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92/15
Northern Basin

PROPOSED NORTHERN GEM FLOW SHEET
FOR THE SINTERING AND SMELTING OF
TABLE CONCENTRATES

The purpose of the following flow sheet is to extract the uranium, cobalt, gold and arsenic contained in the ore as marketable products. The uranium oxide "uraninite" will be concentrated on a table at the same time the cobalt concentrate is made. Uranium oxide would be lost in the slag if the ore were smelted directly. The uranium oxide concentrate could run as high as 50% uranium oxide and should find a market at \$2.50 a pound for the uranium oxide content. Previous flotation tests gave a poor recovery of cobalt and a low concentration ratio.

Sintering of the table cobalt concentrate should produce a desirable cobalt to arsenic ratio of about 1 : 1. If the arsenic runs much higher than the cobalt in the smelting charge the speiss produced will be low in cobalt and high in iron. The loss of cobalt in the slag will increase when the arsenic in the charge is high. The arsenious oxide collected in a baghouse from the sintering and smelting operation would be treated in a refining furnace and either stored or marketed.

Smelting of the cobalt concentrate can be done in either an electric or a blast furnace. The blast furnace would have the advantage of being located at the mine site. Heat generated by the burning of arsenic and sulphur will help to reduce the amount of coke required to smelt the charge in the blast furnace. The amount of coke required to smelt the charge will cost less than the electric power required to do the same job in an electric furnace. It is easier to collect the arsenic fumes off the blast furnace than off an electric furnace.

The gold which is normally collected in the speiss can be collected in a lead bullion by adding lead to the smelter charge. The lead bullion would be treated on the property, producing litharge and gold bars. The litharge would be returned to the sintering charge so as to keep the lead content in the blast furnace about 12 to 16%.

The cobalt speiss containing 30 to 32% cobalt would be sold to eastern cobalt refineries or possibly Japan for its cobalt content. If the cobalt buyers will pay for gold as well as cobalt in the speiss, then the lead bullion treatment would be eliminated.

Cobalt speiss can be reduced to cobalt oxide or metal and marketed as such when the quantity of speiss produced warrants the additional capital investment.

Electric Smelting

Schedule 3015 B.C. Electric Co.

Base charge of \$1.10 per Kw. of Demand Load.
Power at 1.1¢ Kw. hr.
Total cost not to exceed 1.65¢ Kw. hr.

Electric smelting will require between 700 and 1250 Kw. hrs. per ton of charge.

Blast furnace smelting will require 15 to 20% coke in the charge. Coke delivered at the mine will cost \$43.00 per ton.
Cost of coke to smelt one ton of charge will vary between \$6.50 and \$8.50 per ton.

Power Costs per ton of Charge Electric Smelting

Considering 20 ton per day, furnace operating 21 days per month, and 700 Kw. Hrs. consumed per ton of charge.

$$\begin{aligned} \text{Demand Load} &= \frac{700}{21} \times 20 = 670 \text{ Kw.} \\ \text{Energy Demand} &= 700 \times 21 \times 20 = 295,000 \text{ Kw. hrs.} \end{aligned}$$

Power Cost per month

$$\begin{aligned} \text{Demand Load} &= 670 \times \$1.10 = \$ 735.00 \\ \text{Energy} &= 295,000 \times \$0.011 = \$ 3,245.00 \\ \text{TOTAL.....} &= \underline{\underline{\$ 3,980.00}} \end{aligned}$$

Power Cost per ton of Charge (700 Kw. hrs. per ton)

$$= \frac{3,980.00}{21 \times 20} = \$ 9.50$$

Power Cost per ton of Charge when 1250 Kw. hrs. are required compared to 700 Kw. hrs.

$$= 9.50 \times \frac{1250}{700} = \$17.00$$

MILLING AND SMELTING NORTHERN GEM ORE

Ore Heads 2.5% Co., 0.4 oz Au ton and 4 lb. U_3O_8 ton.
 ↓
 Jaw Crusher
 ↓
 Rod Mill

Storage Bin
 70% - 100 Mesh
 ↓

FEEDER
 ↓

WILFLEY TABLE

Free Gold ↓ Mint	U_3O_8 Concentrate ↓ Storage Bin ↓ Custom Smelters for U_3O_8 Recovery	Cobalt concentrate heads Co. 5 - 7.5% Au. 0.8 - 1 oz. ton ↓ Pugnill Sinter Charge Mixer 10 parts Cobalt Conc. 8 parts Return Sinter (-4+ 10) 2 parts + 35 mesh limestone 2 parts + 35 mesh silica 10% total moisture	Gangue to waste
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FLUEDUST &
 ARSENIC

Baghouse
 Arsenic refining fee.

