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Prof of Dr. Rose

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EXTRACTION TESTS ON WHITESAIL LAKE ORE

Submitted by:

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This report is based on tests performed by Messrs D. MacKinnon, R. Morton and A. F. Seraphim.

We are deeply grateful to Professor G. A. Gillies for his patient guidance of our efforts in the laboratory. Without his recommendations and diligent determination of pH values, much of the work would have been impossible. Thanks are due B. Morrison for his work on the cyanidation. R. Manning saved us many tedious hours in the assay room. We are indebted to Dr. H. O. Warren for his microscopic and mineralogical determinations.

Conclusions - 2

Our conclusions are as follows:

1. All reagents 208, 301, 404, Aerofloat 15, carbanalid and thiocarbanalid give approximately the same results - about 50% recovery of gold and 70% recovery of silver. This intimates that the above percentages of gold and silver are all that is floatable.

2. Because grinding to 98% - 200 mesh - gave no increase in recovery the gold must be finer than 200 mesh, or it is tarnished, or present in tarnished sulphides.

3. Gold is not in the pyrite - Acid pH floats more pyrite but percentage recovery is not increased.

4. Treating with Sodium Sulphide did not give higher results which means that the gold is not present in the tarnished sulphides.

5. Gold is probably in arsenopyrite which is difficult to float.

6. Cyanidation gives a high percentage recovery (90.98 %) and will probably prove a satisfactory method of extraction of the gold. Further work should be done on a cyanidation procedure.

Recommendations - 3

1. Investigations should be made on recent literature on flotation reagents for arsenopyrite and oxidized ores.
2. Further tests should be made on the recovery from grinds below 200 mesh.
3. Investigations should be made on flotation results with alkaline pH 7 to 10
4. Further work should be done on cyanidation with respect to grind aeration and reagents.

Introduction - 4

Property

Optioned by Pioneer Gold mines of B.C. Ltd., 607 Rogers Building, Vancouver, B. C.

Location

Located in Tweedsmuir Park about four miles west of the west end of Whitesail Lake and lying to the north of Lindquist Lake and about half way along it.

The claims cover a ridge which forms the divide between the Lindquist Lake and Little Whitesail Lake drainages.

Accessibility

The property is reached by road from Burns Lake to Ootsa Lake and Wistaria, a distance of some sixty miles. From Wistaria the route is by water via Ootsa Lake, Tahtsa River, Whitesail River, Sinclair Lake and Whitesail Lake, a distance of about sixty miles. From the head of Whitesail Lake a six-mile trail leads up to the foot of Lindquist Lake, thence up the slope on the north side of the lake to the property.

Topography and Physical Features

The groups of claims is in the Coast Range Mountains close to the summit on the easterly flank. Elevations on the property range from 2900 to 6500 feet above sea level. The principal showings are on the southern exposure of the small east-west range between Lindquist and Little Whitesail Lakes. The slopes are snow-covered for approximately eight months of the year.

Regional Geology

The claims are in the eastern contact area of the Coast Range Batholith. Marshall (G.S.C. Summary Report 1922) has mapped the geology, geography and topography of the area but on a scale too large (1" - 4 miles)to include important detail. Marshall's map indicates the predominantly granodioritic batholith contact as cutting the Jurassic Hazelton Series of basaltic to rhyolithic volcanics and sediments. Actually in the area the intrusive rocks may be subdivided into diorite, quartz diorite, granite and feldspar porphyries, while "Hazelton Series" may be subdivided into the Jurassic H azelton series proper and early tertiary rhyolite stocks, flows and minor intrusives.

Structure and Mineral Deposits

The main structure containing most of the mineral showings on the property is a wide zone of fracturing in the massive diorite. The quartz lead is a well-defined quartz vein from five to ten or more feet wide with the vein quartz free from the diorite walls. The wall-rock shows no appreciable hydrothermal alteration. The vein is exposed at intervals by outcrop for several hundred feet along the strike and through a vertical range of 200 or more feet. It appears to have been either offset along its strike by cross-faulting or to have an echelon structure within the wide zone of weakness in which it occurs. The quartz lead is composed of a sugary quartz, varying from glossy to milky to rose in colour. The

sulphides are, on the whole, sparsely distributed. They consist of pyrite and some fine-grained molybdenite at the lower end with seemingly increasing amounts of galena, sphalerite and chalcopyrite at the upper end. Also noted at the lower end is a soft, grey, silvery metallic identified by Dr. Warren as a bismuth telluride.

