

TR6-163-170 R. 383

## SAVAGE RIVER MAGNETITE

## BENEFICIATION BY MAGNETIC SEPARATION

## Sample

Beneficiation tests were performed on a bulk sample representing selected section of diamond drill core from holes numbered 7, 9 and 10 of the Savage River iron ore deposits.

Sections of ore specified were:—

Bore hole No. 7	477' to 782'
Bore hole No. 9	178' to 231'
Bore hole No. 9	268' to 497'
Bore hole No. 10	95' to 114'
Bore hole No. 10	124' to 276'
Bore hole No. 10	318' to 331'
Bore hole No. 10	359' to 438'

The sample was composed from jaw crushed residues from laboratory assay samples. A small number of samples was not available for the make up of the composite, but the weight of these is not significant, and the sample may be regarded as typical of the section of core specified.

A head sample was taken from the composite, and assayed with the following results:—

	Percent
Iron .....	47.6
Sulphur .....	5.84
Phosphorus .....	0.12
Silicon .....	4.18
Alumina .....	2.04
Titanium .....	0.42
Manganese .....	0.10
Vanadium .....	0.30

**Previous Literature**

Mines Department Ore Dressing Investigation No. 326, January, 1958.

Mines Department Ore Dressing Investigation No. 334, June, 1958.

Mines Department Ore Dressing Investigation No. 355-359, November, 1959.

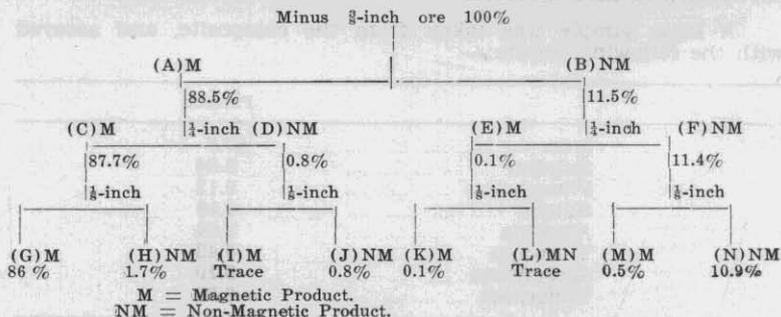
Mines Department Ore Dressing Investigation No. 369-370, June, 1961.

C.S.I.R.O. Mineragraphic Investigations No. 736, 746 and 806.

**Investigation**

Beneficiation by magnetic separation has been investigated at sizings ranging from minus  $\frac{3}{8}$ -inch to minus 200 mesh. Crushing to minus  $\frac{3}{8}$ -inch was performed in a jaw crusher. Due to the nature of the preliminary crushing of the samples, i.e., for assay purposes, the sizing of minus  $\frac{3}{8}$ -inch is unduly fine there being only about 14% of minus  $\frac{3}{8}$ -inch plus  $\frac{1}{4}$ -inch material. Controlled stage crushing would result in a coarser product. Minus  $\frac{1}{4}$ -inch, minus  $\frac{1}{8}$ -inch, and minus 18 mesh B.S.S. sizings were obtained by stage roll crushing. Finer sizings were obtained by closed circuit wet ball mill grinding of minus 18 mesh ore. These sizings were minus 60, 100 and 200 mesh B.S.S. Sixty mesh and 100 mesh grinding circuits were closed by the appropriate screens, and 200 mesh by hydraulic classifier and is therefore nominal only. Sizing analyses of the various size feeds appears later in the report.

