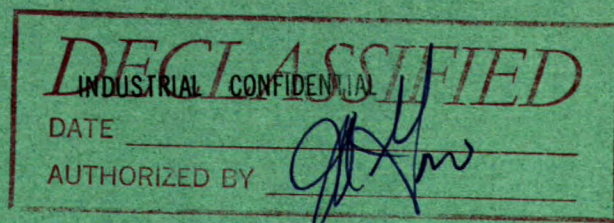


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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

OTTAWA

MINES BRANCH INVESTIGATION REPORT IR 59 36

CONCENTRATION TESTS ON A MOLYBDENITE SAMPLE FROM NORTOBA MINES LIMITED, BEARDMORE, ONTARIO

by

R. S. KINASEVICH

MINERAL DRESSING AND PROCESS METALLURGY DIVISION

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SUMMARY OF RESULTS

The sample treated in test 6 gave a flotation concentrate grading 93.3% MoS₂ with a recovery of 81.8%. Attempts to recover molybdenite left in the flotation tailing by jigging and tabling proved unsuccessful.

In test 4, an attempt was made to concentrate molybdenite by electrostatic means. This method, however, gave results that were unsatisfactory, especially in the finer size range.

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(16 pages, 10 tables, 2 illus.)

INTRODUCTION

Shipment

A 58 lb sample of molybdenite ore was received at the Mines Branch laboratories on November 26, 1958. Consisting of pieces of ore about 2-3 in. in size, the sample was sent by Nortoba Mines Limited.

Location of Property

The property is located about 17 miles north of Beardmore, Ontario, in Dorthea and Sandra townships, Thunder Bay Mining Division.

Purpose of Investigation

In a covering letter dated November 21, 1958, Mr. B. C. Lamble, P. Eng., 133 Matchedash St., N. Orillia, Ontario, stated that he required "the best, quickest, and most economical way of extracting the molybdenite". Mr. Lamble also explained that he was being retained as a consultant by Mr. B. Tyson, P. Eng., Suite 504, 199 Bay St., Toronto, Ontario. Results of the test work were to be sent to Mr. Tyson as well.

Sampling and Analysis

The molybdenite ore was crushed all to -1 in. and mixed thoroughly. One half was retained as rejects and the remainder was crushed to -10 mesh. A 5 lb head sample was riffled out by standard methods and was sent for chemical and spectrographic analysis.

The elements detected by a semi-quantitative spectrographic analysis are listed below in decreasing order of abundance.

- I Si, principal constituent
- II Fe, Mo, Al
- III Ca, Mg, As
- IV Ni, Pb, Cu, Mn, Ti, Cr, Sn
- V V

A chemical analysis on the head sample gave the following results:

<u>Constituent</u>	<u>Assay, percent</u>
MoS ₂	2.33
Fe	1.48
S	0.83
Insol.	91.18

MINERALOGICAL EXAMINATION^{*}

Introduction

Several hand specimens, blocky lumps of ore ranging up to 3 in. or more to a side, were examined megascopically and under a binocular microscope before three polished sections were prepared from them. Next, the polished sections were studied under an ore microscope and the results of both examinations are described below. Mineral identifications are based on optical and physical properties corroborated by X-ray diffraction patterns of powder samples taken

^{*} From Mineralogical Report M-1634-E, January 9, 1959, by W. E. White.

from the hand samples and the polished surfaces.

Hand Samples

To unaided eyes, all of the hand samples examined are composed predominantly of coarse milky white quartz with a few small scattered patches of soft dark green to black chlorite. Under a microscope, a little dolomite is also seen to be present in quartz as narrow light brown veinlets and small disseminated particles. Signs of weathering are prevalent; much of the quartz bears deep reddish brown stains of iron oxides, especially along numerous narrow sinuous fractures which transect it. Thin coatings of brownish black limonite and yellow ferrimolybdate (hydrous ferric molybdate) are also locally visible on quartz.

