 12 or 13 amps. would give the best results. This amperage is higher than the amperage required in the previous tests and is due to the larger amount of fines in the feed. Crushing to minus $\frac{3}{4}$ inch appears to give the most satisfactory results on this ore. Grade can be easily

(Series No. 4, cont'd) -

maintained even under slight fluctuation of amperage. The grade between 10 and 14 amps. held within 1 per cent, although there was considerable difference in recovery.

East Lens. - 13 Amps.

Product	Weight, per cent	ASSAYS, per cent			RECOVERIES, per cent		
		Fe	S	Insol.	Fe	S	Insol.
Feed	100.0	41.92	1.408	33.04	100.0	100.0	100.0
Concentrate	70.4	51.35	1.464	24.27	86.2	73.1	51.7
Tailing	29.6	19.53	1.275	53.86	13.8	26.9	48.3

Ratio of concentration 1.42:1.

This lens does not appear suitable for a coarse cobbing operation both on account of the sulphur in the concentrate and the difficulty in obtaining a suitable grade.

—

Conclusions from Series No. 4:

The final grade of concentrate is determined by the grade of feed, the size of crushing, the character of the ore, and the field strength of the magnet.

If the strength of the magnetic field is held at a critical amperage, the size of ore being constant, then a reasonably uniform grade of concentrate can be maintained despite variations in grade of head sample.

At a constant grade of concentrate there will be quite wide variations in the recovery of the iron.

The above will hold true for the East Lens as well as the West Lens except that the difference in the character of the ore means a difference in the grade of concentrate that should be removed.

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Series No. 5. - Coarse Magnetic Cobbing. A Comparison of the Results Obtained on the Dings Magnetic Pulley With Those Obtained on the Ball-Norton Suspended Magnet Type.

The tests made on the Dings magnetic pulley were made at the plant of the Falconbridge Nickel Mines Limited, Falconbridge, Ontario, through the courtesy of the management.

The Dings magnetic pulley machines were designed for use on the pyrrhotite ores of the Sudbury district and, consequently, had a very much higher field strength than was necessary for the separation of the magnetite. Because of this, considerable difficulty was experienced in making the tests. At low intensities the magnetic field did not bridge the gap between the poles, resulting in the loss of considerable high-grade magnetite, and the field strength directly over the poles was of such a high intensity that low-grade material was delivered to the concentrates.

The ore for the tests at Falconbridge was all crushed to minus $\frac{3}{4}$ inch.

Test No. 1. - 161 X-cut.

Product	Weight, per cent	ASSAYS, per cent			RECOVERIES, per cent		
		Fe	S	Insol.	Fe	S	Insol.
Feed	100.0	55.78	0.174	16.60	100.0	100.0	100.0
Concentrate	95.8	57.96	0.142	14.64	99.6	78.1	84.5
Tailings	4.2	5.93	0.912	61.58	0.4	21.9	15.5

Ratio of concentration 1.04:1.

This test was run at the lowest amperage obtainable on the machine as designed for pyrrhotite separation. The grade of ore was raised very little but a low-grade product was discarded to waste.

In the following tests another resistance was placed

(Test No. 1, cont'd) -

in the electrical circuit and the tests were made at a considerably lower field strength.

Test No. 2. - 161 X-Cut.

Product	Weight, per cent	ASSAYS, per cent			RECOVERIES, per cent		
		Fe	S	Insol.	Fe	S	Insol.
Feed	100.0	55.53	0.168	16.37	100.0	100.0	100.0
Concentrate	91.2	58.90	0.120	13.34	96.8	65.3	74.3
Tailing	8.8	20.48	0.665	47.92	3.2	34.7	25.7

Ratio of concentration 1.18:1.

Test No. 3. - West Lens.

Product	Weight, per cent	ASSAYS, per cent			RECOVERIES, per cent		
		Fe	S	Insol.	Fe	S	Insol.
Feed	100.0	51.17	0.151	21.51	100.0	100.0	100.0
Concentrate	85.0	57.06	0.130	16.39	94.7	73.1	64.8
Tailing	15.0	17.90	0.271	50.38	5.3	26.9	35.2

Ratio of concentration 1.18:1.

These tests were not entirely satisfactory, due mainly to the construction of the machine. As mentioned before, the machine allowed high-grade particles to drop into the tailing and delivered low-grade material to the concentrates.

A comparison with results obtained on the Ball-Norton using a feed of about the same grade and having nearly the same recovery is given below. The ore used on the Ball-Norton was crushed to minus 5/8 inch.

