

774-164-171

**R.355, R.356, R.357, R.358,
R.359**

SAVAGE RIVER MAGNETITE

BENEFICIATION BY MAGNETIC SEPARATION

Sample

Beneficiation tests were requested by the Director of Mines on diamond drill core from No. 3 hole. The total bore length was divided into five separate sections, namely, 0-355 feet, 355-525 feet, 525-588 feet, 588-645 feet, and 785-918 feet, registered numbers R.355 to R.359 respectively.

A preliminary investigation, the main object of which was the production of a quantity of high grade iron concentrate, was undertaken on composite samples, made up to represent the above footages using residual material from pulverised assay samples retained in the laboratory. These samples and products made therefrom will be denoted in this report by the word "pulverised".

A further investigation was undertaken on numbers R.355, 0-355 feet; R.356, 355-525 feet; and R.359, 785-918 feet, composites being made on a footage basis from the underground sample residues. These samples were submitted to stage grinding to various sizes, followed by beneficiation of the sized fractions. The object of this investigation was to determine at what sizing a suitable magnetite concentrate could be produced. These samples and products made therefrom will be denoted by the words "stage grind".

Due to the shortage in weight of some individual samples, the composites show some slight deviations from their theoretical composition.

Composite Head samples were assembled from test products and analysed with the following results:—

Reg. No.	Footage	Grind	Fe	S	P ₂ O ₅	Al ₂ O ₃	SiO ₂	Mn	TiO ₂
R. 355	.. 0-355	.. pulverised ..	52.8	3.80	0.28	1.65	7.56	0.12	0.38
R. 355	.. 0-355	.. stage	49.8	4.51	0.26	1.78	9.13	0.12	0.44
R. 356	.. 355-525	.. pulverised ..	16.1	5.67	0.48	3.94	28.7	0.10	0.56
R. 356	.. 355-525	.. stage	14.8	5.53	0.49	4.27	28.9	0.10	0.56
R. 357	.. 525-588	.. pulverised ..	39.8	4.98	0.59	3.96	14.5	0.16	1.18
R. 358	.. 588-645	.. pulverised ..	16.2	1.66	0.19	10.46	35.5	0.15	1.11
R. 359	.. 785-918	.. pulverised ..	42.0	4.47	0.06	3.83	15.2	0.06	1.38
R. 359	.. 785-918	.. stage	42.1	4.37	0.06	3.54	15.9	0.05	1.38

Previous Literature

Mines Department Ore Dressing Investigation No. 326, January, 1958. (*Tas. Dept. Mines Tech. Reports No. 3, 1959.*)

Mines Department Ore Dressing Investigation No. 334, June, 1958. (*ibid.*)

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

Investigation

Beneficiation by magnetic separation was investigated on the samples; pulverised feeds and stage grind feeds minus 60 mesh were classified in a hydraulic classifier using a rising current velocity of 20 mm. per second.

The overflow was fed direct to a Dings-Crockett wet magnetic separator, having a 6-inch belt and belt speed of 138 feet per minute. Stage grind feeds coarser than 60 mesh were screened to suitable sizings for feeding to the separator.

Due to the extremely fine nature of the pulverised feed, it was found that gangue material became readily entrained in the magnetic concentrates. Low feed rates and repeated cleanings were necessary to remove this entrained gangue material. Entrainment was not so pronounced with stage ground feeds, however, low feed rates were used to ensure optimum separation. Rougher concentrates from pulverised samples were cleaned three times, and rougher concentrates from stage grinding were cleaned twice.

Beneficiation on R.355, R.356 and R.359 was investigated at sizings of $\frac{1}{4}$ -inch, 18 mesh, 60 mesh and 100 mesh, separations of $\frac{1}{4}$ -inch and 18 mesh fractions being performed dry on a "Rapid" type dry magnetic separator. One-eighth inch and 18 mesh feeds were produced by dry stage roll crushing and 60 mesh and 100 mesh feeds by wet closed circuit ball milling and screening.

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 are HCl soluble and in general represent the iron present as magnetite.

Summary

1. The iron content of the various sections of the bore hole varied from 15% to 50%, with variable and in some cases considerable amounts of impurities present.

2. A low grade section of the bore from 355 to 525 feet, (R.356), does not respond to beneficiation to the same extent as all other sections, no doubt due to a difference in mineral associations. This difference is demonstrated in R.356 and R.358 being cores of similar iron grade, but with 0.88% and 0.22% of sulphur, and 58.5% and 69.5% of iron in magnetic concentrates.

3. Grade of concentrate exceeds 65% Fe in all cases where grinding to suitable sizes has taken place, with the exception of R.356, 355-525 feet, which has been commented on in paragraph two (2). Recovery of iron in concentrates varies from 85% in the lowest grade sample, to above 98% in the higher quality sections.

4. Grinding to minus 60 mesh, followed by recleaner wet magnetic separation, resulted in the production of high quality concentrates and no sensible increase in grade was obtained by finer grinding.

