O T T A W A May 13th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1619.

Concentration Tests by Flotation on a Sample of Mill Tailing from the Werner Lake Cobalt Mine, near Kenora, Ontario.

==========

(Copy No.___.)

IR 1619

1619

O T T A W A May 13th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1619.

Concentration Tests by Flotation on a Sample of Mill Tailing from the Werner Lake Cobalt Mine, Near Kenora, Ontario.

==========

Shipment:

One drum containing approximately 100 pounds of mill tailing was received on November 3rd, 1943. The sample was submitted by N. B. Davis, Consulting Engineer, 140 Wellington Street, Ottawa, Ontario, on behalf of Werner Lake Cobalt Mine, c/o C.P. Air Lines, Kenora, Ontario.

Location of Property:

The property from which this material originated is located in the Red Lake mining division of the Patricia District of Ontario, about 50 air miles north of Kenora.

CHARACTER OF THE SAMPLE:

The sample was a gravity mill tailing and was ground practically all through 35 mesh and 40 per cent finer than 200 mesh. Microscopic examination of the sample as received and in polished section revealed the following:

SUPERPANNER PRODUCTS.

A. - Binocular Examination:

Some of the material as received was superpanned into three products designated as, Concentrate, Middlings, and Tailings. Each of these products was first examined by means of the binocular microscope. The following features were noted:

Superpanner Concentrate -

1. Metallic minerals are as abundant as gangue minerals, perhaps even more so, but, in general, their particle size is smaller than that of the gangue minerals.

2. In their approximate order of abundance, the metallic minerals present are: cobaltite, pyrite, chalcopyrite, and iron oxides.

3. The metallic mineral particles were preponderantly uncombined either with gangue or with each other.

4. Gangue was represented largely by colourless quartz and a pinkish, vitreous mineral with uneven or sub-conchoidal fracture which looks like rosy quartz. Under a petrographic microscope, however, it is isotropic with a relatively high index of refraction and is thought to be garnet.

5. Occasional grains of black hornblende and rare flakes of mica were also observed in the concentrate.

Superpanner Middlings -

1. Gangue minerals predominate, but fine particles of sulphides, among which cobaltite is recognizable, are relatively abundant.

2. The sulphides are largely free, but a few grains

(Character of the Sample, cont'd) -

attached to gangue were observed.

3. In general, the particle size of the minerals in this product is smaller than in the concentrate and tailings.

Superpanner Tailings -

1. Gangue. - Scaly minerals, in comparatively large sizes, preponderate.

2. Metallics are very sparse, but one or two grains of sulphide attached to gangue are observed.

B. - Microchemical Tests:

Several pieces of the silvery white mineral, later identified as cobaltite, were carefully removed from the concentrate but it was impossible to be absolutely certain that pyrite was excluded from the material tested microchemically. The results of these tests are:

As	-	Strong.
Co	-	Strong.
S	-	Distinct.
Fe	-	Strong trace.
Cu, Ni, Sb, Bi	-	Negative.

C. Spectrographic Analysis:

C. - Spectrographic Analysis:

A dozen or more particles of the same white mineral were carefully removed from the superpanner concentrate, and these were picked over a second time so that the final product would be as pure as possible. This sample was submitted for spectrographic analysis, with the following results:

Major constituents	-	Co, As.
Trace	-	Fe.
Faint traces	-	Ni, Cu.

D. - Mineragraphic Examination:

Three polished sections, one from each of the superpanner concentrate, middlings and tailings, were prepared and

(Character of the Sample, cont'd) -

examined under an ore-microscope for further study of the metallic minerals.

Superpanner Concentrate -

Metallic mineral particles are abundant in the polished surface and range from about 200 microns (-65+100 mesh) down to only a few microns in size. Listed in their approximate order of abundance, they are: cobaltite, pyrite, chalcopyrite, iron oxides (magnetite, hematite, "limonite"), and covellite. The oxide minerals are frequently associated, but the sulphides are predominantly free, both of each other and of gangue.

The identification of the cobaltite was based on the following microscopic tests on polished surfaces, together with the microchemical tests and spectrographic analysis previously recorded:

Colour	-	White, some grains have a faint pinkish tinge.
Crossed nicols	-	Some grains very weakly anisotropic and others are isotropic.
H	-	Hard and brittle, not scratched by needle point.

Etch tests:

HNO_3	-	Negative; fumes darkened one or two grains after long etching, but tarnish washed off.
KCl, KCN, $FeCl_3$ KOH, $HgCl_2$, Aqua regia	-	All negative.

Superpanner Middlings -

Metallic particles are not so abundant in this section as in the one made from the concentrate but they represent the same minerals in the same relative proportions. The sulphides are still predominantly free, only one or two small grains

(Character of the Sample, cont'd) -

attached to gangue being visible.

Superpanner Tailings -

Grains of metallic minerals are much sparser and finer in this polished section but represent the same species as in those prepared from the superpanner concentrate and middlings. Tiny grains of sulphides are more commonly attached to gangue, but free particles are probably more abundant than combined particles.

