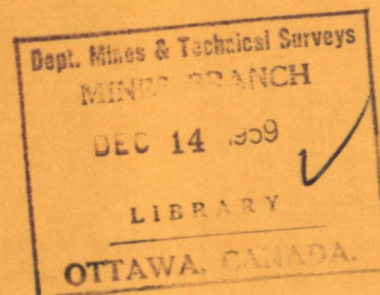




CANADA

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FLOTATION OF URANIUM ORES FROM THE ELLIOT LAKE AREA, ONTARIO



by

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ABSTRACT

The method and results of a series of flotation tests on several Elliot Lake uranium ores are given. The reagents used were NaOH and Na_2SiO_3 in a desliming step, and tall oil fatty acid, Acintol FA-1 or FA-2, was used as collector.

The average recovery obtained was 92% in about 55% of the weight. The leach feed was up-graded from 0.1 to about 0.2% U_3O_8 . The cost of the flotation reagents would be 25 to 30 cents per ton. A saving of about 20 cents per lb of uranium would be effected.

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Direction des mines

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FLOTTAGE DE MINERAIS URANIFÈRES DE LA
RÉGION D'ELLIOT LAKE (ONT.)

par

W.R. Honeywell*

RÉSUMÉ

Le présent bulletin passe en revue la méthode suivie et les résultats obtenus lors d'une série d'essais de flottage effectués à partir de plusieurs minerais uranifères d'Elliot Lake. On s'est servi des réactifs NaOH et Na_2SiO_3 pour éliminer les fines, et d'un mélange de tall oil et d'acide gras Acintol FA-1 ou FA-2 comme collecteur.

On a récupéré en moyenne 92 p. 100 de l'uranium présent dans 55 p. 100 du poids du minerai. Quant au minerai soumis au lessivage, on en a élevé la teneur en U_3O_8 de 0.1 à environ 0.2 p. 100. Le coût des réactifs de flottage s'établit entre 25 et 30 c. la tonne, ce qui permet de réduire d'environ 20 c. le prix de revient d'une livre d'uranium.

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INTRODUCTION

Ore beneficiation has been under study for some time on uranium ores in general, and on the Elliot Lake, Ontario, ores in particular. From various tests on these ores, it is known that from 30 to 40 percent of the total ore contains only from 3 to 8 percent of the total uranium. If this material could be eliminated without too much loss of uranium, savings in the cost of treating these ores could be effected. Also, with a reduction in the price of uranium in the future, beneficiation of the ores will be more attractive than during the present contracts.

The object of the present work was to float the uranium-bearing mineral with maximum recovery and high ratio of concentration. This flotation concentrate could then be leached.

Ore Samples

The tests were carried out on six samples of ore from mines in the Elliot Lake area. All the samples were the usual quartz-pebble conglomerate and quartzite material common to the area. Brannerite, uraninite and monazite occur in the matrix of the conglomerate and also in thin bands in the quartzite. Fine-grained pyrite is usually associated with the radioactive minerals. The brannerite is fine-grained and often inter grown with other minerals, notably rutile.

METHOD AND RESULTS

The ore samples were crushed to -10 mesh, and uniform grinds were obtained by grinding 1150 g of ore in a porcelain Abbe ball mill with 20 lb. of steel balls and 500 ml of water. A grinding period of 20 minutes gave a product containing 51%-200 mesh, which is approximately the degree of fineness employed by the operating mills in the Elliot Lake area.

After grinding and before the flotation step, the ore was deslimed. From experience, it is known that in a fatty acid float, the method here employed, better results are obtained when desliming is used. To further confirm this, tests were carried out without desliming. These gave rather indifferent results. Accordingly, a desliming procedure was used in all tests in this series.

The desliming was effected by diluting the pulp in a pail to about 10% solids, and adding 1.0 lb NaOH and 0.5 lb Na_2SiO_3 per ton ore. After stirring, the diluted pulp was allowed to settle for 10 minutes. At the end of this period, the top portion containing the slimes was syphoned off. This was repeated once without the addition of further reagents. As a rule, from 10 to 15% of the total weight was taken off in this manner. The slime generally contained a U_3O_8 value equal to or greater than the head assay of the ore. Consequently, this slime portion would be combined with the flotation concentrate for subsequent leaching.

Distilled water was used in all but one test, where cold tap water was used. During the flotation step, the pulp pH was between 8.5 and 9.5.

