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AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

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SOUTH AUSTRALIAN GOVERNMENT
DEPARTMENT OF MINES

PROJECT 1/1/42

IRON ORE BENEFICIATION

Grants Quarries - Cutana

by

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1. INTRODUCTION

A feasibility study of beneficiation by magnetic and gravity concentration methods was carried out on 2 samples of iron ore, from Grants Quarries, Cutana, supplied by the South Australian Government Department of Mines.

2. SUMMARY

The test work shows that the samples cannot be concentrated significantly by simple oredressing methods because of the fine grain size. Mineralogical examination indicated that grinding to 150-mesh is required for liberation.

Heavy liquid separations on sized fractions, dry magnetic separation and tabling tests were conducted. Wilfley tabling of North ore at minus 72-mesh plus 200-mesh gave best results, producing a concentrate at a grade of 59.0 per cent. iron representing a recovery of 19.0 per cent., or a grade of 55.5 per cent. iron representing a recovery of 34.0 per cent. Results obtained with Terminus ore were inferior.

3. MATERIAL EXAMINED

Two samples of lump iron ore were supplied for the test work. These samples originated from the Terminus and North Quarries, and assayed 39.5 per cent. iron and 43.2 per cent. iron respectively. The samples were similar and typical of surface ore.

Both samples were crushed to minus $\frac{3}{4}$-inch, and sampled.

4. EQUIPMENT

The following laboratory equipment was used in beneficiation tests:

a. British Standard screens.
b. Infrasizer.
c. Stearns disc-type dry magnetic separator.
d. Wilfley Table.

5. EXPERIMENTAL PROCEDURE AND RESULTS

5.1 Mineralogical Examination

5.1.1 Terminus Ore

This material consists of massive and earthy forms of goethite, typical of surface iron ore.

The constituents vary from massive goethite containing minor quartz grains, to aggregates of quartz and hematite cemented with goethite, and to quartzite with interstitial goethite.

Grain size varies from 1.0 to 0.01 mm with an average of 0.1 mm.

5.1.2 North Ore

This sample consists of nodular forms of goethite with quartz. Occasionally quartz occupies the centres of nodules.

The constituents are quartz and hematite grains in a matrix of goethite, ranging from 40-60 per cent. quartz.

The grain size of the quartz is 1.0 - 0.02 mm averaging 0.1 mm while that of the hematite is 1.0 to 0.01 averaging 0.05mm.

5.2 Sizing and Analyses of Crushed Ore

Tables 1 and 2 show the sizing, iron assays and distribution of the Terminus and North ores.

TABLE 1: SIZING ANALYSIS OF TERMINUS ORE

Size Fraction		Weight %	Fe %	Fe Distribution %
- ¾-inch	+ ¼-inch	70.0	41.1	72.6
- ¼-inch	+ 18-mesh	18.9	41.3	19.7
- 18-mesh	+ 72-mesh	2.4	37.5	2.3
- 72-mesh	+ 200-mesh	2.8	24.1	1.7
- 200-mesh	+ 50-micron	1.3	24.3	0.8
- 50-micron	+ 25-micron	2.3	20.5	1.2
- 25-micron	+ 13-micron	1.3	23.5	0.8
- 13-micron		1.0	34.8	0.9
		100.0	39.6 X	100.0

X Calculated value.

TABLE 2: SIZING ANALYSIS OF NORTH ORE

Size Fraction		Weight %	Fe %	Fe Distribution %
- ¾-inch	+ ¼-inch	71.7	46.9	75.2
- ¼-inch	+ 18-mesh	16.9	43.5	16.4
- 18-mesh	+ 72-mesh	2.0	40.2	1.8
- 72-mesh	+ 200-mesh	1.7	32.2	1.2
- 200-mesh	+ 50-micron	1.3	36.7	1.1
- 50-micron	+ 25-micron	3.3	31.9	2.4
- 25-micron	+ 13-micron	1.8	26.4	1.1
- 13-micron		1.3	29.2	0.8
		100.0	44.7 X	100.0

X Calculated value.

5.3 Heavy-Liquid Separation

The results of heavy-liquid separation on sized fractions of the crushed ores (minus $\frac{3}{4}$-inch) are given in Tables 3 and 4. Separations were carried out at S.G. 2.9.

5.4 Magnetic Separation

A sample of each ore was crushed to minus 18-mesh and magnetic separation tests conducted on the Stearns magnetic separator. The conditions for the tests were:

Magnetising coil current	0.9 amps.
Air gap	minimum
Feed rate	6 lb/inch hr.

