MINING
METALLURGY
CHEMISTRY

4250 0038

Hunt - Sill Coll.

ORE TESTING
PLANT DESIGN
METALLURGICAL RESEARCH
ASSAYS & ANALYSES

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LOS ANGELES

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ITEM 38

November 20, 1947

Mr. Homer C. Mills
c/o Searchlight Consolidated Mining & Milling Co.
Searchlight, Nevada.

Dear Mr. Mills:

I herewith submit the findings of my metallurgical research on ores from your Searchlight, Nevada properties.

These ores, represented by you to be typical of the material to be beneficiated, were submitted for my investigation. They comprised first, a sample from the Eastern part of the Quartzite property showing good silver values together with profitable percentages of copper and lead in an oxidized form and a minor value in gold. A head sample from this mineralized zone gave the following assays:

Gold		Silver		Combined Value	%	%
Ounces	Value	Ounces	Value	Gold-Silver	Copper	Lead
0.04	$ 1.40	22.69	$ 20.53	$ 21.93	6.35	12.9

* Gold @ $ 35.00 per ounce
Silver @ 90.5¢ " "

A second sample of gold, silver and lead from the Western area of the Quartzite and a sample of gold and silver with the gold predominating in association with negligible amounts of copper and lead completed the series of samples stated to be representative of the ore bodies to be mined.

The assays of the last two samples are as follows:

Sample	Gold Ounces	Gold Value	Silver Ounces	Silver Value	Combined Value Gold-Silver	% Lead
Oxidized Gold-silver Lead ore	0.18	$ 6.30	16.8	$15.20	$ 21.50	7.36
Gold ore	0.19	6.65	1.4	1.27	7.92	

* Gold @ $ 35.00 per ounce
Silver @ 90.5¢ " "

The metallurgy of the gold-silver sample was comparatively simple and consisted of fine grinding, (necessitated by the character of the matrix in the ore) followed by cyanidation. The cyanide consumption was not excessive nor the leaching cycle long and the recovery was satisfactory. The amount of cyanide used was but 1.8 pounds per ton of ore treated and the dissolution period was limited to 24 hours. These conditions gave a gold recovery of 93.4 while that of the silver was somewhat lower at 85.7%. The other two character samples were more complex because of the highly oxidized condition of the valuable base minerals. The problem in the recovery of the metals in the gold-silver-copper-lead ore was intensified by the necessity of segregating the copper and lead into saleable products with a minimum of contamination of one base metal with the other.

Various methods were employed in an endeavor to accomplish this objective.

In accordance with your suggestion that leaching be utilized to dissolve and recover the copper, the ore was sub-

jected to leaching by percolation using a 2.5% commercial sulphuric acid solution as a dissolving medium. The ore was crushed to pass 28 mesh and a 24 hour leaching cycle applied. The copper, which was entirely in the form of malachite or copper carbonate responded almost completely to dissolution, leaving only a trace of copper in the tailings. This indicated that the copper occurred in the fracture planes of the rock rather than being locked up in the matrix of the ore. It should be remembered that the ore was crushed to pass only 28 mesh. The elimination of the copper by leaching leaves only the gold,silver and lead to be segregated and recovered.

It should be pointed out, however, that the removal of the copper by dissolution entails two rather costly items in the installation of equipment if electrolysis is used for the deposition of the copper as a saleable product. There are two alternatives possible for the recovery of the copper. The first is by electrolysis, which is standard practice, and which yields an almost chemically pure electrolytic product. In order to accomplish this, acid proof equipment must be used and electrolytic cells and motor generating apparatus installed. Such equipment is expensive but with cheap electric power, such as you have in the immediate vicinity at Boulder Dam and with a yield of say 0.8 pound of copper per kilowatt hour, if lead anodes are used and perhaps 2.0 if graphite anodes are employed, the electrolysis would not be expensive.

A second method of deposition, for the copper, is by precipitation on scrap iron as " Cement " copper and shipment of it as a high grade product to a copper smelter. Theoretically 88.8 pounds of iron are required by weight to precipitate 100 pounds of copper from sulphate solutions but in practice the consumption greatly exceeds the theoretical amount because the solution can not be kept free from acid or ferric salts and because the scrap iron used is contaminated more or less with impurities. With care, the consumption of iron in precipitating copper from sulphate solutions will average about 1.5 pounds per pound of copper precipitated. However, under adverse conditions of free acid, ferric salts and impure scrap iron, the consumption of iron may rise to 2 or even 3 pounds per pound of copper precipitated. If it is your decision to incorporate copper leaching in your " Flow Sheet " you may be able to collect sufficient scrap iron in the form of tin cans etc. in nearby Las Vegas to sustain your copper operation.

