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TOMBSTONE HEAP LEACH

METALLURGICAL TESTS

Dump Location Toughnut

Sample Weight, Lbs. 250 DRY

Total Days Leaching

December, 1974

Conducted by:

Approved by:

Date Day	Date Month/Yr	GMS CaO Added	GMS NaCN Added	cc Water Added	cc Water Removed	Reagent Consumption Lime #/Ton Ore	Reagent Consumption NaCN #/Ton Ore	Solution Assays Silver Oz/Ton	Solution Assays Gold Oz/Ton	MG. Gold Leached	MG. Silver Leached	% Gold Recov.	% Silver Recov.
29	1-75	113.5	0	15,000	0								
30	1-75	56.75	56.75	0	0								
31	1-75	0	0	6000	4780	2.72	.760	2.088	.044	7.2027	341.803	.0018	.088
1	2-75	0	0	6000	4580	.10 / 2.82	.096 / .856	1.575	.034	5.3329	247.038	.0014 / .0032	.063 / .151
2	2-75	56.75	0	5000	4500	.169 / 2.99	.120 / .976	1.182	.030	4.6232	182.157	.0012 / .0044	.047 / .198
3	2-75	0	0	6000	3000	.95 / 3.94	— / .976	.831	.017	1.7466	85.377	.0004 / .0048	.022 / .220
4	2-75	0	0	6000	5250	— / 3.94	— / .976	.520	.011	1.9777	93.493	.0005 / .0053	.024 / .244
Total Ave.										20.8831	949.868	0.054	—

1 / 2

1 - Daily
2 - Cumulative

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53

TOMBSTONE HEAP LEACH

METALLURGICAL TESTS

Dump Location Tenpenny

Sample Weight, Lbs. 250 Dry

Total Days Leaching _____

December, 1974

Conducted by: _____

Approved by: _____

Date Day	Date Month/Yr	GMS CaO Added	GMS NaCN Added	cc Water Added	cc Water Removed	Reagent Consumption Lime #/Ton Ore	Reagent Consumption NaCN #/Ton Ore	Solution Assays Silver Oz/Ton	Solution Assays Gold Oz/Ton	MG. Gold Leached	MG. Silver Leached	% Gold Recov.	% Silver Recov.
29	1-75	113.5	0	15,000	0								
30	1-75	56.75	56.75	0	0								
31	1-75	0	0	7000	4940	2.73	.752	1.753	.046	7.7822	296.569	.0020	.076
1	2-75	0	0	6000	4670	.11 / 2.84	.037 / .784	1.326	.035	5.5976	212.069	.0014 / .0034	.054 / .130
2	2-75	56.75	0	5000	4650	.16 / 3.00	.120 / .904	.964	.024	3.8219	153.513	.0010 / .0044	.039 / .169
3	2-75	0	0	6000	3000	.94 / 3.94	— / .904	.798	.018	1.8493	81.986	.0005 / .0049	.021 / .190
4	2-75	0	0	5000	4830	— / 3.94	— / .904	.510	.012	1.9850	84.360	.0005 / .0054	.022 / .212
Total Ave.										21.036	828.497	/	.213

1 / 2

1 - Daily
2 - Cumulative

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TOMBSTONE HEAP LEACH

METALLURGICAL TESTS

Dump Location *Tombstone Ext.*

Sample Weight, Lbs. *250 Dry*

Total Days Leaching _____

December, 1974

Conducted by: _____

Approved by: _____

Date Day	Date Month/Yr	GMS CaO Added	GMS NaCN Added	cc Water Added	cc Water Removed	Reagent Consumption Lime #/Ton Ore	Reagent Consumption NaCN #/Ton Ore	Solution Assays Silver Oz/Ton	Solution Assays Gold Oz/Ton	MG. Gold Leached	MG. Silver Leached	% Gold Recov.	% Silver Recov.
29	1-75	113.5	0	19,000	0								
30	1-75	0	56.75	1000	0		~~.84~~						
31	1-75	0	0	6000	3600	1.90	.846	.831	.016	1.9726	102.452	.0005	.026
1	2-75	0	0	6000	3120	.07 / 1.97	.026 / .952	.9015	.0185	1.9767	96.325	.0005 / .0010	.025 / .051
2	2-75	56.75	0	5000	4650	.060 / 1.97	– / .952	.716	.012	1.9109	114.020	.0004 / .0014	.029 / .080
3	2-75	0	0	6000	3700	.95 / 2.93	.014 / .960	.620	.011	1.3938	84.897	.0004 / .0018	.022 / .102
4	2-75	0	0	5000	4720	– / 2.97	– / .961	.496	.010	1.6164	80.175	.0004 / .0022	.021 / .123
Total Ave.										8.8704	477.869	.0023	-

1 / 2

1 - Daily
2 - Cumulative

230

55

TOMBSTONE HEAP LEACH

METALLURGICAL TESTS

Dump Location Comet

Sample Weight, Lbs. 250 Dry

Total Days Leaching

December, 1974

Conducted by:

Approved by:

Date Day	Date Month/Yr	GMS CaO Added	GMS NaCN Added	cc Water Added	cc Water Removed	Reagent Consumption Lime #/Ton Ore	Reagent Consumption NaCN #/Ton Ore	Solution Assays Silver Oz/Ton	Solution Assays Gold Oz/Ton	MG. Gold Leached	MG. Silver Leached	% Gold Recov.	% Silver Recov.
29	1-75	113.5	Ø	17,000	Ø								
30	1-75	56.75	56.75	1,000	Removed overflow 2000								
31	1-75	Ø	Ø	6000	3525	2.92	.912	0.800	.021	2.5351	96.575	.0007	.025
1	2-75	Ø	Ø	6000	3640	.04 / 2.96	.032 / .944	0.700	.021	2.6178	87.260	.0007 / .0014	.022 / .047
2	2-75	Ø	Ø	5000	4250	— / 2.94	.016 / .960	.527	.015	2.183	81.070	.0005 / .0019	.021 / .068
3	2-75	Ø	Ø	5000	4800	.01 / 2.97	.008 / .968	.493	.013	2.1370	81.041	.0005 / .0024	.021 / .089
4	2-75	Ø	Ø	5000	3870	— / 2.97	.008 / .976	.362	.009	1.1928	47.977	.0003 / .0027	.012 / .101
Total Ave.										10.6659	393.923		

1 / 2

1 - Daily
2 - Cumulative

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TOMBSTONE HEAP LEACH

METALLURGICAL TESTS

Dump Location Contention 1-A

Sample Weight, Lbs. 250

Total Days Leaching _____

December, 1974

Conducted by: _____

Approved by: _____

Date Day	Date Month/Yr	GMS CaO Added	GMS NaCN Added	cc Water Added	cc Water Removed	Reagent Consumption: Lime #/Ton Ore	Reagent Consumption: NaCN #/Ton Ore	Solution Assays: Silver Oz/Ton	Solution Assays: Gold Oz/Ton	MG. Gold Leached	MG. Silver Leached	% Gold Recov.	% Silver Recov.
20	3/75	113.5	0	15,000	0								
21	3/75	60.0	0	3,000	0								
24	3/75	30.0	56.75	6000	3177			.883	.0575	6.2560	96.07	.0016	.025
25	3/75	0	0	↓	↓	3.07	.936	↓	↓	↓	↓	↓	↓
26		0	0	6500	1260	.07 / 3.54	– / .936	.872	.055	8.0240	127.22	.0021 / .0037	.033 / .058
27		0	0	7000	5130	.06 / 4.00	– / .936	.625	.044	7.7301	109.45	.0020 / .0057	.028 / .086
28		0	0	7000	5750	– / 4.00	.016 / .952	.433	.028	5.5137	85.26	.0014 / .0071	.022 / .108
1	4/75	30.0	0	8000	6250	– / 4.00	.040 / .992	.374	.022	4.3774	80.05	.0011 / .0082	.021 / .129
2		0	0	6000	5810	.52 / 4.52	– / .992	.278	.016	3.1836	55.31	.0008 / .0090	.014 / .143
3		0	30	7000	5130	– / 4.52	.008 / 1.00	.217	.012	2.1082	38.12	.0005 / .0095	.010 / .153
4					5180	– / 4.52	.40 / 1.40	.144	.007	1.2417	25.54	.0003 / .0098	.006 / .159
Total Ave.		233.5	86.75	65500	40,687					38.4347	617.02	.0099	.158