Separations at minus  $\frac{3}{8}$ -inch, minus  $\frac{1}{4}$ -inch, and minus  $\frac{1}{8}$ -inch were performed on one sample. Minus  $\frac{3}{8}$ -inch ore was screened on  $\frac{1}{4}$ -inch,  $\frac{1}{8}$ -inch and 44 mesh B.S.S., and the individual fractions magnetically separated. Fractions coarser than 44 mesh B.S.S. were separated dry on a "Rapid" type electro magnetic belt separator. Minus 44 mesh B.S.S. fractions were treated wet in a 6-inch Dings Crockett submerged belt magnetic separator. All fractions were retreated once for effective separation. Magnetic and non-magnetic products from each fraction coarser than the desired size of separation were stage crushed, screened and re-separated, until a series of magnetic and non-magnetic products of minus  $\frac{1}{8}$ -inch in size were obtained. These were the first products assayed, and from them results of separations at coarser sizings were composed as shown in the following test flow-sheet.



Minus 18, 60, 100 and 200 mesh separations were performed on individual samples using the Crockett wet separator; results shown at these sizings are of recleaner concentration.

No responsibility is accepted for the results shown in this report except in so far as they apply to the sample tested.

All iron determinations reported refer to HCl soluble, and in general represent the iron present as magnetite.

### Summary

1. The sample contained 47.6% of iron, 0.12% of phosphorus, and 5.84% of sulphur.

2. Weight yields of magnetic concentrate ranged from 88.5% of minus  $\frac{3}{8}$ -inch size to 67.5% at minus 200 mesh. Iron recoveries were high, the lowest recovery being 96.3% from separation at minus 200 mesh.

3. Beneficiation at minus  $\frac{1}{2}$ -inch was not appreciably better than at minus  $\frac{3}{8}$ -inch. Figures shown in the test flow-sheet indicate the reason for this, only small amounts of non-magnetic material being released by crushing of  $\frac{3}{8}$ -inch magnetics A. Any gain in quality from this operation is nearly counter balanced by the inclusion of small amounts of low grade magnetic material released by the crushing of  $\frac{3}{8}$  non-magnetics B.

Beneficiation at minus 18 mesh showed a sharp increase in concentrate quality over minus  $\frac{1}{2}$ -inch operations. This trend continues with finer grinding of the feed and is clearly indicated in the following summary of the magnetic concentrates.

### Magnetic Products

Size of Separation	Percent									
	Weight	Fe	Fe Dist	S	P	Al <sub>2</sub> O <sub>3</sub>	Si	Mn	Ti	V
$\frac{3}{8}$ -inch ....	88.5	53.4	99.3	4.59	0.09	1.49	3.00	0.10	0.40	0.34
$\frac{1}{2}$ -inch ....	87.8	53.8	99.2	4.59	0.09	1.47	2.91	0.10	0.40	0.34
$\frac{3}{4}$ -inch ....	86.6	54.6	99.1	4.26	0.08	1.49	2.96	0.10	0.40	0.34
18 mesh	74.9	61.8	97.4	1.63	0.03	1.09	1.78	0.10	0.40	0.35
60 mesh	70.7	65.1	97.0	0.75	0.02	0.91	1.22	0.10	0.40	0.38
100 mesh	68.5	66.7	96.4	0.32	0.02	0.91	0.94	0.09	0.31	0.37
200 mesh	67.5	67.9	96.3	0.33	0.02	0.88	0.80	0.09	0.31	0.37
No Beneficiation	100.0	47.6	100.0	5.84	0.12	2.04	4.18	0.10	0.42	0.30

4. Rejection of impurities generally increases with fine grinding of separator feed, and the pattern is similar to that shown in most previous investigations. A full tabulation of percentages rejection of impurities appears below.