Returning to the residue from the copper leaching the problem consists of the concentration of the lead and the recovery of the gold and silver.

The concentration of the lead was undertaken by Tabling the residue and by Flotation of the Middlings and Taild from Table concentration. The recovery by Tabling ofnthe combined concentrates and middlings was gold 66.66%, silver 88.61 and lead 74.12%. The Flotation of the Table Tails increased the gold

recovery to 77.49%, the silver to 94.66% and the lead to 80.4%. It should be borne in mind that these recoveries are based on the removal of the copper first by leaching in accordance with your request.

The preliminary tests by Flotation alone and by Table Concentration and Flotation show that the separation of the lead and copper are not complete and that too much of the values is left in the tails. However the tests seem to indicate that further testing will demonstrate that a satisfactory separation of the lead and copper can be made to produce commercially profitable operations. At your request all further research was stopped and therefore the specifications for a definite flow sheet can not be incorporated in this report.

From the research that I have performed on your ore, although not completed, I have made certain deductions. If the ore is leached first for the removal of the copper a good lead, silver concentrate can be made. I do not recommend this procedure at this time because of the heavy capital expenditure. Secondly, I believe that even though the copper is not removed by leaching that a commercial saving can be effected by gravity concentration and flotation. My tests by these methods while not conclusive are indicative that such a Flow Sheet is possible. One test made by Tabling after removal of the copper by leaching gave a concentrate of 105.12 ounces of silver and 46% lead. I suggest further work by Tabling and Flotation and believe that such research will give a favorable answer to your metallurgical problem.

Yours very truly,

Consulting Engineer

SEARCHLIGHT RESEARCH

* TABLE TEST AFTER TREATMENT WITH H_2SO_4 FOR REMOVAL OF COPPER

PRODUCT	Wt. in Grams	Weight %	ASSAY PER CENT: Ag OZS Per Ton	ASSAY PER CENT: Au Ozs Per Ton	ASSAY PER CENT: Cu %	ASSAY PER CENT: Pb %	DISTRIBUTION PER CEN: Ag	DISTRIBUTION PER CEN: Au	DISTRIBUTION PER CEN: Cu %	DISTRIBUTION PER CEN: Pb %
Heads	9090	100.00	22.69	0.04	6.35	12.90			Copper leached with acid	
Concentrates	880	9.68	105.12	0.06	All	46.00	44.84	66.66		34.52
Middlings Tails	5675	62.43	15.18	0.02		8.20	41.77			39.60
Calculated Copper	577	6.35								
Calculated Slimes	1958	21.54	10.53		All	15.45	13.39	33.33		25.88
	9090	100.00			All	100.00	100.00	100.00		100.00

FLOTATION TEST No. 7 OF MIDDLINGS AND TAILS FROM TABLE AFTER ACID TREATMENT

Heads			15.18	0.02						
Calculated Heads	1400		15.89	0.03		8.20				
Concentrate #1	170	12.13	47.30	0.06		11.00	36.07	22.69		16.37
Concentrate #2	110	7.86	18.56	0.04		8.20	9.17	9.81		7.91
Middlings	395	28.22	12.71	0.04		7.00	31.42	35.19		24.24
Tails	725	51.79	7.15	0.02		8.10	23.34	32.31		51.48
		100.00					100.00	100.00		100.00

SEARCHLIGHT RESEARCH

Table Test # 2 of 1st Table Test Middlings

Copper Previously Leached

PRODUCT	Weight %	Ag Ozs Per Ton	Au Ozs Per Ton	Cu %	Pb %	Au	Ag	Cu %	Pb %
Calculated Heads		7.92	0.08		6.63				
Reconcentration of Middlings above magnet	1.429	80.40	0.16		43.75		14.40		9.419
Concentrate #2 below Magnet	0.641	35.50			30.50		2.88		2.945
Regular Concentrate	2.83	55.67			20.65		19.80		8.773
Middlings	37.06	5.84			6.00		27.30		33.988
Slime Tails	0.85	9.52			6.55		1.13		0.839
Tails	57.20	4.78			5.11		34.49		44.035
	100.00						100.00		100.00