5. The following is a short summary of the better results of separation, with respect to iron, sulphur and phosphorus. A full tabulation, with analyses of concentrates appears under "test results".

	% Fe recovered	% S rejected	% P ₂ O ₅ rejected
R. 355			
Pulverised	93	96	90
-100 mesh stage grind ..	98	97	91
-60 mesh stage grind ..	98	94	84
R. 356			
Pulverised	85	96	95
-100 mesh stage grind ..	89	93	95
-60 mesh stage grind ..	86	88	92
R. 357			
Pulverised	97	98	95
R. 358			
Pulverised	88	97	91
R.359			
Pulverised	96	97	92
-100 mesh stage grind ..	97	97	80
-60 mesh stage grind ..	97	94	79

Feed Sizings

Typical feed sizings of pulverised and stage ground feeds are shown below.

Screen B.S.S.	Percent Weight				
	Pulverised	100 mesh	60 mesh	18 mesh	$\frac{1}{8}$ inch
+18					65.1
+60				57.5	18.6
+100	0.8		38.4	18.4	
+150	7.4	31.5	23.9	8.8	
+200	8.7	20.4	9.5	3.3	10.9
+300	17.0	48.1	28.2	12.0	5.4
-300	66.1				

Mineragraphic Investigation

Mineragraphic investigation of sections of core discloses magnetite particles from 75 to 2,000 microns, accompanied by pyrite of similar or somewhat coarser grain size. Pyrite grains contain inclusion of magnetite, and some magnetite grains contain minute inclusions of pyrite. While grinding to minus 100 mesh would suffice to liberate the greater proportion of magnetite, very fine grinding of the ore would be necessary for any possibility of removing the final minor amounts of sulphur from the concentrate. Results of test work support this conclusion. Titanium is substantially not removed from the concentrate by magnetic separation, and mineragraphic investigation reveals that minute grains, (as small as 1 micron), of ilmenite are in intimate association with magnetite in the ore.

Test Results

SEPARATION OF PULVERISED FEED

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ORE DRESSING INVESTIGATIONS.

Sample No. and Footage	Product	Percent								Percent Distribution						
		Wt.	Fe	S	P ₂ O ₅	Al ₂ O ₃	SiO ₂	Mn	TiO ₂	Fe	S	P ₂ O ₅	Al ₂ O ₃	SiO ₂	Mn	TiO ₂
R. 355	Mag. Conc. ...	72.0	68.3	0.22	0.04	0.55	1.55	0.11	0.25	93.2	4.2	9.7	24.0	14.8	65.8	47.4
0'-355'	Untreated Ore	100.0	52.8	3.8	0.28	1.65	7.56	0.12	0.38	100.0	100.0	100.0	100.0	100.0	100.0	100.0
R. 356	Mag. Conc. ...	23.4	58.5	0.88	0.10	0.82	7.72	0.06	0.32	85.2	3.6	5.1	4.9	6.3	14.0	13.4
355'-525'	Untreated Ore	100.0	16.1	5.67	0.48	3.94	28.7	0.10	0.56	100.0	100.0	100.0	100.0	100.0	100.0	100.0
R. 357	Mag. Conc. ...	56.6	68.3	0.14	0.05	0.89	1.91	0.10	0.99	97.0	1.6	4.6	12.7	7.5	35.6	47.5
525'-588'	Untreated Ore	100.0	39.8	4.98	0.59	3.96	14.5	0.16	1.18	100.0	100.0	100.0	100.0	100.0	100.0	100.0
R. 358	Mag. Conc. ...	20.4	69.5	0.22	0.08	0.75	2.28	0.09	0.71	87.8	2.7	8.6	1.5	1.3	12.0	13.1
588'-645'	Untreated Ore	100.0	16.2	1.66	0.19	100.46	35.5	0.15	1.11	100.0	100.0	100.0	100.0	100.0	100.0	100.0
R. 359	Mag. Conc. ...	58.1	69.4	0.23	0.01	0.70	1.70	0.04	0.08	96.0	3.0	7.7	10.6	6.5	38.7	33.7
785'-918'	Untreated Ore	100.0	42.0	4.47	0.06	3.83	15.2	0.06	1.38	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Derived Composite Concentrate from above footages		54.0	67.7	0.28	0.04	0.64	2.21	0.09	0.30							

R.355, 0 - 355'

