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BENEFICIATION OF ORE FROM RADIUM HILL SOUTH HILL PROSPECT.

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BENEFICIATION OF ORE

FROM

RADIUM HILL SOUTH HILL PROSPECT.

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Mineralogical & Petrological Report

BENEFICIATION OF ORE

FROM

RADIUM HILL SOUTH HILL PROSPECT.

1. SUMMARY.

A sample assaying 1.7 lb. U_3O_8 per ton, representative of ore from the South Hill Prospect Lode and submitted by the Radium Hill Project, was tested by heavy-media separation and flotation.

A heavy-media concentrate of 7.2 lb. U_3O_8 per ton containing 73 per cent. of the uranium in the H.M.S. feed was obtained when the minus one-inch plus 10-mesh fraction of the ore was treated at a medium specific gravity of 2.79. This fraction together with the minus 10-mesh fraction of the ore represented a recovery of 80 per cent. of the total uranium, at a grade of 3.9 lb. U_3O_8 per ton.

Flotation of this combined fraction produced a concentrate assaying 12 lb. U_3O_8 per ton, representing an overall recovery of 70 per cent. of the uranium in the original feed.

Owing to the mode of occurrence of the davidite in the ore, recovery was lower than that obtained on normal Radium Hill ore.

2. INTRODUCTION.

The Radium Hill Project requested that a sample of ore from the South Hill Prospect be examined with a view to assessing its amenability to treatment by the methods of concentration normally used at Radium Hill.

3. MATERIAL EXAMINED.

The first representative parcel of twelve tons of the South Hill Prospect Lode material assayed 0.45 lb. U_3O_8 per ton. This was lower than anticipated and considered too low to warrant test work.

The second parcel of 11.6 tons assayed 1.68 lb. U_3O_8 per ton. This material was considered to be of satisfactory grade and, after crushing to minus one-inch, a sample was used for the heavy-media tests.

4. EQUIPMENT USED.

(1) Crushing plant.

(2) 2' x 1' Denver Dillon vibrating screen.

(3) 20" diameter cone type heavy-media unit.

(4) Laboratory steel batch ball mill.

(5) Laboratory Fagergren flotation cell, 500 gm. capacity.

5. EXPERIMENTAL PROCEDURE AND RESULTS.

5.1 Heavy-media Separation.

A one ton sample of the ore was crushed to minus one-inch and wet screened at 10-mesh. The minus one-inch plus 10-mesh material was treated in the heavy-media unit using ferrosilicon as the heavy-medium.

Three stages of heavy-media separation were used, each successive stage being at a lower specific gravity.

The float material from the first stage was used as feed for the second, and the float fraction from the second stage used as feed for the final stage.

The separation specific gravity referred to throughout this report will be that of the medium feed to the separating cone.

The specific gravity values of the medium from the top and bottom of the separating cone and of the medium feed to the cone were recorded for each stage of heavy-media separation and are given in Table 1.

TABLE 1.

Average Specific Gravities of Ferrosilicon Medium.

Stage	Feed to Cone	Bottom of Cone	Top of Cone
1	2.79	2.84	2.69
2	2.73	2.75	2.67
3	2.67	2.70	2.60

The results of these stages are shown in Tables 2, 3, and 4 respectively.

TABLE 2.

Heavy Media Separation at Specific Gravity 2.79.

Product.	Based on heavy-media feed.			Based on whole ore.		
	Weight %.	Assay lb. U_3O_8/ton.	Distribution U_3O_8 - %.	Weight %.	Assay lb. U_3O_8/ton.	Distribution U_3O_8 - %.
Whole ore	-	-	-	100.0	1.64 (C) 1.68 (A)	100.0
H.M. Feed	100.0	1.54 (C) 1.6 (A)	100.0	78.9	1.54 (C) 1.6 (A)	74.3
Minus 10-mesh	-	-	-	21.1	2.0	25.7
H.M. Sink	15.6	7.2	72.7	12.3	7.2	54.0
Minus 10-mesh plus H.M. Sink	-	-	-	33.4	3.9	79.7
H.M. Float	84.4	0.50	27.3	66.6	0.50	20.3

'C' denotes calculated assay value.

'A' denotes actual assayed value.

TABLE 3.

Heavy Media Separation at Specific Gravity 2.73.