(See table on next page)

(Test No. 3, cont'd) -

Product	Weight, per cent		Sol. Fe, per cent		Insoluble, per cent		Sol. Fe, per cent		Insoluble, per cent	
	Dings	B-N.	Dings	B-N.	Dings	B-N.	Dings	B-N.	Dings	B-N.
Feed	100.0	100.0	51.17	50.63	21.51	21.56	100.0	100.0	100.0	100.0
Conc.	85.0	78.4	57.06	60.31	16.39	12.94	94.7	93.4	64.8	47.0
Tailing	15.0	21.6	17.90	15.55	50.38	52.80	5.3	6.6	35.2	53.0

Ratio of concentration: Dings, 1.18:1; Ball-Norton, 1.27:1.

(1) Ratio of concentration: the Ball-Norton discarded more material to waste.

(2) Grade of iron: the Ball-Norton gave a better grade of iron in the concentrate.

(3) Recovery of iron: the recovery of iron was slightly better on the Dings.

(4) Rejection of insoluble: the Ball-Norton rejected considerably more insoluble to waste.

Conclusions from Series No. 5:

Where an unsized feed is to be used, the Ball-Norton appears to give much better results than does the Dings magnetic pulley.

Series No. 6. - Coarse Magnetic Cobbing. Tests at Minus ½ inch and Minus 5/8 inch.

These tests were made to produce three different products to send to the Lackawanna Plant of the Bethlehem Steel Corporation, Buffalo, New York.

The following concentrates were shipped:

(1) East Lens and West Lens combined, minus ½ inch.

(2) West Lens, minus ½ inch.

(3) West Lens, minus 5/8 inch.

To obtain Sample No. 1, the East Lens and West Lens

(Series No. 6, cont'd) -

samples were treated separately and then the concentrate combined as if the ratio of feed had been 1:1.

Test No. 1. - East Lens (-½ inch).

Product	Weight, per cent	ASSAYS, per cent			RECOVERIES, per cent		
		Fe	S	Insol.	Fe	S	Insol.
Feed	100.0	41.94	1.440	32.81	100.0	100.0	100.0
Concentrate	43.5	53.82	1.508	22.04	55.8	45.6	29.2
Tailing	56.5	32.79	1.383	41.10	44.2	54.4	70.8

Ratio of concentration 2.30:1.

Test No. 2. - West Lens (-½ inch).

Product	Weight, per cent	ASSAYS, per cent			RECOVERIES, per cent		
		Fe	S	Insol.	Fe	S	Insol.
Feed	100.0	50.40	0.120	21.11	100.0	100.0	100.0
Concentrate	67.5	60.76	0.059	12.40	81.4	33.3	39.7
Tailing	32.5	28.87	0.246	39.22	28.6	66.7	60.3

Ratio of concentration 1.48:1.

Test No. 3. - West Lens (-5/8 inch).

Product	Weight, per cent	ASSAYS, per cent			RECOVERIES, per cent		
		Fe	S	Insol.	Fe	S	Insol.
Feed	100.0	50.63	0.145	21.56	100.0	100.0	100.0
Concentrate	78.4	60.31	0.096	12.94	93.4	52.0	47.0
Tailing	21.6	15.55	0.322	52.80	6.6	48.0	53.0

Ratio of concentration 1.28:1.

East Lens and West Lens Combined (-½ inch).

Product	Weight, per cent	ASSAYS, per cent			RECOVERIES, per cent		
		Fe	S	Insol.	Fe	S	Insol.
Feed	100.0	46.17	0.780	26.96	100.0	100.0	100.0
Concentrate	55.5	58.04	0.063	16.18	69.8	44.6	33.3
Tailing	44.5	31.36	0.971	40.41	30.2	55.4	66.7

Ratio of concentration 1.80:1.

(Continued on next page)

(Series No. 6, cont'd) -

Conclusions from Series No. 6:

In these tests the amperage was too low for good recovery except in the case of the minus 5/8 inch material where the amperage was increased. By running at a higher amperage the grade would drop only slightly but the recovery would be considerably improved. This is borne out by the results obtained on crushing to minus 3/4 inch and reported in Series No. 4 - Tests under West Lens. The results obtained in Test No. 3, this series (Series No. 6), also seem to bear out this assumption as the grade remained practically the same as in Test No. 2 but the recovery was increased to 93 per cent.

Series No. 7. - Coarse Magnetic Cobbing. Products Obtained By Crushing to Minus ¼ inch.

Three tests were made in this series. The ore was crushed to minus ¼ inch and then treated on the Ball-Norton separator at the same field strength.

Test No. 1. - West Lens (No. 163 X-Cut).