Preparation of the Head Sample

The method of obtaining the sample from the ore body is not known. The oxidized nature of the sample shown by the presence of much iron oxide indicates that it was taken near the surface.

The sample was crushed to ½inch size in a jaw crusher and subsequently reduced with rolls to -10 mesh. The sample was then reduced to about 10 pounds by coning and quartering. A sample cutter was used to reduce this to 2 pounds and a disk pulverizer to grind the 2 pounds to -100 mesh. The sample was then rolled on a rubber mat and two 1000 gram samples were carefully taken and put ~~on~~ in labelled paper sample bags

Microscopic Examination

A polished section of ore was made and examined by Dr. H. V. Warren who determined the presence of arsenopyrite and pyrite. A blue-black metallic observed was tentatively labelled as a bismuth tetluride. The gangue mineral is chiefly quartz. Much iron oxide is present which is probably

due to the oxidation of pyrite and arsenopyrite. The sulphides and metallic minerals compose only a small percentage -about 2% of the ore.

Grindability Test

The time of grinding necessary to reduce the -10 mesh feed to -200 mesh was found to be 20 minutes. The grinding to -200 mesh was carried out in a rod mill.

Specifications of rod mill

Length	11.5"
Diameter	10 "
24 rods	11"x7/8"
Weight rods	
R.P.M.	43

Charge to Rod Mill

Ore	1000 grams
Water	1000 grams

Details of the Test

The tests were carried out with 1000 gram samples until a shortage of ore was anticipated for the completion of the tests. We then changed to 500 gram samples. The general method of treatment is outlined below.

The sample of -10 mesh ore and an equal weight of water (either 1000 grams or 500 grams) was charged in the rod mill and ground for 20 minutes at 43 r.p.m. The charge was then washed into a pan with as little dilution as possible and thence into a flotation cell which was kept running in order to prevent the solids from settling out. The pulp was diluted with

water to a 3.5 to 1 ration and the reagents added and conditioned. Concentrates were collected in aluminum pans and failings removed by draining from the bottom of the machine into a large pan. The machine used was a

The pH of the pulps were determined by Professor Gillies who used a Beckman pH Metre.

Products were dried in a drying oven and carefully weighed and a sample taken for assaying.

(A) Flotation

Test details

In all tests conditioning was 10 minutes. All reagents added as lbs per ton.

Test 1

Object: To find floating characteristics of the ore.

Reagents: To the mill - 0.32 lbs. sodium silicate per ton

To the cell - 0.5 lbs Reagent 301
0.16lbs #5 pine oil per ton

Grind: 15 minutes

Results: Clean concentrate of black sulphides and pyrite but froth was scant and brittle.

Test 2

Object: To find floating characteristics of the ore

Reagents: To the mill - 0.32 lbs sodium silicate per ton
- 0.5 lbs Reagent 301

To the cell - 0.16 lbs Aerofloat 15

Grind: 15 minutes

Results: Clean concentrate but poor froth. Sodium silicate gives a clean but poor froth

Test 3

Object: To find floating characteristics of the ore

Reagents: To the mill:-0.5 lbs Reagent 301

To the cell:-0.16 lbs Aerofloat 15
0.16 lbs sodium silicate

Grind: 15 minutes

Results: Good froth but concentrate contaminated with much silica. Addition of sodium silicate killed froth but gave clean concentrate.

Test 4

Object: To find results of using Aerofloat 15 and Xanthate Reagent 301 in combination

Reagents: To the cell: - 0.16 lbs Aerofloat 15
0.5 lbs Reagent 301

Grind: 15 minutes

Results: Contaminated concentrate and poor froth. Recovery 41%.

