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C O N F I D E N T I A L

AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

REPORT No. AMDL-65

PROJECT 1/8/2

SOUTH AUSTRALIAN DEPARTMENT OF MINES

RADIUM HILL PROJECT

RETREATMENT OF MIDDLINGS

by

L.J. Weir
P.K. Hosking.

Investigated by Metallurgical Section
Officer in Charge: D.W. Read

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DIRECTOR: L. Wallace Coffer.

ABSTRACT:

Radium Hill flotation middling containing some coarse composite uranium mineralization responded better to flotation after re-grinding, although the degree of comminution was not critical. Recovery of U_3O_8 by flotation was increased from 30 to 92 per cent. by the further addition of reagents.

CONTENTS

1. INTRODUCTION

A request was received from the South Australian Department of Mines for an examination of the flotation middling fraction from the Radium Hill circuit, and for laboratory investigation into re-grinding if this appeared to be warranted.

2. SUMMARY.

Mineralogical examination of three samples of scavenger concentrate from the Radium Hill mill circuit revealed the presence of composite particles containing uranium minerals. In the highest grade concentrate, about 72 per cent. of these composites were coarser than 200 mesh, indicating that further size reduction could lead to increased U_3O_8 recoveries.

Flotation tests carried out on a composite sample of the two higher grade concentrates, without further reagent addition, showed a significant increase in recovery following light grinding, and only further slight increases in recovery with successively finer grinding.

The initial increase may be due to the exposure of clean mineral surfaces of material which was air dried after removal from the Radium Hill circuit, rather than to the liberation achieved by grinding.

Recoveries of about 30 per cent. were achieved at concentrate grades of about 8 lb. U_3O_8 per ton when floating without additional reagent.

Flotation of ground material after high density conditioning with the normal amount of Radium Hill reagent achieved recoveries of up to 93 per cent., the highest concentrate grade being 6.9 lb. U_3O_8 per ton.

Because of the history of the material treated in the laboratory tests, no predictions of reagent requirements in the plant are made from these results.

It is concluded that satisfactory U_3O_8 recovery can be obtained from this type of material by re-conditioning with reagents. The most satisfactory method of re-conditioning in the Radium Hill mill would be in the ball mill where some size reduction would also occur.

It is recommended that trials should be conducted in the Radium Hill mill along these lines.

3. MATERIAL EXAMINED

Samples of three flotation middling products were taken from the mill circuit by the Radium Hill staff, and approximately 150 lb. of each was forwarded to AMDL.

The samples were labelled 1st, 2nd and 3rd scavenger concentrates, and it was requested that they should be combined in the ratio of 1:1:0.5 respectively, provided the grade of each proved satisfactory. Radiometric assays of the three concentrates were reported to be 4.2, 2.6 and 1.0 lb. U_3O_8 per ton respectively.

Mineralogical examination showed that the 3rd scavenger concentrate was of too low a grade to warrant inclusion, therefore the 1st and 2nd scavenger concentrates were bulked in equal proportions to form a composite sample.

4. EQUIPMENT

(a) British Standard screens.

(b) 500 gm. laboratory ball mill using a charge of 105 one inch diameter steel balls.

(c) 500 gm. Fagergren laboratory flotation machine.

(d) 500 gm. laboratory attrition conditioner.

Adelaide tap water was used throughout.

5. EXPERIMENTAL PROCEDURE AND RESULTS

5.1 Mineralogical Examination

The results of mineralogical examination of briquetted samples of the three concentrates are shown in Table 1.

TABLE 1. MINERALOGICAL EXAMINATION OF SCAVENGER CONCENTRATES

Mineralization	Per cent. Volume Conc. 1	Conc. 2	Conc. 3
Free davidite	0.5	0.3	0.05
Davidite-Oxide Composites	1.9	0.7	0.11
Davidite-Gangue Composites	0.9	0.9	0.43
Oxides (rutile, ilmenite, hematite)	6.2	1.0	0.38
Sulphides (pyrite, chalcopyrite)	0.5	0.1	0.03
Gangue Minerals	90.0	97.0	99.00
	100.0	100.0	100.0

It was reported that the davidite composites occurred as intergrowths with rutile and ilmenite, and as inclusions within the gangue minerals.

A more detailed examination of sized fractions of the 1st scavenger concentrate is shown in Table 2.