Molybdenite is seen to be by far the most abundant metallic mineral in the hand specimens. It is distributed unevenly through quartz largely as little foliated masses up to several centimetres in size. The complete side of one specimen examined consists entirely of such a mass and measures approximately $1\frac{1}{2} \times 1 \times 1/8$ inches. Molybdenite occurs also as individual particles disseminated erratically through gangue in sizes which range down to 0.15 mm (100 mesh) or less but the total quantity of finely divided material is relatively very small. Pyrite is visible in small amount as rare small isolated crystals; in one piece of ore, however, pyrite particles form a granular aggregate which measures about 1 cm in its longest direction.

Polished Sections

To unaided eyes, each of the three polished sections is composed essentially of milky white quartz, which bears numerous reddish brown stains of iron oxides and is transected by narrow sinuous fractures. Limonitic staining is so extensive and intensive in one section in fact, that the whole of the polished surface is a deep rusty brown colour. Metallic minerals are sparingly distributed through quartz but particles with metallic lustre can be seen here and there and range up to approximately 3 mm (-6+8 mesh) in maximum dimension.

As in the hand specimens, molybdenite is seen to be the most abundant ore mineral in the three polished sections when they are examined under a microscope. This mineral usually occurs in little clusters of prismatic sections whose plates tend to be curved or divergent. An approximately average field of such an occurrence is shown in Figure 1. Small individual plates or scales of molybdenite are also disseminated at random through gangue but are very rare in the three polished sections.

A few small irregular grains of pyrite, ranging up to 2 mm (-8+10 mesh) in size, are visible here and there in gangue but, as represented in the three polished sections, the total quantity of iron sulphide is comparatively small. Rare to occasional small particles of rutile are also present in the polished sections and are both equidimensional and elongated in shape. Particles with the latter shape

are often strung out in alignment as if following an incipient fracture or other plane of weakness in quartz, Figure 2. As represented in the three polished surfaces, the total amount of rutile is, like pyrite, relatively very small.

Gangue material is, of course, composed of the same minerals as found in the hand specimens. In addition, however, a few small scattered particles of montmorillonite, a clay mineral, were found in the severely oxidized section.

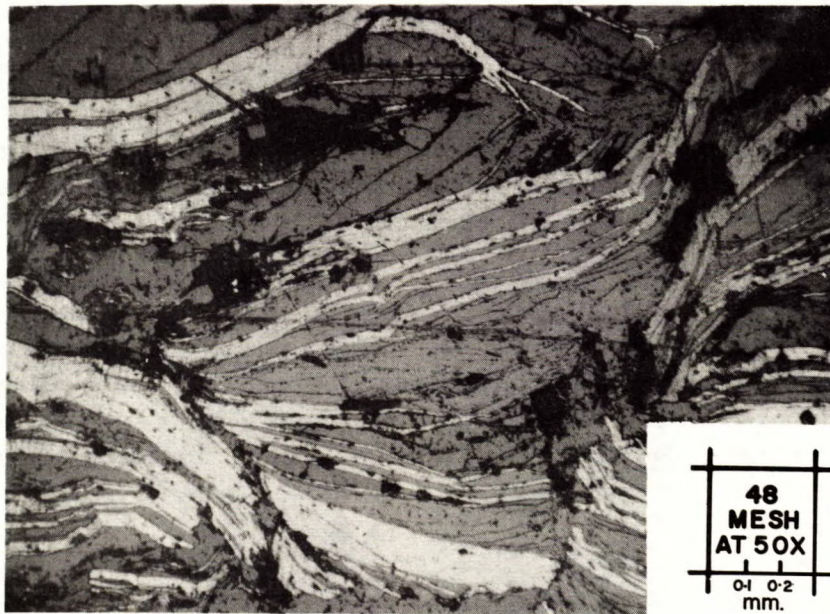


Figure 1 - Photomicrograph of polished section showing molybdenite (white) in gangue (grey); note the narrow lenses of gangue between plates of molybdenite; polishing pits are black.

