

TR 16-282-287

R.628. Investigations on ore from Mt Pelion wolfram mine for Scamander Mining Corporation N.L.

PART 1. EVALUATION OF ORE AND TREATMENT METHODS

The quartz and wolfram ore body at the Mt Pelion mine occurs in a largely barren quartzite country rock, some of which must be broken with the ore to obtain a workable stoping width. It is desired to reject barren material at as coarse a size as possible. The objects of this investigation are to provide data relative to this situation and to obtain a head value indicative of mill head grade.

A sample of approximately 5 tons was taken while mucking out one driving cut in the adit. This cut was about 60 m in from the adit portal. This sample contained obvious large pieces of quartzite, apparently barren of wolfram, but sparsely impregnated with pyrite. Some large composites of lode material with quartzite were observed. Maximum size in the sample was about 375 mm, and a considerable amount of fine material, under about 12 mm, was present.

PRELIMINARY EXAMINATION

A visual inspection of the sample indicated that much of the quartzite could be removed by hand sorting. A lower size limit of about 75 mm was considered practical for this operation.

Much free quartzite was present below this size and heavy media separation would be required to reject sizes from 75 mm down to 12 or 6 mm from the ore. It was not considered practical to subject finer material than this to such preliminary separations, and concentration of this material would be carried out by sizing, jigging and tabling.

TREATMENT METHOD

Based on the above general observations the following treatment plan was adopted:

- (1) Hand sorting to discard +75 mm quartzite.
- (2) Jaw crushing retained ore to -3 inch (75 mm) and screen jaw crusher product on $\frac{7}{8}$ inch and $\frac{5}{16}$ inch.

The above operations were on a continuous basis, using the crushing and sampling plant rigged to produce the desired size.

- (3) Heavy liquid separation at a specific gravity of 2.70 of the -3 inch + $\frac{7}{8}$ inch and - $\frac{7}{8}$ inch + $\frac{5}{16}$ inch fractions.
- (4) Sizing floats and sinks from (3) to give floats and sinks at -3 inch + $1\frac{1}{4}$ inch, - $1\frac{1}{4}$ inch + $\frac{7}{8}$ inch, - $\frac{7}{8}$ inch + $\frac{1}{2}$ inch and - $\frac{1}{2}$ inch + $\frac{5}{16}$ inch.

Products from the above operations provided data for the assessment of the benefits of hand sorting and heavy media separations throughout the size ranges practical for these procedures, and a derived head value for the ore sample.

- (5) Concentrate the wolfram in the - inch fraction by sizing and jigging to broadly verify the results obtained by similar treatment of Mt Pelion ore in investigation R.616 (*Technical Reports No. 15:184-190, 1973*).

RESULTS OF HAND SORTING AND HEAVY LIQUID SEPARATION

Test results are given in Table 1.

Rearranging the products to show an overall cumulative sizing analysis of +3 inch quartzite reject and -3 inch jaw crushed ore:

Products	% Wt	% Cum. Wt	% WO ₃	WO ₃ Distribution	
				%	% Cum.
+3 in Quartzite	16.59	16.59	0.07	1.3	1.3
-3 in +1½ in	10.54	27.13	0.23	2.4	3.7
-1½ in +¾ in	24.24	51.37	0.29	6.8	10.5
-¾ in +½ in	12.01	63.38	0.29	3.4	13.9
-½ in +⅜ in	11.09	74.47	0.68	7.3	21.2
-⅜ in +¼ in	9.46	83.93	1.47	13.5	34.6
-¼ in	16.07	100.00	4.18	65.3	100.0

Consolidated results of hand sorting and heavy liquid separations:

Products	% Wt	% WO ₃	% WO ₃ Distn
+3 in Quartzite	16.59	0.07	1.3
Total -3 in +⅜ in F/T	44.59	0.06	2.9
Total -3 in +⅜ in S/K	13.29	1.32	17.0
Total -3 in +⅜ in	57.88	0.35	19.9
⅜ in Ore untreated*	25.53	3.18	78.8
Composite Head	100.00	1.03	100.0

* This material assayed 0.23% F (0.47% CaF₂)

The total rejects from these operations, i.e. +3 inch quartzite and -3 inch +⅜ inch H/L F/T, amount to 61.18% of total weight containing 4.2% of total WO₃.

However, while the efficiency of H/L separation is good, with a weight rejections of 44.59% assaying 0.06% WO₃, only 19.9% of the total wolfram content is involved in the separation at the size range considered to be practicable. The composite sink product contains 17% of the wolfram overall.