After grinding and desliming as outlined above, the collector reagent was added in stages. Each stage had a conditioning time of about three minutes followed by the float. The collector used was either Acintol FA-1 or FA-2. These are tall oil fatty acids and were obtained from Charles Albert Smith Ltd., Montreal, Que. They are one of the best collectors for uranium minerals tried by the author and are relatively cheap, costing from 7 to 8 cents per pound. When using this reagent, a frother was found generally to be unnecessary, although occasionally cresylic acid was used to improve the characteristics of the froth. A typical flotation procedure and results are given below:

<u>Reagents Added</u>	<u>lb/ton</u>
NaOH	1.0
Na ₂ SiO ₃	0.5
Deslimed	
Na ₂ SiO ₃	1.0
Acintol FA-1	0.75
Conditioned -4 min -(pH 9.1)	
Rougher float - 4 min	
Acintol FA-1	1.0
Conditioned -3 min	
1st scavenger float -4 min	
Acintol FA-1	1.0
Conditioned - 3 min	
2nd scavenger float - 3 min	
Acintol FA-1	0.5
Conditioned - 3 min	
3rd scavenger float - 3 min	
Combined 2nd and 3rd scavenger floats for assay	

<u>Products</u>	<u>Wt (%)</u>	<u>U₃O₈ Assay (%)</u>	<u>U₃O₈ Dist. (%)</u>
Slimes	12.60	0.09	11.2
Rougher float	7.87	0.23	17.9
1st scav. float	11.55	0.47	53.6
2nd and 3rd scav. float	14.17	0.063	8.8
Tailing	53.81	0.016	8.5
Original Ore	100.00	0.10	100.0

If all products except the tailing were combined for leaching, the recovery would be 91.5% in 46.2% of the weight, at a grade of 0.20% U₃O₈.

In this particular test 3.25 lb of Acintol was used while in some other tests about 2.0 lb was used. If too large a scavenger float was obtained, it was cleaned by refloating.

In the one test in which cold tap water was used, the recovery fell off badly. It is not known whether this was due to the cold water or to the salts in the tap water.

Some typical results are given in Table 1.

TABLE 1

Typical Results of Flotation Tests

Test No.	Slimes			R. Float			1st Scav. Float		
	Wt (%)	U ₃ O ₈ Assay (%)	U ₃ O ₈ Dist. (%)	Wt (%)	U ₃ O ₈ Assay (%)	U ₃ O ₈ Dist. (%)	Wt (%)	U ₃ O ₈ Assay (%)	U ₃ O ₈ Dist. (%)
N-2	13.43	0.15	18.5	7.24	0.21	14.0	14.12	0.44	57.3
C-2	12.09	0.095	8.6	14.20	0.22	23.4	16.48	0.19	23.5
M-3	16.65	0.089	15.3	7.98	0.12	9.9	5.81	0.58	34.8
Q-3	13.40	0.16	18.4	6.53	0.32	17.9	2.44	0.91	19.0
P-2	14.18	0.16	20.9	6.21	0.10	5.7	7.09	0.59	38.4

Test No.	2nd and 3rd Scav. Float			Tailings			Leach Feed			Head
	Wt (%)	U ₃ O ₈ Assay (%)	U ₃ O ₈ Dist. (%)	Wt (%)	U ₃ O ₈ Assay (%)	U ₃ O ₈ Dist. (%)	Wt (%)	U ₃ O ₈ Assay (%)	U ₃ O ₈ Dist. (%)	Calc. U ₃ O ₈ (%)
N-2	25.80	0.028	6.6	39.41	0.010	3.6	60.6	0.17	96.4	0.11
C-2	23.05	0.24	41.4	34.18	0.012	3.1	65.8	0.20	96.9	0.13
M-3	24.24	0.13	32.5	45.32	0.016	7.5	54.7	0.16	92.5	0.10
Q-3	33.94	0.13	36.5	43.69	0.022	8.2	56.3	0.19	91.8	0.12
P-2	26.60	0.10	24.4	45.92	0.025	10.6	54.1	0.18	89.4	0.11

DISCUSSION

The curve shown in Figure 1 indicates a possible recovery of 92% of the uranium in a flotation concentrate containing 55% of the total weight. These results were obtained under laboratory conditions, and the possibility of duplicating these results under plant conditions is now being investigated. A program to determine the leaching characteristics of the flotation concentrate has also been initiated.

Assuming that comparable flotation results can be obtained on a plant scale, and that the cost of leaching the flotation concentrate is no more than that of leaching the run-of-mine ore, the following preliminary economic evaluation may be made,

Without Flotation

Ore mined (tons/day)	- 3000
Ore leached (tons/day)	- 3000
Ore grade (lb U ₃ O ₈ /ton)	- 2.0
Overall recovery of U ₃ O ₈ (%)	- 95
Overall recovery of U ₃ O ₈ (lb/day)	- 5700
Daily mining cost (\$) -3000 x 4.50	- \$13,500
Daily milling cost (\$) -3000 x 3.50	- \$10,500
Total daily cost (\$)	- \$24,000
Mining and milling cost (\$/ton leached)	- \$ 8.00
Mining and milling cost (\$/lb U ₃ O ₈ recovered)	\$ 4.21

With Flotation

Ore mined (tons/day)	- 3200
Ore leached (tons/day) - $3200 \times .55$	- 1760
Ore crushed, ground and floated (tons/day)	- 3200
Overall recovery of U_3O_8 (%) *	89
Overall recovery of U_3O_8 (lb/day)	- 5700
Daily mining cost (\$) - 3200×4.50	- \$14,400
Daily crushing and grinding cost (\$) - 3200×0.70	- \$ 2,240
Daily flotation cost (\$) - 3200×0.40	- \$ 1,280
Daily leaching cost (\$) - 1760×2.80 **	- \$ 4,928
Total daily cost	\$22,848

Mining and milling cost (\$/ton floated) \$ 7.14

Mining and milling cost (\$/lb U_3O_8 recovered) \$ 4.01

* Based on 97% extraction of the uranium in the higher grade flotation concentrate.