Beneficiation — $\frac{1}{2}$ inch Ore-Stage Crushed

Product	Percent									Percent Distribution					
	Wt.	Fe	S	P ₂ O ₅	Al ₂ O ₃	SiO ₂	Mn	TiO ₂	Fe	S	P ₂ O ₅	Al ₂ O ₃	SiO ₂	Mn	TiO ₂
— $\frac{1}{8}$ " Mag. Conc.	86.0	56.6	3.12	0.21	1.00	5.81	0.13	0.39	99.1	59.5	67.9	48.3	54.7	93.3	76.1
— $\frac{1}{8}$ " N.M. Prod.	14.0	3.11	13.05	0.60	6.57	29.5	0.06	0.75	0.9	40.5	32.1	51.7	45.3	6.7	23.9
— $\frac{1}{8}$ " Ore	100.0	49.1	4.51	0.26	1.78	9.13	0.12	0.44	100.0	100.0	100.0	100.0	100.0	100.0	100.0
<i>Beneficiation — 18 Mesh Stage Crushed</i>															
—18 Mesh Mag. Conc.	79.9	61.2	1.53	0.13	0.80	4.44	0.14	0.41	98.7	27.1	40.5	35.9	38.9	93.3	74.5
—18 Mesh N.M. Prod.	20.1	3.22	16.4	0.77	5.68	27.8	0.04	0.56	1.3	72.9	59.5	64.1	61.1	6.7	25.5
—18 Mesh Ore	100.0	49.5	4.51	0.26	1.78	9.13	0.12	0.44	100.0	100.0	100.0	100.0	100.0	100.0	100.0
<i>Beneficiation — 60 Mesh Stage Ground</i>															
—60 Mesh Mag. Conc.	74.3	66.0	0.36	0.06	0.73	2.73	0.14	0.34	98.1	6.0	15.8	30.5	22.2	86.7	57.5
—60 Mesh N.M. Prod.	25.7	3.64	16.5	0.85	4.82	27.6	0.06	0.73	1.9	94.0	84.2	69.5	77.8	13.3	42.5
—60 Mesh Ore	100.0	49.9	4.51	0.26	1.78	9.13	0.12	0.44	100.0	100.0	100.0	100.0	100.0	100.0	100.0
<i>Beneficiation — 100 Mesh Stage Ground</i>															
—100 Mesh Mag. Conc.	73.8	67.7	0.19	0.03	0.58	1.94	0.14	0.35	98.3	3.1	8.5	24.0	15.7	85.8	58.6
—100 Mesh N.M. Prod.	26.2	33.31	16.7	0.91	5.16	29.4	0.06	0.69	1.7	96.9	91.5	76.0	84.3	14.2	41.4
—100 Mesh Ore	100.0	50.8	4.51	0.26	1.78	9.13	0.12	0.44	100.0	100.0	100.0	100.0	100.0	100.0	100.0

R.359, 785' - 918'

Beneficiation — ½ inch Stage Crushed

Product	Percent								Distribution Percent						
	Wt.	Fe	S	P ₂ O ₅	Al ₂ O ₃	SiO ₂	Mn	TiO ₂	Fe	S	P ₂ O ₅	Al ₂ O ₃	SiO ₂	Mn	TiO ₂
—½" Mag. Conc.	72.7	55.9	2.69	0.04	1.92	7.7	0.04	1.49	97.1	44.7	51.5	39.4	35.2	58.0	78.5
—½" N.M. Prod.	27.3	4.40	8.86	0.11	7.85	37.7	0.08	1.09	2.9	55.3	48.5	60.6	64.8	42.0	21.5
—½" Ore	100.0	41.8	4.37	0.06	3.54	15.9	0.05	1.38	100.0	100.0	100.0	100.0	100.0	100.0	100.0
<i>Beneficiation — 18 Mesh Stage Ground</i>															
—18 Mesh Mag. Conc. . .	66.6	61.1	1.32	0.03	1.42	5.6	0.04	1.53	96.9	20.1	29.8	26.7	23.5	54.0	73.8
—18 Mesh N.M. Prod. . .	33.4	3.9	10.45	0.13	7.77	36.4	0.07	1.08	3.1	79.9	70.2	73.3	76.5	46.0	26.2
—18 Mesh Ore	100.0	41.9	4.37	0.06	3.54	15.9	0.05	1.38	100.0	100.0	100.0	100.0	100.0	100.0	100.0
<i>Beneficiation — 60 Mesh Stage Ground</i>															
—60 Mesh Mag. Conc. . .	61.9	66.5	0.39	0.02	1.02	2.97	0.04	1.25	96.9	5.5	20.8	17.8	11.6	50.0	56.1
—60 Mesh N.M. Prod. . .	38.1	3.45	10.84	0.13	7.64	36.9	0.07	1.59	3.1	94.5	79.2	82.2	88.4	50.0	43.9
—60 Mesh Ore	100.0	42.5	4.37	0.06	3.54	15.9	0.05	1.38	100.0	100.0	100.0	100.0	100.0	100.0	100.0
<i>Beneficiation — 100 Mesh Stage Ground</i>															
—100 Mesh Mag. Conc. . .	59.4	68.7	0.18	0.02	0.57	2.02	0.04	1.11	96.8	2.4	19.8	9.6	7.6	48.0	47.8
—100 Mesh N.M. Prod. . .	40.6	3.32	10.5	0.12	7.89	36.2	0.06	1.78	3.2	97.6	80.2	90.4	92.4	52.0	52.2
—100 Mesh Ore	100.0	42.1	4.37	0.06	3.54	15.9	0.05	1.38	100.0	100.0	100.0	100.0	100.0	100.0	100.0