TABLE 2. MINERALOGICAL ANALYSES OF SIZED FRACTIONS OF 1st SCAVENGER CONCENTRATE

Size Fraction	Weight %	A	B	C	D	E	F	G	H
+ 36 mesh	0.2	0.3	74	1.2	0.8	1.1	20	0.5	2.3
- 36 + 100 mesh	18.0	-	79	2.2	1.0	0.9	14	0.6	2.0
- 100 + 200 mesh	18.6	0.5	75	4.5	0.8	0.6	15	1.9	1.9
200 mesh + 40 microns	15.9	0.1	93	3.7	0.2	0.7	22	0.1	0.4
- 40 + 14 microns	32.8	-	92	4.5	0.5	0.2	2.0	0.3	0.4
- 14 microns	14.5	0.3	94	3.8	0.4	0.4	0.8	0.2	-
	100.0								

A. Free davidite particles.
B. Free silicate particles.
C. Free oxide particles.
D. Sulphide particles plus sulphide-silicate composites.
E. Davidite - silicate composites.
F. Oxides - silicate composites.
G. Oxides - davidite composites.
H. Oxide - davidite - silicate composites.

5.2. Sizing

500 g. charges of composite sample were ground to three degrees of fineness in a laboratory ball mill at 60 per cent. solids. Sizings of unground and ground material are shown in Table 3.

TABLE 3. SIZING OF UNGROUND AND GROUND COMPOSITE SAMPLE

Mesh	Weight %			
	Unground	Grind A	Grind B	Grind C
+ 36	Less than 0.1	-	-	-
- 36 + 52	1.2	0.7	0.1	-
- 52 + 72	6.4	4.1	1.0	0.5
- 72 + 100	9.6	7.2	3.0	2.4
- 100 + 150	8.0	7.4	4.8	2.6
- 150 + 200	9.8	11.5	10.9	6.3
- 200	65.0	69.1	80.2	89.2
	100.0	100.0	100.0	100.0

5.3. Flotation Tests

5.3.1. Tests without Reagent Addition

500 g charges of the composite sample, unground and ground under conditions identical to grinds A, B and C, were treated in a laboratory flotation cell as shown in Table 4.

TABLE 4. FLOTATION CONDITIONS

Flotation Stage	Time Interval
Rougher Concentrate 1.	0 - 45 secs.
" " 2.	45 secs - 2 min.
" " 3.	2 mins - 4 mins
" " 4.	4 mins - 14 mins.

Temperature of flotation 25°C.

Results of this series of tests are shown in Table 5.

TABLE 5. RESULTS OF FLOTATION WITHOUT REAGENT ADDITION

	Product.	Weight % .	Cum. Weight %.	Assay U_3O_8 lb/ton.		% Dist. U_3O_8.	Cum. % Dist. U_3O_8.
Test 1. Unground.	Conc. 1.	4.2	4.2	5.82		8.0	8.0
	" 2.	4.2	8.4	4.48		6.2	14.2
	" 3.	4.5	12.9	4.82		7.1	21.3
	" 4.	8.5	21.4	2.24		6.3	27.6
	Tail.	78.6	100.0	2.80		72.4	100.0
		100.0		3.04	(Calc.)	100.0	
Test 2. Grind A.	Conc. 1.	4.2	4.2	8.06		11.3	11.3
	" 2.	2.9	7.1	4.48		4.4	15.7
	" 3.	4.1	11.2	3.36		4.5	20.2
	" 4.	10.6	21.8	2.58		9.2	29.4
	Tail.	78.2	100.0	2.69		70.6	100.0
		100.0		2.98	(Calc.)	100.0	
Test 3. Grind B.	Conc. 1.	3.2	3.2	8.4		9.3	9.3
	" 2.	3.3	6.5	6.16		7.0	16.3
	" 3.	3.5	10.0	4.03		4.9	21.2
	" 4.	8.7	18.7	3.25		9.7	30.9
	Tail.	81.3	100.0	2.46		69.1	100.0
		100.0		2.90	(Calc.)	100.0	
Test 4. Grind C.	Conc. 1.	2.7	2.7	8.29		7.7	7.7
	" 2.	2.2	4.9	6.38		4.8	12.5
	" 3.	3.7	8.6	5.37		6.8	19.3
	" 4.	8.3	16.9	3.70		10.6	29.9
	Tail.	83.1	100.0	2.46		70.1	100.0
		100.0		2.91	(Calc.)	100.0	

5.3.2. Tests with Reagent Addition

500 g charges of composite sample were conditioned for 20 minutes at 60 per cent. solids in a laboratory attrition-conditioner with 11.0 lb/ton of reagent prior to flotation at the conditions shown in Table 4.

