OTTAWA April 1st, 1943.

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of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1379.

Gravity Concentration of Scheelite Ore from the Negus Mine, Yellowknife, Northwest Territories.

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Gravity Concentration of Scheelite Ore from the Negus Mine, Yellowknife, Northwest Territories.

Shipment:

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The shipment, creceived on Octobera5th;s1942;cribed consisteds of three samples, described as follows:

Sample B-5, $71\frac{1}{2}$ pounds, from the north end of 339 drift; Sample B-6, $59\frac{1}{2}$ pounds, from the same location; and Sample B-7, 53 pounds, from cobbed ore in bin,

The samples were taken from the property of the Negus mine at Yellowknife, Northwest Territories, and were submitted for this investigation by Dr. A. W. Jolliffe of the Bureau of Geology and Topography, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ontario.

Purpose of the Investigation:

Dr. Jolliffe submitted the samples of ore for separate assays for WO₃, and also requested that milling tests be made on the combined samples to determine what recovery of scheelite could be obtained when equipment generally similar to that available at the Negus mine **was** used.

Character of the Ore!

The samples of ore were sent primarily for chemical analysis and no specimens were selected for polished sections.

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Microscopic examination of test products shows quartz gangue containing scheelite and metallic minerals, varying in size from coarse to extremely fine size. The scheelite in the samples varies from approximately -14+20 mesh to minus 200 mesh. Numerous 20-mesh particles of quartz fluoresce under the ultra-violet light but contain only a small particle of scheelite. Other particles of quartz contain very numerous minute particles of sulphides. Arsenopyrite appears to be the most abundant metallic mineral. Some pyrite was also seen.

Sampling and Analysis:

Each of the three samples was crushed minus 14 mesh and sampled by standard methods. The three samples were assayed and were reported as follows:

4. 5.1						54.	and the second second
Sample	B-5	-	Tungsten	trioxide	(WO3)		1.09
Sample	B-6	-		11	Ħ	-	0.51
Sample	B-7	-			Ħ	-	2.04

After these samples had been obtained, all three lots were mixed together and sampled. The assay of this composite was as follows:

Gold (Au)	-	0.13	oz./ton.
Arsenic (As)	-	0.73	per cent.
Sulphur (S)	-	2.72	
Tungsten trioxide (WO3)	-	0.97	11
Phosphorus (P)	-	0.06	11
Calcium oxide (CaO)	-	9.80	

Per cent

This ore was used as the feed for the test work.

Investigative Procedure:

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The Negus mill flow-sheet is said to consist essentially of the following:

A Contraction

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- Page 3 -

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Sorting belt. Jaw crusher. Ball mill. Denver jig. Akins spiral classifier. Blanket tables. Cyanide plant.

In this flow-sheet the jig and blanket concentrates would contain some scheelite and would include only the coarser particles. The slime portion of the grind would not be recovered.

Several tests were made using a laboratory mineral jig and blankets.

Table concentration of sized and unsized feed was included to determine the recovery and grade of concentrate obtained.

The table concentrates were reasted and magnetically concentrated.

Several straight flotation tests for scheelite were also included.

Results of Investigative Tests:

A jig concentrate assayed 5.87 per cent WO3 and 2.67 per cent arsenic.

A blanket concentrate assayed 2.80 per cent WO3 and 1.88 per cent arsenic.

Flotation of the blanket tailing yielded a concentrate which assayed 1.77 per cent WO3 and 0.11 per cent arsenic.

Table concentration of a sized feed resulted in a combined concentrate which assayed 14.08 per cent WO₃ with a recovery of 63 per cent of the WO₃; when roasted and magnetically concentrated the concentrate assayed 36.86 per cent WO₃, 0.22 per cent arsenic, 0.57 per cent sulphur and 0.09 per cent - Page 4 -

(Results of Investigative Tests, cont'd) -

phosphorus,

The unsized feed gave a concentrate which assayed 3,92 per cent WO₃; recovery, 56 per cent. This concentrate when superpanned and roasted assayed 23,93 per cent WO₃ and 0,55 per cent arsenic.