1	2

1 - Daily
2 - Cumulative

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TOMBSTONE HEAP LEACH

METALLURGICAL TESTS

Dump Location Contention 1-B

Sample Weight, Lbs. 250

Total Days Leaching _____

December, 1974

Conducted by: _____

Approved by: _____

Date Day	Date Month/Yr	GMS ~~CaO~~ Caustic Added	GMS NaCN Added	cc Water Added	cc Water Removed	Reagent Consumption Lime #/Ton Ore	Reagent Consumption NaCN #/Ton Ore	Solution Assays Silver Oz/Ton	Solution Assays Gold Oz/Ton	MG. Gold Leached	MG. Silver Leached	% Gold Recov.	% Silver Recov.
20	3/75	to 1st 10-11	0	15,000	0								
21	3/75	60.0	0	1,000	0								
24	3/75	30.0	56.75	4000	2292			.688	.049	3.8461	54.00	.0010	.014
		0	0	↓	↓	1.57	.616	↓	↓	↓	↓	↓	↓
		0	0	5000	2650	– / 1.57	.304 / .920	.730	.057	5.1730	66.25	.0013 / .0023	.017 / .031
1		0	0	5000	3560	– / 1.57	.008 / .928	.605	.046	5.6082	73.76	.0014 / .0037	.019 / .050
28		0	0	5000	3670	– / 1.57	.024 / .952	.472	.035	4.399	59.32	.0011 / .0048	.015 / .065
1	4/75	30.0	0	6000	3970	– / 1.57	.032 / .984	.432	.0295	4.0108	58.76	.0010 / .0058	.015 / .080
2	"	0	0	5000	3890	.53 / 2.10	– / .984	.295	.020	2.6644	39.30	.0007 / .0065	.010 / .090
3		0	30	6000	3650	– / 2.10	.048 / .992	.242	.016	2.0000	30.25	.0005 / .0070	.008 / .098
4					3890	– / 2.10	.032 / 1.024	.172	.010	1.3082	22.50	.0003 / .0073	.006 / .104
Total Ave.		1.20 +	86.75	52000	27502					29.0097	404.14	.0074	–

1 / 2

1 - Daily
2 - Cumulative

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TOMBSTONE HEAP LEACH

METALLURGICAL TESTS

Dump Location Contention 2-A

Sample Weight, Lbs. 250

Total Days Leaching _____

December, 1974

Conducted by: _____

Approved by: _____

Date Day	Date Month/Yr	GMS CaO Added	GMS NaCN Added	cc Water Added	cc Water Removed	Reagent Consumption Lime #/Ton Ore	Reagent Consumption NaCN #/Ton Ore	Solution Assays Silver Oz/Ton	Solution Assays Gold Oz/Ton	MG. Gold Leached	MG. Silver Leached	% Gold Recov.	% Silver Recov.
20	3/75	113.5	0	15,000	0								
21	3/75	60.0	0	0	0								
24	3/75	30.0	56.75	6000	5052			3.586	.081	14.0141	620.43	.0036	.159
		0	0	↓	↓	3.06	.736	↓	↓	↓	↓		
		0	0	5000	4350	.37 / 3.43	.104 / .840	3.088	.090	13.0849	460.03	.0034 / .0070	.118 / .277
		0	0	5000	3560	.15 / 3.58	.072 / .912	2.451	.086	10.4849	298.82	.0023 / .0096	.077 / .354
25		0	0	6000	3950	– / 3.58	.024 / .936	1.858	.068	9.1986	251.39	.0024 / .0120	.064 / .418
1	4/75	0	0	7000	5290	– / 3.58	.048 / .984	1.428	.051	9.2394	258.70	.0024 / .0144	.066 / .484
2	"	0	0	5000	4700	– / 3.58	– / .984	1.067	.048	7.7260	171.74	.0019 / .0163	.044 / .528
3		0	30	8000	4090	– / 3.58	.008 / .992	.811	.038	5.3226	113.60	.0014 / .0177	.029 / .557
4					6300	– / 3.58	.384 / 1.376	.562	.023	4.9623	121.25	.0013 / .0190	.031 / .588
Total Ave.		203.5	86.75	57000	37,265					74.0328	2295.91		.590

1	2

1 - Daily
2 - Cumulative

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TOMBSTONE [illegible] LEACH

METALLURGICAL TESTS

Dump Location Contention 2-B

Sample Weight, Lbs. 250 lbs

Total Days Leaching _____

December, 1974

Conducted by: _____

Approved by: _____

Date Day	Date Month/Yr	GMS ~~CaO~~ Caustic Added	GMS NaCN Added	cc Water Added	cc Water Removed	Reagent Consumption: Lime #/Ton Ore	Reagent Consumption: NaCN #/Ton Ore	Solution Assays: Silver Oz/Ton	Solution Assays: Gold Oz/Ton	MG. Gold Leached	MG. Silver Leached	% Gold Recov.	% Silver Recov.
0	3/75	pH 10-11	0	15,000	0								
1	3/75	30.0	0	1,000	0								
24	3/75	30.0	56.75	8000	6152			2.90	.069	14.5372	610.99	.0037 /	.157 /
		0	0	↓	↓	.418	.656	↓	↓	↓	↓		
		0	0	7500	6510	.13 / 1.02	184 / .840	2.468	.083	18.5044	550.23	.0048 / .0085	.141 / .298
		0	0	7000	5710	– / 1.04	.076 / .916	1.804	.067	13.1017	352.77	.0034 / .0119	.091 / .389
		0	0	8000	5620	– / 1.04	.024 / .940	1.229	.049	9.4308	236.54	.0024 / .0143	.061 / .449
1	4/75	0	0	8000	6770	– / 1.04	.016 / .956	.852	.033	7.6510	197.54	.0020 / .0163	.051 / .500
2		0	0	7000	6460	– / 1.04	.008 / .964	.571	.028	6.1945	126.32	.0016 / .0179	.032 / .532
3		0	30	8000	5810	.02 / 1.04	– / .964	.368	.018	3.5815	73.22	.0009 / .0188	.019 / .551
4					6810	– / 1.04	.432 / 1.396	.373	.013	3.0319	86.99	.0008 / .0196	.022 / .573
Total Ave.		60 +	86.75	6950	49,842					76.0379	2234.60	.0195	.574

02 = 3.6
.6 = 7.4
4.6

1 / 2

1 - Daily
2 - Cumulative

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6c

TOMBSTONE HEAP LEACH

METALLURGICAL TESTS

Dump Location Contention II

Sample Weight, Lbs. _____

Total Days Leaching _____

December, 1974

Conducted by: _____

Approved by: _____

Date Day	Date Month/Yr	GMS ~~CaO~~ NaOH Added	GMS NaCN Added	cc Water Added	cc Water Removed	Reagent Consumption ~~Lime~~ NaOH #/Ton Ore	Reagent Consumption NaCN #/Ton Ore	Solution Assays Silver Oz/Ton	Solution Assays Gold Oz/Ton	MG. Gold Leached	MG. Silver Leached	% Gold Recov.	% Silver Recov.
9	4-75	60.0	—	15,000	—								
10	4-75		56.55		—			—	—	—	—		
11		30.0		5000	3750	1.06	.792	4.631	.147	18.878	594.73	.0048	.153
14				5000	3400	.34 / 1.40	.112 / .904	3.822	.132	15.3699	445.03	.0039 / .0087	.114 / .267
15				5000	3440	.15 / 1.55	.032 / .936	3.114	.108	12.7233	366.85	.0033 / .0120	.094 / .361
16				5000	3590	— / 1.55	.024 / .960	2.328	.081	9.9586	286.77	.0026 / .0146	.074 / .435
18				0	3500	— / 1.55	.024 / .984	1.843	.061	7.3116	221.03	.0019 / .0165	.057 / .492
Total Ave.													