Summary and Conclusions

The operations described have provided data relevant to separation processes which can be applied to coarsely broken and crushed Mt Pelion ore.

Several significant conclusions can be drawn from the results:

- (1) Hand sorting of run of mine ore can reject a considerable amount of barren quartzite down to 3 inches in size without appreciable loss of wolfram. Visual identification of country rock quartzite and ore body quartz is not difficult.
- (2) The application of heavy media separation methods to the -3 inch +⅜ inch fraction of ore crushed to -3 inches hardly seems warranted as only 20% of the total wolfram occurs in this size range.

This remark is made in view of the limited scale of operations envisaged

Table 1. TEST RESULTS OF HAND SORTING AND HEAVY LIQUID SEPARATION

Product	% Wt	% WO ₃	% Sn	% S	% Distribution			Individual % WO ₃ Recovery in S/Ks at indicated sizings
					WO ₃	Sn	S	
+3 in Quartzite	16.59	0.07	Trace	0.14	1.3	Trace	7.9	
-3 in +1¼ S/K	2.35	0.79	0.12	0.58	1.8	7.8	4.6	75.0
-3 in +1¼ F/T	8.19	0.07	0.01	0.12	0.6	2.3	3.4	
-3 in +1¼ Comp.	10.54	0.23	0.03	0.22	2.4	10.1	8.0	
-1¼ in +7⁄8 in S/K	6.28	0.89	0.13	0.60	5.4	22.6	12.9	79.4
-1¼ in +7⁄8 in F/T	17.96	0.08	0.01	0.11	1.4	5.0	6.7	
-1¼ in +7⁄8 in Comp.	24.24	0.29	0.04	0.24	6.8	27.6	19.6	
-7⁄8 in +½ in S/K	2.46	1.25	0.13	0.67	3.0	8.9	5.6	88.2
-7⁄8 in +½ in F/T	9.55	0.05	0.01	0.10	0.4	2.7	3.3	
-7⁄8 in +½ in Comp.	12.01	0.29	0.03	0.22	3.4	11.5	8.9	
-½ in +5⁄16 in S/K	2.20	3.17	0.16	0.88	6.8	9.8	6.6	93.1
-½ in +5⁄16 in F/T	8.89	0.06	Nil	0.08	0.5	Nil	2.4	
-½ in +5⁄16 in Comp.	11.09	0.68	0.03	0.24	7.3	9.8	9.0	
-5⁄16 in +1⁄8 in JF	9.46	1.47	0.03	0.27	13.5	8.3	8.7	
-½ in Ore	16.07	4.18	0.07	0.69	65.3	32.7	37.9	
-5⁄16 in Comp.	25.53	3.18	0.06	0.53	78.8	41.0	46.6	
Composite Head	100.00	1.03	0.04	0.29	100.0	100.0	100.0	

From the above tabulation the following composite head values were obtained: WO₃ 1.03%; Sn 0.04%; S 0.29%.

by the company, which would be in the order of a 50 tons per day treatment plant.

- (3) Screening of -3 inch crushed ore on a $\frac{1}{16}$ inch screen produces an undersize material amounting to only 25% by weight, but containing nearly 80% of the total wolfram. It appears therefore that a crushing and screening operation alone would suffice to reject the major portion of the ore as oversize with a reasonably high recovery of wolfram in an enriched undersize product.

JIG CONCENTRATION OF THE $\frac{1}{16}$ INCH ORE

Treatment

The $\frac{1}{16}$ inch material amounting to 25.53% of the total weight and containing 78.8% of the total wolfram was sized by wet screening on the following screens: $\frac{1}{8}$ inch, 16, 30 and 60# and the fractions coarser than 60# concentrated by jiggling as in Investigation R.616.

The -30 +60# fraction is rather too fine for jig concentration and was tabled in project R.616. However, discussion with company representatives indicated that installation of tables was not being considered in the proposed treatment plant and it was decided to jig the fractions to assess the recovery obtainable from it by this means.

The -60# material was not further treated and appears in the tabulation as such.