Flotation at a grind of 70 per cent minus 200 mesh indicated a recovery of 90 per cent WO_3 ; at 83 per cent minus 200 mesh, 93 per cent WO_3 ; and at 90 per cent minus 200 mesh, 94 per cent WO_3 . The concentrate grade was 5 per cent WO_3 at the 83 per cent minus 200 mesh grind. The ratio of concentration was 19:1.

DETAILS OF TESTS:

Test No. 1, Jig and Blanket Concentration.

A sample of the ore was ground 70 per cent minus 200 mesh in a ball mill; dilution, 4 parts solids to 3 parts water. The ground ore was jigged in a Denver laboratory mineral jig. The jig tailing was passed over corduroy blankets, sloping $2\frac{1}{2}$ inches in 12 inches. The jig and blanket concentrates were combined for assay.

			110 011 01	ao rome	
Product	Weight, per	Assays, per cent		Distribution	Ratio of
	cent	W03	AS	: per cent	: tration
Feed [®] Jig and blanket	100,0	0,89		100,0	
concentrates Blanket tailing	14.7 85.3	3,62 0,42	2 . 14	59,8 40,2	: 6,8:1.
	t <u>a se se s</u>			• • • • • • • • • • • • • • • • • • • •	1

Results: Jig and Blanket Concentration.

Feed calculated from the products.

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(Details of Tests, cont'd) -

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Test No. 2. - Jig, Blanket and Flotation Concentration.

This test was made similarly to Test No. 1. The jig and blanket concentrates were assayed separately. The blanket tailings were filtered and then floated to remove sulphides first and scheelite as a separate concentrate.

R	ea	Se	Ξ'n	ts
-			_	_

To float sulphides	-	Lb,/ton		
Soda ash Copper sulphate Amyl xanthate Cresylic acid	1 4 Î 4	4.0) 1.0) 0.4 0.2	conditioned in stages, """"	lO mins.

To float scheelite (W03) concentrate -

Water glass	÷	1.0	conditioned 10 mins,
Emulsol X-1	1 interest	0,05)	no conditioning
Orso	#	0,06)	time required.

Flotation period, 2 minutes,

To float scavenger W03 concentrate -

Emulsol X+1	<u>i</u>	0,05
Orso	÷	0,20
Cresylic acid	. è	None 🖡

Flotation period, 10 minutes.

Results:

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Jig and Blanket Concentration

	CTR. Critic 17	rannoo ooneonor		
Product	:Weight, : per : cent	Assays, 	Distribution: of WO ₃ , per cent	Ratio of concen- tration
Feed Jig concentrate Blanket conc. Blanket tailing	100,0 3,4 12,9 83,7	0,92 5,87 2,67 2,80 1,88 0,42	100,0 21.7 39,9 38,4	29.3.1. 7.8.1.

Feed calculated from the products,

Flotation of Blanket Tailing,							
Product	Weight, per cent	: Ass : per	ays, cent	:Distri :_WO3,	bution of per cent	Ratio of	
	feed	: W03	As	test	feed	tration	
Flotation feed Sulphide conc. WO3 concentrate Scavenger WO3 conc. Flotation tailing	83,7 7,1 9,1 28,5 39,0	0,42 0,16 1,77 0,57 0,05	• • 0.11	100.0 3.2 45.5 45.8 5.5	38°4 1,2 17,5 17,6 2,1	11,9:1, 9,2:1, 2,9:1,	

(Details of Tests, cont'd) =

Test No. 3. - Jig and Blanket Concentration.

This test was made to determine the recovery of scheelite by jigging a coarse feed. The jig feed was ground minus 14 mesh with 27 per cent minus 200 mesh, theujigotailing Was passed over the blanket table. Theujigotailing

Results:

Product	Weight,	WO3	:Distribution	: Ratio of
	per	assay,	: of WO3,	: concen-
	cent	per cent	: per cent	: tration
Fe d Jig concentrate Blanket conc. Blanket tailing	100.0 11.4 10.3 78.3	1,21 5,80 2,05 0,43	100.0 54.7 17.5 27.8	: 8,78:1, 9,7:1,

The concentrate was similar in grade to that obtained with a 70 per cent minus 200 mesh grind. Less scheelite is lost by sliming in a coarser grind.