SEARCHLIGHT RESEARCH

Flotation Test of First Table Middlings

PRODUCT	Weight %	ASSAY PER CENT				DISTRIBUTION PER CENT			
		Ag Ozs	Au Ozs	Cu %	Pb %	Ag	Au	Cu %	Pb %
Heads		13.39	0.06		7.75				
Concentrate: #1	6.16	46.83			15.00	21.41			9.79
Concentrate: #2	6.27	10.88			7.00	5.06			4.65
Middlings	12.55	15.89			7.60	14.80			10.09
Tails	75.02	10.55			9.50	58.73			75.47

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SEARCHLIGHT RESEARCH
(Flotation Crude Ore)

PRODUCT	Weight %	Assay Per Cent: Au Ozs Per Ton	Ag Ozs Per Ton	Cu %	Pb %	Distribution Per Cent: Au	Ag	Cu	Pb
Calculated Heads		0.085	22.35	6.01	13.67				
Bougher Concentrate No. 1	39.85	0.14	24.88	7.10	20.00		44.34	47.06	54.63
" " No. 2	16.00	0.11	42.10	5.00	9.00		30.14	13.31	10.53
Middlings	9.90	0.08	8.65	6.25	18.70		3.74	10.29	13.55
Tails	34.25	0.02	14.22	5.15	8.50		21.78	29.34	21.29
	100.00						100.00	100.00	100.00

TABLE CONCENTRATION TEST

Calculated Heads		0.09	19.75	5.11	12.41				
Copper Concentrates	10.36	0.15	64.73	5.65	29.10	17.25	33.94	16.02	24.28
Lead "	5.51	0.04	45.90	3.45	43.20	2.44	12.82	12.98	19.19
Middlings	60.00	0.02	14.38	4.10	8.50	13.33	43.67	60.54	41.09
Slime Tails	24.12	0.25	7.83	7.80	7.95	66.98	9.57	10.46	15.44
	100.00						100.00	100.00	100.00

SEARCHLIGHT RESEARCH

Flotation Without Previous Treatment

PRODUCT	Weight %	ASSAY PER CENT: Ag Ozs Per Ton	ASSAY PER CENT: Au Ozs Per Ton	ASSAY PER CENT: Cu %	ASSAY PER CENT: Pb %	DISTRIBUTION PER CENT: Ag	DISTRIBUTION PER CENT: Au	DISTRIBUTION PER CENT: Cu %	DISTRIBUTION PER CENT: Pb %
Heads		23.02	0.04	5.74	12.90				
Rougher Conc 1	14.50	78.05		14.00	24.75	49.16		27.76	26.42
Rougher Conc 2	43.65	16.10		6.5	15.00	30.52		38.78	48.20
Middlings	12.75	14.90		5.5	12.20	8.26		9.58	11.45
Tails	29.10	9.54		0.60	6.50	12.06		23.88	13.93
	100.00							100.00	100.00

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ASSAYS MADE FOR HOMER C. MILLS, SEARCHLIGHT, NEVADA

Date	Description	Gold Ounces	Gold Value	Silver Ounces	Silver Value	% Lead	% Copper	Zinc
1/4/47	Quartette	0.02	$0.70	—	--	—	—	
1/4/47	Collins	0.02	0.70	1.0	$0.90	0.90	1.75	
1/4/47	Gordon Lease	0.03	1.05	2.20	1.99	0.75	0.25	
1/4/47	Gordon "	0.01	0.35	0.29	0.26	5.25	—	
1/4/47	Quartz rock	Trace	None	0.69	0.62	0.45		
3/5/47	Reid shaft	0.01	0.35	Trace	None			
3/5/47	Gordon vein	0.02	0.70	1.40	1.27			
3/5/47	Gordon footwall	0.01	0.35	0.45	0.41			
3/11/47	Hand sample	0.41	14.35	0.40	0.36			
5/12/47	Under Supt. House	0.99	34.65	1.23	1.11			
6/4/47	Hand sample	0.01	0.35	1.00	0.90	Trace		
6/4/47	Head sample mill test	0.04	1.40	42.72	38.66	12.9	6.35	
6/17/47	No designation, marked 1	0.02	0.70	0.99	0.90	4.1		1.5
6/17/47	" " " 2	0.01	0.35	0.23	0.20	31.0		
6/17/47	" " " 3	0.03	1.05	7.15	6.47	36.4		1.4
8/4/47	Iron ore	0.08	2.80	0.85	0.77	1.0		
8/4/47	Copper stained	0.15	5.25	0.80	0.72	1.1		
8/4/47	White quartz	0.25	8.75	0.26	0.23	1.0		
8/8/47	Selected ore	2.40	84.00	1.60	1.45			
8/8/47	Mill ore	0.08	2.80	0.50	0.45			
9/18/47	# 1	0.02	0.70	0.45	0.41			
	# 2	0.78	27.30	1.32	1.19			

