

TR80-340-347

R.696. Recovery of foundry grade chromite from the Barnes Hill deposit.

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Northern Chromite N.L., requested a further investigation of Barnes Hill chromite with a view to producing two foundry products for the Australian market as well as a chromite concentrate for export.

The foundry products are:

- (1) A moulding sand subject to sizing specification, and
- (2) A mould wash subject to sizing and chemical specifications.

These specifications for the moulding sand are given below. (Sizing according to American Foundry Society's grade 55/65 a typical analysis of which was given as:)

AFS Screen No.	*Aperture (μm)	% Mass
+20	833	Nil
+28	589	Nil
+35	417	9.1
+48	295	30.3
+65	208	30.7
+100	147	16.8
+150	104	7.2
+200	74	3.8
-200		2.1

*Aperture sizes are for Tyler screens of the mesh stated.

No specific sizes for the mould wash were given but the material should be:
Sizing - less than 125 μm and preferably between, say 55 μm and 45 μm .
SiO₂ - not more than 2%.

SAMPLES

A suite of twelve samples taken from costeans in the Barnes Hill deposit was received from Douglas McKenna and Partners, Consulting Geologists. The registered numbers and co-ordinates are:

Reg. No.	Mass (kg)	Co-ordinates*	Calculated % Cr ₂ O ₃
750221	3.66	45N 55E	13.4
750222	4.66	43N 57E	1.7
750223	4.09	44N 56E	0.9
750224	3.02	45N 58E	8.7
750225	3.90	46N 56E	5.8
750226	2.89	47N 51E	1.7
750227	4.35	47N 58E	1.0
750228	3.81	48N 55E	6.7
750229	3.73	48N 57E	10.6
750230	2.89	49N 53E	3.7
750231	3.96	51N 52E	9.2
750232	4.11	51N 54E	22.2

Average grade: 7.2% Cr₂O₃ equivalent to approximately 10.6% chromite.

*Grid laid at 100 foot centres on lease at Barnes Hill [DQ807366].

TREATMENT METHOD

Previous concentration by flotation has produced a product too fine

for moulding sand for which a high recovery of the coarse chromite is mandatory. As flotation is unlikely to recover the coarse chromite gravity concentration was considered.

It was envisaged that gravity concentration using jigs and tables would recover practically all the chromite suitable for moulding sand from the un-sized -600 μm ore, and would itself constitute an appropriate sizing step.

The fine sizes could then be recovered from the gravity tailing by froth flotation, the size range suitable for mould wash being stripped from the flotation concentrate, leaving the remainder as chemical grade chromite. Silica should be removed from the mould wash fraction by magnetic separation.

The same considerations described in Investigation R.632 regarding scrubbing and desliming before flotation, would also apply in this treatment.

The treatment procedure was as follows:

- (1) Each individual sample was pulped in water and the virtually barren +600 μm gravel removed by wet screening.
- (2) The -600 μm material was then diluted to about 10% solids and the slime removed by cycloning in a 75 mm Warman hydraulic cyclone. Cyclone overflows were finished tailings.
- (3) The cyclone underflow was treated in a Denver laboratory mineral jig to produce a low grade chromite concentrate.
- (4) Small samples of the individual jig concentrates were examined by screening on 125 μm and the fractions assayed for Cr_2O_3 .
- (5) The jig concentrates were then combined on a weighted average basis, excluding the minor amounts of concentrate emanating from the four low grade samples, 750222, 750223, 750226 and 750227.
- (6) The composite jig concentrate was roughly screened on 300 μm and the two fractions separately tabled to high grade concentrates. The table tailings were finished products.
- (7) The jig tailings were combined on a weighted average basis and the chromite content concentrated by recleaner flotation after scrubbing and desliming, as reported in R.632, and using the same reagent combination as R.632, Test N22.
- (8) The various chromite concentrates were examined by magnetic separation, sizing and chemical determinations for Cr_2O_3 and SiO_2 .

