Economics Division
(Miss Stewart)

O T T A W A March 14, 1945.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1808.

A Process for Eliminating Bismuth from Molybdenite Concentrate.

(Copy No. 11.)

Bureau of Mines
Division of Metallic
Minerals
-
Physical Metallurgy
Research Laboratories

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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Origin of Request and Purpose of Investigation:

In December, 1944, the Wartime Metals Corporation, 637 Craig Street West, Montreal, Quebec, per H. P. Dickey, General Manager, requested that these Laboratories attempt to develop a method for eliminating bismuth from the molybdenite concentrate put out by their La Corne Project at Val d'Or, Quebec. This mill run concentrate at present grades approximately 85 per cent MoS_2, 2.0 per cent Bismuth, with other impurities such as Iron and Copper. Peacetime specifications for MoS_2 concentrate usually call for +90 per cent MoS_2, with acid-soluble impurities below 0.5 per cent.

Material Received:

A shipment of 1,000 pounds of molybdenite concentrate arrived from the La Corne Project on December 11, 1944. A 100-pound bag taken from this shipment for test work gave the following analysis:

		Per Cent
MoS_2	-	85.66
Bismuth	-	2.89
Copper	-	0.55
Iron	-	2.32

Investigation Results:

The concentrate was found to consist of molybdenite, chalcopyrite, pyrite, with gangue minerals, mica and quartz. Bismuthinite could be identified with difficulty. In polished sections, all of these minerals were evident.

The relevant details from these investigations may be summarized as follows:

1. Bismuth is closely associated with chalcopyrite, and is sometimes included in that mineral.
2. Bismuth is never intimately mixed with molybdenite.
3. Quartz always contains some molybdenite, making a middling product. Bismuthinite has not been discovered as a middling, probably due to greater friability, in the grinding circuit.
4. Bismuthinite is affected by roasting at a lower temperature than is molybdenite. The same is true of chalcopyrite and pyrite.
5. Bismuthinite has a higher specific gravity than the associated minerals.
6. A high percentage of the bismuth reports in the slime fraction of the concentrate.

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Flotation Tests.

Preliminary Tests -

Experiments designed to find a method for eliminating bismuth from the concentrate by leaching and by gravity concentration were tried. These have been discussed in other correspondence with the Wartime Metals Corporation.

The tests described herein were begun on January 22, 1945.

As molybdenite is so easily floated, it was decided to work only with the hope of depressing the impurities out of the molybdenite. Previous experience has convinced the writer that depressing molybdenite is never a satisfactory procedure.

Accordingly, various depressing agents were used, with indifferent success. Then it was found that after a low-temperature roast, it was possible to float most of the molybdenite away from the bismuth, copper and iron, because the roasting left these sulphides coated with a slight film of oxide, whereas the molybdenite was still untarnished.

Working on this principle, a series of tests was carried out, to determine the proper temperature for the roast and to decide upon the proper reagents for flotation of the roasted material.

Results:

Test No.	Roast temperatures, ° C.	ASSAYS, per cent						Number of floats
		Feed		Conc.		Tailing		
		MoS_2	Bi	MoS_2	Bi	MoS_2	Bi	
1	None	82.70	2.54	88.40	2.78	3.63	4.30	One.
2	300	82.70	2.54	90.65	2.25	4.57	13.38	"
3	400	82.70	2.54	-	0.86	26.44	14.98	"
4	450	82.70	2.54	-	1.45	20.87	12.95	"
5	500	82.70	2.54	-	1.78	66.60	6.69	"
6	400	82.70	2.54	96.51	0.10	66.06	6.00	Four.

These results showed that a clean, high-grade molybdenite concentrate could be made by roasting a rougher concentrate

(Flotation Tests, cont'd) -

to approximately 400° C., floating a concentrate, and re-cleaning this product three times.

Further Tests -

The next problem was to evolve a method for assuring a high recovery of the molybdenite, and to make a bismuth concentrate. A flow-sheet was thought out, keeping in mind the desirability of as much simplicity as possible, in view of the present situation, the difficulty of obtaining mill equipment. This flowsheet is illustrated in Figure 1.

It has the advantage of being simple, and it will make a high-grade, clean, MoS_2 concentrate. However, there is bound to be around 15 to 20 per cent molybdenite in the bismuth concentrate, and there is no provision made for removing the gangue from the concentrate, or for regrinding the middlings. In this flow-sheet, most of the gangue material from the rougher concentrate will report in the bismuth concentrate.