1 / 2

1 - Daily
2 - Cumulative

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TOMBSTONE HEAP LEACH

METALLURGICAL TESTS

Dump Location Contention II

Sample Weight, Lbs. _____

Total Days Leaching _____

December, 1974

Conducted by: _____

Approved by: _____

Date Day	Date Month/Yr	GMS ~~CaO~~ NaOH Added	GMS NaCN Added	cc Water Added	cc Water Removed	Reagent Consumption ~~Lime~~ NaOH #/Ton Ore	Reagent Consumption NaCN #/Ton Ore	Solution Assays Silver Oz/Ton	Solution Assays Gold Oz/Ton	MG. Gold Leached	MG. Silver Leached	% Gold Recov.	% Silver Recov.
9	4-75	60.0	56.75	15,000	-0-								
10	4-75			–	4940	.784	.672	3.510	0.142	24.0233	593.82	.0062	.153
11				5000	3240	.274 / 1.04	.216 / .888	3.230	.136	15.0904	358.40	.0038 / .0100	.092 / .245
14				5000	3330	– / 1.04	.057 / .944	2.770	.113	12.8866	315.89	.0033 / .0133	.081 / .326
15				5000	2840	– / 1.04	.037 / .976	2.204	.092	8.9479	214.36	.0023 / .0156	.055 / .381
16				5000	2990	– / 1.04	.016 / .992	1.713	.071	7.2702	175.41	.0019 / .0195	.045 / .426
18					3140	.02 / 1.06	– / .992	1.333	.053	5.7175	143.80	.0015 / .0190	.037 / .463
Total Ave.													

1 / 2

1 - Daily
2 - Cumulative

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EFFECT OF CRUSHING

Note that the values(Au & Ag) are generally evenly distributed between the coarse and fines. Therefore, crushing of the coarse would be economical at a later date.

GEOLOGIC DESCRIPTION OF THE PRINCIPAL

DUMPS, TOMBSTONE DISTRICT, ARIZONA

Mine - Dump	Principal* Rock Types		CU Oxides	Mn Oxides	Sulfates	Sulfides	Remarks
Lucky Cuss	Arg., Ls., Monz.		xxx	xxxx	xx	xx	Some trash & carbon on s
Oregon	Ls.	Not sampled	-	xxxx	-	-	Not samp.-produced Mn o
Prompter	Ls.	Not sampled	-	xxxx	-	-	Not samp.-produced Mn o
Telephone	Ls.	Not sampled	-	xxxx	-	-	Not samp.-produced Mn o
Bunker Hill	Ls.	Not sampled	-	xxxx	-	-	Not samp.-produced Mn o
Rattlesnake	Ls.	Not sampled	-	xxxx	-	-	Not samp.-produced Mn o
Comet	Ls., Monz.	Not sampled	-	xxxx	-	-	Not samp.-produced Mn o
Black Eagle	Ls. Monz.	Not sampled	-	xxxx	-	-	Not samp.-produced Mn o
Emerald	Ls., qtzt.		xxxx	xxx	xxx	xxx	Copper oxides and wulfe ite abundant
Silver Plume	Ls., qtzt.		xx	xxx	xx	xx	
Luck Sure	Ls.	Not sampled	-	xxx	-	-	
State of Maine	Latite porph.		x	xxx	x	-0-	Contains some trash & t

Abbreviations: Ls=limestone, Arg=argillaceous quartzite, Monz=intermediate igneous intrusive rock, Novac=fine grained quartzite, qtzt=quartzite

* Rock types listed in order of decreasing amounts generally present in dump

(x = very rare) (xx = rare) (xxx = common) (xxxx = abundant)

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GEOLOGIC DESCRIPTION OF THE PRINCIPAL

DUMPS, TOMBSTONE DISTRICT, ARIZONA

Mine - Dump	Principal* Rock Types		CU Oxides	Mn Oxides	Sulfates	Sulfides	Remarks
Empire	Arg., Ls., Monz		xxx	x	x	xx	
Tranquility	Arg., Monz., Ls.		xxx	x	x	x	Fluorite & wulfenite, some rotted timber
Toughnut	Arg., Ls., Novac.		xxx	xx	xx	xx	Some timber expected
Visina	Novac., Ls.	Not sampled	-	-	-	-	Very siliceous
Westside	Arg., Ls., Novac.		xxx	xx	x	xx	East ½ only is ours
Silver Thread	Arg., Ls., Novac.	Not sampled	-	-	-	-	Probably similar to the Westside
Boss	Arg., Monz.	Not sampled	-	-	-	-	Probably similar to the Westside
Defence	Novac., Arg., Monz.	Not sampled	-	-	-	-	Probably similar to the Westside
Tribute	Arg., Ls., Monz.	Not sampled	-	-	-	-	Probably similar to the Westside
Contention	Arg., Monz.		xxx	x	xxx	xxx	Lots of carbon and trash in and on the dumps
Grand Central	Arg., Monz.		xxx	x	xxx	x	
Little Joe	Arg., Monz.		xxx	x	xxx	x	
Arizona Queen	Arg.	Not sampled	-	-	-	-	Probably similar to Tranq.
Sulphuret	Arg., Monz.	Not sampled	-	-	-	-	Probably similar to Tranq.

COMPILATION
PAST SAMPLING PROGRAMS (Austral Oil)

Mine Dumps	Tons		Au oz/ton		Ag oz/ton	
Boss #1	3,400	0.030	0.037	.001	2.39	.072
Bunker Hill #1	15,300	0.134	0.030	.004	3.59	.481
Bunker Hill #2	10,500	0.091	0.007	.001	3.10	.282
Emerald #2	1,600	0.014	0.020	-	2.10	.029
Empire #1	41,000	0.358	0.080	.029	1.90	.680
Herschedl #1	6,800	0.059	0.015	.001	3.47	.205
Lucky Cuss #1	18,200	0.159	0.040	.006	2.98	.474
Oregon #1	1,000	0.009	0.005	-	5.52	.050
Oregon #2	1,500	0.013	0.002	-	3.27	.043
Prompter #1	1,600	0.014	0.005	-	3.65	.051
Rattlesnake	3,000	0.026	0.005	-	2.33	.061
San Pedro	1,500	0.013	0.005	-	4.48	.058
Tranquility #1	9,200	0.080	0.060	.005	3.22	.258
	114,600	1.001		0.047		2.74

Weighted averages

Au 0.047 oz/ton	@ $100.00	-	$ 4.70
Ag 2.47 oz/ton	@ $3.00	-	7.41
	Value per ton		$12.11