Date	Description	Gold Ounces	Gold Value	Silver Ounces	Silver Value	% Lead	% Copper
10/10/47	Gordon lease Quartette	0.35	$12.25	2.85	$2.58	4.1	
10/10/47	East end Quartette	0.02	0.70	1.16	1.05	2.0	
10/10/47	Bug group	0.36	12.60	1.91	1.73	2.85	
1/30/48	Henry Emory Cropping	0.01	0.35	0.33	0.30	1.00	
1/30/48	" " 2 C.C.	0.02	0.70	0.48	0.43	0.80	
2/2/48	# 1	0.01	0.35	Trace	None	0.70	
2/2/48	#2	0.02	0.70	0.32	0.29	0.75	
2/2/48	#3	0.02	0.70	0.41	0.37	0.85	
2/2/48	#4	0.02	0.70	0.35	0.32	0.80	
2/2/48	#5	0.01	0.35	0.54	0.41	0.70	
2/2/48	#6 Gordon shaft 135'	0.11	3.85	0.66	0.60	1.00	
2/2/48	#7 Reed shaft 165'	0.03	1.05	0.53	0.40	1.10	
2/17/48	Gordon Lease	0.02	0.70	0.82	0.74	8.30	1.6
2/17/48	Cropping near Smith S'ft	0.02	0.70	0.76	0.69	6.50	
2/17/48	Porphyry " " "	0.03	1.05	0.15	0.13	2.80	
2/17/48	Smith shaft	0.03	1.05	0.54	0.49	5.00	
2/23/48	Hand specimen	0.03	1.05	0.80	0.72	1.35	1.18
2/27/48	Hand sample	0.02	0.70	0.60	0.54	1.00	2.55
3/1/48	Nellis shaft	0.44	15.40	1.90	1.72	1.55	
3/1/48	Gordon x cut	0.02	0.70	0.80	0.72	1.10	1.0
3/9/48	Gordon shaft near house	0.04	1.40	1.23	1.11		
3/9/48	Smith shaft fines	0.04	1.40	1.54	1.39	1.25	
3/9/48	Smith shaft West face	0.02	0.70	1.76	1.59	1.50	
3/9/48	Smith shaft East face	0.03	1.05	1.35	1.22	1.05	
4/12/48	#1	0.02	0.70	0.95	0.86	1.28	0.69
6/21/48	Placer	0.01	0.35				