Test 6

Object: To find effect of acid pH with Reagent 208

Grind: 20 minutes

(a)Reagents: T o the mill: -0.5 lbs Reagent 208

To the cell: 0.16 lbs Aerofloat 15

pH: 7.1

Results: Fair froth but brittle. Gangue and sulphides up. Recovery 50.5% Gold and 71.8% silver.

(b)Reagents: To the cell: 2 lbs copper sulphate

pH: 6.3

Results: Froth not so brittle. No additional recovery.

(c)Reagents: To the cell: 4 lbs 10% H_2SO_4

Test 6 Con't

pH: 5.5

Results: Much pyrite floated and no increase in gold and silver recovery.

Test 7

Object: To find effect of using acid pH with Reagent 301 and 30 minute grind.

Grind: 30 minutes

Reagents: To the cell: - 0.32 lbs pine oil
0.16 lbs Aerofloat 15
0.5 lbs Reagent 301

pH: 5.5

Results: Watery froth. Pyrite up at pH 5.5. 30 minute grind gave 6.3% increase in recovery.

Test 8

Object: To try cresylic acid as a frother with pH 5.5

Grind: 30 minutes

Reagents: T o the cell - 0.16 lbs cresylic acid
1.5 lbs Reagent 301
6.8 lbs 10% Sulphuric

pH: 5.6

Results: Small brittle bubbles. Very little sulphide floated. Not a success.

Test 9

Object: To test floating properties of Thiocarbanalid and Reagent 301

Grind: 30 minutes

Reagents: To the mill: .025 lbs thiocarbanalid

To the cell: .16 lbs pine oil

2 lbs Reagent 301

pH: 2.75

Test 9 Con't

Results: Watery froth with abundant gangue. Recovery 63.4% of gold and 76.6% of silver.

Test 10

Object: To test Thiocarbanalid with sodium.sulphide. To resulphidize tarnished sulphides.

Grind: 30 minutes

Reagents: To the mill: 0.25 lbs thiocarbanalid
0.35 lbs sodium sulphide

To the cell: 0.16 lbs pine oil

pH: 5.5

Results: Good froth loaded with black sulphides and pyrite but only 38% recovery. Sodium sulphide gave depressing action.

Test 11

Object: To test floating characteristics of Reagent 404 with sodium sulphide.

Grind: 30 minutes

Reagents: To the mill: 0.25 lbs sodium sulphide
0.25 lbs reagent 404

To the cell: 0.16 lbs pine oil

pH: 6.6

Results: Good froth with black sulphides and pyrite. Recovery 43.3% of gold and 42.2% of silver.

Test 13

Object: To test thiocarbanalid to the cell and acid pH.

Grind: 30 minutes

Reagents: To the cell: -0.32 lbs pine oil
0.25 lbs thiocarbanalid

Test 13 Cont.

pH: 2.3

Results: Pulp too acid, froth poor. Recovery 59.2% of gold and 64.1% of silver.

Test 14

Object: To test sodium sulphide with Aerofloat 15.

Grind: 30 minutes

Reagents: To the mill: 0.15 lbs sodium sulphide

To the cell: 0.16 lbs creoylic acid
0.5 lbs aerofloat 15

pH: 2.8

Results: Black sulphides and pyrite floated. Recovery 64% of gold and 51.5% of silver.

Test 15

wt of concentrate = 5.85 gms = reduction ratio of 171 to 1. looks like tellurides. G.A.G.

Object: To test sodium sulphide with thiocarbanalid to the cell and cresylic acid frother

Grind: 30 minutes

Reagents: To mill: 0.15 lbs sodium sulphide

To cell: 0.32 lbs cresylic acid
0.25 lbs thiocarbanalid

pH: 6.3

Results: Good froth with much pyrite floated. Recovery 52.5% of gold and 60.8% of silver.

Test 16

Object: To test action of thiocarbanalid with cresylic acid and pine oil with acid pH

Grind: 30 minutes

Reagents: To cell: 0.16 lb pine oil
0.16 lb cresylic acid
7.0 lb sulphuric acid
0.05 lb thiocarbanalid 125

Test 16 Con't

pH: 4.1

Results: No black sulphides came up, pyrite and gangue came up. Good froth, Low recovery.