Product.	Based on heavy-media feed.			Based on whole ore.		
	Weight %	Assay lb. U_3O_8/ton.	Distribution U_3O_8 - %.	Weight %.	Assay lb. U_3O_8/ton.	Distribution U_3O_8 - %.
Whole ore	-	-	-	100.0	1.59 (C) 1.68 (A)	100.0
H.M. Feed	100.0	1.49 (C) 1.6 (A)	100.0	78.9	1.49 (C) 1.6 (A)	73.5
Minus 10-mesh	-	-	-	21.1	2.0	26.5
H.M. Sink	25.9	4.6	80.2	20.4	4.6	58.8
Minus 10-mesh plus H.M. Sink	-	-	-	41.5	3.3	85.3
H.M. Float	74.1	0.40	19.8	58.5	0.40	14.7

'C' denotes calculated assay value.

'A' denotes actual assayed value.

TABLE 4.

Heavy Media Separation at Specific Gravity 2.67.

Product.	Based on heavy media feed.			Based on whole ore.		
	Weight %.	Assay lb. U_3O_8/ton.	Distribution U_3O_8 - %.	Weight %.	Assay lb. U_3O_8/ton.	Distribution U_3O_8 - %.
Whole ore	-	-	-	100.0	1.59 (C) 1.68 (A)	100.0
H.M. Feed	100.0	1.48 (C) 1.6 (A)	100.0	78.9	1.48 (C) 1.6 (A)	-
Minus 10-mesh				21.1	2.0	26.5
H.M. Sink	55.5	2.4	89.8	43.8	2.4	66.0
Minus 10-mesh, plus H.M. Sink	-	-	-	64.9	2.3	92.5
H.M. Float	44.5	0.34	10.2	35.1	0.34	7.5

'C' denotes calculated assay value.

'A' denotes actual assayed value.

5.2. Flotation.

The minus 10-mesh fraction of the original sample was combined proportionately with the sink fraction from heavy-media separation at a specific gravity 2.79. This mixture was used as feed for the flotation tests and represented 33.4 per cent. of the original material by weight and contained 79.7 per cent. of the total U_3O_8 content.

Tests 1 to 3 were carried out on 500 gram charges of flotation feed ground in the laboratory ball mill at 60 per cent. solids for 30 minutes. The ground pulp was conditioned at 50 per cent. solids in a high-speed agitator for 25 minutes with 7, 10 and 14.5 lb. of reagent mixture per ton of flotation feed.

Reagent.	Mixture.
Peltogen	1.5 parts
Linseed fatty acids	2.5 "
Fuel oil	10.0 "
Naphthenic acid	0.5 "
Total:	14.5 "

Tests 4 to 6 were carried out under identical conditions to Tests 1 - 3, but with the grinding time increased to 45 minutes.

Screen analyses for the 30 and 45 minutes grinds are shown in Table 5.

Results are shown in Table 6 and in Figure 3.

Rougher concentrates taken over the following time intervals were weighed and assayed and the tests assessed by plotting the cumulative weight floated against the cumulative recovery per cent.

Time intervals:

Rougher concentrate	1.	0 - 15 seconds
	2.	15 - 45 "
	3.	45 secs. - 2 minutes
	4.	2 " - 4 "
	5.	4 " -10 "

TABLE 5.

Screen Analyses.

Screen Mesh (B.S.)	30 min. grind- % Weight.	45 min. grind - % Weight.
+ 52	0.6	0.3
- 52 + 72	2.7	1.6
- 72 + 100	4.9	4.1
- 100 + 150	5.3	4.2
- 150 + 200	14.4	12.2
- 200	72.1	77.6
Feed:	100.0	100.0

TABLE 6.

Flotation Test Results.

