

TR3-183-189

R. 334

## SAVAGE RIVER - MAGNETITE

## BENEFICIATION BY MAGNETIC SEPARATION.

## Sample.

Beneficiation tests were requested by the Director of Mines on diamond drill core from No. 2 Hole which had been received from the Rio Tinto Australian Exploration Pty. Ltd. The core had been previously split by the Rio Tinto Company and half submitted to the Department for assaying. Half of the split core from 313 feet to 718 feet 6 inches in alternative 3-inch lengths was used as a sample for this investigation, irrespective of core recovery. This sample weighed approximately 100 lbs. and after crushing to minus  $\frac{1}{2}$ -inch size the sample was halved and one half reserved for future use. A composite was assembled from test products and was assayed as a head sample with the following results.

Iron	46.2
Sulphur	0.44
P <sub>2</sub> O <sub>5</sub>	0.05
SiO <sub>2</sub>	13.6
Al <sub>2</sub> O <sub>3</sub>	2.3
TiO <sub>2</sub>	1.8
Mn	0.11

## Previous Literature.

Tas. Dept. Mines Ore Dressing Investigation No. 326, January, 1958 (this volume).

C.S.I.R.O. Mineragraphic Investigation No. 736, March, 1958.

## Investigation.

Magnetic separation has been investigated from sizings ranging from minus  $\frac{1}{2}$ -inch size to minus 200 mesh. Preliminary crushings to minus  $\frac{1}{2}$ -inch was undertaken in a jaw crusher, and minus  $\frac{1}{4}$ , minus  $\frac{1}{8}$  and minus 18 mesh B.S. were roll crushed. Finer sizings were produced by stage wet ball mill grinding of minus 18 mesh ore. These sizings were minus 60, 100 and 200 mesh B.S.

To obtain reasonable accuracy it was necessary to stage crush and magnetically separate at each sizing from minus  $\frac{1}{2}$ -inch to minus  $\frac{1}{8}$ -inch and the first samples assayed were products from the minus  $\frac{1}{8}$ -inch separation. Results at coarser sizings were derived from these assays. A quantity of minus  $\frac{1}{2}$ -inch ore was roll crushed to minus 18 mesh B.S. and separate quantities of this were used for the remaining tests. Coarse separations were made with a permanent magnet to plus 44 mesh size, and the minus 44 mesh fractions were separated wet in a Dings-Crockett separator. The minus 18 mesh grind and all finer grinds were separated in the Crockett unit. The minus 18 mesh grind was sized into plus 60, plus 200, and minus 200 mesh fractions and each treated separately. The minus 60 mesh and minus 100 mesh grinds were sized to plus and minus 200 mesh and treated separately. All wet magnetic separations were cleaned, and recleaned, unless otherwise stated. B.S. screens were used throughout except the  $\frac{1}{2}$  and  $\frac{1}{4}$  and  $\frac{1}{8}$ -inch screens which have apertures of 0.4375, 0.21 and 0.132 of an inch respectively.

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 herein are HCl soluble and generally represent the iron from magnetite.

### Summary.

1. The sample of magnetite ore contained 46.2% of iron, 0.44% of sulphur and 0.05% of phosphorus. Other determinations are shown under "Sample".

2. The tests from minus  $\frac{1}{2}$ -inch to minus 200 mesh in seven separate sizings clearly indicate the problem of beneficiation as related to iron content and the removal of impurities.

At  $\frac{1}{2}$ -inch the magnetic fraction contained 55.3% of iron, 0.33% of sulphur. At minus 18 mesh the iron content was 61.2%, and the sulphur had dropped to 0.14%. The three remaining sizes show gradually increasing quality to a maximum of 68.4% of iron and 0.02% of sulphur.

The phosphorus content in all magnetic products ranged from 0.01% to 0.03%. Other impurities are shown in the table below.