Test 17

Object: To test action of thiocarbanalid with cresylic acid and aerofloat with varying pH.

(a) Reagents: To mill: 0.16 lb aerofloat 31

To cell: 0.16 lb cresylic
0.05 lb thiocarbanalid 125

pH: 5.05

Results: Black sulphides and pyrite came up

(b) Reagents: as above with addition of .1 lb thiocarbanalid 125 and acid.

pH: 1.87

Results: Good clean froth with small conc. of pyrite improved with addition of thiocarbanalid. Recovery 45.5% of gold and 62.9% of silver.

Test 19

Object: To test reagents 301 and 208 with cresylic acid and pine oil in an attempt to combine ability of 301 to float pyrite and 208 as a promoter for gold ores.

Reagents: To Mill: 1.12 lb reagent 208
.80 lb reagent 301

To cell: .64 lb pine oil
.80 lb cresylic
.80 lb reagent 301
.80 lb reagent 208

Results: pH-9 froth disappeared, then two more drops cresylic added, pH 10.25 very watery froth.

Test 19 Con't

Very low recovery, 36.4% of gold and 50.4% of silver.

Test 20

Object: To test action of aerofloat 31 with cresylic acid as a promoter of silver sulphides and galena.

Reagents: To mill: 0.96 lb aerofloat 31

To cell: 0.32 lb cresylic acid

Results: With pH 5.5 black concentrate, tough froth. With pH-2 sulphides (pyrite) came up very slowly. Recovery 50% of gold and 68.7% of silver.

Test 21

Object: To test Aerofloat 31 alone to float silver and to try effect of lowering pH.

Reagents: To mill: 1.44 lb Aerofloat 31

To cell: Acid

(a) pH: 6.5

Results: Thick tough froth, both gangue and sulphides came up. Too much reagent was used. 54.7% of gold and 68.5 % of silver recovered.

(b) pH: 3.4

Results: Watery froth, pyrite floated. Recovery of 54.7% of gold and 74.6 of silver.

Test 22

Object: To test Aerofloat 15 in acid, circuit for floating iron and silver sulphides

Reagents: To cell: 0.386 Aerofloat 15

H_2SO_4 acid

pH: 1.75

Test 22 Con't

Results: Watery froth pyrite floated. No improvement in recovery: gold 54.7% and silver 64.1%

Test 23

Object: To test reagent 425 with oxidized ore.

Reagents: To mill: 4 lb. reagent 425
0.96 lb aerofloat 31

To cell: 0.80 lb cresylic acid

Results: Copious black tough froth, Recovery of gold 59.2% and silver 70.8%.

Test 24

Object: To test reagent 425 alone with oxidized ore and as a promoter of auriferous pyrite with acid pH

Reagents: To mill: 2 lb reagent 425

To cell: .32 lb cresylic acid

Results: Watery weak froth-pyrite floated but no increase over test 23 in recovery.

Test 25

Object: To test reagent 404 with aerofloat 31, reagents 301 and 208 as a promoter of auriferous pyrite.

Reagents: To mill: .5 lb reagent 40

To cell: .32 lb aerofloat 15
1.25 lb reagent 301
1.25 lb reagent 208
0.48 lb sodium sulphide

Results: Black tough froth with much gangue. Recovery of 59.2 gold and 66.2% silver.

Since the course of studies in mineral dressing is primarily a course in flotation the bulk of the work done on the Whitesail Lake ore(sample rejects) was devoted to flotation tests. Because the ore is a gold ore it was deemed necessary to do some cyanidation tests to make a complete report on the possible methods of extracting the gold.

Early in the fall term four unsuccessful cyanide tests (that were run simultaneously) were made. The results of these tests were very inconsistant. The results were a failure since (1) The cyaniding pulp could not be properly aerated with the equipment used.

(2) The alkalinity of the pulp could not be maintained.