Product	Weight, per cent	ASSAYS, per cent			RECOVERIES, per cent		
		Fe	S	Insol.	Fe	S	Insol.
Feed	100.0	53.93	0.047	18.36	100.0	100.0	100.0
Concentrate	82.7	63.22	0.027	10.56	97.0	47.2	48.4
Tailing	17.3	9.51	0.144	55.68	3.0	52.8	51.6

Ratio of concentration 1.21:1.

Test No. 2. - East Lens.

Product	Weight, per cent	ASSAYS, per cent			RECOVERIES, per cent		
		Fe	S	Insol.	Fe	S	Insol.
Feed	100.0	41.29	1.702	32.81	100.0	100.0	100.0
Concentrate	66.7	55.39	1.822	19.90	88.1	71.4	40.4
Tailing	33.3	14.99	1.462	58.64	11.9	28.6	59.6

Ratio of concentration 1.48:1.

(Series No. 7, cont'd) -

Test No. 3. - East Lens and West Lens Combined.

Product	Weight, per cent	ASSAYS, per cent			RECOVERIES, per cent		
		Fe	S	Insol.	Fe	S	Insol.
Feed	100.0	46.84	0.840	26.48	100.0	100.0	100.0
Concentrate	75.3	58.08	0.820	16.30	93.4	73.6	46.4
Tailing	24.7	12.53	0.900	57.54	6.6	26.4	53.6

Ratio of concentration 1.33:1.

At this sizing the East Lens appears to be more amenable to magnetic concentration. The sulphur in this lens is still objectionable, however.

At this size it is probable that wet concentration methods could be utilized. This type of concentration would give better results than those shown above.

DISCUSSION OF RESULTS.

General:

The ore must be absolutely dry (less than 1 per cent moisture) for dry magnetic concentration to be effective. Any appreciable moisture causes agglomeration of the fines and no separation occurs.

The Ball-Norton suspended-magnet type of separator appears to give better results on an unsized feed than does the magnetic-pulley type. A machine of this type, with the magnets in three banks separately controlled, would probably give the best results.

A relatively constant grade of concentrate can be maintained for any given crushing size despite the changes in head that would be expected from normal mining operations. The variations in head content of iron will affect the recovery

(Discussion of Results, cont'd) -

more than the grade.

East Lens:

This ore body is not amenable to coarse cobbing operations. The disseminated condition of the magnetite causes difficulty in obtaining a sufficiently high grade in the concentrate and the sulphur content is such that further treatment for its removal is necessary.

A summary of the concentrates obtained is given below:

Crushing size	Weight, per cent	ASSAYS, per cent			RECOVERIES, per cent		
		Fe	S	Insol.	Fe	S	Insol.
-1½ inch	82.9	50.90	1.520	23.16	94.0	80.4	66.5
-1 "	46.9	52.54	1.590	21.96	62.7	79.0	57.9
-¾ "	70.4	51.35	1.464	24.27	86.2	73.1	51.7
-½ "	43.5	53.82	1.508	22.04	55.8	45.6	29.2
-¼ "	66.7	55.39	1.822	19.90	88.1	71.4	40.4

A satisfactory grade is not obtained until the ore is crushed to at least minus ½ inch. Even at this low crushing size the recovery is poor for the grade of concentrate obtained.

West Lens:

This lens reacts quite well to coarse magnetic cobbing. The sulphur elimination is reasonably good and a satisfactory grade can be obtained at a size of 1½ inch. Successively finer grinding gives better concentrates at as good or better recoveries.

The following table gives the results obtained by crushing to various sizes:

(Continued on next page)

(West Lens, cont'd) -

Crushing size	Heads, % Fe	Weight, per cent	ASSAYS, per cent Fe	S	Insol.	RECOVERIES, per cent Fe	S	Insol.
-1½ inch	50.90	77.5	59.50	0.098	12.30	90.8	45.5	47.5
-1 "	54.48	83.1	60.54	0.057	12.51	92.4	21.2	57.4
-¾ "	48.99	76.1	58.25	0.093	12.84	90.4	39.0	44.4
-5/8 "	50.63	78.4	60.31	0.096	12.64	93.4	52.0	47.0
-½ "	50.40	67.5	60.76	0.059	12.40	81.4	33.3	39.7
-¼ "	53.93	82.7	63.22	0.027	10.56	97.0	47.2	48.4

Conclusions:

1. Fine Grinding: This is the only method by which both lenses of ore could be utilized. Although a product high in sulphur is produced this would be reduced to make a marketable product on sintering.

2. Coarse Cobbing: This method is not applicable to the ore in the East Lens but the West Lens responds quite well at any screen size from 1½ inch down. Final grade of concentrates will depend largely upon the screen size desired, grade of feed, and recovery. A grade of about 58 per cent iron can be made at a reasonable recovery from practically any screen size from a head of 50 to 51 per cent iron.

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