Slag

Fume

Blast Furnace

As. Chambers

As_2O_3
 Market

Charge (approx)

SINTERING PLAN

SCREEN SINTER

- 4 Mesh

4 Mesh Sinter

As. 5.0% Co. 7.5-11.0%

Au. 1.2 - 1.5 oz. Ton

10 parts Sinter

2 parts Ore

1 Part Silica

2 parts Slag

2 parts Lead as

Litharge

No. 2 Mace Combination Fee.

SLAG

CRUDE Pb. BULLION

SPEISS

(BAGHOUSE)

WASTE

FURNACE REFINING

32% Co.

28% As.

40% Fe.

Litharge

Gold Bullion

CUSTOM SMELTER
 or

TREAT AS OUTLINE

ON 2100-sheet

For 2100-sheet

2100-sheet

TREATMENT COSTS NORTHERN GEM ORE

ORE HEADS 2.5% Cobalt; 0.4 oz. Gold per ton
and 4 pounds Uranium Oxide per ton

COST PER TON OF ORE WHEN TREATING 25 TONS PER DAY

Exploration and Development	$\frac{3 \times \$20.00}{25}$	=	\$ 2.40 ton
Mining and transportation to Mill	$\frac{3 \times \$20.00 + \$1.00}{25}$	=	3.40
Crushing, Milling, Table Concentration	$\frac{3 \times \$20.00}{25}$	=	2.40
Sintering - Mixing - charging, sintering screening + Fluxes	$\frac{2 \times \$20.00 + \$200 \times 10}{25}$	=	2.40
Baghouse and Arsenic Refining.			
Smelting - charging - tapping furnace of slag - speiss and bullion + coke + Litharge	$\frac{4 \times \$20.00 + 80^{00} + 45^{00}}{25}$	=	8.25
Refining Lead Bullion, Assay Office + materials	$\frac{4 \times 21.00 + \$1.00}{25}$	=	4.35
Overhead	$\frac{75.00}{25}$	=	3.00
Mine materials and supplies			2.00
Mill supplies, Power etc.			2.00
Cook House + Cook + helper + \$1.00 per man			2.00
Mechanic			1.00
Truck			1.00