The results of these tests are as follows:

	Mill			Tank			
Test	Charge	Lime	Grind +-	Cyanide	Lime	Agitation	Assay
1	1000 gm	2#/ton	20 min	½ gm	0.5gm	24 hrs	.085
2	"	"	30 "	"	"	"	.09
3	"	"	35 "	"	"	"	.09
4	"	"	40 "	"	"	"	.215

The inconsistency of results shows something is obviously remiss with the cyaniding technique.

Once again in the spring term, cyanidation tests were made; this time the results were very encouraging. The improved consistent results were due to improved methods of aeration and greater alkalinity control.

Apparatus

The apparatus used consisted a small motor with a glass rod impellar attached, set on a movable frame attached to a burette stand. The washed and filtered pulp from the rod

mill was added to a 1000 gm beaker with 500 cc of water, to the pulp solution; the lime and cyanide solution was added in the proportions shown in the table. The pulp was agitated for 36 hours. The alkalinity of the pulp was checked periodically until it remained constant. Portions of the pulp were removed at intervals (see table) and these portions were filtered and washed. The residues were assayed by the regular fire assay methods.

Results of cyanidation

Test No.	Charge	Lime To Mill	Grind Mill	Cyanide	Lime with Cyanide	Assay Residue	Time	Screen Analysis
1	500	16#/ton	60	1#/ton	2#/ton	0.02	36	
						0.02	19	99.65 -200 mesh
						0.14	9	
2	500	16#/ton	20	1#/ton	2#/ton	0.02	36	

Percentage recovery $\frac{.20}{.22}$ x 100 equals 90.98%

No difficulty was encountered in these two tests.

Further tests to determine the following should be made:

(1) a. Most efficient grind as far as cyanidation is concerned.

b. The most economical grind; balancing cost of grind and extraction.

(2) Most economical and efficient quantities of reagents and methods of use.

(3) Best aeration technique.

(4) An attempt should be made to determine the reason for the relatively high tails assay. This may be a mineralogical consideration, however, if it is due to cyanidation some attempt should be made to remedy the fault.

It should be borne in mind that the 90.98% is an absolute recovery and in actual cyanide practice there is a circulating weakly charged gold solution that would undoubtedly lower the percentage recovery.

It is hoped that these few results will shed some light on the cyanidation of Whitesail Lake ore and that further more detailed work will ultimately determine the true worth of cyaniding as a method of treating the ore.

Appendix A

Assay Method

The ordinary fire assaying methods of collecting the gold and silver by slagging the ore with litharge in a crucible then cupelling the lead button in a "marganita" cupel.

Assay Charge	(Tails)
Litharge	70 gm.
Soda Ash	30 gm
Borax	8 gm
Ore	1 AT.
Flour	2.4 gms.

Any assays of the concentrates were done by using a special charge and niter as required.

HEADS = 0.22 oz. Au
4.76 oz. Ag.