EFFECT OF SCREENING
TOMBSTONE DUMPS

Dump No.	Unscreened		Screened					
			-3/4 inch			-1/4 inch		
	Au	Ag	Wgt.%	Au	Ag	Wgt.%	Au	Ag
Empire								
41-1	.046	.68	85	.050	.72	60	.055	.64
41-2	.026	1.27	78	.022	1.29	55	.020	1.35
41-3	.057	1.29	72	.060	1.23	40	.070	1.31
41-4	.010	.24	84	.015	.28	58	-	.30
41-5	.025	1.66	84	.027	1.52	59	.030	1.80
41-6	.065	3.58	76	.091	3.34	50	.045	4.80
41-7	.063	.94	73	.078	0.83	48	.055	.87
41-8	.047	.93	74	.054	1.07	46	.035	1.16
41-9	.031	.50	59	.040	.60	32	.060	.62
41-10	.029	2.10	74	.030	2.42	50	.030	2.95
41-11	.026	.68	78	.031	0.72	52	.040	.76
41-12	.051	.62	74	.063	0.64	48	.040	.74
41-13	.018	.45	75	.016	0.39	50	.020	.41
41-14	.039	1.61	75	.029	1.30	46	.025	.44
41-15	.027	.83	62	.033	0.90	36	.045	1.16

EMPIRE

Sample	Total Tons	Unscreened Tons	Unscreened Au	Unscreened Ag	Screened Tons	Screened Au	Screened Ag
41-1	4,500	4,500	.046	.678	3,915	.049	.715
2	3,500	3,500	.026	1.267	595	.039	1.302
3	2,500	2,500	.067	1.290	2,500	.067	1.290
4	Waste	-	-	-	-	-	-
5	6,800	6,800	.025	1.66	6,800	.025	1.66
6	3,600	3,600	.065	3.58	3,600	.065	3.58
7	1,835	1,835	.063	.940	1,835	.063	.940
8	3,420	3,420	.047	.930	2,770	.052	0.979
9	2,000	2,000	.031	.497	640	.060	.62
10	5,000	5,000	.029	2.098	4,050	.030	2.34
11	4,000	4,000	.026	.685	3,320	.030	.73
12	1,000	1,000	.051	.621	810	.059	.61
13	Waste	-	-	-	-	-	-
14	1,500	1,500	.039	1.611	810	.051	2.61
15	1,500	1,500	.027	0.826	540	.045	1.16
		41,155	.039	1.416	32,185	.044	1,582

EFFECT OF SCREENING
TOMBSTONE DUMPS

Dump No.	Unscreened		Screened					
			-3/4 inch			-1/4 inch		
	Au	Ag	Wgt.%	Au	Ag	Wgt.%	Au	Ag
Contention								
38-1	.035	.93						
38-2	.009	.73	75	.006	.92	49	.005	1.06
38-3	.010	.21						
38-4	.023	.56	66	.025	.58	40	.040	.64
38-5	.041	1.92	64	.048	2.31	40	.050	1.61
38-6	.010	.23						
38-7	.027	1.21	76	.031	1.34	48	.045	1.76
38-8	.014	.86	66	.017	.97	40	.015	1.09
38-9	.027	.96	67	.038	1.37	39	.055	1.88
38-10	.005	.80	68	.006	.49	41	.010	.81
38-11	.030	1.89	46	.015	1.18	41	.030	1.89
38-12	.015	1.37	67	.019	1.02	41	.020	1.14
38-13	.002	.30	59	.002	.25	33	.005	.46
38-14	.016	.68	85	.025	1.03	33	.040	1.30

EFFECT OF SCREENING
TOMBSTONE DUMPS

Dump No.	Unscreened		Screened					
			-3/4 inch			-1/4 inch		
	Au	Ag	Wgt.%	Au	Ag	Wgt.%	Au	Ag
Toughnut								
39-1	.050	5.90	78	.058	6.89	51	.085	8.64
39-2	.018	1.85	75	.019	2.13	46	.025	2.80
39-3	.015	1.36	76	.015	1.46	47	.020	1.64
39-4	.003	1.36	64	-	1.00	38	.007	1.01
39-5	.003	1.31	69	-	1.39	39	.008	1.58
39-6	.040	2.10						
39-7	.017	2.69	71	.024	3.18	33	.030	2.18
39-8	.015	1.92	74	.019	2.17	34	.035	3.99
39-9	.010	.63						
39-10	.006	.94	49	.014	2.00	24	.025	3.54
39-11	.009	1.13	80	.011	1.29	55	.015	1.70
39-12	.015	1.38	53	.023	1.32	33	.030	1.71
39-13	.022	1.93	64	.030	2.42	38	.035	3.20
39-14	.002	.26	42	.006	.37	22	.005	.61
39-15	-	.62	46	-	.75	32	-	.84
39-16	-	.43	21	-	.38	9.5	-	.34

TRANQUILITY

Sample	Total Tons	Unscreened Tons	Unscreened Au	Unscreened Ag	Screened Tons	Screened Au	Screened Ag
40-1	2,000	2,000	.045	1.83	1,240	.055	2.53
2	2,000	2,000	.023	.564	Waste	-	-
3	2,500	2,500	.045	1.687	1,525	.060	2.19
4	1,500	1,500	.011	1.702	1,100	.010	2.13
5	4,000	4,000	.061	1.420	4,000	.061	1.42
6	1,500	1,500	.028	.898	2,120	.090	1.64
7	3,000	3,000	.005	.680	Waste	-	-
8	Waste	-	-	-	Waste	-	-
9	3,000	3,000	.064	2.91	1,290	.108	5.85
10	1,500	1,500	.021	.954	525	.050	1.75
11	2,000	2,000	.017	2.197	1,180	.010	2.18
12	2,000	2,000	.070	0.40	1,316	.088	.458
13	6,500	6,500	.087	2.17	6,500	.087	2.166
		31,500	.049	1.590	20,796	.070	2.101