—

SCREENED FRACTIONS.

Over 600 grams of the head sample was screened into seven sizes, as shown in Table I.

TABLE I.

Size	Weight, in grams	Weight, per cent
+ 35	6.2	0.98
- 35+ 48	18.9	2.98
- 48+ 65	55.7	8.79
- 65+100	109.0	17.20
-100+150	100.0	15.78
-150+200	87.4	13.79
-200	256.5	40.48
Totals	633.7	100.00

A. - Binocular Examination:

Each of the above fractions was examined under the binocular microscope for general mineral contents, etc.

+35 Mesh Size -

Scaly minerals (mica and chlorite) preponderate, with some quartz, feldspar and calcite.

A few particles of soft pink erythrite (cobalt bloom) were observed, but the total amount is small. Metallics are almost nil; occasional grains of iron oxide, but no free grains

(Character of the Sample, cont'd) -

of sulphides, are observed. A tiny remnant of original cobalt mineral appeared to occur within an erythrite particle.

+48 Mesh Size -

Very similar to the +35 mesh fraction. Erythrite is not so abundant; only two pieces observed, one of which appeared to be mixed with "limonite".

+65 Mesh Size -

Much the same as the larger sizes described above. Sulphides appear to be absent and cobalt bloom is sparse. One or two grains of garnet were observed.

+100 Mesh Size -

Still essentially the same as the previous size. Gangue minerals compose almost the entire fraction. Mica and chlorite are less in amount; quartz and garnet, more prevalent. Occasional grains of black hornblende are also recognizable.

One small particle of erythrite and two tiny grains of sulphides attached to gangue were observed.

+150 Mesh Size -

The scaly minerals are present in minor amount, the major portion of the mineral content now being composed of quartz and garnet with black hornblende and perhaps some pyroxene.

No typical erythrite and no free sulphides were observed but one or two grains which appeared to be a mixture of cobalt bloom and "limonite", as well as a few tiny particles of sulphides attached to gangue, were seen.

+200 Mesh Size -

This fraction appears to be very similar to the previous size. No erythrite was seen, but one grain of magnetite and a few small free particles of tarnished sulphide were

(Character of the Sample, cont'd) -

observed.

-200 Mesh Size -

This fraction is too fine to distinguish the minerals with a high degree of accuracy, but tiny grains of sulphides, which appear to be largely free from gangue, are seen to be present.

B. - Chemical Analyses:

A chemical analysis for cobalt was obtained on each screen size, as shown in Table II.

TABLE II. - Chemical Analyses of Screened Fractions.

Screen size	Weight, grams	Cobalt, per cent	Units	Distribution of cobalt, per cent
+ 35	6.2	0.24	1.488	0.5
- 35+ 48	18.9	0.21	3.969	1.3
- 48+ 65	55.7	0.19	10.583	3.4
- 65+100	109.0	0.22	23.980	7.6
-100+150	100.0	0.27	27.000	8.6
-150+200	87.4	0.29	25.346	8.1
-200	256.5	0.86	220.590	70.5
Totals	633.7		312.956	100.0

C. - Mineragraphic Examination:

Twenty-one polished sections, three from each screen size, were prepared and examined under the reflecting microscope for the purpose of determining the condition of the cobaltite; that is, whether it is free or combined. Traverses were made across the polished surfaces and an estimate was made of the relative amounts of combined and free sulphides present.

It was found impossible to distinguish with certainty between every grain of pyrite and cobaltite in polished section, and so the data are recorded as combined and free sulphides. Since this includes pyrite and chalcopyrite as well as cobaltite, it is reasonable to assume that the latter mineral is combined in even less amounts than that shown in Table III, below:

(Continued on next page)

(Character of the Sample, cont'd) -

TABLE III. - Microscopic Estimate of Combined and Free Sulphides.

Screen sizes	Sulphides		Conversion factors		Dist'n of cobalt in the combined and free sulphides, per cent	
	Combined, per cent	Free, per cent	Combined	Free	Combined	Free
+ 35	53.6	46.4	80	70	0.3	0.2
- 35+ 48	39.6	60.4	158	236	0.5	0.8
- 48+ 65	32.6	67.4	346	717	1.1	2.3
- 65+100	22.4	77.6	538	1,862	1.7	5.9
-100+150	16.8	83.2	454	2,246	1.4	7.2
-150+200	8.1	91.9	206	2,330	0.7	7.4
-200	1.3	98.7	287	21,773	0.9	69.6
Totals			2,069	29,234	6.6	93.4

Note: While the column headed "Sulphides, Combined" in the above table means sulphides combined with gangue or with one another, as in previous mineragraphic reports of work done on samples of heads and flotation concentrates, the microscopic analysis showed them to be attached to gangue almost entirely.