Test No.	Fraction		% Wt.	Cum. % Wt.	Assay U_3O_8 lb./ton	% U_3O_8 Dist.	Cum. % U_3O_8 Recovery
1. Reagent 7 lb./ton	Rougher conc.	1	10.1	10.1	18.7	46.2	46.2
	" "	2	5.5	15.6	12.3	16.6	62.8
	" "	3	7.3	22.9	6.7	12.0	74.8
	" "	4) 5)	11.5	34.4	4.1	11.5	86.3
	Rougher tail.		65.6	100.0	0.86	13.7	100.0
	FEED:		100.0		4.1	100.0	
2. Reagent 10 lb./ton	Rougher conc.	1	12.0	12.0	19.4	52.0	52.0
	" "	2	4.8	16.8	13.4	14.3	66.3
	" "	3	5.6	22.4	7.8	9.8	76.1
	" "	4	13.2	35.6	3.1	9.2	85.3
	" "	5	5.4	41.0	3.9	4.7	90.0
	Rougher tail.		59.0	100.0	0.76	10.0	100.0
	FEED:		100.0		4.5	100.0	
3. Reagent 14.5 lb./ton	Rougher conc.	1	12.7	12.7	18.0	53.5	53.5
	" "	2	6.1	18.8	12.7	17.9	71.4
	" "	3	6.5	25.3	6.3	9.5	80.9
	" "	4	10.2	35.5	2.5	5.8	86.7
	" "	5	15.0	50.5	1.9	6.5	93.2
	Rougher tail.		49.5	100.0	0.58	6.8	100.0
	FEED:		100.0		4.3	100.0	

(Contd.)

TABLE 6 (Contd.):

Test. No.	Fraction		% Wt.	Cum. % Wt.	Assay U_3O_8 lb./ton	% U_3O_8 Dist.	Cum. % U_3O_8 Recovery
4. Reagent 7 lb./ton	Rougher conc.	1	13.0	13.0	16.4	49.5	49.5
	" "	2	6.6	19.6	11.4	17.3	66.8
	" "	3	11.0	30.6	4.7	12.0	78.8
	" "	4	12.6	43.2	2.5	7.2	86.0
	" "	5	3.7	46.9	5.6	4.9	90.9
	Rougher tail.		53.1	100.0	0.74	9.1	100.0
	FEED:		100.0		4.3	100.0	
5. Reagent 10 lb./ton	Rougher conc.	1	12.4	12.4	17.0	48.2	48.2
	" "	2	6.1	18.5	11.6	16.2	64.4
	" "	3	9.0	27.5	6.5	13.2	77.6
	" "	4	15.2	42.7	2.7	9.4	87.0
	" "	5	3.8	46.5	5.3	4.6	91.6
	Rougher tail.		53.5	100.0	0.67	8.4	100.0
	FEED:		100.0		4.4	100.0	
6. Reagent 14.5 lb./ton	Rougher conc.	1	14.2	14.2	16.4	55.4	55.4
	" "	2	5.9	20.1	10.9	15.2	70.6
	" "	3	8.8	28.9	5.4	11.2	81.8
	" "	4	13.5	42.4	1.9	6.2	88.0
	" "	5	11.5	53.9	2.0	5.5	93.5
	Rougher tail.		46.1	100.0	0.58	6.5	100.0
	FEED:		100.0		4.2	100.0	

These results show that grinding to 72 per cent. minus 200-mesh and conditioning the pulp at 50 per cent. solids with 14.5 lb. of reagent mixture per ton of ore (Test 3) gives optimum results.

A cyclic test was conducted on six 500 gram charges of flotation feed ground to 72 per cent. minus 200-mesh and conditioned with reagent as in Test 3. The rougher concentrate was cleaned twice, the cleaner tailing being added to the next charge after grinding and the recleaner tailing being added to the rougher concentrate produced from the next charge and so on. The results of this test are shown in Table 7.

TABLE 7.

Fraction.	% Weight.	U_3O_8 lb./ton	U_3O_8 Dist. %.
Recleaner concentrate ...	29.5	12.2	87.3
Recleaner tailing	2.0	2.2	1.0
Cleaner tailing	4.7	1.6	1.9
Rougher tailing	63.8	0.6	9.8
FEED (calculated)	100.0	4.1	100.0

6. DISCUSSION OF RESULTS.

6.1 Heavy Media Separation.

It can be seen from Table 2 that at a specific gravity of 2.79 only 73 per cent. of the uranium in the heavy-media feed is recovered in a concentrate assaying 7.2 lb. U_3O_8 per ton with a ratio of concentration of 6.4 to 1. The low recovery achieved in the tests is believed to be due to the mode of occurrence of the davidite in the ore. A mineralogical examination of the heavy-media concentrates showed that some of the davidite was free but the greater amount was present as composite particles.