Screen	Test	on	Jig Feed.
			Weight,
<u>Mesh</u>		:	per cent
S . 13.12			
- 14 +	20	<u></u>	9,1
+ 20 +	28		14,2
# 28 +	35	÷	14.0
- 35 +	48	nji s	10,4
- 48 +	65	***	6,0
* 65 +	100	-	8,3
-100 +	150	÷	6,8
⇒150 +	200	-	4.5
#200			26.7

100,0

Test No. 4. - Table Concentration of a Sized Feed.

This test was made to determine the recovery and grade of concentrate obtainable by tabling the ore.

A sample of the ore was screened on 20-, 48- and 65-mesh screens to give products -14+20 mesh, -20+48 mesh, -48+65 mesh, and -65 mesh. The plus 65 mesh products were D

(Test No. 4, cont'd) -

treated separately on a Wilfley table. The concentrates were held. The middling and tailing from each size were dried and crushed minus 65 mesh and combined with the original minus 65 mesh product. The minus 65 mesh was then tabled, giving a minus 65 mesh concentrate, middling, sand tailing, slime tailing, and slime overflow.

Each concentrate was roasted to remove arsenic and sulphur and was then subjected to magnetic concentration to remove magnetic iron oxide formed in the roast.

Each sample was analysed separately for WO_{3*} . It was noted that none of the concentrates was up to a grade of 70 per cent WO_{3*} .

R	pasting,	and Magneti	c Concentration,	,	
Product	In test	Weights, Roast in terms of orig, feed	<pre>> per cent :Mag. concent :tration, in term :of orig. feed</pre>	: WO3 assay, s per cent	Distri- bution, per cent
Feed -14+20 mesh conc, -20+48 " " -48+65 " " -65 " "	100,00 0,16 0,78 0,32 3,99	100.00 0.15 0.69 0.27 3.23	100.00 0.12 0.52 0.16 2.59	1.17 52.31 46,40 37,54 14,01	100.00 5.35 20.56 5.12 30.91
Combined conc., roasted and non- magnetic portion of original conc.	5 _* 25	4,,34	3,39	21,44	61,94
Magnetic fraction	:		0,95	: 1,15 :	0,93
Table tailing	94,75	94,75	94,75	0,46	37,13
Loss in roasting		0,9ĭ	0,91		

Summary of Table Concentration,

Combined Concentrate Assay:

A composite sample was made from the +20, +48, +65

and 65 mesh concentrates which assayed as follows:

· · · · ·		Per cent
WOz		22.00
Arsenic		.0.26
Sulphur	-	1,01
Phosphorus	. .	0.17
Iron	÷	24,40
Insoluble	· •••	20,55

- Page 8 -

(Details of Tests, cont'd) -

Test No. 5. - Table Concentration of an Unsized Feed.

This test was made to determine what recovery could be made by tabling an unsized feed.

A sample of ore ground 27 per cent minus 200 mesh was fed to a Wilfley table. The table products included concentrate, middling, and sand and slime tailings. The table concentrate was recleared by reconcentrating it on a Haultain superpander. The concentrate recovered from superpanning was roasted.

Results:

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Product	Weight,	WOz	:Distribution:	Ratio of
	per	assay,	: of WO3, :	concen-
	<u>cent</u>	per cent	: per cent :	tration
Feed Concentrate Middling Sand tailing Slime tailing	100.0 18.3 13.1 28.1 40.5	1,28 3,92 0,37 0,40 0,99	100.0 56.0 3.8 8.8 31.4	5,48:1, 7,63:1,

Roasted Panner Concentrate:

,	· •
•	Per cent
•	······································
	23,93
- **	27,51
-	0,55

Test No. 6. - Straight Flotation.

This test was made to determine the grade of concentrate and recovery that could be made by straight flotation,

A sample of ore was ground 70 per cent minus 200 mesh with water at a dilution of 4:3. Sodium cyanide was used in this test to depress sulphides.