Size of Separation	Percent Rejection of					
	S	P	Al <sub>2</sub> O <sub>3</sub>	Si	Mn	Ti
3-inch ....	26.9	33.1	40.7	36.6	12.9	16.6
3-inch ....	27.4	34.6	42.1	38.6	13.9	17.3
3-inch ....	33.7	39.3	42.3	38.7	13.9	17.1
18 mesh ....	78.4	79.2	60.0	68.1	25.7	28.7
60 mesh ....	91.0	88.0	68.5	79.4	29.7	32.8
100 mesh ....	96.1	88.9	69.5	84.6	38.6	49.6
200 mesh ....	96.1	89.7	70.9	87.1	39.6	50.4

## Sizings

Size	Sizing of Separator Feeds		
	Percent 3-inch Feed	Percent 4-inch Feed	Percent 4-inch Feed
— 3" + 1/4" ..	14.3	....	....
— 1/4" + 1/8" ..	31.4	38.0	....
— 1/8" + 44 mesh ..	36.4	42.4	75.2
— 44 mesh ....	17.9	19.6	24.8

Size B.S.S.	Sizing of Separator Feeds			
	Percent 18 mesh	Percent 60 mesh	Percent 100 mesh	Percent 200 mesh (Nominal)
— 18 + 60 mesh	50.3	Trace	....	....
— 60 + 100 mesh	17.5	39.3	Trace	....
— 100 + 150 mesh	10.6	21.4	27.0	Trace
— 150 + 200 mesh	2.6	10.9	18.0	15.5
— 200 mesh	19.0	28.4	55.0	84.5

**DETAILED TEST RESULTS AND ANALYSES OF PRODUCTS**

Product	Wght.	Fe	S	P	Minus 1/4-inch Ore Percent				
					Al <sub>2</sub> O <sub>3</sub>	Si	Mn	Ti	V
G - 1/8" Mag.	86.0	54.9	4.26	0.08	1.43	2.86	0.10	0.40	....
H - 1/8" NM	1.7	3.2	21.70	0.37	2.92	5.21	0.04	0.19	....
I - 1/8" Mag.	Trace	5.9	6.98	0.17	3.76	7.79	0.04	0.46	....
J - 1/8" NM	0.8	5.1	4.17	0.23	5.29	12.72	0.08	0.44	....
- 3/8" Mag. A	88.5	53.4	4.59	0.09	1.49	3.00	0.10	0.40	0.34
K - 1/8" Mag	0.1	5.2	2.32	0.09	10.07	16.85	0.08	0.87	....
L - 1/8" NM	Trace	2.0	2.13	0.10	10.32	17.88	0.08	0.85	....
M - 1/8" Mag.	0.5	4.8	4.15	0.18	9.42	16.99	0.11	0.75	....
N - 1/8" NM	10.9	2.9	13.5	0.34	7.8	13.09	0.11	0.60	....
- 3/8" NM B	11.5	3.0	13.0	0.33	7.89	13.30	0.10	0.61	....
- 3/8" Ore	100.0	47.7	5.56	0.12	2.23	4.18	0.10	0.42	0.30

Product	Wght.	Fe	S	P	Minus 1/4-inch Ore Percent				
					Al <sub>2</sub> O <sub>3</sub>	Si	Mn	Ti	V
G - 1/8" Mag.	86.0	54.9	4.26	0.08	1.43	2.86	0.10	0.40	....
H - 1/8" NM	1.7	3.2	21.7	0.37	2.92	5.21	0.04	0.19	....
K - 1/8" Mag.	0.1	5.2	2.32	0.09	10.07	16.85	0.08	0.87	....
L - 1/8" NM	Trace	2.0	2.13	0.10	10.32	17.88	0.08	0.85	....
- 1/4" Mag. (C + E)	87.8	53.8	4.59	0.09	1.47	2.91	0.10	0.40	0.34
I - 1/8" Mag.	Trace	5.9	6.98	0.17	3.76	7.79	0.04	0.46	....
J - 1/8" NM	0.8	5.1	4.17	0.23	5.29	12.72	0.08	0.44	....
M - 1/8" Mag.	0.5	4.8	4.15	0.18	9.42	16.99	0.11	0.75	....
N - 1/8" NM	10.9	2.9	13.5	0.34	7.8	13.09	0.11	0.60	....
- 1/4" NM (D + F)	12.2	3.1	12.5	0.33	7.70	13.23	0.10	0.60	....
- 1/4" Ore	100.0	47.7	5.56	0.12	2.23	4.18	0.10	0.42	0.30