Another weak point of this flow-sheet is seen in the fact that slimes and sands are not handled in separate treatments. The impalpable molybdenite is difficult to float, as is the extremely coarse molybdenite. When attempting to float slime and coarse molybdenite away from the impurities, a high percentage of MoS_2 must be left behind.

If there is a good market for a bismuth concentrate grading around 20 per cent bismuth and 20 per cent MoS_2, and if the purchaser will pay for the contained MoS_2, then this flow-sheet would probably be the most efficient.

(Continued on next page)

(Flotation Tests, cont'd) -

TABLE I. - Results of Treatment of Mill Concentrate by Flow-Sheet No. 1.

Roast temperature, ° C.	MoS_2 CONCENTRATE			Bi CONCENTRATE		
	MoS_2 assay, per cent	Bi assay, per cent	Recovery, per cent	MoS_2 assay, per cent	Bi assay, per cent	Recovery, per cent
400	95.0	0.26	92.3	33.6	18.2	93.0

Refinements -

The flow-sheet shown in Figure 2 is the recommended procedure for the solution of this problem.

It has these advantages:

1. It ensures high recovery of the MoS_2 in a clean +95 per cent MoS_2 concentrate.

2. It will allow for the making of a gangue-free bismuth concentrate, grading about 25 per cent bismuth, which could be further improved by a process for removing the copper and iron minerals by magnetic separation.

3. It provides for regrinding the middlings, thus making it possible to pull harder in the rougher concentrate cells, lifting all the metallics, with later elimination of the waste after regrinding. With a regrind mill in the circuit, it would be possible to grind to a much coarser product in the primary grinding circuit, thus lowering costs, improving recovery, and raising the tonnage.

4. It provides for separate treatment of the slimes and sands, allowing the flotation cells to work much more efficiently.

5. It takes advantage of the extremely high specific gravity of bismuthinite, taking off the coarse fraction of the mineral in a table concentrate that grades over 45 per cent bismuth.

6. The middling product sent to the regrind mill consists

(Flotation Tests, cont'd) -

of coarse molybdenite that has been tarnished by contact with iron in the primary grind. It also contains quartz with attached molybdenite. When these products are ground in a pebble mill, the liberated MoS_2 is bright and easily floated.

TABLE II. - Results of Treatment of Mill Concentrate by Flow-Sheet No. 2.

Roast temperature, ° C.	MoS_2 CONCENTRATE			Bi CONCENTRATE		
	MoS_2 assay, per cent	Bi assay, per cent	Recovery, per cent	MoS_2 assay, per cent	Bi assay, per cent	Recovery, per cent
450	96.42	0.20	98.40	17.94	36.35	91.60

General Discussion:

The results shown above cannot be accepted as final, until a continuous mill run has been made. Care has been taken, however, to duplicate operational conditions, and there should be no great difficulty in achieving results of this order in a concentrator.

The new machinery required for the mill, to install equipment suitable for Flow-Sheet No. 2, is listed here:

1. Two 2-inch Wilfley pumps.
2. A roaster of the Herreschoff type, about 6 feet in diameter, with four hearths.
3. An oil burner to heat the roaster.
4. A five-leaf American-type filter.
5. Three Denver #18 flotation cells.
6. Four #12 Denver flotation cells.
7. One quarter- or half-deck Wilfley table.
8. A small classifier or hydraulic sizer.
9. A small pebble mill.

The reagent consumption for this procedure cannot be

(General Discussion, cont'd) -

calculated except under continuous-run conditions. It is estimated that the reagent consumption will be 50 per cent greater than at present. In this experimental work, a combination of kerosene, pine oil, and Artic Syntax 'M' seems to give the best results. pH is regulated with either lime or soda ash; the opinion of this writer is that lime should be used during the flotation of the coarse molybdenite, and soda ash in the slime circuit. By this method, slimes and impurities may be depressed out of the first circuit, while leaving the concentrate in good condition to be filtered. It is extremely difficult to filter molybdenite from a pulp in which soda ash is present in noticeable quantities.

In comparison with the only other method yet discovered for eliminating bismuth from MoS_2 concentrate, i.e., leaching, this process is probably cheaper in operational costs. It has been found that in leaching, the concentrate does not respond to treatment unless it has been first roasted. Leaching raises the grade of the concentrate very little while eliminating the impurities; the present method raises the grade to a point where it can compete with the best on the market.

Summary:

The process described herein shows that a molybdenite concentrate may be made from the La Corne ore that will be +95 per cent MoS_2 with acid soluble impurities below 0.5 per cent. The indications are that the overall mill recovery, considering the MoS_2 in the bismuth concentrate made in this process as lost, will be higher than it is at present. A bismuth concentrate, that is well within the requirements of the specifications known to us, may be produced.