TOTAL COST PER TON \$34.20

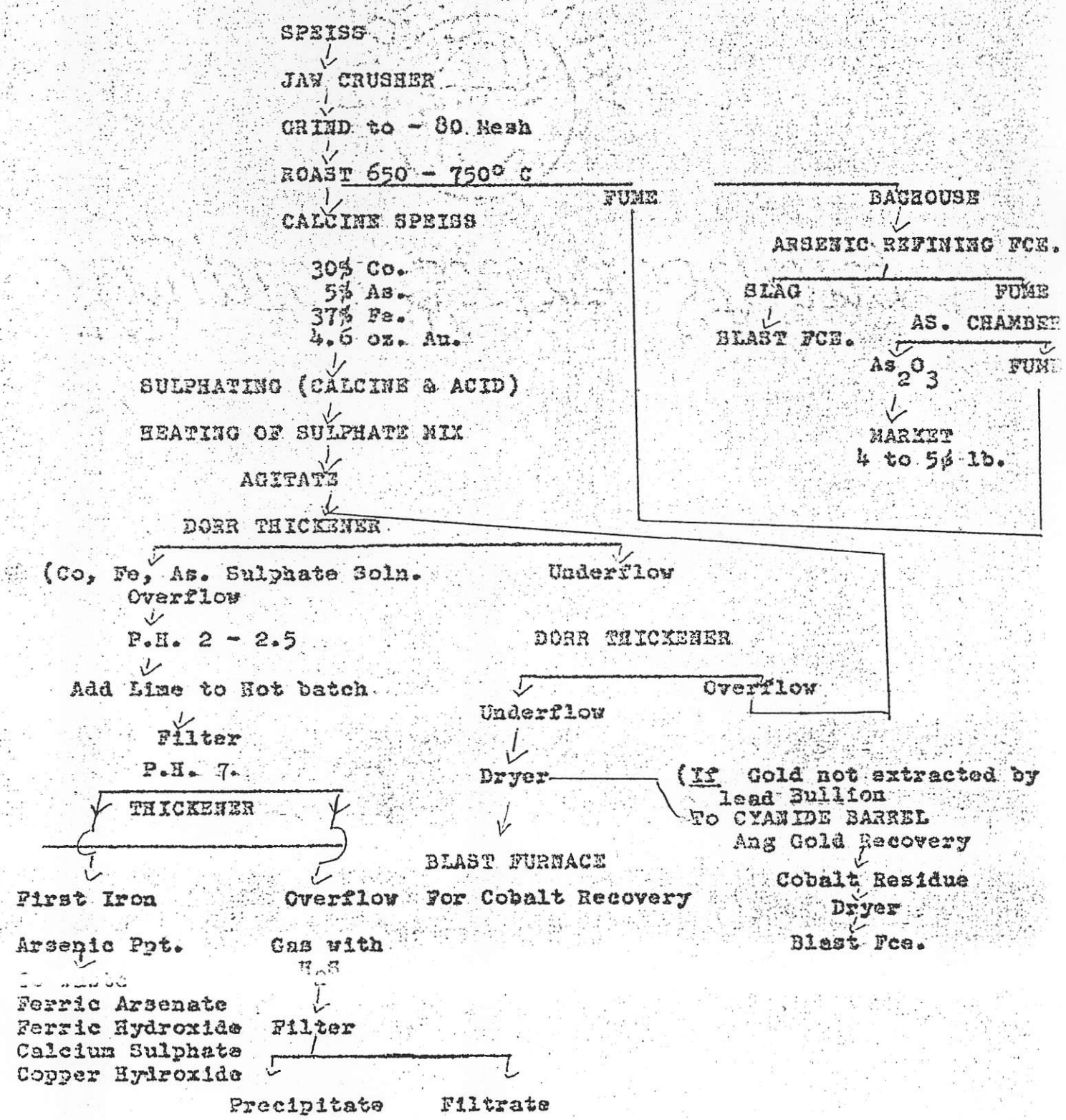
COST PER TON OF ORE WHEN TREATING 50 TONS PER DAY

Exploration and Development	$\frac{4 \times \$20.00}{50}$	=	\$ 1.60
Mining and transportation to mill	$\frac{4 \times \$20.00 + \$1.00}{50}$	=	2.60
Crushing, Milling, Table Conc.	$\frac{4 \times 20.00}{50}$	=	1.60
Sintering - Mixing - charging - sintering screening + fluxes	$\frac{(4 \times \$20.00) + (\$2.00 \times 20)}{50}$	=	2.40
Baghouse and Arsenic Refining			
Smelting - charging - tapping of furnace - slag - speiss and lead bullion + coke and litharge	$\frac{6 \times 20.00 + 160^{00} + 90^{00}}{50}$		7.40
Refining Lead Bullion, Assay Office + materials	$\frac{5 \times 21.00 + \$1.00}{50}$	=	3.10
Overhead	$\frac{\$50.00 + \$30.00 + (3 \times \$20.00)}{50}$	=	2.80
Mine materials and supplies		=	2.00
Mill supplies, power etc.		=	2.00
Cook house	$\frac{25.00 + (2 \times 15.00 - 35.00) + \$1.00}{50}$	=	1.40
Mechanic	$\frac{2 \times 25.00}{50}$	=	1.00
Truck Driver		=	1.00

TOTAL COST PER TON..... \$ 28.90

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SPEISS TREATMENT NORTHERN GEM



Precipitate	Filtrate
or	
As, Ni, Mo	Soda ash
Cu sulphide	or
	Sodium Hypochlorite Ph 8.5

Precipitate	Filtrate
Cobalt Carbonate	To waste
or Cobalt Hydroxide	(If Uranium is found in
Cobalt Refinery	spiss)
	OR: Uranium Precipitation
	with Caustic Soda P.H. 10-12