RESULTS

Jig concentration of individual samples

Reg. No. and Product	% Mass	% Cr_2O_3	% Cr_2O_3 Distn
750221 +600 μm gravel	18.9	n d	-
C O/F	26.0	4.0	7.8
JC	15.6	39.3	45.7
JT	39.5	15.8	46.5
Comp. Head	100.0	13.4	100.0

Reg. No. and Product	% Mass	% Cr ₂ O ₃	% Cr ₂ O ₃ Distn
750222 +600 μm gravel	22.5	n d	-
C O/F	36.7	1.9	42.2
JC	0.2	10.2	1.2
JT	37.6	2.5	56.6
Comp. Head	100.0	1.7	100.0
750223 +600 μm gravel	47.0	n d	-
C O/F	18.4	1.1	21.7
JC	0.4	21.2	9.2
JT	34.2	2.0	69.1
Comp. Head	100.0	0.9	100.0
750224 +600 μm gravel	15.8	n d	-
C O/F	48.1	4.5	24.7
JC	5.8	43.4	28.8
JT	30.3	13.4	46.5
Comp. Head	100.0	8.7	100.0
750225 +600 μm gravel	32.6	n d	-
C O/F	20.3	3.8	13.2
JC	8.9	22.4	34.2
JT	38.2	8.0	52.6
Comp. Head	100.0	5.8	100.0
750226 +600 μm gravel	19.9	n d	-
C O/F	24.7	0.4	5.8
JC	0.4	56.4	13.3
JT	55.0	2.5	80.9
Comp. Head	100.0	1.7	100.0
750227 +600 μm gravel	46.5	n d	-
C O/F	16.8	1.2	19.8
JC	0.4	41.5	16.3
JT	36.3	1.8	63.9
Comp. Head	100.0	1.0	100.0
750228 +600 μm gravel	21.5	n d	-
C O/F	26.8	1.9	7.6
JC	10.1	32.8	53.9
JT	41.6	6.2	38.5
Comp. Head	100.0	6.7	100.0
750229 +600 μm gravel	23.9	n d	-
C O/F	26.3	4.7	11.7
JC	16.8	30.6	48.5
JT	33.0	12.8	39.8
Comp. Head	100.0	10.6	100.0
750230 +600 μm gravel	29.8	n d	-
C O/F	23.5	1.9	12.3
JC	2.1	52.2	30.2
JT	44.6	4.7	57.5
Comp. Head	100.0	3.7	100.0

Reg. No. and Product	% Mass	% Cr ₂ O ₃	% Cr ₂ O ₃ Distn
750231 +600 μm gravel	41.0	n d	-
C O/F	16.9	5.1	9.4
JC	9.8	42.6	45.6
JT	32.3	12.8	45.0
Comp. Head	100.0	9.2	100.0
750232 +600 μm gravel	11.8	n d	-
C O/F	29.4	14.6	19.4
JC	32.0	34.1	49.2
JT	26.8	26.0	31.4
Comp. Head	100.0	22.2	100.0

Sizing and assay of jig concentrates ±125 μm

Reg. No.	Bore No.	+125 μm			-125 μm		
		% Mass	% Cr ₂ O ₃	% Cr ₂ O ₃ Distn	% Mass	% Cr ₂ O ₃	% Cr ₂ O ₃ Distn
750221	45N 55E	93.5	38.0	90.3	6.5	58.5	9.7
750222*	43N 57E		10.2			-	
750223*	44N 56E		21.2			-	
750224	45N 58E	96.9	43.0	96.1	3.1	52.0	3.9
750225	46N 56E	96.4	21.1	90.9	3.6	56.1	9.1
750226*	47N 51E		56.4			-	
750227*	47N 58E		41.5			-	
750228	48N 55E	94.5	32.0	92.3	5.5	46.2	7.7
750229	48N 57E	87.8	28.0	80.4	12.2	49.1	19.6
750230	49N 53E	96.9	52.2	96.9	3.1	52.2	3.1
750231	51N 52E	91.2	40.9	87.8	8.8	58.5	12.2
750232	51N 54E	71.0	28.0	58.3	29.0	49.1	41.7

*Very small amounts of concentrate were obtained from these four low grade samples. Screening was not carried out on them.

Composite head sample

A head sample value was calculated to correspond with the jig concentrates used to make up a composite for further upgrading by tabling. As mentioned previously, this excluded the four low grade samples and amounted to 64.5% of the total mass submitted and contained 93.4% of the total chromite. The head sample assayed 10.4% Cr₂O₃ equivalent to approximately 15.3% chromite.

Tabling of composite jig concentrate

Some difficulty was experienced in excluding minor amounts of quartz from the table concentrates. A stage of dry high intensity magnetic separation was therefore included.

In the table of results both individual and overall distribution of mass and Cr₂O₃ are shown.