A rough estimate of the increased cost of milling,

(Summary, cont'd) -

according to this system, is that it should be less than a a cent a pound, calculated on the MoS_2 concentrate. It is suggested that Wartime Metals Corporation supply two tons of their mill concentrate. This material will be treated and the products will be returned to the corporation. At the same time some information should be given about the specifications for a bismuth concentrate.

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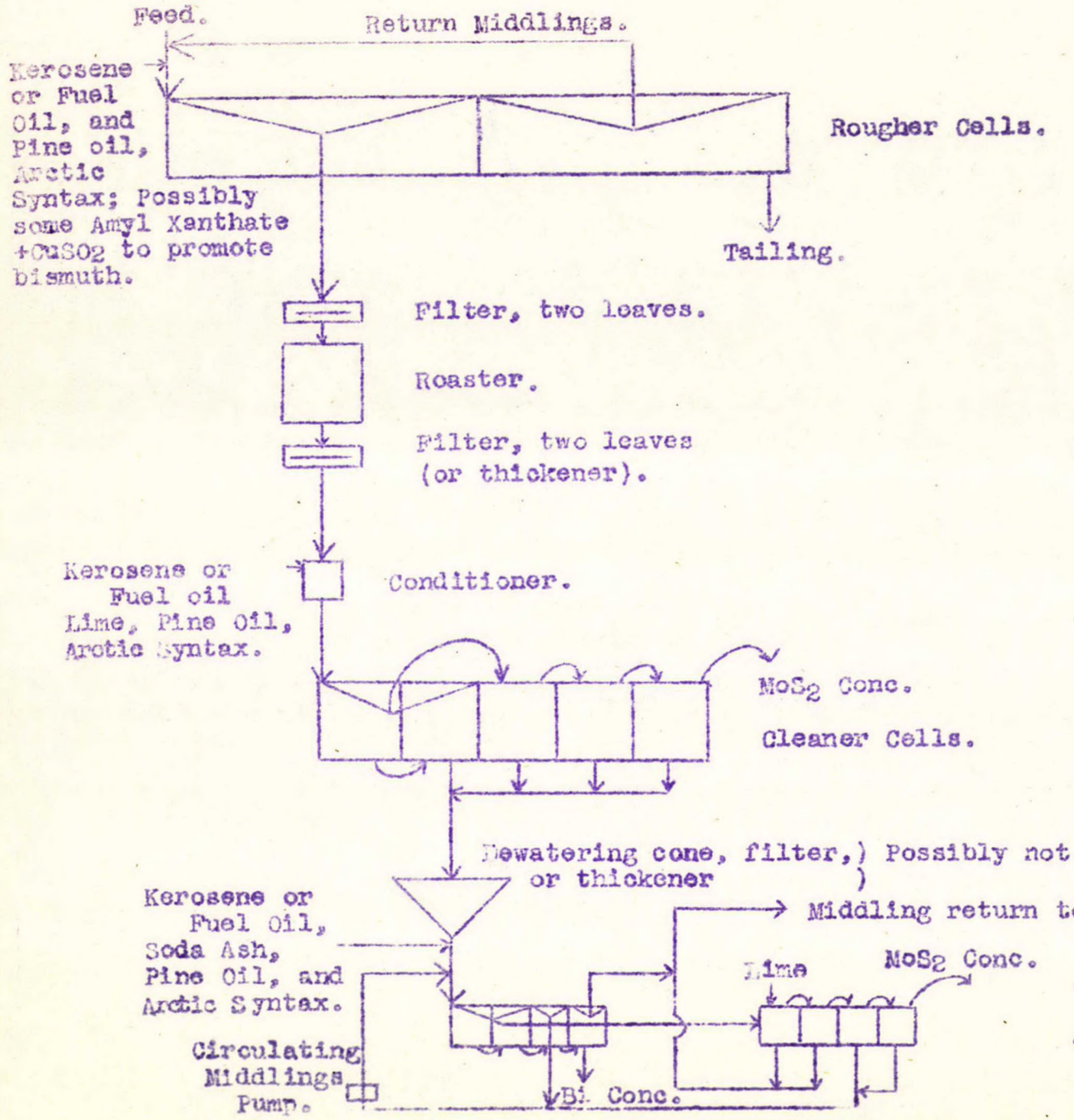
(Flow-Sheets Nos. 1 and 2)
(follow, on Pages 9 and 10.)



FLOWSHEET NO. 1. -

Process For Removing Bismuth From Molybdenite.