Table 2 and Figure 1 show that by combining the minus 10-mesh material in the ore with the heavy-media concentrate produced at specific gravity 2.79, a product is obtained representing 33.4 per cent. by weight of the original feed containing 80 per cent. of the uranium. The ore is upgraded from 1.7 to 3.9 lb. U_3O_8 per ton.

If the specific gravity of separation is lowered from 2.79 to 2.73 (see Table 3 and Figures 1 and 2) the amount of heavy-media feed reporting in the sink fraction is increased from 15.6 to 25.9 per cent. by weight with a reduction of grade of concentrate from 7.2 to 4.6 lb. U_3O_8 per ton. At this lower specific gravity an increase of 7.5 per cent. uranium recovery in the heavy media feed is gained. A mixture of the minus 10-mesh fraction and the heavy-media concentrate recovered 85 per cent. of the uranium in the ore, in a concentrate assaying 3.3 lb. U_3O_8 per ton.

By decreasing the specific gravity of separation to 2.67, 55 per cent. of the heavy-media feed material reports in the sink fraction. The tailing fraction, assaying 0.34 lb. U_3O_8 per ton, indicates high losses due to the fineness and composite nature of the davidite in the ore.

6.2. Flotation.

Comparing Tests 1-3 and 4-6 there is no evidence to show that finer grinding would increase the recovery of uranium.

The results of the cyclic test show that a concentrate grade of 12.2 lb. U_3O_8 per ton can be obtained with a recovery of 87.3 per cent. of the uranium in the flotation feed.

Generally the material presents no abnormalities in flotation compared with normal Radium Hill ore, although the ratio of concentration of uranium is somewhat lower.

7. CONCLUSIONS.

The heavy-media tests indicate that 80 per cent. of the uranium is recovered in upgrading the ore from 1.7 to 3.9 lb. per ton. This is achieved by using a separation specific gravity of 2.79. Alternatively, 85 per cent. of the uranium can be recovered in a combined concentrate of 3.3 lb. U_3O_8 per ton by using a separation specific gravity of 2.73.

These tests indicate that the recovery of davidite by heavy-media from the South Hill Prospect Lode will not be as high as the recoveries obtained by heavy-media separation from other lodes at Radium Hill. The lower recovery is believed to be caused by the mode of occurrence of the davidite.

Flotation of the combined heavy-media sink fraction at 2.79 specific gravity and minus 10-mesh fraction of the ore produces a concentrate of 12.2 lb. U_3O_8 per ton, representing a recovery of 87.3 per cent. of the uranium in the flotation feed. This is equivalent to an overall recovery of almost 70 per cent. of the uranium in the original ore.

APPENDIX.

MINERALOGY & PETROLOGY SECTION

REPORT NO. P.R.C. 1/59.

MATERIAL:	Radium Hill ore.
SUBMITTED BY:	Metallurgical Section
DATE RECEIVED:	16th January, 1959.
MARKS OR NUMBERS:	M.9037 - M.9040.
SOURCE:	South Lode Prospect.
INFORMATION REQUIRED:	Mode of occurrence of davidite.
METHOD OF EXAMINATION:	Magnetic separation and microscopic.

RESULTS OF EXAMINATION:

A representative portion of each of the four samples was divided into a magnetic and non-magnetic fraction. Briquettes were prepared from all these fractions. Comments on the microscopic observations are as follows:

M.9037 - H.M. Sink (at S.G. 2.79):

The magnetic fraction contains large amounts of magnetite, free or composite with silicates. Smaller amounts of pyrite, haematite and ilmenite occur composite with silicates containing magnetite. Minor davidite was found in quartz-magnetite composites.

The non-magnetic fraction contains an abundance of davidite. Some is free, although containing its usual inclusions, but the bulk of it is composite as fine grained complex intergrowths with quartz, rutile and pyrite. Grinding to at least -100 mesh would be necessary to free this davidite.

Numerous other composites are present, such as silicate-rutile, ilmenite-haematite-silicates, magnetite-silicates, and minor pyrite and chalcopyrite.

M.9038 - H.M. Sink (at S.G. 2.73, float at S.G. 2.79):

This magnetic material is as that described above, but no davidite was observed.

The non-magnetic material is mostly silicates with small inclusions of haematite, rutile, ilmenite and magnetite amongst which minor davidite may be seen as fine-grained intergrowths.