Products	% Mass		Assays (%)		% Cr ₂ O ₃ Distn	
	Individual	Overall	Cr ₂ O ₃	SiO ₂	Individual	Overall
'+300' TC M/A	11.3		56.4	0.5	17.7	
'+300' TC N	0.5		3.0	90.7	0.1	
'+300' TC Comp.	11.8	1.6	54.1	4.3	17.8	8.1

Products	% Mass		Assays (%)		% Cr ₂ O ₃ Distn	
	Individual	Overall	Cr ₂ O ₃	SiO ₂	Individual	Overall
'-300' TC M/A	45.2		60.8	0.2	77.3	
'-300' TC N	1.4		22.4	62.3	0.9	
'-300' TC Comp.	46.6	6.2	59.6	2.1	78.2	35.2
Total JC TC Comp.	58.4	7.8	58.5	2.6	96.0	43.3
JC TT	41.6	5.5	3.4		4.0	1.8
JC Composite	100.0	13.3	35.6		100.0	45.1
Total '+300' TC M/A	56.5	7.5	59.9	0.3	95.1	42.9

Sizing of the table concentrates

Both fractions of the magnetic portion of the table concentrates were sized by screening. From the results a composite sizing for the total magnetic concentrate was calculated. By sizing of the non-magnetic fraction of the table concentrates a composite sizing of the table concentrate before magnetic separation was calculated. These results are given below.

Fraction (μ m)	% Mass				Total Mass %	
	' +300 μ m'		' -300 μ m'		TC	TC M/A
	TC	TC M/A	TC	TC M/A		
+600	nil	nil	nil	nil	nil	nil
+425	12.8	13.1	nil	nil	2.6	2.6
+300	63.1	65.1	nil	nil	12.6	13.0
+212	19.8	18.3	23.0	23.6	22.4	22.6
+150	3.8	3.1	30.7	31.5	25.4	25.8
+125	0.5	0.4	21.1	21.6	16.9	17.4
+106	trace	trace	7.5	7.4	6.0	5.9
+75	trace	trace	10.3	9.7	8.2	7.7
-75	trace	trace	7.4	6.2	5.9	5.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Average grades: Total TC 58.5% Cr₂O₃, total TC M/A 59.9% Cr₂O₃.

Flotation of composite jig tailings

A weighted average composite of jig tailings excluding the four low grade samples, was made up as flotation section feed. The theoretical head sample on which this exercise is based would be the same as described under the heading 'Composite head sample'.

The composite jig tailing was prepared for flotation by high density attrition scrubbing in the flotation cell followed by four stages of dilution and decantation to remove slime.

The flotation conditions used were as in Investigation R.632, N22, namely:

Reagent	g/t
Sulphuric acid	1000 (pH 2.5)
Fuel oil	750
Aeromine 3035	250
Calgon	500

All reagents were added in the rougher flotation stage. In view of the

low silica requirement two stages of cleaning were used. The only further reagent added in the cleaner and recleaner stages was a small amount of MIBC (methyl-iso-butyl-carbinol) as an auxiliary frother.

Individual and overall distributions of mass and Cr₂O₃ are given below.

Products	% Mass		Assays (%)		% Cr ₂ O ₃ Distn	
	Individual	Overall	Cr ₂ O ₃	SiO ₂	Individual	Overall
F3C	15.4	5.5	55.9	5.7	72.0	29.6
FT (total)	71.7	25.5	3.4		20.4	8.4
Slime (decant.)	12.9	4.5	7.1		7.6	3.1
Composite JT	100.0	35.5	12.0		100.0	41.1

Sizing of the flotation concentrate

The flotation concentrate was sized by wet and dry screening. Cr₂O₃ and SiO₂ determinations were made on total +75 μm and ±45 μm to indicate grades and silica contamination on material possibly suitable for mould wash. The results are:

Fraction (μm)	% Mass	% Cr ₂ O ₃	% SiO ₂
+150	0.8	56.4	3.6
+125	6.4		
+106	6.6		
+75	16.5		
+45	32.8	57.1	4.7
-45	36.9	54.4	8.3
Composite F3C	100.0	55.9	5.7

Magnetic separation of -75 μm +45 μm flotation concentrate

The specification for mould wash material requires silica content to be less than 2.0%. The -75 μm +45 μm flotation concentrate was therefore submitted to a stage of high intensity dry magnetic separation with the following result:

Product	% Mass	% Cr ₂ O ₃	% SiO ₂	% Cr ₂ O ₃ Distn
M/A	92.0	60.8	0.3	97.7
N	8.0	16.4	54.9	2.3
-75 μm +45 μm	100.0	57.1	4.7	100.0

Consolidated results - overall treatment

Product	% Mass	% Cr ₂ O ₃	% SiO ₂	% Cr ₂ O ₃ Distn
+600 μm gravel	24.5	n d	n d	-
C O/F (primary slime)	26.7	5.3	n d	13.8
JC TC	7.8	58.5	2.6	43.3
JC TT	5.5	3.4	n d	1.8
F3C	5.5	55.9	5.7	29.6
FT	25.5	3.4	n d	8.4
Decant. (secondary slime)	4.5	7.1	n d	3.1
Composite Head	100.0	10.4	-	100.0

Details of chromite recovered by gravity and flotation as concentrates before magnetic separation.

		%
Mass recovery		13.3
Chromite recovery		72.9
Mass distribution:	gravity concentrate	58.6
	flotation concentrate	41.4
Cr ₂ O ₃ distribution:	gravity concentrate	59.7
	flotation concentrate	40.3
Average assays:	Cr ₂ O ₃	57.4
	SiO ₂	3.9

Sizing: Composite of gravity and flotation concentrates before magnetic separation.

Fraction	% Mass	Cum. % Mass
+600 μm	nil	nil
+425 μm	1.5	1.5
+300 μm	7.4	8.9
+212 μm	13.1	22.0
+150 μm	15.2	37.2
+125 μm	12.6	49.8
+106 μm	6.2	56.0
+75 μm	11.6	67.6
+45 μm	15.9	83.5
-45 μm	16.5	100.0

SUMMARY

Moulding sand

Jig and table concentration yielded a composite moulding sand product finer than the typical size analysis supplied. It was made up of the two table concentrates, one coarse and one finer than required. The details of the two concentrates and the total composite are summarised below.

Item	Coarse (+300 μm)		Fine (-300 μm)		Total	
	%	Cum. %	%	Cum. %	%	Cum. %
Sizing: +600 μm	nil	nil	nil	nil	nil	nil
+425	12.8	12.8	nil	nil	2.6	2.6
+300	63.1	75.9	nil	nil	12.6	15.2
+212	19.8	96.7	23.0	23.0	22.4	37.6
+150	3.8	99.5	30.7	53.7	25.4	63.0
+125	0.5	100.0	21.1	74.8	16.9	79.9
+106			7.5	82.3	6.0	85.9
+75			10.3	92.6	8.2	94.1
-75			7.4	100.0	5.9	100.0

% of total mass concentrated in product

1.6

6.2

7.8

% of total chromite in product

8.1

35.2

43.3

Assays: % Cr₂O₃

54.1

59.6

58.5

% SiO₂

4.3

2.1

2.6

Depending on the degree of flexibility permitted in the sizing of the final product, a moulding sand could be produced which would represent between 1.6 and 7.8% of the total mass treated and contain between 8 and 45% of the total chromite. The product would assay in excess of 54% Cr₂O₃ and between 2 and 4% SiO₂.

The samples treated represent about two thirds of the total mass submitted and contained 93% of the chromite.

Mould wash

Flotation of chromite from the jig tailings produced a concentrate amounting to 5.5% of the total mass and containing 29.6% of the total chromite. It assayed 55.9% Cr₂O₃ and 5.7% SiO₂.

The flotation concentrate contained the -75 μm +45 μm fraction suitable for mould wash. This fraction was isolated by screening and amounted to about 2% of the overall mass and contained about 10% of the total chromite. It assayed 57.1% Cr₂O₃ and 4.7% SiO₂.

The SiO₂ content was more than double the desired 2%.

Magnetic separation of the product resulted in a concentrate assaying 60.8% Cr₂O₃ and 0.3% SiO₂.

Chemical grade chromite

About 66% of the flotation concentrate remained after removal of the mould wash fraction. This material represents the amount of chemical grade chromite concentrate recovered. It amounts to about 3% of the total mass treated and contains about 20% of the total chromite in the ore. It assays approximately 55% Cr₂O₃ and 5 to 6% SiO₂.

The final amount of the product would be augmented by whatever chromite concentrate was rejected from the moulding sand to comply with the sizing requirements of that product.

[5 June 1975]