3. Yields of magnetic concentrate ranged from 67.4% to 81%, with high recoveries of the iron of the order of 98%.

### MAGNETIC PRODUCTS.

Sizing	PERCENT					PERCENT				
	Wght.	Fe	Fe Dist.	S	P <sub>2</sub> O <sub>5</sub>	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	TiO <sub>2</sub>	Mn	
— $\frac{1}{2}$ inch	81.1	55.3	97.1	0.33	0.03	8.3	0.91	1.99	0.13	
— $\frac{1}{4}$ inch	81.0	56.1	98.3	0.29	0.03	7.9	0.85	2.0	0.13	
— $\frac{1}{8}$ inch	80.7	56.4	98.5	0.27	0.02	7.7	0.83	2.0	0.13	
— 18 mesh	74.6	61.2	97.7	0.14	0.02	4.9	0.71	1.92	0.13	
— 60 mesh	70.7	64.9	97.6	0.06	0.01	3.0	0.38	1.78	0.10	
— 100 mesh	69.7	66.4	98.1	0.04	0.01	2.3	0.35	1.51	0.11	
— 200 mesh	67.4	68.4	98.1	0.02	0.01	1.5	0.3	1.51	0.10	

### No Beneficiation.

	100.0	46.2		0.44	0.05	13.6	2.3	1.8	0.11
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4. The rejection of impurities follows a variable pattern. From  $\frac{1}{2}$ -inch size to minus 200 mesh the percentage rejection of impurities was as follows:—

	Reduction Size.				Mesh B.S.			
	$\frac{1}{2}$ "	$\frac{1}{4}$ "	$\frac{1}{8}$ "	18	60	100	200	
Sulphur	46	52	56	78	92	94	97	
Phosphorus	56	66	68	81	89	93	89	
Silica	52	54	55	72	83	88	93	
Alumina	70	72	72	78	89	90	92	
Titanium	10	10	10	18	27	41	43	
Manganese	13	13	13	25	32	33	39	

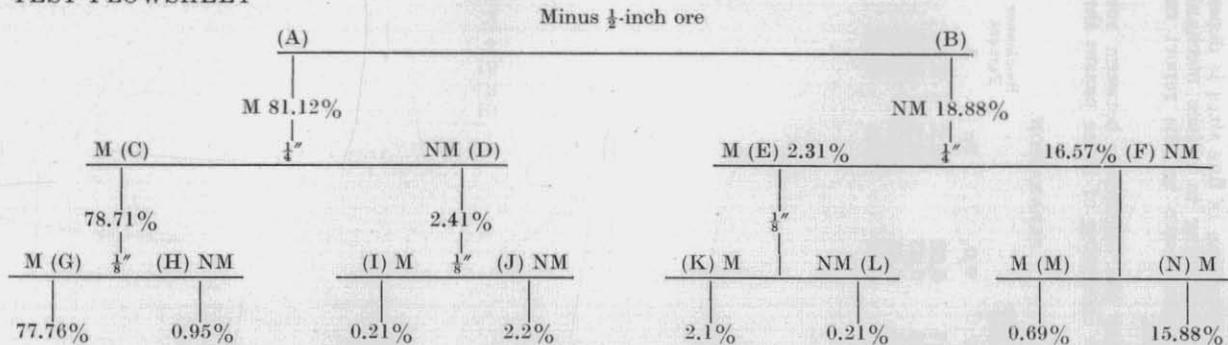
5. Effectiveness of magnetic separation in fine sizes is dependent upon low feed rates and repeated cleaning to reduce mechanically entrained impurities, and the results shown in this report can be regarded as of optimum separation.

The following results indicate the difference between rougher separation and cleaner separation consisting of three passes through the separator.

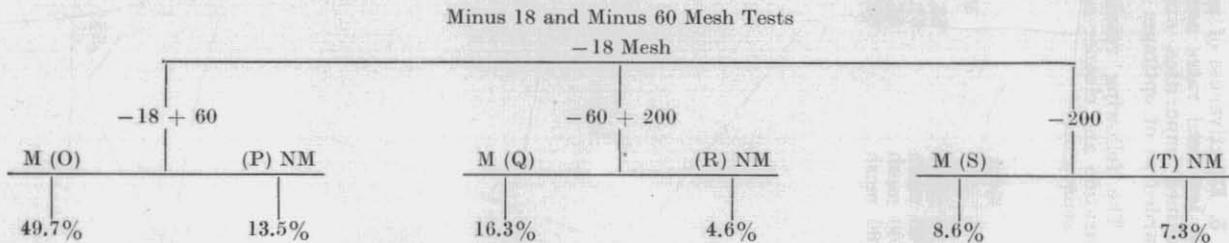
Sizing	SEPARATION.					
	Rougher Percent			Re-cleaner Percent		
	Fe	S	P <sub>2</sub> O <sub>5</sub>	Fe	S	P <sub>2</sub> O <sub>5</sub>
— 18 mesh ....	59.2	0.17	0.02	61.2	0.14	0.02
— 60 mesh ....	61.4	0.13	0.03	64.9	0.06	0.01
— 100 mesh ....	61.6	0.15	0.03	66.4	0.04	0.01
— 200 mesh ....	62.7	0.21	0.03	68.4	0.02	0.01

TEST RESULTS  
TEST FLOWSHEET

(M = Magnetic and NM = Non-magnetic)



Minus  $\frac{1}{2}$ -inch products sampled and assayed. After reduction to minus 18 mesh B.S. portions of the samples were mixed as a composite for subsequent tests.