Test Results

Product		% Wt	% WO ₃	% Sn	% S	% Distribution	
						WO ₃	Sn
- $\frac{1}{16}$ in + $\frac{1}{8}$ in	JC	0.38	31.4	0.35	3.7	11.6	3.7
	JM	0.50	1.55	0.16		0.8	2.2
	JT	8.58	0.14	0.01		1.1	2.4
- $\frac{1}{16}$ in + $\frac{1}{8}$ in Comp.		9.46	1.47	0.03		13.5	8.3
- $\frac{1}{8}$ in +16#	JC	0.44	60.2	0.47	3.8	25.7	5.7
	JM	0.33	4.21	0.29		1.3	2.7
	JT	7.29	0.17	0.02		1.2	4.0
- $\frac{1}{8}$ in +16# Comp.		8.06	3.61	0.06		28.2	12.4
-16 +30#	JC	0.25	51.0	0.55	4.0	12.4	3.8
	JM	0.18	1.39	0.07		0.2	0.4
	JT	1.77	0.15	0.02		0.3	1.0
-16 +30# Comp.		2.20	6.03	0.08		12.9	5.2
-30 +60#	JC	0.18	46.0	0.69	4.3	8.0	3.4
	JT	2.03	0.73	0.03		1.5	1.7
-30 +60# Comp.		2.21	4.42	0.04		9.5	5.1
-60# Untreated		3.60	4.19	0.10		14.7	10.0
- $\frac{1}{16}$ in Comp.		25.53	3.18	0.06		78.8	41.0

Summary of Jigging Tests

The individual recoveries of WO_3 in fractions treated range from 84 to 96%, thus serving to generally confirm the results obtained in investigation R.616. As the table shows a sulphur concentration in the jig concentrates, this would have to be eliminated with the tin in subsequent treatment by magnetic separation. A significant amount of wolfram remained untreated in the -60# fraction.

OVERALL RESULTS

Hand sorting +3 inch, crushing to -3 inch screening on $\frac{5}{16}$ inch, and primary jig concentration of $-\frac{5}{16}$ inch +60# fractions:

Product	% Wt	% WO_3	% WO_3 Distn
+3 in Quartzite, hand sorted	16.59	0.07	1.3
-3 in + $\frac{5}{16}$ in Screen o/size	57.88	0.35	19.9
-60# Untreated	3.60	4.19	14.7
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Total Not Concentrated	78.07	0.47	35.9
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Total Jig Feed	21.93	2.56	64.1
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$-\frac{5}{16}$ in +60# Concentrates	1.25	47.6	57.7
Middling	1.01	2.39	2.3
Tailing	19.67	0.21	4.1
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Composite Head	100.00	1.03	100.00

DISCUSSION

Hand sorting of broken ore in sizes from 375 mm (15 inch) to 75 mm (3 inch) appears to be a feasible operation to discard significant amounts of barren quartzite.

Treatment of material in the jigging size range ($-\frac{5}{16}$ in +60#) produced by crushing to -3 inch results in an overall wolfram recovery of 57.7% in primary jig concentrates.

The application of table concentration to the -60# portion of this material (containing 14.7% of total wolfram) would result in an additional recovery of about 12.5%, based on results from project R.616.

Therefore, jig and table concentration of the comparatively minor weight fraction of 25.5% undersize produced by crushing and screening at 1 inch would result in an overall recovery of about 70% in primary stage concentrates.

Ore in the size range suitable for heavy media separation amounts to about 58% by weight containing 19.9% of the total wolfram of which 17% can be recovered in sinks assaying an average 1.32% WO_3 . Jig and table concentration of these sinks, suitably crushed and sized would contribute a further estimated 14% to total wolfram recovery.

To summarise the above remarks, the cumulative projected recoveries of wolfram by application of the above procedures are:

- (1) Treatment by jig of $-\frac{5}{16}$ inch +60# ore: WO_3 recovery 57.7%
- (2) Treatment as in (1) with tabling of -60#: WO_3 recovery 70%

- (3) Treatment (1) and (2) with jig and table concentration of -3 in + $\frac{1}{8}$ in Heavy Media Sink: WO₃ recovery 84%.

PART 2. EXAMINATION FOR BISMUTH AND SCHEELITE

A qualitative test for the presence of bismuth and scheelite in the ore was made by selecting the highest grade wolfram concentrate, i.e. - $\frac{1}{8}$ in +16# JC, magnetically separating this and determining Bi, WO₃ and Ca on the non-magnetic fraction.

Results of the Examination

- $\frac{1}{8}$ in +16# JC

Product	% Wt	% WO ₃	% Ca	% Bi
M/A	84.9	nd	nd	nd
N	15.1	0.55	0.3	4.2
Comp. - $\frac{1}{8}$ in +16# JC	100.0	0.08	0.05	0.63

The WO₃ as determined above is present as scheelite.

Visual inspection of the other concentrates in ultraviolet light showed the presence of scheelite in all cases.

The order of abundance is considered to be similar to that in the concentrate which was analysed.