" F L O W S H E E T "

- 0 2 -

HIGH TEMPERATURE PRESSURE LEACHING OF NORTHERN CEM ORE IN WHICH MARKET-
ABLE PRODUCTS OF COBALT CARBONATE ~~URANIUM~~ CARBONATE AND GOLD WOULD BE
MADE. SODIUM DIURINATE

	MINE RUN ORE
"Heads"	Co. 2.5%
	U ₃ O ₈ 4 pounds per ton
	Gold 0.4 oz. ton

JAW CRUSHER

GRIND 70% - 200 Mesh

High temperature leaching tower

(300° F & 125 - 150 p. s. i.

8 hrs. 25% solids.

Tower 3' Internal Diam. 60' high

3 tons in 8 hrs. 9 tons 24 hrs.

90 - 95% in solution

(Three towers required for 25 ton day plant.

SULPHUR ADDITIONS
1% (Fe S₂ REQUIRED
or (H₂ S O₄

p.H. 2 - 2.5

Add Lime to Hot Batch PH 8.5

F I L T E R

FILTRATE

Gas with H₂S to remove

Remainder of As, Ni, Cu & Mo
if any & filter

FILTRATE

COBALT AND

PRECIPITATE & RESIDUE

95% of Iron & Arsenic

Calcium Sulphate

Ferric Hydroxide

Ferric Arsenate

Cyanide
for Gold Recovery

Gold to mint

Residue

PRECIPITATE

COBALT CARBONATE

TO COBALT SMELTER

FOR REFINING

FILTRATE

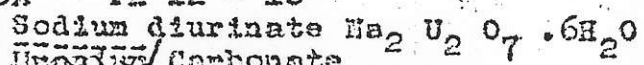
CAUSTIC SODA PH 12 - 10

FILTER off ~~URANIUM~~ Carbonate
& ship to Uranium SMELTER

TO TOWERS

Dryer

To waste



TAKE CARBONATE
into SULPHATE SOLN.

↓
Arsenic present in form of
SODIUM ARSENATE
5 parts in Million is BAD

↓
PPT. Fe & As.
Filter.

↓
Soda Ash

↓
Cobalt Carbonate → Ignite → Reduce → Cobalt shot.

HIGH TEMPERATURE PRESSURE LEACHING
OF NORTHERN GEM ORE
TWENTY-FIVE TON PLANT

Ore Heads

Cobalt 2.5%
Gold 0.4 oz/ton
Uranium Oxide 4 pounds per ton

Gross value of ore per ton

Cobalt carbonate	50 lb. @ \$1.00	=	\$ 50.00
Gold	0.4 oz. @ \$35.00	=	14.00
Uranium Oxide	4 lb. @ \$5.00	=	20.00
			\$ 84.00
TOTAL VALUE PER TON.....			\$ 84.00

Value of products recovered from leaching plant per ton

Cobalt 80% recovery of \$50.00	=	\$ 40.00
Gold 80% " " 14.00	=	11.25
Uranium Oxide 75% recovery of \$20.00	=	15.00
TOTAL RECOVERABLE VALUE PER TON...\$ 66.25		