		Gold		Silver			
		Ounces	Value	Ounces	Value	% Lead	% Copper
6/29/48	No number	0.10	$ 3.50	Trace	None	1.35%	
7/14/48	Acme	0.10	3.50	0.55	$0.50	1.55	
7/14/48	Quartette (red)	0.03	1.05	0.83	0.75	2.60	
9/30/48	Annette claim	Trace	None	1.00	0.90	0.65	
10/18/48	Jasper	2.91	101.85	5.40	4.89	[illegible]	[illegible]
10/18/48	M-G-D level 1	0.24	8.40	1.40	1.27	0.40	3.15
10/18/48	M-G-D- upper	0.04	1.40	0.70	0.63	0.60	0.97
10/18/48	M-G-D- lower	0.02	0.70	5.00	4.50	Trace	3.20
10/18/48	Quartette (Reid)	0.02	0.70	Trace	None	0.30	
10/18/48	" (House)	0.08	2.80	Trace	None	0.40	
11/13/48	#1	0.01	0.35	1.47	1.33	1.00	
11/13/48	#2	0.09	3.15	0.32	0.27	2.00	
11/13/48	#3	0.03	1.05	3.87	3.50	1.45	
11/13/48	#4	0.01	0.35	0.17	0.15	1.10	
11/13/48	#5	0.03	1.05	0.28	0.25	2.00	
11/22/48	Quartette-House vein 2nd level	0.04	1.40	0.25	0.22	0.50	
2/26/49	Fines Brower clm	0.06	2.10	0.93	0.84	0.42	
2/26/49	E.E.Brewer clam	0.06	2.10	1.28	1.16	0.29	
2/26/49	Brewer claim Cu	0.10	3.50	10.06	9.10		11.23
2/26/49	Brewer colored ore	0.11	3.85	2.32	2.10		3.02
2/26/49	Searchlight Gordon lease	0.04	1.40	3.04	2.75	5.12	18.67
2/26/49	Large sack ore	0.03	1.05	1.30	1.18	1.09	
2/26/49	Railroad pass	0.20	7.00	14.15	12.80		
3/1/49	Brewer # 1	0.05	1.75	3.80	3.44		
3/1/49	Brewer # 2	0.20	7.00	0.67	0.62		
3/1/49	Brewer # 3	0.11	3.85	15.69	14.20	0.54	
3/1/49	Reid shaft 220' level	0.02	0.70	0.49	0.45	0.55	

Date	Description	Gold Ounces	Gold Value	Silver Ounces	Silver Value	% Lead	% Copper
5/3/49	128' station	0.17	$5.95	Trace	None		
5/3/49	Muck pile 1st level	0.15	5.25	0.62	0.56		
5/3/49	X cut 1st level	0.31	10.85	0.59	0.54		
5/3/49	Shallow shaft	0.73	25.55	2.38	2.15		
5/3/49	Blue v on highway	0.10	3.50	1.00	0.90	0.84	
5/3/49	Back of drift 2nd level	0.02	0.70	Trace	None		
5/3/49	325' level small drift	4.03	141.05	1.93	1.75		
5/3/49	Thompson property	0.56	19.60	1.48	1.34		
6/2/49	Hillery sample	0.25	8.75	0.76	0.69	33.20	
6/21/49	Western mine 8' shaft	1.00	35.00	1.80	1.63		
6/21/49	" " dump E of sh	0.10	3.50	0.44	0.40		
6/21/49	" " open cut 100' west of shaft	0.01	0.35	Trace	None		
6/21/49	Duplex Tunnel	0.10	3.50	38.12	34.50	56.70	
6/21/49	So. Nevada H.W. vein 138' level	0.08	2.80	0.37	0.33		
6/21/49	So. Nevada F.W. vein 138' vein	0.09	3.15	0.82	0.74		
7/27/49	Hand sample	0.02	0.70	0.54	0.49	0.42	
8/2/49	Boston oxidized ofe	0.11	3.85				
8/2/49	Talc surface Boston	0.08	2.80				
8/2/49	Copper shaft	0.12	4.20	2.50	2.26		2.60
8/2/49	So.Nevada stope 138' level	0.15	5.25	Trace	None		
8/2/49	138' level drift	0.25	8.75	0.55	0.50		
8/2/49	F.W. North of shaft 200' level	0.67	23.45	0.89	0.80		
8/2/49	Drift 200' level	0.18	6.35	Trace	None		
8/2/49	200' level C.J.Hodgen	0.65	22.75	0.94	0.85		
8/2/49	200' level C. J. Hodgen	0.35	12.25	Trace	None		
2/28/50	Southern Nevada Mine	0.03	1.05	Trace	None		

Date	Description	Gold Ounces	Gold Value	Silver Ounces	Silver Value	% Lead	% Copper
3/7/49	Western ore	1.04	$36.40	0.64	$0.58		
3/7/49	Western Tailings	0.27	9.45	0.06	0.05		
3/7/49	Morning Star ore	0.02	0.70	6.50	5.85	1.68	0.43
3/7/49	M S Concentrates	1.45	50.75	14.44	13.00	7.56	0.95
3/7/49	M S Tails	0.27	9.45	0.73	0.66	0.48	Trace

* Gold @ $ 35.00 per ounce
Silver @ 90.5¢ " "