Treatment of finer sizings are shown under "Investigation."

## ANALYSES OF PRODUCTS

Product	Wght.	PERCENT						
		Fe	S	P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub>	Mn	TiO <sub>2</sub>
G — $\frac{1}{8}$ " Mag. ....	77.7	57.5	0.24	0.02	0.77	7.05	0.13	2.04
H — $\frac{1}{8}$ " NM ....	1.0	5.7	2.59	0.25	3.71	35.4	0.08	0.96
I — $\frac{1}{8}$ " Mag. ....	0.2	19.4	1.36	0.18	2.07	29.7	0.04	0.52
J — $\frac{1}{8}$ " NM ....	2.2	3.8	2.42	0.39	4.35	37.7	0.08	0.91
(A) — $\frac{1}{2}$ " Mag. Prod. ....	81.1	55.3	0.33	0.03	0.91	8.3	0.13	1.99
K — $\frac{1}{8}$ " Mag. ....	2.1	33.4	0.93	0.13	2.22	22.3	0.08	1.06
L — $\frac{1}{8}$ " NM ....	0.2	3.5	1.97	0.22	3.41	40.6	0.05	0.43
M — $\frac{1}{8}$ " Mag. ....	0.7	16.6	1.40	0.16	3.25	32.0	0.05	0.59
N — $\frac{1}{8}$ " NM ....	15.9	3.4	1.22	0.19	10.20	40.3	0.08	1.00
(B) — $\frac{1}{2}$ " Non. Mag. Prod. ....	18.9	7.2	1.21	0.18	8.99	38.0	0.07	0.99
Comp. — $\frac{1}{2}$ " Ore ....	100.0	46.3	0.50	0.06	2.43	13.9	0.12	1.80
Beneficiation at — $\frac{1}{2}$ "								
G — $\frac{1}{8}$ " Mag. ....	77.7	57.5	0.24	0.02	0.77	7.05	0.13	2.04
H — $\frac{1}{8}$ " NM ....	1.0	5.7	2.59	0.25	3.71	35.4	0.08	0.96
K — $\frac{1}{8}$ " Mag. ....	2.1	33.4	0.93	0.13	2.22	22.3	0.08	1.06
L — $\frac{1}{8}$ " NM ....	0.2	3.5	1.97	0.22	3.41	40.6	0.05	0.43
(C + E) — $\frac{1}{2}$ " Mag. Prod. ....	81.0	56.1	0.29	0.03	0.85	7.9	0.13	2.00
I — $\frac{1}{8}$ " Mag. ....	0.2	19.4	1.36	0.18	2.07	29.7	0.04	0.52
J — $\frac{1}{8}$ " NM ....	2.2	3.8	2.42	0.39	4.35	37.7	0.08	0.91
M — $\frac{1}{8}$ " Mag. ....	0.7	16.6	1.4	0.16	3.25	32.0	0.05	0.59
N — $\frac{1}{8}$ " NM ....	15.9	3.4	1.22	0.19	10.20	40.3	0.08	1.00
(D + F) — $\frac{1}{2}$ " Non. Mag. Prod. ....	19.0	4.1	1.37	0.21	9.18	39.6	0.08	0.97
Composite — $\frac{1}{2}$ " Ore ....	100.0	46.3	0.50	0.06	2.43	13.9	0.12	1.80
Beneficiation at — $\frac{1}{2}$ "								