Estimated cost of mining milling, leaching and overhead per ton is \$40.00

Profit per ton = \$ 66.25 - \$40.00 = \$ 26.25

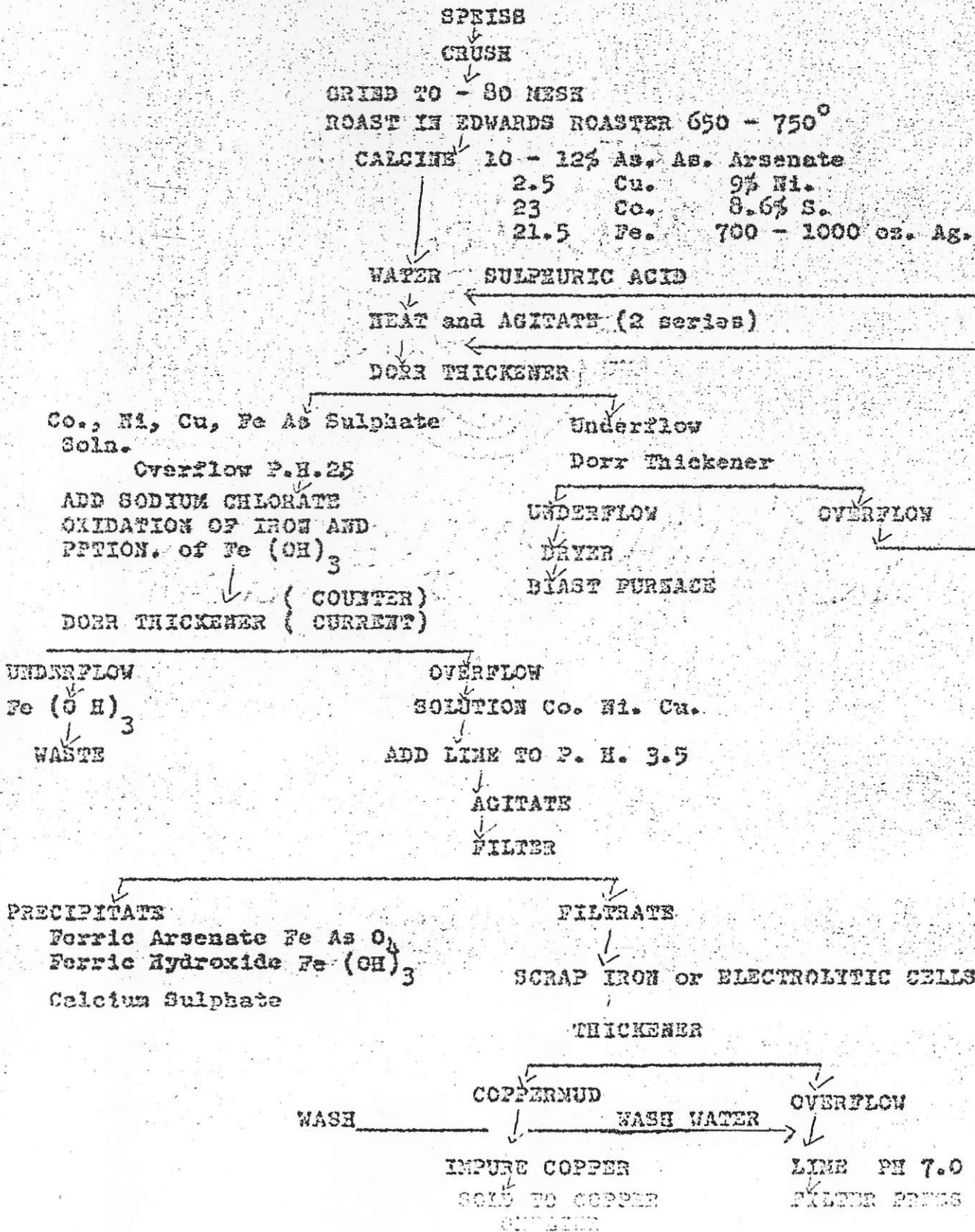
Note

The estimated profit from a 25 ton per day smelting operation is..... \$ 26.80 per ton

The number of men required would be similar to that required for a smelting plant of the same size. The cost of a high pressure leaching plant would be more than a smelting plant of the same size. The leaching plant would require a cyanide circuit to extract the gold from the leached residue. A higher degree of supervision will be required for the leaching plant.

The smelter can be adapted to a custom smelting operation quite easily. The smelter could treat the gold, silver, lead, antimony ore from Bonanza Basin, antimony stibnite ores from various locations in the Bridge River area and heavy arsenical gold ores which are numerous in the area. The Bralorne gold concentrates could be treated by mixing them with the various ores mentioned above.

COBALT SPIESS TREATMENT AT DELORO



FILTER PRESS.

FILTRATE P.H.7.0

IRON COPPER MUD CO.

SODIUM HYPOCHLORITE
Oxidation of Cobalt Ppton.
as Co. (OH)₃

DRYER

Cobalt Blast Furnace

FILTER PRESS

PRECIPITATE (Co. (OH)₃)

FILTRATE

Sodium Hypochlorite

FILTER PRESS

SODA WASH to make Na₂ SO₄ with
Residual Sulphur

HEAT to 800°C

WASH out soluble Na₂ SO₄

Caustic Soda P.H.8.5

Heat Ni (OH)₂ ppt.