Results of the separations are shown in Tables 5 and 6.

5.5 Tabling Tests

A sample of each ore was crushed to minus 18-mesh and wet screened to produce the size fractions shown in Table 7.

Tabling tests were carried out on the first 2 fractions of each ore listed in Table 7 using the conditions given in Table 8.

The results of the tests are given in Tables 9 - 12.

5.6 Roasting of North Ore

A sample of North ore, ground to minus 52-mesh, was heated at 800°C. for 3-hours to determine whether any significant improvement in grade could be achieved. Loss in weight was 6.3 per cent., the grade correspondingly increasing from 43.2 to 46.1 per cent. iron.

TABLE 3: HEAVY LIQUID SEPARATIONS ON SIZE FRACTIONS - TERMINUS ORE

Size Fraction	Product	Weight % of fraction	Weight % of feed	Fe % Heavy	Fe % Light	Fe Distribution % Heavy	Fe Distribution % Light
- 3/4-inch + 1/4-inch	Heavy	70.0	49.2	44.4	-	54.3	-
	Light	30.0	20.8	-	36.0	-	18.6
- 1/4-inch + 18-mesh	Heavy	90.8	17.2	43.4	-	18.6	-
	Light	9.2	1.7	-	24.8	-	1-05
- 18-mesh + 72-mesh	Heavy	84.3	2.0	44.0	-	2.2	-
	Light	15.7	0.4	-	7.6	-	0.1
- 72-mesh + 200-mesh	Heavy	51.7	1.45	45.0	-	1.6	-
	Light	48.3	1.35	-	4.3	-	0.15
- 200-mesh	Heavy	49.4	2.9	42.4	-	3.1	-
	Light	50.6	3.0	-	4.1	-	0.3
				44.2[X]	33.3[X]	79.8	20.2
				40.2[X]		100.0	

X Calculated value

TABLE 4: HEAVY LIQUID SEPARATIONS ON SIZE FRACTIONS - NORTH ORE

Size Fraction	Product	Weight % of fraction	Weight % of feed	Fe % Heavy	Fe % Light	Fe Distribution % Heavy	Fe Distribution % Light
- 3/4-inch + 1/4-inch	Heavy	99.0	71.0	45.9	-	73.8	-
-	Light	1.0	0.7	-	38.6	-	0.6
- 1/4-inch + 18-mesh	Heavy	96.3	16.3	45.4	-	16.7	-
	Light	3.7	0.6	-	11.7	-	0.18
- 18-mesh + 72-mesh	Heavy	89.5	1.8	44.9	-	1.8	-
	Light	10.5	0.2	-	5.1	-	0.02
- 72-mesh + 200-mesh	Heavy	74.5	1.3	47.1	-	1.3	-
	Light	25.5	0.4	-	5.3	-	0.1
- 200-mesh	Heavy	57.4	4.4	47.2	-	4.7	-
	Light	42.6	2.3	-	10.6	-	0.8
				45.9[x]	13.8[x]	98.3	1.70
				44.2[x]		100.0	

[x] Calculated value

TABLE 5: DRY MAGNETIC SEPARATION OF TERMINUS ORE

	Weight %	Fe %	Fe Distribution %
Concentrate	23.0	47.5	28.2
Tailing	77.0	36.3	71.8
	100.0	39.8*	100.0

* Calculated value

TABLE 6: DRY MAGNETIC SEPARATION OF NORTH ORE

	Weight %	Fe %	Fe Distribution %
Concentrate	54.6	47.8	60.5
Tailing	45.4	37.6	39.5
	100.0	43.2*	100.0

* Calculated value.

TABLE 7: SIZE FRACTIONS OF CRUSHED ORES

Size Fraction	Weight % of Crude Ore		Fe %	
	Terminus	North	Terminus	North
- 18-mesh + 72-mesh	45.9	53.0	42.2	46.6
- 72-mesh + 200-mesh	16.4	19.7	36.6	44.3
- 200-mesh	37.7	27.3	37.9*	35.8*

* Calculated value

TABLE 8: CONDITIONS FOR TABLING TESTS

	Feed Rate lb/hr.	Water Rate gal./min.	Table Motion Strokes/min.
Terminus - 18 + 72-mesh	61	3	350
" - 72 + 200-mesh	45	3	350
North - 18 + 72-mesh	62	3	350
" - 72 + 200-mesh	40	3	350

