O T T A W A September 24th, 1942.

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of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1306.

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Concentration Tests on Cobalt Ore from
the H. Shakt Mine at Latchford, Ontario.

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Shipments:

Two samples of ore were received on July 10th, 1942. Each of these samples consisted of a number of smaller parcels which were mixed together to form the composite samples which were later assayed and tested. One of these was known as the Main Vein sample and the other was known as the Chimney Ore sample. On July 30th, another parcel of ore was received, which was known as the Edison sample. On August 5th, 1942, six further samples were received, two of which were Chimney Ore samples and four of which were Main Vein samples. These

(Shipments, cont'd) -

four Main Vein samples were assayed separately and then mixed together for testing purposes (Composite Sample M-ABCD).

The samples were submitted by Mrs. H. S. Davis, Apt. 102, 4855 Cote St. Luc Road, Montreal, Quebec.

Location of Property:

This property is situated in the southwest corner of Coleman township, near the town of Latchford, Ontario.

Character of the Ore:

Samples -

The samples from the above property were submitted for tests during August, 1942. Four were taken from the Main Vein and lettered A, B, C and D; two from the Chimney Vein are lettered A and B.

Main Vein -

Study of polished sections from these samples indicates that the character of the ore varies essentially only in the degree of mineralization. The metallic minerals are scattered erratically through a carbonate-rich gangue, and occasionally form discontinuous stringers composed of gangue and clouds of tiny crystals. Sample D exhibits the richest mineralization observed, and shows two types of grains, the coarser white mineral averaging well over 200 mesh in grain size while the finely disseminated white mineral averages well below that size. The coarser grains gave microchemical tests for Ni, As and S but failed to give a test for Co; it is identified as gersdorffite (NiAsS). The fine-grained mineral occurring in the gangue both adjacent to and removed from the gersdorffite is identified as smaltite-chloanthite ($(Co,Ni)As_2$), and microchemical tests indicate that the cobalt predominates over the

(Character of the Ore, cont'd) -

nickel. It is impossible to estimate the relative proportions of these two minerals in the ore as a whole. A very small quantity of niccolite occurs as very small inclusions in gersdorffite, and comparatively rare scattered grains of pyrite are scattered through the gangue. Samples A, B and C exhibit much leaner mineralization, and there appears to be very little gersdorffite. Hand specimens from all of the samples show more or less cobalt bloom, (erythrite), and here again it is impossible to estimate the relative proportions of cobalt occurring as the arsenide and as erythrite.

Chimney Vein -

Sections from the chimney vein are very sparsely mineralized. They show finely-disseminated gersdorffite, occasional large masses of chalcopyrite, and rare pyrite. The material is considerably oxidized with the formation of some "limonite".

Discussion -

Certain facts which have a definite bearing on the possible treatment of the material are brought out by the microscopic study.

(1) The cobalt-bearing arsenide (smaltite-chloanthite) is disseminated erratically through the gangue as very small grains.

(2) A minor, but possibly an appreciable, quantity of cobalt is present as cobalt bloom (erythrite).

(3) The chief nickel mineral (gersdorffite) occurs as comparatively large grains, usually exceeding 200 mesh in size and sometimes several millimetres in diameter.

(4) Most of the sections are very leanly mineralized, and here smaltite-chloanthite is present but gersdorffite is usually absent; the latter mineral appears to favour the strongly mineralized portions of the ore.

It was noted during the tests that nickel showed a distinct tendency to concentrate, while cobalt appeared to be

(Character of the Ore, cont'd) -

much more difficult to recover. This would be explained by the relative sizes of the smaltite-chloanthite and the gersdorffite. Further aggravation of this condition would be brought about by the presence of erythrite.