Co (OH)₃
Ni (OH)₃

Na₂ SO₄
to waste

Co. O Cobalt Oxide

OVERFLOW
WASTE

UNDERFLOW

Oil Fired ROTARY KILN @ 1000°C

Charcoal

Fines - Melt in electric fce.
granulate in water.

PRESS

DRYER

Ignite 800°C to
Ni O

Grinder - MARKET

PRELIMINARY ESTIMATE OF SINTERING AND SMELTER PLANT COST

BASED ON AN INITIAL PRODUCTION OF 25 TONS PER DAY
AND THEN EXPANDED TO 50 TONS PER DAY

NOTE:

All major pieces of equipment to have a rated capacity of
50 tons ore in 24 hrs. The concentration ratio is
estimated to be 2.5 : 1.

- 1. Buildings 10,000.00
- 2. Crushing, grinding- classification-
table 25,000.00
- 3. Sintering Plant

Pug mill mixer	2,900.00
No. 2 Sintering Hearth	11,000.00
6 compartment baghouse	17,500.00
Refining fee	2,000.00
Arsenic Chambers	2,000.00
Screen	1,500.00

\$ 36,900.00

Installation 2,500.00

39,400.00 39,400.00

3. Smelting Plant

No. 2 Combination Blast Fee	\$14,500.00
4 compartment Type B Baghouse	12,800.00
No. 1 Bullion Refining Fee	3,000.00
Slag, Speiss and Bullion Pots	2,500.00
Speiss Cav.	500.00
Charging, floor, storage bins for sinter, coke, silica & L's	2,500.00
Lift truck	2,500.00

38,400.00

Installation 5,000.00

43,400.00 43,400.00

\$ 117,800.00

SINTERING AND SMELTING PLANT

Forward..... \$ 117,800.00

4. Assay Office

Buildings	\$ 1,000.00
Fire Assay	3,000.00
Gold Scale	600.00
Cobalt Assay	1,000.00
Uranium	1,000.00
Supplies	1,000.00

\$ 7,600.00

7,600.00

5. 100 H.P. Diesel Generator and Switch Gear installed

20,000.00

6. Duty @ 10% on Baghouse 1 & 2
Pugmill, Refining Fee, etc. \$ 4,000.00
Freight on Sintering & Smelting
equipment 5,000.00

9,000.00

9,000.00

7. Pickup Truck (4-wheel drive) 4,000.00
D6 Bulldozer winch & blade used 12,000.00
4 ton truck 6,000.00
Compressor 900 Rental Purchase
for 6 Mo. 11,400.00
Compressor 315 Fix for Stand-by 500.00
Misc. Mine Equipment & Supplies 10,000.00
Misc. Surface Plant Supplies 10,000.00

53,900.00

53,900.00

TOTAL..... \$ 208,300.00

Initial "PRODUCTION CAPACITY"

25 Tons per day expanding to 50 tons per day
Ore heads averaging 25% Cobalt; 0.40 oz. Gold
and 4 pounds Uranium Oxide per ton will have
a concentration of 2.5 %

Based on 25 Tons of Ore per day the following daily
Production will be made

Cobalt concentrates	6% Co.	10 Tons daily
Cobalt Sinter	7.9% Co.	7.5 Tons (containing 1.5 - 2.0 tons of L's and Silica Flux)
Cobalt Spines	32% Co.	1.75 Tons

Gold		8.5 Ounces
Uranium Oxide Conc.	50% U ₃ O ₈	150 Pounds
Arsenious Oxide	"Crude"	4.4 Tons

The above figures are based on the following losses :

Table Concentration

Cobalt	5% Loss
Uranium Oxide	25%
Gold	10%

Sintering

Cobalt	1%
Gold	1%

Smelting

Cobalt	8%
Gold	2%

Bullion Refining

Gold	2%
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Arsenic Refining

33¹/₃% Loss from ore assaying
20% Arsenic

The Gross Daily Production

From a 25 Ton per day plant will be F.O.B. Vancouver.