Product	Wght.	PERCENT							Beneficiation at $\frac{1}{2}$ "
		Fe	S	P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub>	Mn	TiO <sub>2</sub>	
G — $\frac{1}{2}$ Mag. ....	77.7	57.5	0.24	0.02	0.77	7.05	0.13	2.04	
I — $\frac{1}{2}$ Mag. ....	0.2	19.4	1.36	0.18	2.07	29.7	0.04	0.52	
K — $\frac{1}{2}$ Mag. ....	2.1	33.4	0.93	0.13	2.22	22.3	0.08	1.06	
M — $\frac{1}{2}$ Mag. ....	0.7	16.6	1.40	0.16	3.25	32.0	0.05	0.59	
— $\frac{1}{2}$ Mag. Prod. ....	80.7	56.5	0.27	0.02	0.83	7.7	0.13	2.00	
H — $\frac{1}{2}$ Non Mag. ....	1.0	5.7	2.59	0.25	3.71	35.4	0.08	0.96	
J — $\frac{1}{2}$ Non Mag. ....	2.2	3.8	2.42	0.39	4.35	37.7	0.08	0.91	
L — $\frac{1}{2}$ Non Mag. ....	0.2	3.5	1.97	0.22	3.41	40.6	0.05	0.43	
M — $\frac{1}{2}$ Non Mag. ....	15.9	3.4	1.22	0.19	10.20	40.3	0.08	1.00	
— $\frac{1}{2}$ " Non Mag. Prod. ....	19.3	3.5	1.44	0.22	9.13	39.8	0.08	0.98	
Composite Ore ....	100.0	46.3	0.50	0.06	2.43	13.9	0.12	1.80	
—18 Mesh Grind.									
O —18 + 60 Mag. ....	49.7	59.3	0.18	0.02	0.85	5.90	0.15	2.07	
Q —60 + 200 Mag. ....	16.3	63.7	0.08	0.01	0.59	3.50	0.11	1.79	
S —200 Mag. ....	8.6	67.4	0.05	0.01	0.16	1.90	0.08	1.32	
—18 Mesh Mag. Comp. ....	74.6	61.2	0.14	0.02	0.71	4.90	0.13	1.92	
P —18 + 60 Non Mag. ....	13.5	4.4	1.41	0.25	N.D.	37.00	0.15	0.93	
R —60 + 200 Non Mag. ....	4.6	4.7	2.47	0.19		35.9	0.09	0.89	
T —200 Non Mag. ....	7.3	3.1	1.17	0.18		36.7	0.13	1.95	
—18 mesh Non Mag. Comp. ....	25.4	4.1	1.53	0.22		36.7	0.13	1.21	
—60 Mesh Grind.									
—60 + 200 Mag. ....	51.1	63.8	0.07	0.01	0.43	3.5	0.1	1.90	
—200 Mag. ....	19.6	67.8	0.04	0.01	0.25	1.8	0.08	1.43	
—60 Mag. Comp. ....	70.7	64.9	0.06	0.01	0.38	3.0	0.10	1.78	
—60 + 200 Non Mag. ....	13.6	3.5	2.06	0.18	N.D.	37.2	0.09	1.17	
—200 Non Mag. ....	15.7	3.8	1.09	0.18		36.0	0.13	2.01	
—60 Mesh Non Mag. Comp. ....	29.3	3.7	1.54	0.18		36.6	0.11	1.62	

Product	Wght.	Fe	S	PERCENT					
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub>	Mn	TiO <sub>2</sub>	
—100 <i>Mesh Grind.</i>									
—100 + 200 Mag. ....	36.3	64.9	0.05	0.01	0.40	2.90	0.11	1.54	
—200 Mag. ....	33.4	68.1	0.03	0.01	0.29	1.70	0.10	1.49	
—100 Mag. Comp. ....	69.7	66.4	0.04	0.01	0.35	2.30	0.11	1.51	
—100 + 200 Non Mag. ....	9.1	3.2	2.21	0.17	N.D.	37.30	0.10	1.59	
—200 Non Mag. ....	21.2	2.8	1.07	0.19		40.5	0.13	2.82	
—100 Non Mag. Comp. ....	30.3	2.9	1.41	0.18		39.5	0.12	2.45	
—200 <i>Mesh Grind.</i>									
—200 Mesh Mag. ....	67.4	68.4	0.02	0.01	0.30	1.5	0.1	1.51	
—200 Mesh Non Mag. ....	32.6	2.8	1.36	0.18	N.D.	38.6	0.13	2.40	

## SIZINGS.

Fraction	Size of Reduction.		
	— $\frac{1}{2}$ "	—1"	—1"
— $\frac{1}{2}$ " + 1"	70.2		
+ $\frac{1}{8}$ "	9.3	42.2	
+44 Mesh	16.0	46.3	84.8
—44 Mesh	4.5	11.5	15.2
B.S. Fraction	Size of Reduction (B.S. Screen).		
	18	60	100
—18 + 60	63.2		
+200	20.9	64.7	45.4
—200	15.9	35.3	54.6