M.9039 - H.M. Sink (at S.G. 2.67, float at S.G. 2.73):

No davidite was observed in either fraction; the predominantly siliceous material containing only inclusions of magnetite, haematite, ilmenite and rutile as euhedral laths of small size.

M.9040 - H.M. Float (at S.G. 2.67):

The material of both fractions was found to be devoid of davidite after the examination of four briquettes.

CONCLUSIONS:

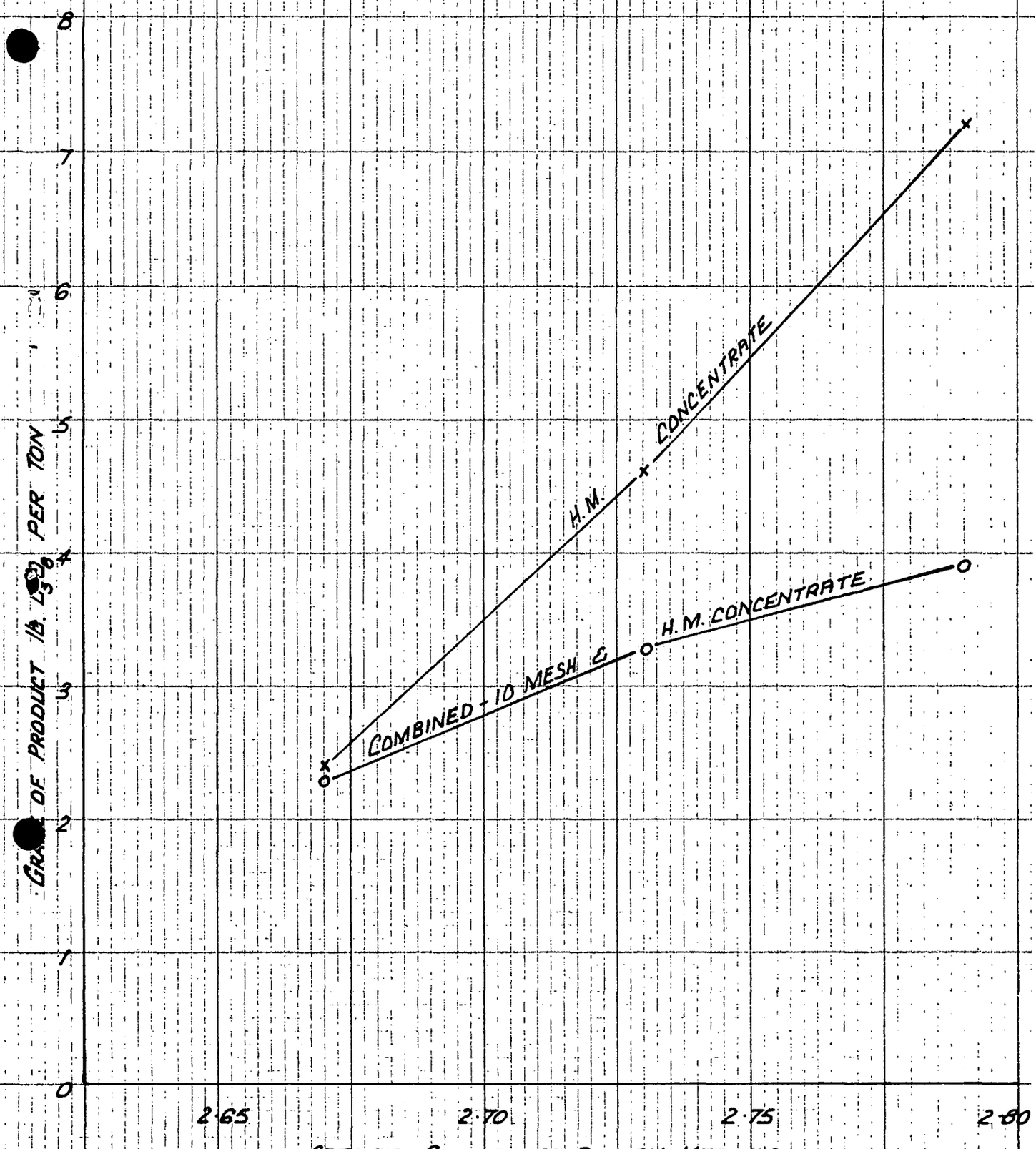
In the case of the relatively rich 7 lbs. ore davidite is in complex intergrowth except for a few free particles of maximum size 1.0 mm.