The flotation reagent was made up of the following components:-

Fuel Oil	8.0 parts
S 100 Fatty Acids	2.5 parts
Peltogen	1.5 parts
Cresylic Acid	0.4 parts

Results of this series of tests are shown in Table 6.

TABLE 6. RESULTS OF FLOTATION AFTER REAGENT ADDITION

	Product.	Weight %	Cum. Weight %	Assay U_3O_8 lb/ton.	% Dist. U_3O_8.	Cum. % Dist. U_3O_8.
Test 5. Unground.	Conc. 1.	27.4	27.4	7.16	62.8	62.8
	" 2.	10.9	38.3	3.25	11.3	74.1
	" 3.	11.8	50.1	2.8	12.4	86.5
	" 4.	13.1	63.2	1.35	5.7	92.2
	Tail.	36.8	100.0	0.67	7.8	100.0
		100.0		3.12(Calc.)	100.0	
Test 6. Grind A.	Conc. 1.	34.5	34.5	6.84	76.2	76.2
	" 2.	13.3	47.8	2.8	12.0	88.2
	" 3.	9.8	57.6	1.46	4.6	92.8
	" 4.	7.2	64.8	0.90	2.1	94.9
	Tail	35.2	100.0	0.45	5.1	100.0
		100.0		3.10(Calc.)	100.0	
Test 7. Grind B.	Conc. 1.	31.5	31.5	6.95	74.4	74.4
	" 2.	15.4	46.9	2.59	13.5	87.9
	" 3.	8.5	55.4	1.46	4.4	92.3
	" 4.	7.8	63.2	0.78	2.1	94.4
	Tail.	36.8	100.0	0.45	5.6	100.0
		100.0		2.94(Calc.)	100.0	
Test 8. Grind C.	Conc. 1.	30.1	30.1	7.5	72.7	72.7
	" 2.	11.1	41.2	3.58	12.8	85.5
	" 3.	9.0	50.2	2.02	5.9	91.4
	" 4.	6.6	56.8	1.12	2.4	93.8
	Tail.	43.2	100.0	0.45	6.2	100.0
		100.0		3.11(Calc.)	100.0	

Results tabulated in Tables 5 and 6 are also shown graphically in Figure 1.

6. DISCUSSION

From Table 1, it may be seen that the 3rd scavenger concentrate contained only one per cent. of ore minerals, just over half of which contained uranium mineralization in the form of composites. Because of the low grade, this sample was not used for further work.

Of the uranium bearing composites found in the 1st scavenger concentrate approximately 72 per cent. were coarser than 200 mesh, and it was anticipated that grinding to liberate uranium minerals could result in higher recoveries. In tests on the composite sample this was not achieved without further reagent addition, although concentrate grades were a little higher on ground samples than on the unground material.

Flotation of similarly ground samples, to which the normal amount of Radium Hill reagent was added, achieved greatly increased recoveries at somewhat lower concentrate grades. (Table 6) Slightly increased recovery with increasing fineness of grind was noticed.

Recoveries were increased from about 30 per cent. to about 93 per cent. by the addition of reagent.

A summary of the results in Tables 5 and 6 is presented in graphical form in Figure 1.

7. CONCLUSIONS

Although the addition of the normal quantity of Radium Hill flotation reagent resulted in greatly increased recoveries at similar concentrate grades, it is not known what effect air drying of the feed sample had on subsequent laboratory tests. Therefore no definite conclusions as to reagent requirements can be drawn from these tests.