(Continued on next page)

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10.00

(Test No. 6, c	ont'd) 🛥			• •
n <u>Reag</u> To	<u>ents</u> ball mill		Lb./ton	•••
	Soda ash Sodium cy	anide 🗕	4 •0 0 •2	
To	flotation	of WOg còn	<u>centrate</u> -	
· · · · · · · · · · · · · · · · · · ·	Water gla Emulsol X Orso	uss	1.0 0.25 0.06	
Ψo	Flotation	for 2 1 min	utes.	.
	Emulsol X Orso		1.0) in sta	ågea *
	Flotation	for 10 min p. 8.4.	utes.	
Results of Flo	tation:		**************************************	
Product	Weight) per cent	WOz assay, per cent	Distribution of WO3, per cent	Ratio of concen- tration
Feed WOg conc.	100,00 2,27	1,26 5,85	: 100.0 10.5	44:1.
wog scavenger conc _*	24,07	3 _* 84	73,2	4,2:1,
Combined conc.	26,34	4.01	83,7	.3.8.1.
Flot, tailing	73,66	0,28	16.3	

Test No. 7. - Straight Flotation.

A sample of ore was ground 70 per cent minus 200 mesh at a dilution of 4:3 with water.

Reagents

To the ball mill \rightarrow <u>Lb./ton</u>

Soda ash 4.0 Amyl xanthate 0.2 Reagent No. 208 - 0.2 Water glass - 1.0

The pulp was floated at a dilution of 30 per cent

- Page 10 -

10. ml

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(Test No. 7, co	ont'd) 🚽				; 5
solids and at a	pH o'f 9.	3.	, • т.	h /+ an	
Rea	gents to	flotation	<u>نظ</u> ، بر	0 • 7 0 0 f1	
	Cresylic	acid	e	0,10	
	Flotation 3 minu	of sulph utes.	ides	(pyrite), ab	out
Řea	igents to	float ar s	enop	yrite =	
:	Copper su Amyl xantl Cresylic a	lphate hate acid	* *	1.0 0.2 in stag 0.05)es *
	Flotation	, about 5	min	utes.	
Flo	station of	scheelit	<u>a</u> á		
	Emulsol X. Orso	# 1	÷ .	0.15 0.20 in sta	ges.
	WO3 concer Scavenger 10 min	ntrate flo WO3 conce nutes _*	oate	d for l minut ate floated f	e. or
Results:			÷		
Product	:Weight, : per : cent	WOz assay per cer	it .	Distribution of W03, per cent	: Ratio of : concen- : tration
Feed Sulphide conc. WO3 concentrate Scavenger conc. Flot, tailing	$100.0 \\ 9.1 \\ 14.6 \\ 29.7 \\ 46.6 \\ $	1,07 0,27 2,76 1,92 0,16		100,0 2,3 37,6 53,2 6,9	11,0:1. : 6,8:1. : 3,4:1.
Combined WOr					

concentrate : 44.3 : 2.20 : 90.8 : 2.25:1.

Test No. 8. - Straight Flotation.

A sample of ore was ground 83 per cent minus 200 mesh at a dilution of 4:3 with water.

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(Continued on next page)

(Test No. 8, cont*d) -

29) 20)

Reagents	Т	b. Ator	
To the ball mill -	· ·	10	↓
Soda ash Amyl xanthate Reagent No. 208 Water glass	₽ * *	4.0 0.2 0.2 1.0	
pH of pulp in f.	lotatic	n mach	ine, 9,3.
Reagents to flotat:	Lon -		
Cresylic acid	e	0,10	
Flotation of py 3 minutes,	rite co	ncentr	ate, about
Reagents to float a	ar se nop	yrite	
Copper sulph at e Amyl xanthate	بینی د	1,0 0,2	in stages.
Flotation period	l, abou	it 5 mi	nutes.
Flotation of scheel	Lite -		
Emulsol X-l Orso	₽ ₽	0 _* 15 0 _* 20	in stages.

W03 concentrate flotation for 1 minute. Scavenger W03 concentrate floated for 10 minutes.

Υ. • . . * .

pH of pulp, 9,2, with soda ash.

• •

Results:				4
Product	:Weight, per cent	WO3 assay, per cent	Distribution: of W03, per cent	Ratio of concen- tration
Feed, Sulphide conc. WO ₃ concentrate WO ₃ scavenger concentrate Flot, tailing	100,0 9,6 5,2 34,8 50,4	1,09 0,17 5,01 2,17 0,12	100.0 1.5 23.7 69.3 5.5	10,4:1, 19,4:1, 2,9:1,
Combined WO ₃ concentrate	40,0	2,54	93,0	2,5:1,

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(Details of Tests, cont'd) -

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Test No. 9. - Straight Flotation.