Sampling and Assaying:

The samples received were assayed and reported as follows:

	Co, per cent	Ni, per cent	Cu, per cent	Fe, per cent	S, per cent	As, per cent
Chimney Ore, July 10 Sample -	0.88	0.14	0.40	7.20	0.23	0.38
Main Vein Ore, July 10 Sample -	1.11	0.45	0.07	7.12	1.22	4.43
Edison Sample -	1.20	0.11	Trace			
Chimney Ore, Aug. 5 Samples CH-A	0.74	0.09	0.69			
CH-B	0.35	0.04	0.04			
Main Vein Ore, Aug. 5 Samples M-A	0.02	0.29	0.06			
M-B	0.06	0.12	Nil			
M-C	0.74	0.02	Nil			
M-D	2.82	5.32	0.01			
Composite Sample, M-ABCD -	0.73	1.13	Trace			

Experimental Tests:

Concentration tests were conducted on the Main Vein Sample received on July 10th and on the Composite Sample M-ABCD. Flotation and table concentration tests were conducted on each of these samples. The object of the tests was to produce a concentrate assaying 8 per cent or better in cobalt, with the best possible recovery.

A concentrate assaying 9.86 per cent cobalt was produced by table concentration from the Main Vein Sample of July 10th. Flotation failed to produce an 8 per cent concentrate from this sample and neither flotation nor table concentration produced an 8 per cent concentrate from the Composite Sample M-ABCD.

(Continued on next page)

(Experimental Tests, cont'd) -

It will be noticed that in the Main Vein Sample of July 10th the cobalt-to-nickel ratio is almost 2.5:1, but in the Composite Sample M-ABCD the ratio is reversed, the nickel being 1.5 times as high as the copper. This helps to explain the failure to produce an 8 per cent cobalt concentrate from this sample.

Details of Tests:

The following tests, typical of a number conducted, will be described in detail:

Test No. 1. - Flotation.

A sample of the ore (Main Vein Sample, July 10th), was ground 75 per cent finer than 200 mesh and floated as follows:

Charge to ball mill -

Ore	-	2,000 grams at -14 mesh.
Water	-	1,500 grams.
Caustic soda	-	1.0 lb./ton.
Coal tar creosote No. 634	-	0.07 "
Grinding time	-	20 minutes.

Reagents to cell -

Amyl xanthate	-	0.20 lb./ton.
Pine oil	-	0.10 "

The concentrate was cleaned without additional reagents.

(Continued on next page)

(Details of Tests, cont'd) -

Results of Test No. 1:

Product	Weight, per cent	Cobalt assay, per cent	Distribution of cobalt, per cent
Concentrate	8.13	7.88	54.07
Cleaner tailing	2.27	3.45	6.61
Flotation tailing	89.60	0.52	39.32
Feed (cal.)	100.00	1.18	100.00

This concentrate was the highest grade of any produced by flotation from this sample. The high tailing loss is typical of all the flotation tests conducted.

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Test No. 2. - Table Concentration.

A sample of the ore (Main Vein Sample, July 10th), at minus 14 mesh was sized on 28-, 48-, and 100-mesh screens. The fractions were treated on a table, to produce a concentrate and tailing. The table concentrate was then treated by hand panning to produce the best possible grade of concentrate and a middling product which, in practice, would be recirculated. The different sizes of product were then mixed together, weighed, and assayed.

Results of Test No. 2:

Product	Weight, per cent	Cobalt assay, per cent	Distribution of cobalt, per cent
Concentrate	7.5	9.86	75.4
Middling	7.9	1.45	11.7
Tailing	84.6	0.15	12.9
Feed (cal.)	100.0	0.98	100.0

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(Details of Tests, cont'd) -

Test No. 3. - Table Concentration.

This test was the same as Test No. 2 except that the ore was ground all through 35 mesh. Examination of the products of Test No. 2 under a binocular microscope indicated that the mineral would be pretty well all free from gangue at this grind. The test was carried out in the hope of increasing recovery and grade of concentrate over that obtained in Test No. 2.

Results of Test No. 3:

Product	Weight, per cent	Cobalt assay, per cent	Distribution of cobalt, per cent
Concentrate	7.37	9.16	66.59
Middling	23.82	0.44	10.34
Tailing	68.81	0.34	23.07
Feed (cal.)	100.00	1.01	100.00

The finer grinding was responsible for a higher tailing loss with resultant lower recovery. The concentrate, though lower grade than that obtained in Test No. 2, is still good enough to sell. The last of the July 10th sample of Main Vein ore was used for this test. All further tests were conducted on the composite of Samples M-ABCD, received August 5th, 1942.

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Test No. 4. - Flotation.