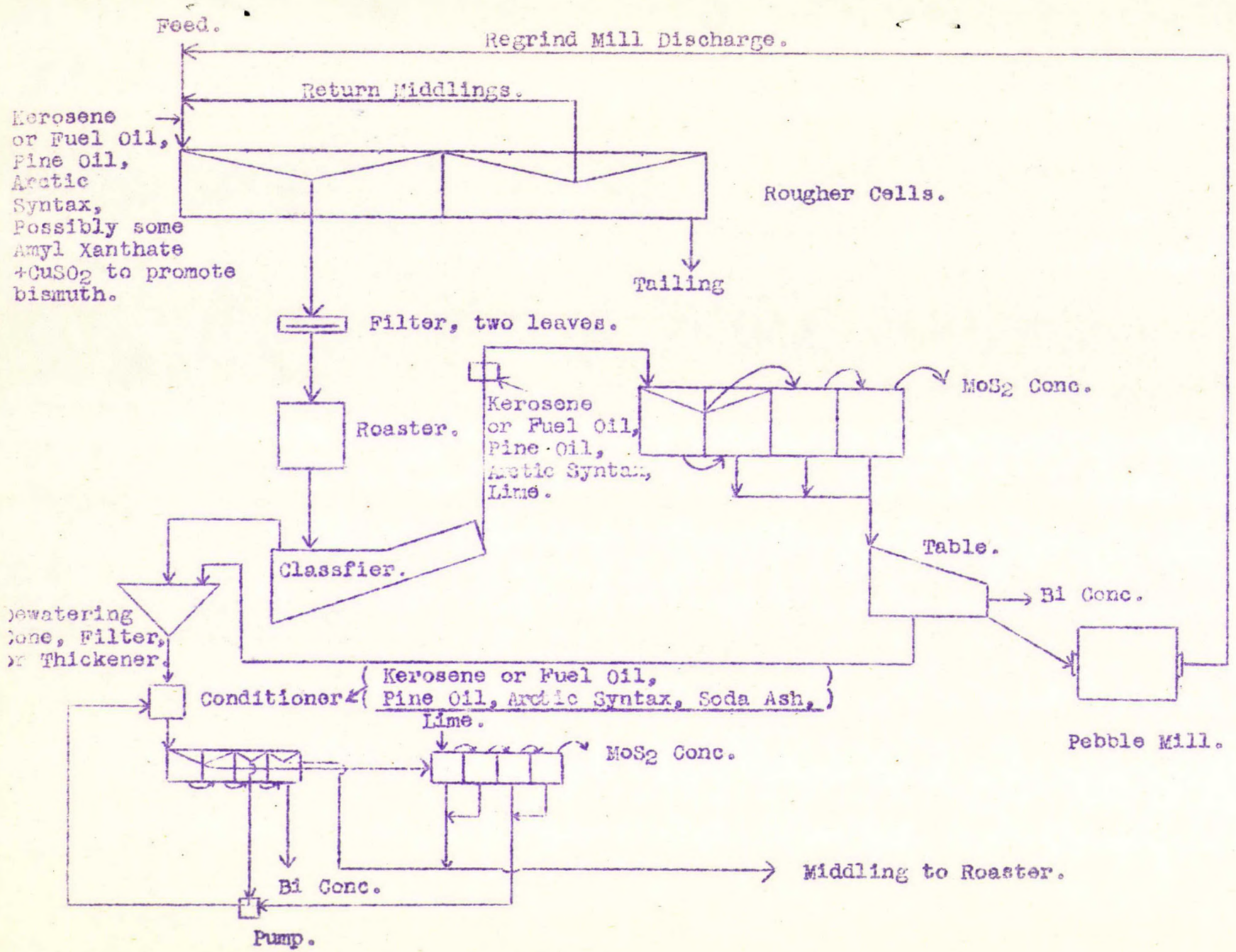
	MoS_2 - Per	Bi Cent -
MoS_2 conc. -	95	0.25
Bi conc. -	20	20.00

(On rougher concentrate containing 2.5 per cent Bi).

Bank of cells designed:

- First, to float MoS_2 away from Bi and other impurities.
- Second, to clean the impurities out of the MoS_2, that has been floated.

Middlings high in MoS_2 may be re-circulated.
Middlings high in Bi may be re-roasted.



FLOWSHEET NO. 2.

Process For

Removing Bismuth

From Molybdenite.

	MoS_2 - Per	Bi Cent -
MoS_2 conc. -	95	0.25
Bi conc. -	10	35.00

(On rougher concentrate containing 2.5 per cent Bi).

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