A sample of ore was crushed 90 per cent minus 200 mesh at a dilution of 4:3 with water.

Re	age	nt	S

To the ball mill -

Soda ash	*	4.0
Amyl xanthate		0,2
Reagent No, 208	eujit:	0,2
Water glass	÷	1.0

pH of pulp in flotation machine, 9,2,

 Lb_{\star}/ton

Reagents to flotation -

Cresylic acid 🐱 0.10

Flotation of pyrite concentrate, about 2 minutes.

Then add 👄

Copper sulphate = 1.0 Amyl xanthate = 0.2, in stages.

Flotation of arsenopyrite, about 5 minutes.

Flotation of scheelite -

Emulsol X-1 - 0.15 Orso - 0.25, in stages.

W03 concentrate, float 1 minute, Scavenger W03 concentrate floated for 10 minutes.

pH of pulp, 9,1.

Results:

Product	:Weight <u>;</u> : per : cent :	WOg assay, per cent	: Distribution : of WO3, : per cent	Ratio of concen- tration
Feed Sulphide conc. WO ₃ concentrate WO3 scavenger concentrate Flot, tailing	100.0 10.1 8.8 39.3 41.8	0,80 0,12 3,57 1,13 0,08	100.0 1.5 39.1 55.2 4.2	9.85:1. 11.4:1. 2.55:1.
Combined WO3 concentrate	48.1	1,58	94.3	2,1:1,

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Summary:

The material recovered as a jig concentrate at a grind of 70 per cent minus 200 mesh consisted largely of sulphides, coarse gangue, and some fairly pure scheelite. Additional scheelite was recovered in the blanket concentrate. Approximately 62 per cent of the scheelite in the ore reported in the two concentrates, which were low in grade (5,87 per cent WO3 and 2,80 per cent WO3 respectively). Each concentrate contained considerable arsenopyrite, which would contribute arsenic to a final scheelite concentrate,

Practically the same grade of concentrate was recovered when a coarser **feed** (27 per cent minus 200 mesh) was concentrated. The overall recovery was slightly higher, 72 per cent of the scheelite reporting in the two concentrates.

Table concentration of sized feed, followed by roasting the table concentrates and magnetic concentration, did not yield an acceptable grade of concentrate for direct use. In the coarser sizes at was observed that particles of quartz contained numerous minute particles of sulphides which apparently made separation from the scheelite difficult. They were observed to mingle with the scheelite during concentration on the table.

Table concentration of an unsized minus 14 mesh feed yielded a low-grade concentrate containing 3.92 per cent WO3. When recleaned and roasted, the WO3 content was 23.9 per cent. Several flotation tests indicated increased recovery with finer grinding without raising the grade of the concentrate. - Page 14 -

CONCLUSIONS:

The results of the investigation indicate that approximately 60 per cent of the scheelite in the one can be recovered by jigs and blankets with a grind of 70 per cent minus 200 mesh. The concentrate was too low-grade and contained excessive amounts of impurities which included arsenic, sulphur, and phosphorus.

The ore contains about 10 per cent calcium oxide. A considerable portion of this is activated in the scheelite flotation and reports in the scheelite flotation concentrates, resulting in a low-grade flotation concentrate.

The various methods of treatment indicate that a low-grade concentrate can be recovered which would be acceptable for chemical treatment.

The above results show that it would be unprofitable to use the existing concentrating equipment for the concentration of scheelite. Jigging and blanket concentration produce a concentrate assaying approximately 3.6 per cent WO₃ with a 60 per cent recovery. Additional equipment, such as a concentrating table, would be required to raise the grade of this product to a degree that would stand shipping charges to Ottawa for processing to meet specifications.

For highest recovery the entire flow-sheet would need to be changed to a coarse grind, table concentration of classified feed, and a regrind of the products to recover gold by cyanidation.

Therefore, the possibilities of producing anything but a very small quantity of marketable scheelite concentrate from even selected ore, as represented by the sample furnished, appear to be slight,

WSJ:GHB.