A sample of the composite ore was ground about 70 per cent finer than 200 mesh and floated as follows:

(Continued on next page)

(Test No. 4, cont'd) -

Charge to ball mill -

Ore	-	2,000 grams at -14 mesh.
Water	-	1,500 grams.
Na_2SiO_3	-	0.50 lb./ton.
Coal tar creosote No. 634	-	0.07 "
Grinding time	-	20 minutes.

Reagents to cell -

Amyl xanthate	-	0.20 lb./ton.
Pine oil	-	0.075 "

Concentrate cleaned without additional reagents.

Results of Test No. 4:

Product	Weight, per cent	Cobalt assay, per cent	Distribution of cobalt, per cent
Concentrate	4.84	4.72	32.80
Cleaner tailing	3.15	1.13	5.11
Flotation tailing	92.01	0.47	62.09
Feed (cal.)	100.00	0.70	100.00

This test is typical of a number of flotation tests conducted on this sample using different reagent combinations. All of them showed low-grade concentrates and high tailing losses.

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Test No. 5. - Table Concentration.

A sample of the composite ore was crushed all finer than 35 mesh and sized on 48-, 65- and 100-mesh screens. The different size fractions were treated on a table, where a tailing and concentrate were produced. The table concentrates were cleaned by panning and mixed together for assay, as was done in Tests Nos. 2 and 3. A fairly complete analysis was made on this concentrate, to find out what was in it and why

(Test No. 5, cont'd) -

it was so low in cobalt. The assay showed a very high nickel content and also a high sulphur content.

Results of Test No. 5:

Product	Weight, per cent	Cobalt assay, per cent	Distribution of cobalt, per cent
Concentrate	4.57	6.90	42.50
Middling	8.00	1.29	13.90
Tailing	87.43	0.37	43.60
Feed (cal.)	100.00	0.74	100.00

This sample does not seem to respond to table concentration so well as did the earlier one. The unfavourable ratio of nickel-to-cobalt will, in some measure, account for this.

The following assays give some idea of the composition of the concentrate:

		Per cent
Cobalt	-	6.90
Nickel	-	17.12
Iron	-	4.93
Arsenic	-	32.13
Calcium carbonate	-	13.05
Sulphur	-	12.18
Insoluble	-	7.20
Total determined	-	93.51

It will be noted that the ratio of nickel to cobalt is even higher in the concentrate than it is in the feed. This may be due to two reasons, viz.,

(1) Part of the cobalt in the feed is present as erythrite (cobalt bloom), a light, soft mineral which would all be lost in the tailing.

(2) The greater proportion of the nickel occurs as coarse-grained gersdorffite, which would concentrate more readily than the cobalt minerals.

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(Details of Tests, cont'd) -

Test No. 6. - Table Concentration.

This test was conducted on a sample of the ore crushed through 14 mesh and sized on 28-, 48-, and 100-mesh screens. The products were handled the same as in the foregoing table concentration tests. The object of the test was to find out whether a better grade of concentrate could be made at the coarser size.

Results of Test No. 6:

Product	Weight, per cent	Cobalt assay, per cent	Distribution of cobalt, per cent
Concentrate	4.41	6.75	48.85
Middling	10.88	0.84	15.00
Tailing	84.71	0.26	36.15
Feed (cal.)	100.00	0.61	100.00

While a slightly higher recovery is shown in this test, the grade of concentrate is practically the same as in Test No. 5. Failure to produce a concentrate of marketable grade from this sample may be attributed to the unfavourable nickel-to-cobalt ratio.

CONCLUSIONS:

The results of tests conducted on these two samples of ore from the main vein indicate that gravity concentration is the only hope for producing a concentrate of marketable grade with anything approaching a satisfactory recovery. In order to do this the feed to the concentrator must have a ratio of cobalt to nickel of at least 2.5:1. Otherwise, the concentrates will

(Conclusions, cont'd) -

be low in cobalt owing to dilution by nickel.

As explained in the microscopic examination, the nickel occurs chiefly as coarse-grained gersdorffite which concentrates more readily than the cobalt. In addition to this, some of the cobalt occurs as cobalt bloom, which is practically all lost in any concentrating operation because it is both light and soft and does not float.

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