DETAILED TEST RESULTS AND ANALYSES OF PRODUCTS—continued

Product	Minus 1/8-inch Ore									
	Wght.	Fe	S	P	Al <sub>2</sub> O <sub>3</sub>	Si	Mn	Ti	V	
G — 1/8" Mag. ....	86.0	54.9	4.26	0.08	1.43	2.86	0.10	0.40	....	
I — 1/8" Mag. ....	Trace	5.9	6.98	0.17	3.76	7.79	0.04	0.46	....	
K — 1/8" Mag. ....	0.1	5.2	2.32	0.09	10.07	16.85	0.08	0.87	....	
M — 1/8" Mag. ....	0.5	4.8	4.15	0.18	9.42	16.99	0.11	0.75	....	
— 1/8" Mag. Prod. ....	86.6	54.6	4.26	0.08	1.49	2.96	0.10	0.40	0.34	
H — 1/8" NM ....	1.7	3.2	21.7	0.37	2.92	5.21	0.04	0.19	....	
J — 1/8" NM ....	0.8	5.1	4.17	0.23	5.29	12.72	0.08	0.44	....	
L — 1/8" NM ....	Trace	2.0	2.13	0.10	10.32	17.88	0.08	0.85	....	
N — 1/8" NM ....	10.9	2.9	13.5	0.34	7.8	13.09	0.11	0.60	....	
— 1/8" NM Prod. ....	13.4	3.1	14.0	0.34	7.03	12.06	0.10	0.54	....	
— 1/8" Ore ....	100.0	47.7	5.56	0.12	2.23	4.18	0.10	0.42	0.30	
Beneficiation Minus 18 Mesh B.S.S.										
—18 Mesh Mag. ....	74.9	61.8	1.63	0.03	1.09	1.78	0.10	0.40	0.35	
—18 Mesh NM ....	25.1	4.9	17.7	0.34	4.88	11.35	0.10	0.48	....	
—18 Mesh Ore ....	100.0	47.5	5.66	0.11	2.04	4.18	0.10	0.42	0.30	
Beneficiation Minus 60 Mesh B.S.S.										
—60 Mesh Mag. ....	70.7	65.1	0.75	0.02	0.91	1.22	0.10	0.40	0.38	
—60 Mesh NM ....	29.3	4.8	18.2	0.38	4.77	11.31	0.10	0.47	....	
—60 Mesh Ore ....	100.0	47.4	5.86	0.12	2.04	4.18	0.10	0.42	0.30	
Beneficiation Minus 100 Mesh B.S.S.										
—100 Mesh Mag. ....	68.5	66.7	0.32	0.02	0.91	0.94	0.09	0.35	0.37	
—100 Mesh NM ....	31.5	5.4	17.3	0.35	4.50	11.22	0.12	0.66	....	
—100 Mesh Ore ....	100.0	47.4	5.67	0.12	2.04	4.18	0.10	0.42	0.30	
Beneficiation Minus 200 Mesh (Nominal)										
—200 Mesh Mag. ....	67.5	67.9	0.33	0.02	0.88	0.80	0.09	0.31	0.37	
—200 Mesh NM ....	32.5	5.4	17.1	0.36	4.45	11.22	0.12	0.65	....	
—200 Mesh Ore ....	100.0	47.6	5.78	0.13	2.04	4.18	0.10	0.42	0.30	

### Appendix

#### Summary of Investigations to date on Savage River Iron Ore

Table of Head Values of each bore or section of bore tested:

Reg. No.	Bore No.	Footage	Fe	Per Cent		Ti
				S	P	
R.326	1	....	40.9	0.7	0.07	0.97
R.334	2	313-718	46.2	0.44	0.02	1.09
R.355	3	0-355	49.1	4.51	0.11	0.26
R.356	3	355-525	14.8	5.53	0.21	0.34
R.357	3	525-588	39.8	4.98	0.26	0.70
R.358	3	588-645	16.2	1.66	0.08	0.67
R.359	3	785-918	41.8	4.37	0.03	0.83
R.369	4	100-840	46.4	5.6	0.14	0.37
R.370	5	36-874	30.4	3.6	0.15	0.48
	6	52-559				
R.383	7	477-782	47.6	5.84	0.12	0.42
	9	178-231				
R.383	10	268-497	47.6	5.84	0.12	0.42
		95-114				
		124-276				
		318-331				
		359-438				

Table of iron sulphur titanium phosphorus contents of magnetic concentrates produced from above bore samples. Degree of size reduction before magnetic separation is also shown. For ease of comparison results at each sizing are grouped.

Reg. No.	Bore No.	Footage	Size of Separation	Fe	S	Percent		Ti
						P	Ti	
R.334	2	....	$\frac{1}{2}$ inch	55.3	0.33	0.01	1.2	
R.383	7, 9, 10	....	$\frac{3}{8}$ inch	53.4	4.59	0.09	0.4	
R.334	2	....	$\frac{1}{4}$ inch	56.1	0.29	0.01	1.2	
R.383	7, 9, 10	....	$\frac{1}{4}$ inch	53.8	4.59	0.09	0.4	
R.334	2	....	$\frac{1}{8}$ inch	56.5	0.27	0.01	1.2	
R.355	3	....	$\frac{1}{8}$ inch	56.6	3.12	0.09	0.23	
R.359	3	....	$\frac{1}{8}$ inch	55.9	2.69	0.02	0.89	
R.383	7, 9, 10	....	$\frac{1}{8}$ inch	54.6	4.26	0.08	0.4	
R.334	2	....	18 mesh	61.2	0.14	0.01	1.15	
R.355	3	....	18 mesh	61.2	1.53	0.06	0.25	
R.356	3	....	18 mesh	33.6	4.83	0.12	0.23	
R.359	3	....	18 mesh	61.1	1.32	0.01	0.92	
R.383	7, 9, 10	....	18 mesh	61.8	1.63	0.03	0.4	

Reg. No.	Bore No.	Foot- age	Size of Separation	Fe	S	Percent P	Ti
R.334	2	....	60 mesh	64.9	0.06	Trace	1.07
R.355	3	....	60 mesh	66.0	0.36	0.03	0.20
R.356	3	....	60 mesh	47.5	2.52	0.06	0.22
R.359	3	....	60 mesh	66.5	0.39	0.01	0.75
R.369	4	....	60 mesh	64.8	0.5	0.02	0.37
R.370	5, 6	....	60 mesh	64.4	0.5	0.02	0.36
R.383	7, 9, 10	....	60 mesh	65.1	0.75	0.02	0.40
R.334	2	....	100 mesh	66.4	0.04	Trace	0.90
R.355	3	....	100 mesh	67.7	0.19	0.01	0.21
R.356	3	....	100 mesh	53.9	1.50	0.04	0.22
R.359	3	....	100 mesh	68.7	0.18	0.01	0.67
R.383	7, 9, 10	....	100 mesh	66.7	0.32	0.02	0.31
R.326*	1	....	200 mesh	65.0	0.06	0.01	0.98
R.334	2	....	200 mesh	68.4	0.02	Trace	0.91
R.355*	3	....	200 mesh	68.3	0.22	0.02	0.15
R.356*	3	....	200 mesh	58.5	0.88	Trace	0.19
R.357*	3	....	200 mesh	68.3	0.14	0.02	0.6
R.358*	3	....	200 mesh	69.5	0.22	0.03	0.43
R.359*	3	....	200 mesh	69.4	0.23	Trace	0.48
R.383	7, 9, 10	....	200 mesh	67.9	0.33	0.02	0.30

\* Results of separation of pulverized feeds grouped with 200 mesh grinds for comparative purposes.