In the lower grade materials davidite was also observed to be present as fine intergrowth, but the more sparsely distributed as the grade decreased.

No further upgrading of ore can be expected by heavy-media separation at the coarse sizing used.

FIGURE. — 1.

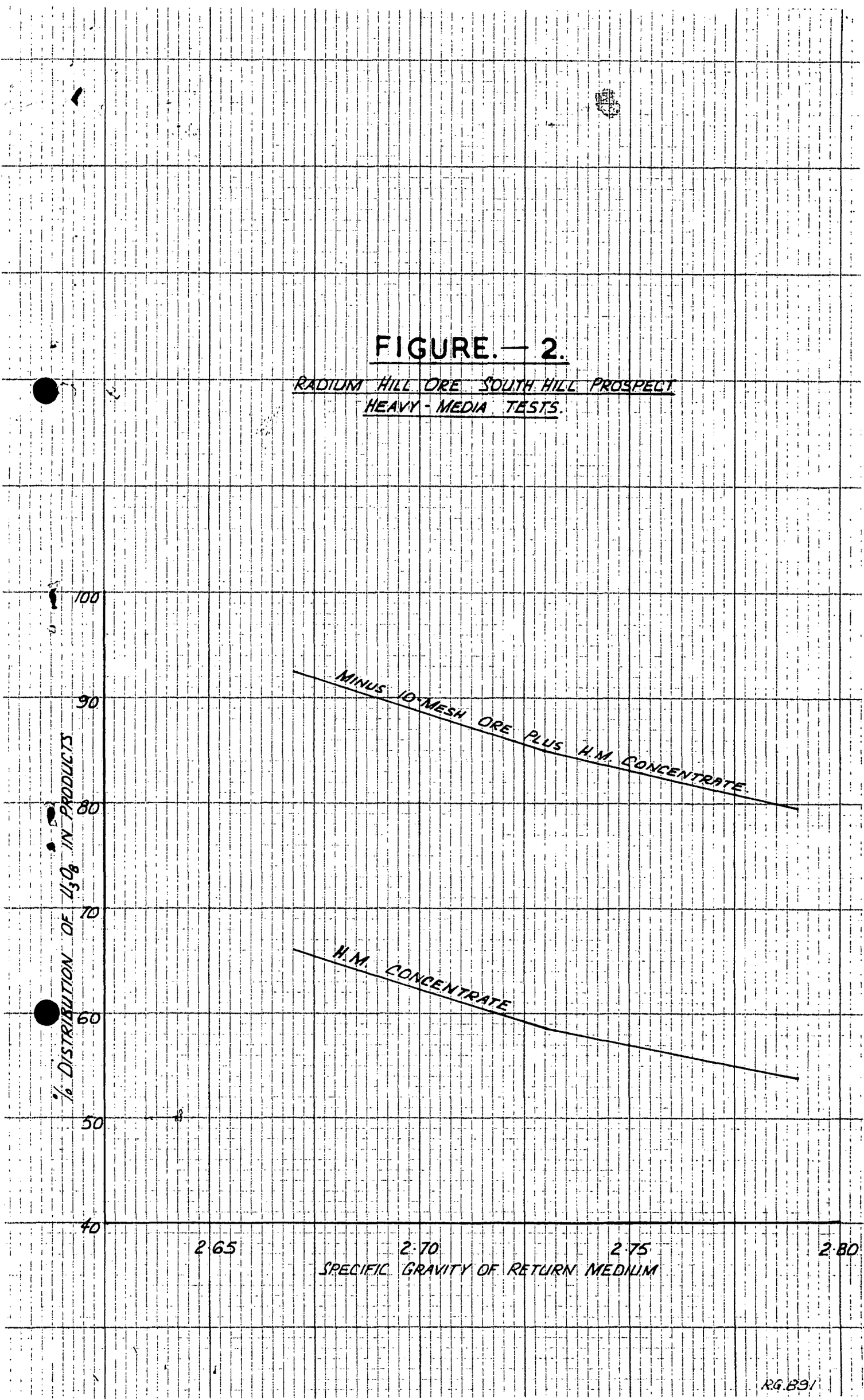
RADIUM HILL ORE SOUTH HILL PROSPECT
HEAVY MEDIA TESTS.