Why values higher after screened

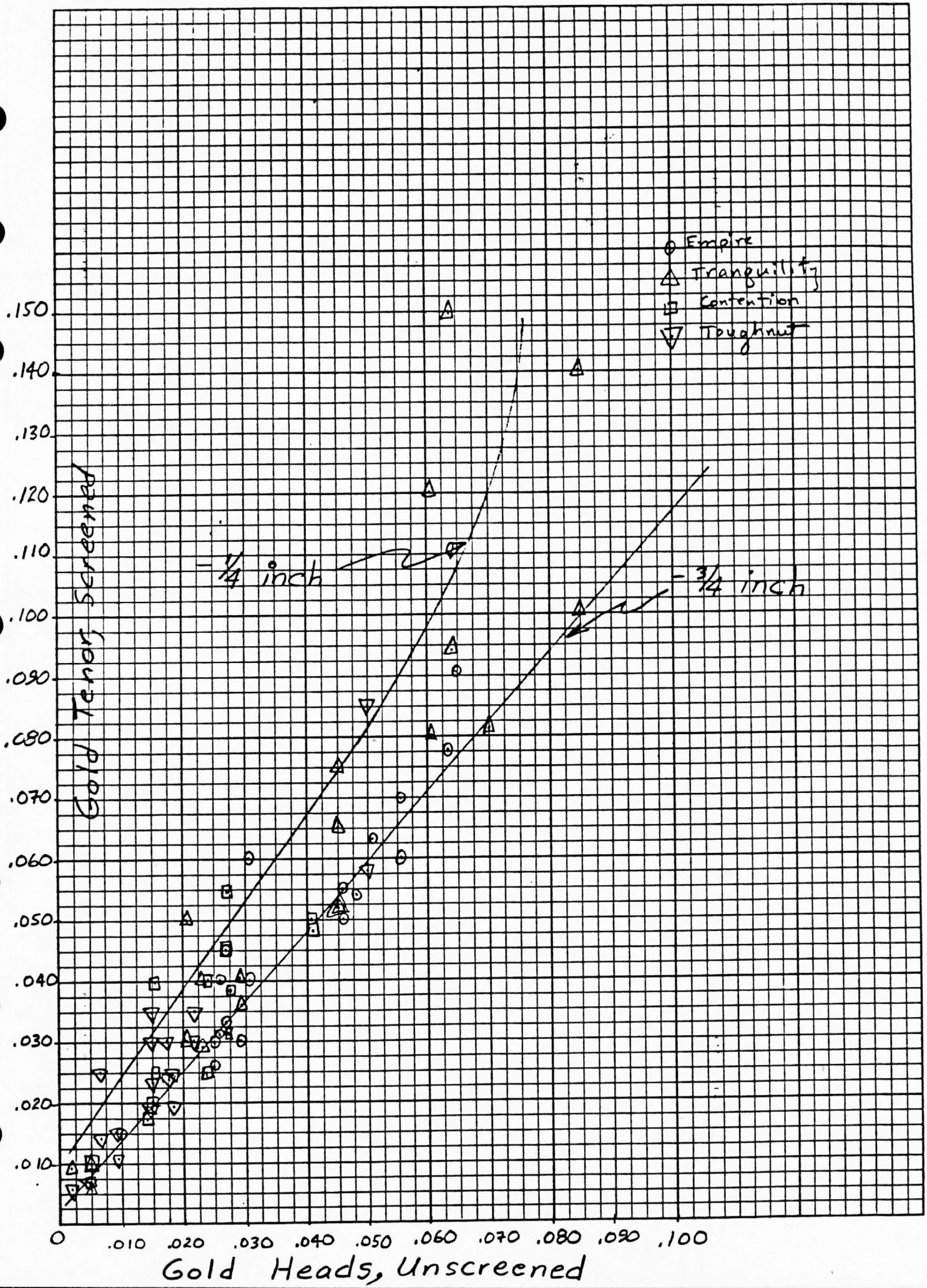
SIERRA MINERAL MANAGEMENT

R. F. HEWLETT
President

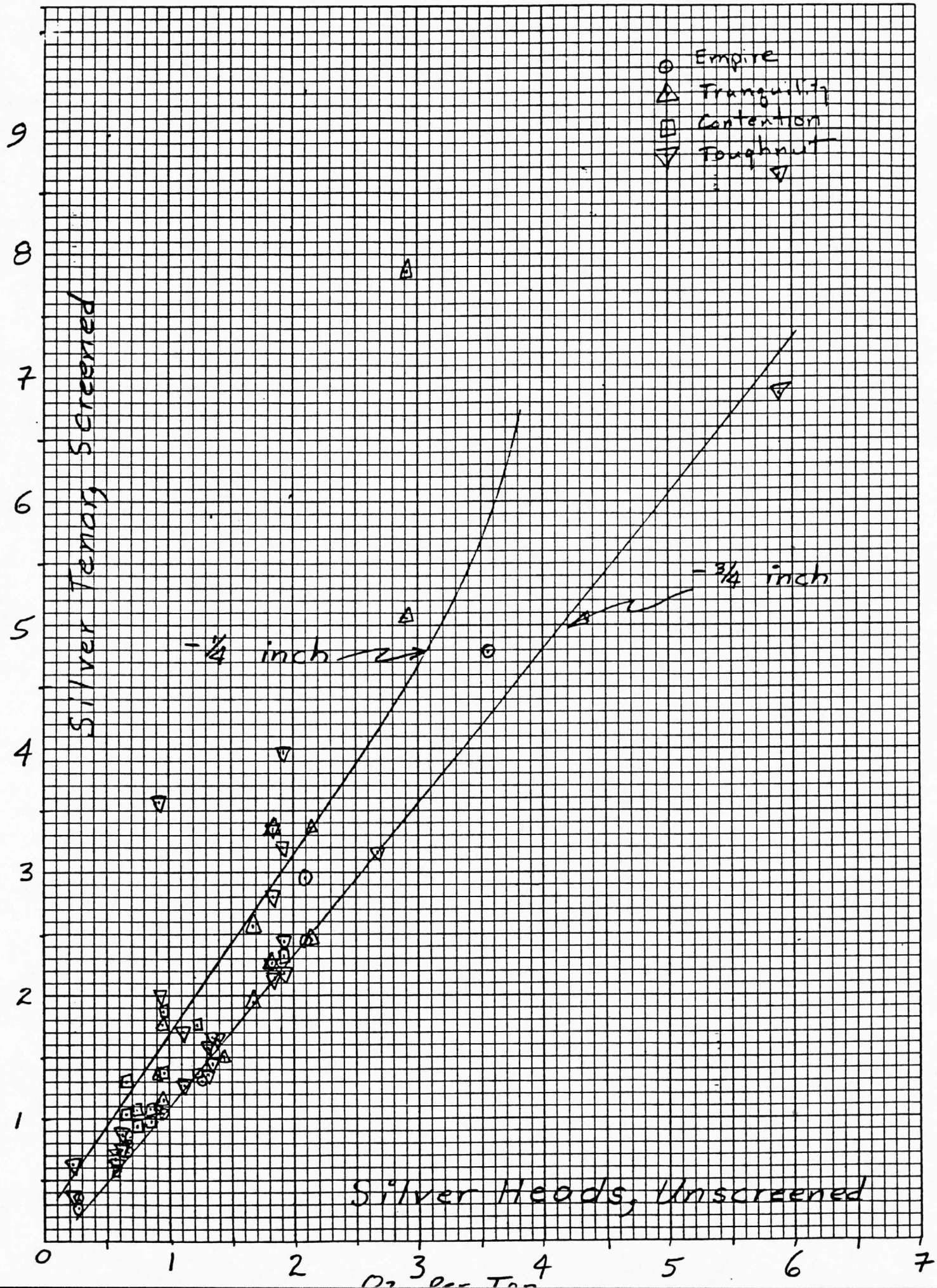
4741 EAST SUNRISE DRIVE
SKYLINE BEL AIRE PLAZA
TUCSON, ARIZONA 85718
602 / 299-9736

State of Maine- Brother Jonathan Dump

Sample No.	Tons	Au	Ag
J-1	2500	0.0138	2.6271
M-1	1700	0.0130	2.9867
M-2	1600	0.0090	3.9579
M-3	1500	0.0051	2.0187
M-4	500	---	2.7862
M-5	500	0.0072	3.0912
M-6	1000	---	3.6436
M-7	1000	0.0032	3.5445
M-8	1000	---	2.55
M-9	1000	---	3.57
M-10	1000	---	1.96
	13,300	.006	2.95



EUGENE DIETZGEN CO.
MADE IN U. S. A.
NO 340R-B DIETZGEN GRAPH PAPER
8 X 8 PER INCH



EUGENE DIETZGEN CO.
MADE IN U. S. A.
NO. 340R10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