** This figure is the current milling cost of \$3.50 less the crushing and grinding cost of \$0.70.

It would appear that there is an indicated operating saving of about 20 cents per lb of uranium produced. It is emphasized that these figures are indicative only. However, they are sufficiently encouraging for further larger scale work to be warranted.

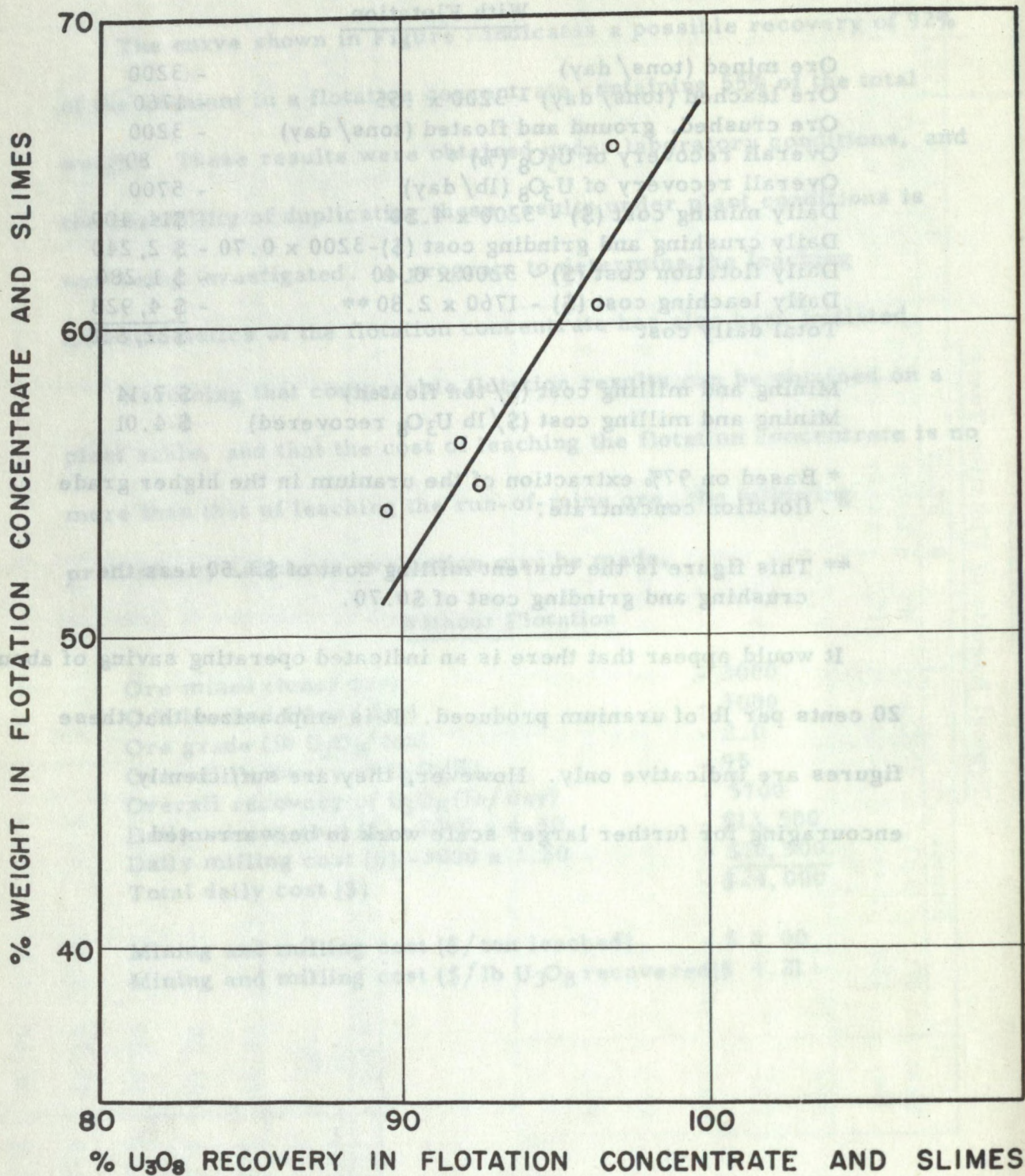


FIGURE I

RESULTS OF SEVERAL FLOTATION
TESTS ON ELLIOT LAKE ORES