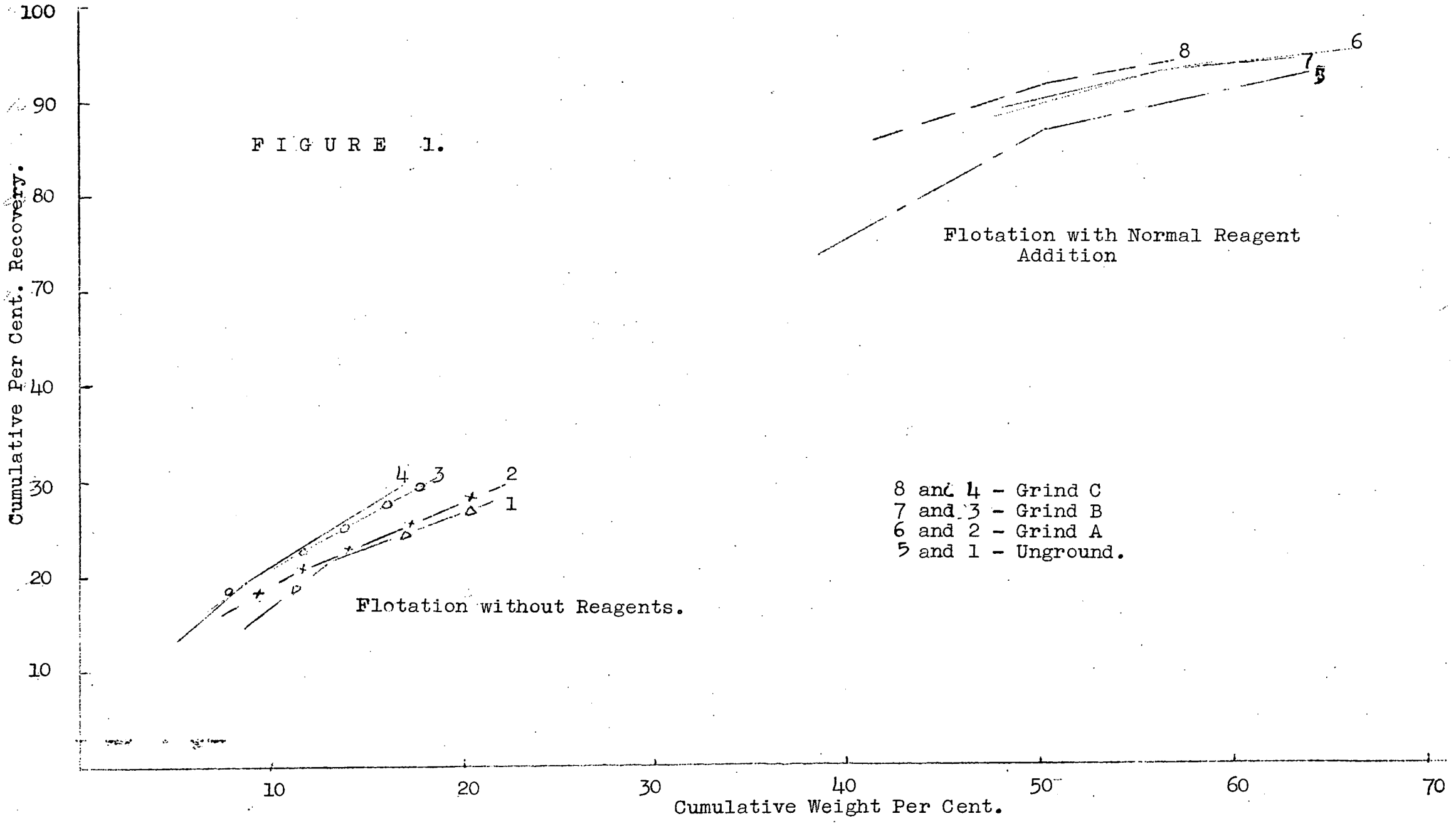
However, it can be reasonably concluded that some reagent addition following light grinding is required. The extent of the grinding is apparently not critical, the improvement in results obtained on the ground sample being probably due more to the exposure of a clean surface than to the liberation of locked mineral particles.

Because of the difficulties in attempting to predict plant behaviour from a sample receiving different treatment it can only be recommended that plant trials be conducted at Radium Hill. This could best be done initially by

feeding the thickened scavenger concentrate to the head of the ball mill treating minus 10 mesh material, where it would be subjected to light grinding and would receive additional conditioning with reagents.

A thickening / classification step may be accomplished in a hydrocyclone, under-flow going to the grinding circuit, and overflow returning to the flotation circuit.

F I G U R E 1.


Cumulative Per Cent. Recovery.
100
90
80
70
40
30
20
10
10
20
30
40
50
60
70
Cumulative Weight Per Cent.
8
6
7
5
Flotation with Normal Reagent Addition
4
3
2
1
Flotation without Reagents.
8 and 4 - Grind C
7 and 3 - Grind B
6 and 2 - Grind A
5 and 1 - Unground.