TOMBSTONE
PRODUCTION SCHEDULE
(450 tons per day) Mellong

Time	Dump	Grade Au	Grade Ag	Recovered Value 95% Au, 75% Ag: $130/$3.50 Per Ton	Recovered Value 95% Au, 75% Ag: $130/$3.50 Per Month
March '74	Lucky Cuss	.039	2.91	$12.46	$155,750
April	Lucky Cuss	.039	2.91	12.46	155,750
May	Lucky Cuss	.039	2.91	12.46	155,750
June	Lucky Cuss	.039	2.91	12.46	155,750
July	Herschel	.015	3.47	10.96	137,000
Aug.	Oregon, Prompt., Boss	.018	3.25	10.75	134,375
Sept.	Tranquility	.049	1.59	10.23	127,875
Oct.	Tranquility	.049	1.59	10.23	127,875
Nov.	Tranquility	.049	1.59	10.23	127,875
Dec. '76	Tranq./Empire	.046	1.53	9.70	121,250
Jan. '75	Empire	.039	1.42	8.54	106,750
Feb.	Empire	.039	1.42	8.54	106,750
March	Empire	.039	1.42	8.54	106,750
April	Emp./Toughnut	.033	2.65	11.03	137,875
May	Toughnut	.027	2.82	10.74	134,250
June	Contention	.042	1.45	9.00	112,500
July	Contention	.042	1.45	9.00	112,500
Aug.	Contention	.042	1.45	9.00	112,500
Sept.	Contention	.042	1.45	9.00	112,500
Oct.	Cotention	.042	1.45	9.00	112,500
Nov.	Little Joe	.050	2.20	11.95	149,375
Dec. '75	Little Joe	.051	2.23	12.15	151,875
Jan. '76	Silver Thread	.030	2.22	9.53	119,125
Feb.	Bunker Hill	.021	3.39	11.49	143,625
March	Bunker Hill	.021	3.39	11.49	143,625
April	BH/San Pedro/St. M.	.008	3.53	10.25	128,125
May	St. Maine/Ingersol	.011	2.43	7.74	96,750
June	Comet/Defence	.028	1.78	8.13	101,625
July	Defence/Emerald	.025	1.93	8.15	101,875
Aug.	Emerald	.025	1.75	7.68	96,000
Sept.	Emerald	.025	1.75	7.68	96,000

PRODUCTION SCHEDULE

Dump	Total Tonnage	Segregated or Screened Au	Ag	Tonnage
Lucky Cuss	50,000	.039	2.91	50,000
Herschel	10,000	.015	3.47	10,000
Oregon	5,000	.003	4.17	5,000
Prompter	4,000	.005	3.63	4,000
Boss	5,000	.037	2.39	5,000
Tranquility	45,000	.049	1.59	45,000
Empire	45,000	.039	1.42	45,000
Toughnut	50,000	.027	2.82	20,000
Contention	127,800	.042	1.45	65,000
Little Joe	20,000	.051	2.23	20,000
Silver Tread	16,000	.030	2.22	16,000
Bunker Hill	25,800	.021	3.39	25,800
San Pedro	2,000	.005	4.48	2,000
State of Maine	15,000	.006	2.95	15,000
Ingersol	12,000	.017	1.71	5,000
Comet	15,000	.030	1.56	6,000
Defence	26,000	.025	2.01	11,000
Emerald	55,000	.025	1.75	38,000
Old Guard	20,000	.020	1.49	14,000
Rattlesnake	5,000	.010	2.80	3,000
Silver Plume	25,000	.014	1.03	11,000
Sulphuret	6,000	.043	1.05	3,000
West Side	60,000	.019	1.62	42,000
	644,600	.032	2.07	460.800

SIERRA METALS

R. F. HEWLETT
President

4741 EAST SUNRISE DRIVE
SKYLINE BEL AIRE PLAZA
TUCSON, ARIZONA 85718
602/299-9736

TOMBSTONE

METAL PRICE SENSITIVITY ANALYSIS

FOR HEAP LEACHING VS. MILLING

Assume:

1. Rate of mining for heap leaching is 45,000 tons-per-month
2. Heap leaching extraction percentages are 60% Au and 50% Ag
3. Heap leaching cost of production = $3 per ton
4. Rate of milling is 12,500 tons-per-month
5. Milling extraction percentages are 75% for Au and Ag
6. Milling cost of production = $7.50 per ton
7. Base prices are $170 Au and $4 Ag

Extraction Method	Recv. Au	Ext. Time	Au Month	Recv. Ag	Ext. Time	Ag Month
Heap Leach	11,239	12.6 ms.	892	550,602	12.6 ms.	43,699
Mill (H.L.)	3,938	16.8 ms.	234	505,439	16.8 ms.	30,086
H.L. & Mill	15,177	13.5 ms.	1126	1,056,041	14.3 ms.	73,785
Mill Only	14,999	64 ms.	234	1,313,901	64 ms.	20,530

Gold Price Change

$4 Ag - Monthly Net Profit Before Tax

Ext. Method	Gross Value Ag/Mo	Production Costs/Mo	Monthly Net	Au Gross Value		Au NPBT	
				$150	$200	$150	$200
Heap Leach	$174,796	$135,150	$39,646	$133,800	$178,400	$173,446	$218,046
Mill (H.L.)	120,344	93,754	26,590	35,100	46,800	61,690	73,390
H.L. & Mill	295,140	228,904	66,236	168,900	225,200	235,136	291,436
Mill Only	82,120	93,743	-11,623	35,100	46,800	23,477	35,177

SIERRA METALS

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From the above, notice the advantage of both heap leaching and milling. Comparisons of heap leaching and milling vs. milling follows:

	Heap Leaching & Milling	Milling Only
Tons Processed	567,631 + 210,009 = 799,940	799,940
Extraction Time	Less than 2 years	Over 5 years
Recovered Au	15,702 t. ounces	16,999 t. oz.
Recovered Ag	1,056,041 t. ounces	1,313,902 t. oz.
Gross Sales	$7,331,868	$8,668,641
Production Costs	$3,256,960	$5,919,556
Net Profit B. Tax	$4,074,908	$2,749,085
Av.Mon. Net Profit B.T.	$ 169,788 (2 yrs.)	$ 45,818 (5 yrs.)
Depletion, Total	$1,022,795	$1,209,275
Depletion, Yearly	$ 511,398 (2 yrs.)	$ 241,855

Utilization of the heap leaching method of gold-silver extraction in combination with the milling of the high-grade manganese ores minimizes the risks involved with using only ore extraction method, such as milling.

Evaluating the variables (risks) results as follows:

	Heap Leaching	Mill
Break-even Extraction Rate (Dec. 5)	23%	53%
Break-even Precious Metal Prices		
Gold (H.L. %=60/50; Mill %=85/75)	$54	$193
Silver (Same; Gold=60 & 85, Silver=50 & 75)	$ 2	$ 2

The graphical presentation is shown on the following page.