Test No	Wt of Ore (Gm.)	Reagents to Mill: Wt. of Concr.	% Ratio Conc.	Conditioned	Pulp Dilution	Wt. of Pulp	pH	Grind.	Na2S	Sodium Silicate	Reagent 301	Reagent 208	NaCN	Thiocarbanilid	Reagent 404	Aerofloat 31	Reagents to Cell: Pine Oil	Cresylic Acid	Aeromoat 15	Reagent 301	Reagent 208	CuSO4	Reagent 204	Na2S	Na2SiO3	H2SO4	Thiocarbanilid 125	Assays: Au oz/Ton	Ag oz/Ton	Wt. of Conc.	% Recovery Au.	% Recovery Ag.	
1	1000			10	3.5:1			15		1 drop							1 drop			.27 gm								.05	2.25		77.5	52.7	
2	1000	13.9		10	3.5:1			15		1 drop	.27								1						1			.11	1.48		50.0	76.9	Poor froth. Froth deilled by Na_2SiO_3
3	1000	20.9		10	3.5:1			15			.27								1						1			.16	2.24		27.3	52.9	Good froth until Na_2SiO_3 was added
4	1000	4.9		10	3.5:1			15											1	.27								.13	2.19		41.0	41.4	Froth poor. Gangue & Sulphides upper
(a) 5	1000			10	3.5:1		7.1	20			.27								1									.105	1.34		50.5	71.8	Fair brittle froth. Gangue & Sulphides upper
(b)	1000			10	3.5:1		6.3	20			.27										.27	2# 2/7											Froth not as brittle
(c)	1000			10	3.5:1		5.5	20			.27															2cc		.105	1.34		50.5	71.8	Pyrite floated
6	1000	16.0		10	3.5:1			20											1		.27							.11	1.30		50.0	70.8	Large no. of good bubbles.
7	1000	17.2		10	3.5:1		5.5	30									2		1		.27					15cc		.095	1.11		56.8	76.7	Watery froth. Pyrite up with pH 5.5
(a) 8	1000			10	3.5:1		7.15 6.5 5.6	30										1		.81						1cc +2cc +3.3cc							Small brittle bubbles. Very little sulphide. Not a success.
(b) 9 (b)	1000	26.2 67.2		10	3.5:1		6.7 2.75	30					50mg							1.08						6.5		.08 .08	1.28 1.21		63.4	76.6	Water froth. No increase in pyrite. To much gangue up.
(a) 10 (b)	1000	28.2 131.0		10	3.5:1		7.0 5.5	30	50mg				50						1									.36 2.24 1.35	4.20 5.1 1.54		38.7	67.6	Good bubbles. Loaded with black sulphides & pyrite
11	1000	103.2		10	3.5:1		6.6	30	50mg					50mg					1									.125	2.75		43.3	42.2	Good large bubbles. Lifted dark sulphides & pyrite
12	1000	83.3		30	3.5:1			30	50mg					50mg					1									.120	1.80		45.5	62.2	Black sulphide, fair froth not very abundant
(c) 13	1000	52.2		30	3.5:1		2.3												1+1							50mg		.09	1.11		59.2	64.1	Pyrite & gangue poor froth watery
(b)		3.9					2.7																										Pyrite & gangue poor froth.
14	1000	58.5		30	3.5:1		2.8	30											1	#31 3 drops								.03	2.31		63.1	51.5	Black Sulphide & pyrite up. froth small bubbles.
a 15	1000			30	3.5:1		6.3	30											2							50mg		.105	1.39		52.5	60.8	Good froth. pyrite up.
(b)	1000			30	3.5:1														1	#31 1						25mg		.10	2.8		54.7	55.8	
16	500			30	3.5:1		4.1	30											1	#31 1						25mg	2cc + 1.5	.12	3.08		45.5	35.2	No black sulphides. Good froth.
(a) 17	500			30	3.5:1		6.9 5.05	30											1							25mg		.12	1.23		45.5	42.9	pH – 6.9 black sulphides good froth pH 5.05 few black sulphides pyrite
(b)				10			1.87												1							25mg. 25mg.		.12	2.16		45.5	54.6	Good froth – clean small of pyrite Additional 25mg ThioC. Good froth. More Clean froth
18				10				30	SPOILED																								
19	500			10			10.25	30	5 drops	1 drop									1 1/2	3d	5d							.14	2.36		36.4	50.9	pH 9.3 froth dissapeared added 2 more drops Cresylic Pyrite floated. Froth stick
20				10			2	30								6d 2#												.11	1.49		50.0	68.7	Pyrite Slow coming up. Tough froth
(a) 21	500	38					6.5	60								9d												.10	1.58		54.7	68.5	Thick tough froth. Gangue & sulphide
(b)		38					3.4	60											2									.10	1.51		54.7	74.6	Watery froth. pyrite floated
22	500	38					1.75	60											2									.10	4.71		54.7	64.1	
23	500	32.1						30		(1gm) 4#/ton 425.66									3 2									1.36 .09	34.66 1.39		59.2	70.8	Copious Black froth.
24	500	40						30		(1gm) 4#/ton 425																		1.28 .09	33.16 1.42		59.2	70.2	Watery froth.
25	500	184						30		(.125) 0.5#/ton 404									1							30cc 1% sol		.10	1.61		54.7	66.2	Tough black froth
26	500	61						30		(.125) 0.5#/ton 208									1									.09	1.61		59.2	66.2	Good sulphide carrying some gangue. Froth good.