TABLE 9: TABLING OF TERMINUS ORE
Minus 18-mesh plus 72-mesh

	Weight % Feed	Fe %	Fe Distribution % Feed	Fe Distribution % Crude Ore
Concentrate	17.7	48.1	20.4	10.0
Middling 1.	35.8	42.4	36.4	17.8
Middling 2.	20.4	39.7	19.4	9.5
Tailing	26.1	37.9	23.8	11.7
Feed	100.0	41.7 X	100.0	49.0

X Calculated value

TABLE 10: TABLING OF TERMINUS ORE
Minus 72-mesh plus 200-mesh

	Weight % Feed	Fe %	Fe Distribution % Feed	Fe Distribution % Crude Ore
Concentrate	1.8	60.2	3.0	0.5
Middling 1.	24.5	46.3	31.2	4.7
Middling 2.	26.9	36.0	26.7	4.1
Tailing	46.8	30.3	39.1	5.9
Feed	100.0	36.3 X	100.0	15.2

X Calculated value

TABLE 11: TABLING OF NORTH ORE
Minus 18-mesh plus 72-mesh

	Weight % Feed	Fe %	Fe Distribution % Feed	Fe Distribution % Crude Ore
Concentrate	7.1	52.6	8.0	4.6
Middling 1.	86.2	46.4	85.7	49.0
Middling 2.	0.6	42.7	0.6	0.3
Tailing	6.1	43.6	5.7	3.3
Feed	100.0	46.6 X	100.0	57.2

X Calculated value

TABLE 12: TABLING OF NORTH ORE
Minus 72-mesh plus 200-mesh

		Weight % Feed		Fe %		Fe Distribution % Feed		Fe Distribution % Crude Ore
Concentrate		14.5)	27.5	59.0)	55.5	19.0)	34.0	3.8
Middling	1.	13.0)		51.8)		15.0)		3.0
Middling	2.	35.1		43.8		34.3		6.9
Tailing		37.4		38.1		31.7		6.4
Feed		100.0		44.9 X		100.0		20.1

X Calculated value

6. DISCUSSION

Examination of Tables 1 and 2 shows that the iron is distributed through the size fractions, indicating that no significant upgrading can be achieved by simple classification or other size separation.

The results of heavy liquid separations, given in Tables 3 and 4, show that a low-grade tailing cannot be rejected at a sizing greater than 18-mesh. Thus for all beneficiation tests, the material was crushed to minus 18-mesh.

Tables 5 and 6 show the low grades and poor recoveries of concentrates produced by magnetic separation.

The best tabling test results were obtained on the minus 72-mesh plus 200-mesh fraction of the North ore. From this material a concentrate representing 14.5 per cent. weight of the feed was produced. This concentrate assayed 59.0 per cent. iron representing a recovery of 19.0 per cent. Increasing the concentrate weight to 27.5 per cent. resulted in a concentrate grade of 55.5 per cent. iron representing a recovery of 34.0 per cent. See Table 12.

Although a reasonably high grade concentrate can be obtained by tabling the corresponding recovery is very low, and can only be increased at the expense of grade.

Mineralogical examination reveals that the average grain size of the constituent minerals is 0.1 mm corresponding to a mesh of liberation of 150. Results of the tabling tests show that although the finer fractions, minus 72-mesh plus 200-mesh, produced higher grade concentrates than did the coarser fractions, finer grinding is required before any effective beneficiation can be obtained. With fine grinding, gravity concentration methods would result in low recoveries due to slime losses.

Roasting of North ore gave no significant improvement in grade.

7. CONCLUSIONS

No effective beneficiation of either sample can be obtained by washing or simple gravity concentration because of the fine grain size and even distribution of the constituent minerals. Grinding to approximately 150-mesh is required to achieve liberation of the gangue, at which size gravity concentration, particularly by Humphrey spirals, would result in large losses in the slime fraction. Gravity concentration methods could be used to produce a primary concentrate, with subsequent retreatment of the tailing. This tailing could possible be treated by flotation, or by reduction roasting and subsequent magnetic separation. These latter processes entail high unit costs and would be justified only if reserves were sufficiently great.

8. RECOMMENDATIONS

It is not recommended that further work be carried out unless reserves warrant an intensive investigation. If work is considered desirable the feasibility and economics of flotation and reduction roasting followed by magnetic separation should be studied.