SIERRA METALS

R. F. HEWLETT
President

4741 EAST SUNRISE DRIVE
SKYLINE BEL AIRE PLAZA
TUCSON, ARIZONA 85718
602/299-9736

SUMMARY COMPARISON OF

MILLING AND HEAP LEACHING

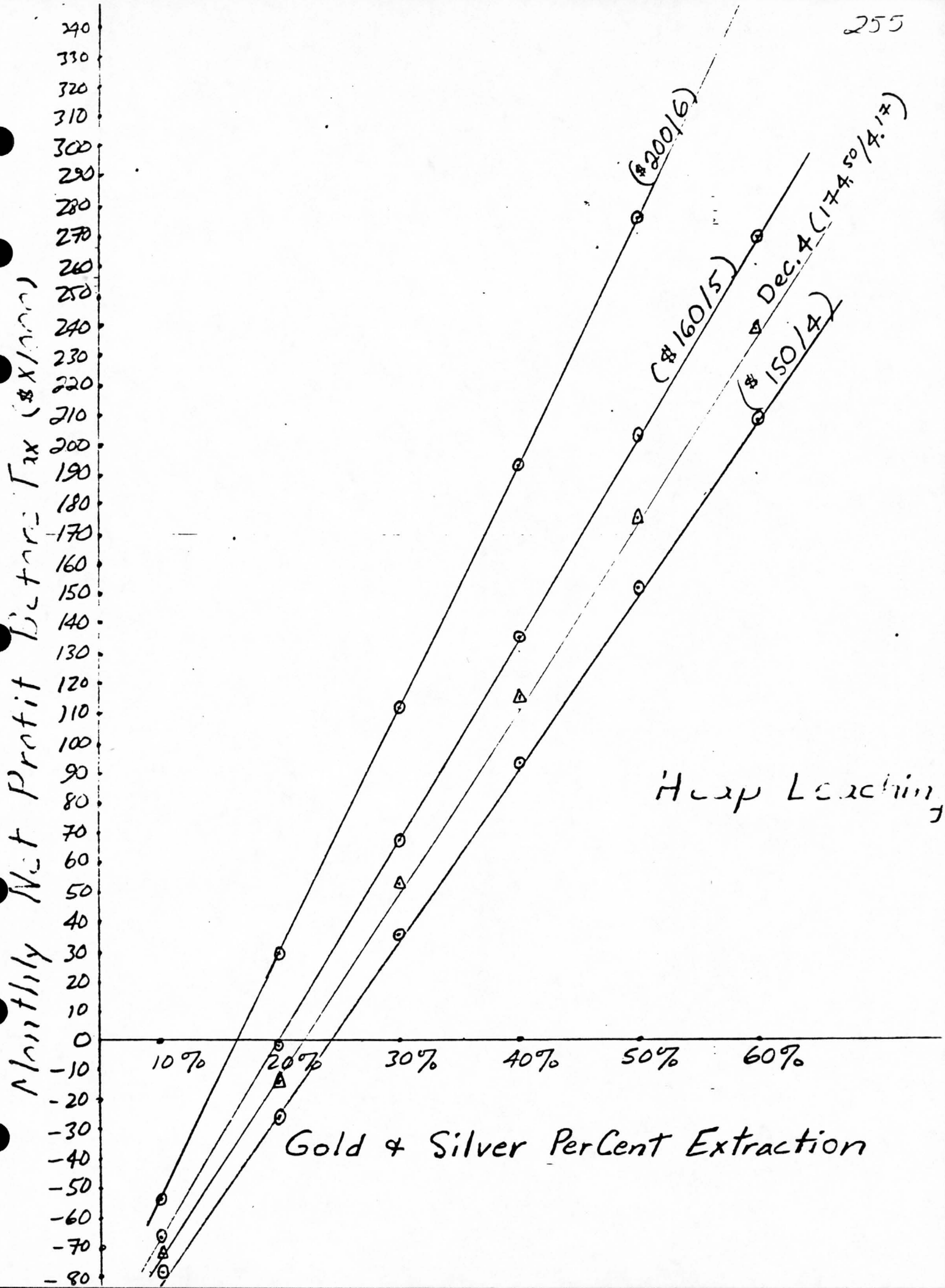
Constants:

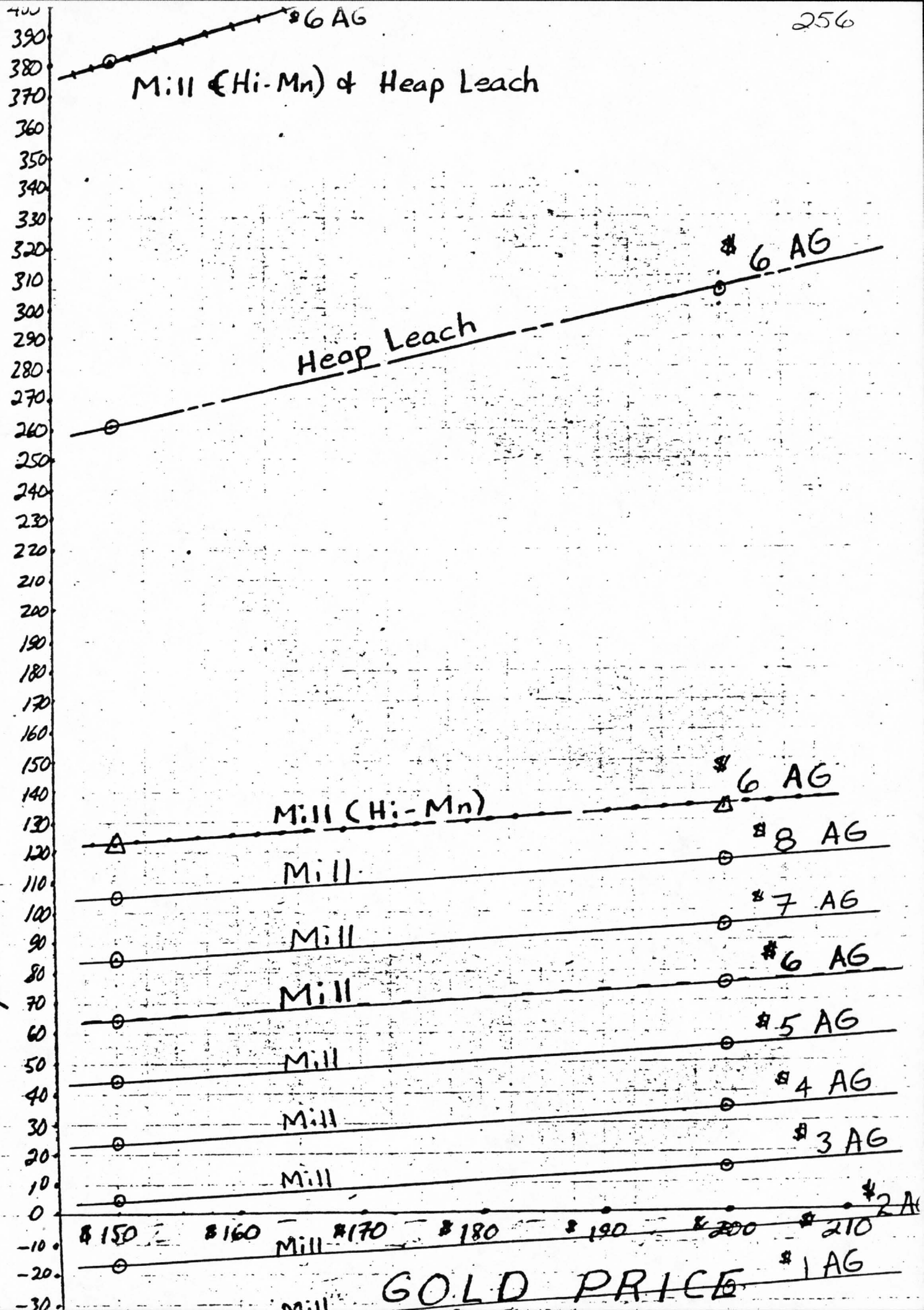
1. Gross Au = 19,999 t. ounces
2. Gross Ag = 1,751,869 T. ounces
3. Total tonnage = 799,940
4. Mill costs are $7.40 per ton
5. Heap leaching costs are $3.00 per ton