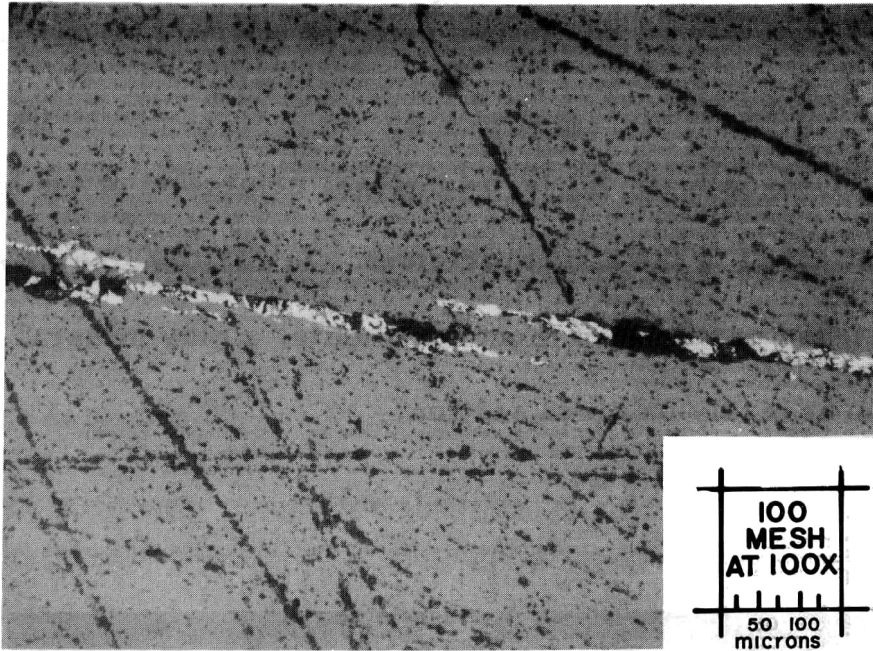


Figure 2 - Stringer of rutile particles (white) transecting quartz (grey); the black spots and straight black lines are polishing pits and scratches.

DETAILS OF INVESTIGATION

With the exception of test 4, an attempt was made to concentrate the molybdenite by flotation where the following conditions were varied:

- a) degree of fineness of grind.
- b) reagent combination.
- c) reagent concentration.

Test 1

This test was an exploratory one to determine the behaviour of MoS_2 when floated with kerosene and pine oil.

A 2000 g sample was ground 20 min in 1500 cc of water to 54.6% -200 mesh. The pulp was diluted to about 25% solids. After conditioning the pulp with kerosene and pine oil, a rougher molybdenite concentrate was floated. The rougher concentrate was then cleaned in a 500 g Denver cell, weighed and then assayed for molybdenite.

The rougher and cleaner flotation tailings were combined, weighed and assayed. Weights and assays of the cleaner concentrate and of the combined tailings are reported in tabular form for each test.

The conditions used in test 1 are given below:

<u>Operation</u>	<u>Reagent - lb/ton</u>	<u>Time, min</u>	<u>pH</u>
Conditioning	Kerosene - 0.3		
	Pine oil - 0.05	3	-
Rougher float	-	6	-
Cleaner float	-	4	-

TABLE 1Results of Test 1

Product	Weight, Percent	MoS ₂ , Percent	MoS ₂ Distribution, Percent
Cleaner conc.	1.69	98.6	73.5
Combined tailing	98.31	0.61	26.5
Calc. head	100.00	2.27	100.0

Test 2

A 2000 g sample was ground 30 min to 72% -200 mesh, and floated at approximately 25% solids using the following conditions and reagents:

<u>Operation</u>	<u>Reagent - lb/ton</u>	<u>Time, min</u>	<u>pH</u>
Conditioning	Kerosene - 0.34		
	Pine oil - 0.05	3	6.3
Rougher float	-	4	-
Cleaner float	-	6	-

TABLE 2Results of Test 2

Product	Weight, Percent	MoS ₂ , Percent	MoS ₂ Distribution, Percent
Cleaner conc.	1.89	92.47	78.8
Combined tailing	98.11	0.48	21.2
Calc. head	100.00	2.22	100.0