R.G.390

FIGURE. — 2.

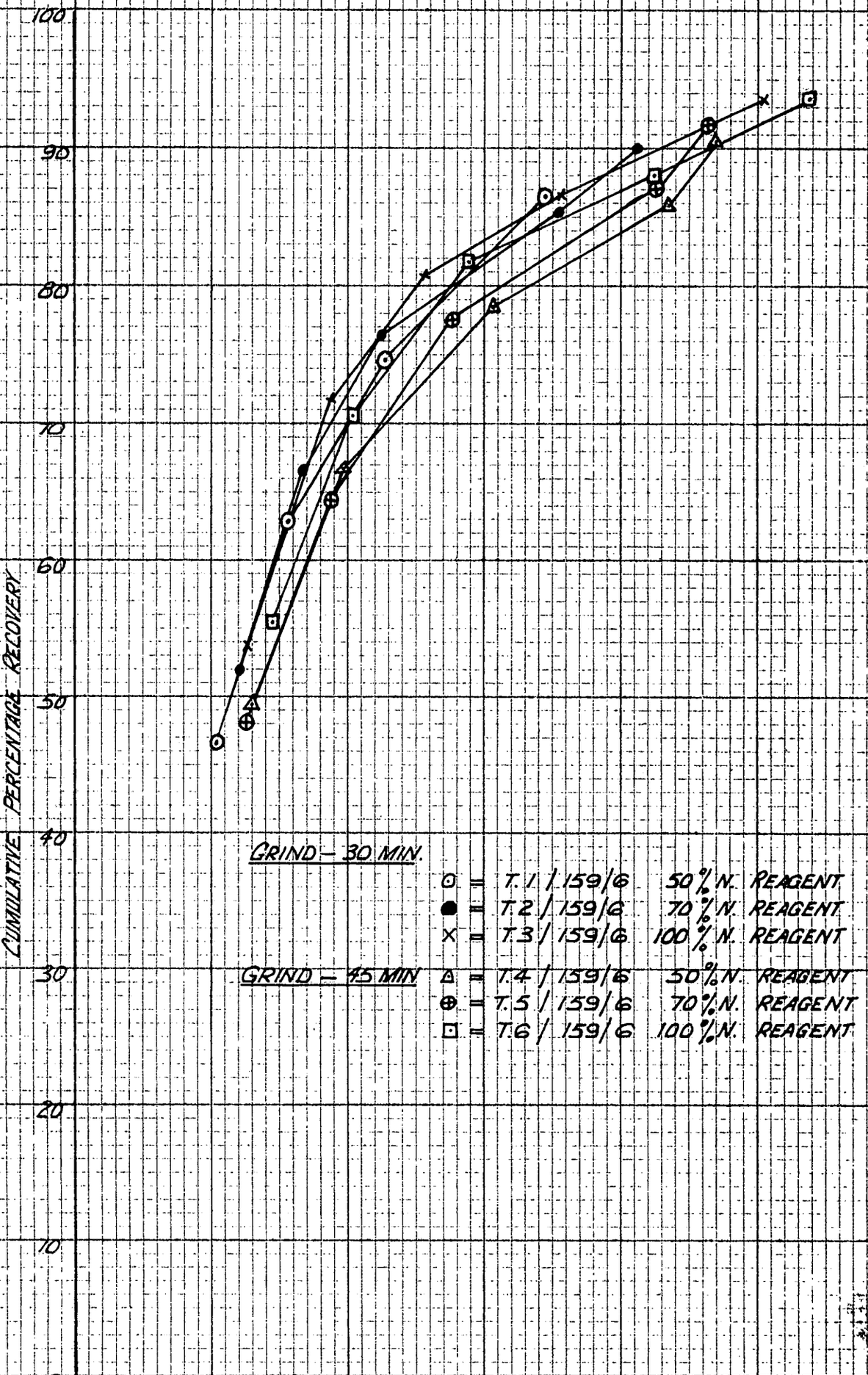
RADIUM HILL ORE SOUTH HILL PROSPECT
HEAVY-MEDIA TESTS.



RG.891

FIGURE. —— 3.

RADIUM HILL ORE SOUTH HILL PROSPECT.



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