Cobalt	=	32 x 20 x 1.75 x \$0.95	=	1,060.00
Gold	=	25 x .85 x .40 x \$35.00	=	285.00
Uranium Oxide	=	25 x .75 x 4.0 x \$2.50	=	187.00
Arsenious Oxide	=	25 x 350 (\$0.048 - \$0.02)	=	246.00

13.5 x 20 x $\frac{198}{150}$ = 350 lb. As₂O₃ per Ton of Ore
13.5% As. will make \$ 1, 778.00 Total

in 1959. It will cost 2¢ per pound to bring oxide to Vancouver

Value of Arsenious Oxide = 25 x 350 (\$0.048 - 0.020) = 246.00

NOTE

The arsenious oxide will have little net value unless it can be sold into an area where the freight rate is less than 2.8¢ per pound. Arsenious oxide because of its toxic and poisonous qualities is charged a premium freight rate, and has to be packed in barrels sealed inside with paper to prevent spillage.

The marketing of uranium oxide will be uncertain for some time. There will always be a market for a 50% uranium concentrate if you are willing to sell it cheap enough. The large uranium mines could produce yellowcake cheaper from a 50% uranium oxide concentrate costing them \$2.50 per pound for the uranium oxide content than from their own ore. The average uranium ore has two pounds of uranium oxide per ton from which it costs about \$5.00 to produce a pound of purified uranium oxide as yellowcake.

Gross Income Per Day

When treating 25 tons of ore per day.

Cobalt speiss	1060.00
Gold	285.00
Uranium Oxide	187.00
	<hr/>
	1,532.00

Value per ton of ore

= $\frac{1532.00}{25}$	=	\$ 61.00
Cost per ton of ore is		\$ 34.20
Profit per ton = 61.00 - 34.20		\$ 26.80

Gross Income per day

When treating 50 tons of ore per day \$3,064.00

Cost of mining - sintering and smelting is \$ 28.00 ton
Profit per ton = \$61.00 - 28.90 = 32.10

Profit per Month

(1) before taxes, depreciation, marketing and transportation.

(2) Based on 21 productive days per month

A. 25 Tons per day
Profit per month = 25 x \$26.80 x 21 = \$14,200.00

B. 50 tons per day
Profit per month = 50 x \$32.10 x 21 = \$33,705.00

Number of employees required to operate the mine and smelter, when 25 tons of ore are treated per day.

Mine

Exploration and Development	3	
Mining and transportation	3	
	<u>6</u>	6 Men.

Mill

Crushing, Milling, Table Conc.	3	
Sintering	2	
Smelting	4	
Refining and Assay	4	
	<u>13</u>	13 Men.

General

Supervision	1	
Office	2	
Cook House	2	
Mechanic	1	
Truck Driver	1	
	<u>7</u>	7 Men.

TOTAL MEN... 26 Men

Number of employees required to operate the mine and smelter, when 50 tons of ore are treated per day and at full rated capacity.

Mine

Exploration and Development	4	
Mining and transportation	4	
	<u>8</u>	8 Men

Mill

Crushing, Milling, Table Conc.	4	
Sintering	4	
Smelting	6	
Refining and Assay	5	
	<u>19</u>	19 Men

Number of employees for 50 tons per day

Number of employees for 50 tons per day

General

Supervision	2	
Office	3	
Cook House	3	
Mechanics	2	
Truck Drivers	2	
	<hr/>	
	12	12 Men

TOTAL MEN.... 32

NOTE

Additional equipment amounting to \$25,000.00 will be required to bring the production up from 25 to 50 tons of ore per day. Mechanization of the existing equipment by the use of conveyors, bins and pay-loader truck, will take place when the production is increased.

Improvements to the existing mine road will require an expenditure of \$20,000.00 to improve it into an all-weather truck road. Half this amount could be provided by obtaining a road grant from the Department of Mines, Victoria.

Working capital amounting to \$125,000.00 will be required to tune up the smelter and bring it into full production. Production returns will provide the necessary operating capital by the end of the third month.

Mine exploration and development prior to milling and smelting will require an expenditure of \$50,000.00.

Total amount of capital required to bring mine into production including \$125,000.00 working capital is \$418,000.00.

Raymond R. Taylor