Test 3 - Flotation of molybdenite using Syntex M

A sample was ground to 72.0% -200 mesh and floated using the following conditions and reagents:

<u>Operation</u>	<u>Reagent - lb/ton</u>	<u>Time, min</u>	<u>pH</u>
Conditioning	Syntex M - 0.1		
	Kerosene - 0.08	3	7.4
Rougher float	Pine oil - 0.05	4½	
Cleaner float	Kerosene - 0.02		
	Pine oil - 0.02	3	

TABLE 3Results of Test 3

<u>Product</u>	<u>Weight, Percent</u>	<u>MoS₂, Percent</u>	<u>MoS₂ Distribution, Percent</u>
Cleaner conc.	1.80	88.79	73.0
Combined tailing	98.20	0.60	27.0
Calc. head	100.00	2.19	100.0

Test 4 - Electrostatic Test

A 2000 g sample, ground all to -10 mesh, was screened into five fractions and each was passed separately through the Carpco electrostatic separator.

With the exception of the -200 mesh fraction, the separation of each fraction was done at a meter setting of 90 A.C. volts. The middling and tailing products were cleaned by passing them several times through the separator.

The +200 mesh fraction was treated at settings 70, 50, 40, and 30 A.C. volts, and this continuous decrease in voltage increased the proportion of middling which was recirculated through the separator.

Of the different voltages used, a setting of 60 volts gave the cleanest concentrate for the -200 mesh portion. Continuous recirculation of the middling and tailing increased the amount of gangue in the concentrate. This may be due to the deposit of static charges on the surface of the finer particles of gangue and molybdenite, causing both to be pinned to the rotating drum.

The screen test of the feed to the CarpcO and the results of the test are tabulated below.

TABLE 4

Screen Analysis of Feed to CarpcO Separator

Mesh	Weight, Percent	Cum. Weight Percent Retained	Percent Passing
+ 20	22.4	22.45	77.55
+ 48	39.5	61.95	38.05
+100	16.8	78.75	21.25
+200	10.6	89.35	10.65
- 200	10.7	100.00	--
Total	100.0	--	--

TABLE 5Results of Test 4

Product	Weight, Percent	MoS ₂ Assay, Percent	MoS ₂ Distribution, Percent
+ 20 mesh conc.	6.64	6.38	19.4
+ 20 mesh tailing	16.29	0.19	1.4
+ 48 mesh conc.	6.30	11.80	34.0
+ 48 mesh tailing	34.00	0.21	3.3
+100 mesh conc.	0.27	70.39	8.7
+100 mesh tailing	16.85	0.99	7.6
+200 mesh conc.	0.14	67.44	4.3
+200 mesh tailing	10.72	1.59	7.8
- 200 mesh conc.	0.01	19.31	0.1
- 200 mesh tailing	8.78	3.32	13.4
Total	100.00	2.19	100.0

Test 5

A 2000 g sample was ground to 72.0% -200 mesh and was floated under conditions similar to test 3 except that the concentration of the reagents was increased.

<u>Operation</u>	<u>Reagent - lb/ton</u>	<u>Time, min</u>	<u>pH</u>
Conditioning with air	Syntex M - 0.15		
	Kerosene - 0.12	5	6.5
Rougher float	Kerosene - 0.02		
	Pine oil - 0.02	5	6.8
Cleaner float	Kerosene - 0.02		
	Pine oil - 0.02	8	--

TABLE 6

Results of Test 5

<u>Product</u>	<u>Weight, Percent</u>	<u>MoS₂, Percent</u>	<u>MoS₂ Distribution, Percent</u>
Cleaner conc.	2.29	85.4	78.8
Combined tailing	97.71	0.54	21.2
Calc. head	100.00	2.48	100.0

Test 6

This sample was also ground to 72.0% -200 mesh, and floated as follows:

<u>Operation</u>	<u>Reagent - lb/ton</u>	<u>Time, min</u>	<u>pH</u>
Conditioning with air	Syntex M - 0.02		
	Kerosene - 0.5	5	7.3
Rougher float	Pine oil - 0.04	8	--
Cleaner float	Kerosene - 0.04		
	Pine oil - 0.02	3½	--

TABLE 7Results of Test 6

Product	Weight, Percent	MoS ₂ , Percent	MoS ₂ Distribution, Percent
Cleaner conc.	2.3	93.31	81.8
Combined tailing	97.7	0.51	18.2
Calc. head	100.0	2.64	100.0

Impurities in the concentrate assayed as follows:

Fe - 0.98%; Cu - 0.01%; As - 0.36%.

Test 7 - Sample ground 40 min to 80.7% -200 mesh

<u>Operation</u>	<u>Reagent - lb/ton</u>	<u>Time, min</u>	<u>pH</u>
Conditioning with air	Kerosene - 0.5	5	7.5
	Syntex M - 0.02		
Rougher float	Pine oil - 0.054	3½	--
Cleaner float	Kerosene - 0.02		
	Pine oil - 0.02	3½	7.4

TABLE 8Results of Test 7

Product	Weight, Percent	MoS ₂ , Percent	MoS ₂ Distribution, Percent
Cleaner conc.	2.34	90.38	79.7
Combined tailing	97.66	0.55	20.3
Calc. head	100.00	2.66	100.0

Impurities in the concentrate assayed as follows:

Fe - 1.14%; Cu - 0.01%; As - 0.30%.

Test 8

This sample was ground to 80.7% -200 mesh and was conditioned with reagents at 50% solids. The pulp was then diluted to about 25% solids and floated.

<u>Operation</u>	<u>Reagent - lb/ton</u>	<u>Time, min</u>	<u>pH</u>
Condition	Kerosene - 1.0		
	Syntex M - 0.15	5	6.8
Rougher float	Pine oil - 0.054	4½	7.3
Cleaner float		3	--

TABLE 9Results of Test 8

<u>Product</u>	<u>Weight, Percent</u>	<u>MoS₂ Assay, Percent</u>	<u>MoS₂ Distribution, Percent</u>
Cleaner conc.	2.6	80.23	79.4
Combined tailing	97.4	0.56	20.6
Calc. head	100.0	2.65	100.0

Test 9A

On March 6, 1959, Mr. Lambie wished to know if the molybdenite in the flotation tailing could be recovered by gravity methods using concentrating or corduroy mat tables.

The flotation tailing from test 6 was fed to a Wilfley concentrating table, but no satisfactory concentration of the molybdenite could be made.

Test 9B

The flotation tailing from test 5 was used as jig feed to see if the molybdenite in the tailing could be recovered by this method.

As the results obtained looked more promising than in the previous test, the jig products were collected for weights and assaying.

TABLE 10Results of Jig Concentration of Flotation Tailing

Product	Weight, Percent	MoS ₂ Assay, Percent	MoS ₂ Distribution, Percent
Jig conc.	0.25	5.31	2.2
Jig tailing	99.75	0.59	97.8
Calc. head	100.00	0.60	100.0

CONCLUSIONS AND DISCUSSION

The sample from test 6 gave the best combination of grade and recovery of molybdenite. Increasing the time of the grind and varying the reagent combination and concentration did not yield results better than that of test 6.

Tabling and jigging of the tailing from tests 5 and 6 in order to recover more molybdenite gave poor results. Attempts were made to remove traces of flotation reagents from the molybdenite, but no satisfactory separation could be made probably because of the flaky nature of the mineral and also because of its fineness.

The specifications for a saleable molybdenite concentrate are given below:

MoS ₂	-	85% minimum
Cu	-	0.6% maximum
Fe	-	3.0% "
Combined Sb, P, Sn	-	0.2% "

Assays of iron, and arsenic in the concentrates from tests 6 and 7 satisfied these requirements. The remainder of the flotation concentrates are expected to contain these impurities in amounts about the same as those in tests 6 and 7.

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