—

Three superpanner products and seven screened fractions were made and each one was examined under the binocular microscope. Twenty-four polished sections were also prepared and studied under the ore-microscope. In addition, a qualitative spectrographic analysis of material obtained from the superpanner concentrate and a quantitative chemical analysis for cobalt of each of the sized fractions were obtained and tabulated. The metallic minerals are identified and a microscopic estimate of the relative amounts of "combined" and "free" sulphides is given.

From all the information thus obtained the following conclusions are drawn:

1. Cobaltite is the principal ore mineral in the tailings as received.

2. Erythrite (cobalt bloom) is also present but its total quantity appears very small.

3. Metallic mineral particles are present largely in the

(Character of the Sample, cont'd) -

finer sizes and, in general, the cobalt content of the head sample increases as the particle size decreases, over 70 per cent being contained in the -200 mesh fraction. - Table II.

4. As previously reported, the sulphides are largely uncombined, and where combination was observed it is almost entirely with gangue. The degree of freedom of the sulphides increases as grain size decreases. - Table III.

5. Most of the iron and copper in the flotation concentrates cannot be due to pyrite and chalcopyrite combined with cobaltite.

Sampling and Assaying:

A sample was cut with the aid of a pipe sampler and then assayed. The results were as follows:

Gold	-	0.01 ounce per ton.
Silver	-	0.07 "
Cobalt	-	0.56 per cent.
Copper	-	0.12 "
Iron	-	8.85 "
Sulphur	-	0.22 "
Arsenic	-	1.18 "

CONCLUSIONS:

The cobalt minerals in this sample have been identified as cobaltite and erythrite.

A number of flotation tests have been conducted, using different reagent combinations, in an attempt to recover as much as possible of the cobalt, in the form of a concentrate assaying at least 10 per cent cobalt and not more than 1 per cent copper.

None of these attempts has been successful with respect either to grade or to recovery. The flotation feed is a table tailing and 70 per cent of the cobalt is in the minus 200 mesh sizes, which may in some measure account for the low recovery. The concentrates obtained were also low-grade in cobalt and at the same time carried large amounts of copper and iron. The tests

(Conclusions, cont'd) -

seemed to indicate that the copper and iron minerals, which are perhaps more readily floatable than the cobalt minerals, could not be depressed by any of the common depressants without also depressing the cobalt. Yet, at the same time, when prior flotation of the copper and iron minerals was attempted most of the recoverable cobalt floated off with them.

The microscopic examination having revealed that the cobalt minerals are free from the other sulphides, it is indicated that their separation by flotation depends on the development of a reagent combination suitable for this purpose.

Details of Tests:

The following tests are described in detail and are typical of a number conducted:

Test No. 1.

A sample of the mill tailing was ground in a ball mill to about 50 per cent finer than 200 mesh and then floated.

Charge to Ball Mill:

Mill tailing	-	2,000 grams.
Water	-	1,500 "
Caustic soda	-	1.0 lb./ton.
Sodium silicate	-	1.0 "
Coal tar creosote No. 634	-	0.06 "
Amyl xanthate	-	0.20 "

Reagents to Cell:

Pentasol xanthate	-	0.10 lb./ton.
Pine oil	-	0.05 "

Results of Test No. 1:

Product	Weight, per cent	Assays, per cent				Distribution of cobalt, per cent
		Co	Cu	Fe	S	
Concentrate	5.65	4.34	3.24	15.29	15.75	50.97
Tailing	94.25	0.25	-	-	-	49.03
Feed (cal.)	100.00	0.48	--	-	-	100.00

This concentrate is low-grade in cobalt and at the

(Details of Tests, cont'd) -

same time so high in copper and iron as to make it undesirable for mixing in with higher-grade concentrates.

-

Test No. 2. - Selective Flotation.

In this and other similar tests an attempt was made to float the copper first and then float the cobalt but in all cases it was found impossible to effectively separate the cobalt from the other contaminating minerals.

In this test a sample of mill tailing was ground about 50 per cent finer than 200 mesh without reagents and a concentrate was floated with butyl xanthate and cresylic acid. A second concentrate was floated with amyl xanthate and pine oil. Lime and cyanide were found to depress cobalt as well as other minerals.

Results of Test No. 2:

Product	Weight, per cent	Assays, per cent			Distribution, per cent		
		Co	Cu	Fe	Co	Cu	Fe
No. 1 concentrate	9.35	2.54	2.04	14.36	46.06	58.31	15.03
No. 2 concentrate	1.03	6.12	1.06	12.31	12.23	3.33	1.42
Tailing	89.62	0.24	0.14	8.33	41.71	38.35	83.55
Feel (cal.)	100.00	0.52	0.33	8.93	100.00	100.00	100.00

The results shown in the above table are typical of those obtained in a number of tests conducted with the same object in view. Practically all of the recoverable cobalt floats with the greater part of the copper and enough iron minerals to cause considerable dilution and it seems unlikely that a cobalt concentrate of marketable grade can be produced from this material.

oooooooooooo
oooooo
oo

JDJ:GHB.