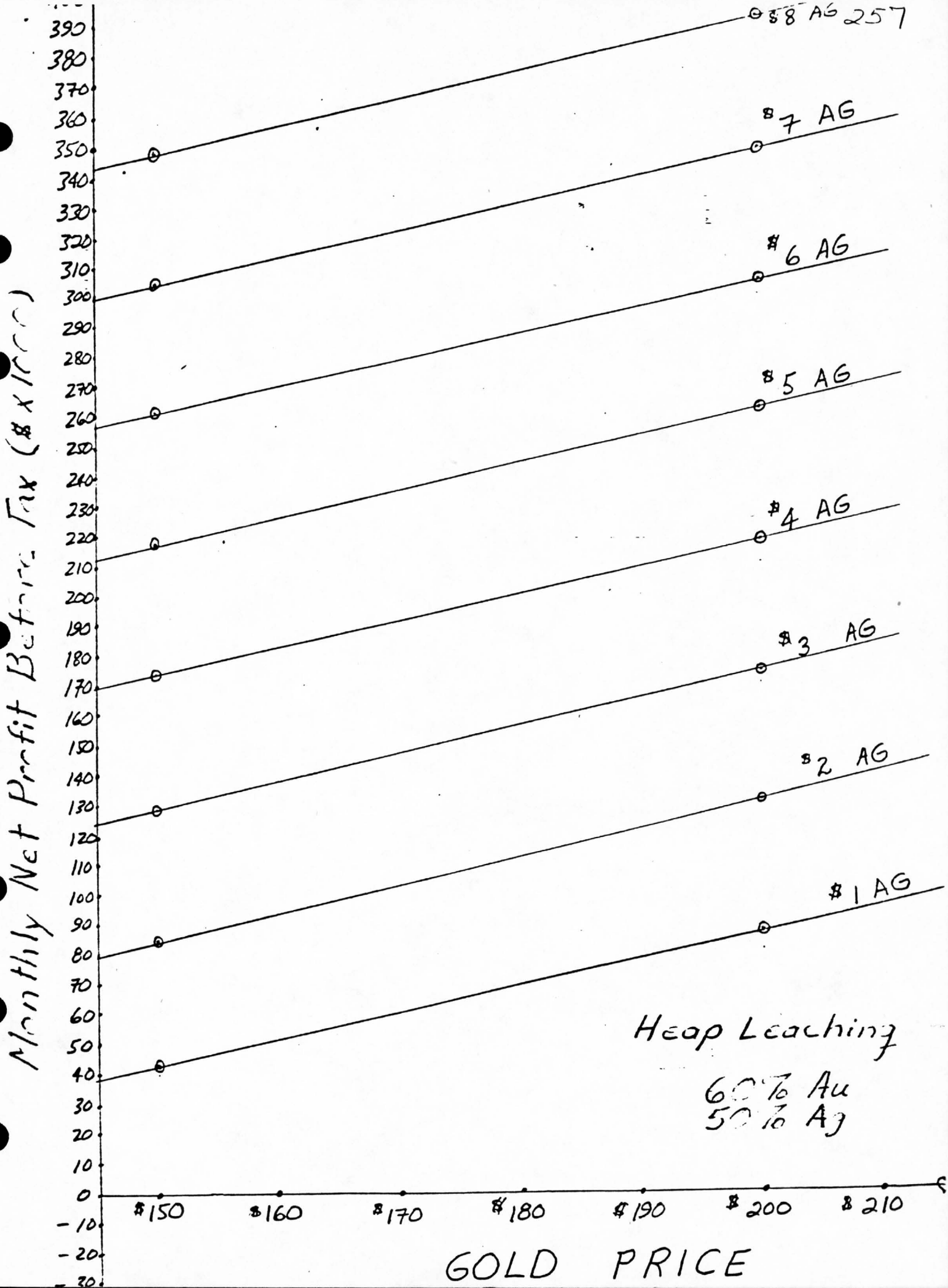
Variables:

1. Precious metal prices (Dec. 5; Au=$178.75, Ag=$4.285
2. Recovery - Mill: assumed 85% Au and 75% Ag
3. Recovery - Heap leach: assumed 60% Au and 50% Ag
4. Heap leaching rate: assumed 1500 tons-per-day

	Heap Leaching & Milling		Milling Only
	Heap Leach	Mill High-Manganese	Mill All Ore
Tons Processed	567,631	210,009	799,940
Extraction Rate	45,000 t.p.m.	12,500 t.p.m.	12,500 t.p.m.
Total Ext. Time	12.6 months	16.8 months	64 months
Recoverable Au	11,239	4,463	16,999
Recoverable Ag	550,602	505,439	1,313,902
Gross Sales	$4,368,301	$2,963,567	$8,668,641
Production Costs	1,702,893	1,554,067	5,919,556
Net Profit B. Tax	2,665,408	1,409,500	2,749,085
Av. Monthly NPBT	211,540	83,899	42,954
Depletion	$609,378	$413,417	$1,209,275


Monthly Net Profit Before Tax ($X/000)
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
10%
20%
30%
40%
50%
60%
($200/6)
($160/5)
Dec. 4 (174.50/4.17)
($150/4)
Heap Leaching
Gold & Silver PerCent Extraction


Monthly Net Profit Before Tax ($X1000)
$6 AG
Mill (Hi-Mn) & Heap Leach
$6 AG
Heap Leach
$6 AG
Mill (Hi-Mn)
$8 AG
Mill
$7 AG
Mill
$6 AG
Mill
$5 AG
Mill
$4 AG
Mill
$3 AG
Mill
$2 AG
Mill
$1 AG
Mill
$150
$160
$170
$180
$190
$200
$210
GOLD PRICE


$8 AG
$7 AG
$6 AG
$5 AG
$4 AG
$3 AG
$2 AG
$1 AG
257
Monthly Net Profit Before Tax ($ x 1000)
390
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
$150
$160
$170
$180
$190
$200
$210
GOLD PRICE
Heap Leaching
60% Au
50% Ag

SIERRA METALS

R. F. HEWLETT
President

4741 EAST SUNRISE DRIVE
SKYLINE BEL AIRE PLAZA
TUCSON, ARIZONA 85718
602/299-9736

SUMMARY OF TOMBSTONE HEAP LEACHING TESTS

Dump	Gold, T.oz. per ton			Silver, t.oz. per ton		
	1st Day	3rd	6th	1st Day	3rd	6th
Tranquility	.0133	.0190	.0200	.287	.37	.37
Empire	.0110	.0160	.0167	.193	.27	.27
Toughnut	.0056	.007	.007	.195	.24	.25
Contention #1	.0192	.024	.0244	.40	.54	.55
Little Joe	.0053	.007	.0077	.282	.44	.44
West Side	.0100	.0139	.0154	.453	.57	.57
Grand Central	.00882	.0103	.0103	.448	.58	.60
Lucky Cuss	.01422	.0182	.0182	.383	.55	.56
Emerald	.004	.0046	.0046	.40	.47	.47
Contention #2	.0170	.028	.0295	.764	1.08	1.14

SIX DAY RECOVERY DATA

Dump	Au	Ag	Gross Value ($185/4.50)	NPBT
Tranquility	.0200	.37	$ 5.37	$ 106,650
Empire	.0167	.27	4.30	58,500
Toughnut	.007	.25	2.43	--
Contention #1	.0244	.55	6.99	598,500
Little Joe	.0077	.44	3.40	--
West Side	.0154	.57	5.42	72,600
Grand Central	.0103	.60	4.61	80,500
Lucky Cuss	.0182	.56	5.89	158,950
Emerald	.0046	.47	2.97	--
Contention #2	.0295	1.14	10.59	151,800
				$1,227,500

NOTE: 395,000 tons at an average of $3.11 net profit per ton (not leaching Toughnut, Little Joe & Emerald)

HEAP LEACHING VS. MILLING

Dump	Mill Recvry. (Au/Ag)	H.L. Recovery Troy Ounces Au	H.L. Recovery Troy Ounces Ag	Mill Recovery Troy Ounces Au	Mill Recovery Troy Ounces Ag	Tons
Tranquility	75/75	900	16,650	1,654	53,663	45,000
Empire	75/75	752	12,150	1,316	47,925	45,000
Contention # 1	75/75	3,660	82,500	4,725	163,125	150,000
West Side	81/75	462	17,100	462	36,450	30,000
Grand Central	75/75	515	30,000	1,125	54,000	50,000
Lucky Cuss	75/60	1,001	30,800	1,609	110,550	55,000

Dump	Heap Leaching Gross Value ($185/4.5) Au	Ag	Total	Prod. Cost (3)	Net Profit Before Tax
Tranquility	$166,500	$ 74,925	$ 241,425	$135,000	$106,425
Empire	139,120	54,675	193,795	135,000	58,795
Contention # 1	677,100	371,250	1,048,350	450,000	598,350
West Side	85,470	76,950	162,420	90,000	72,420
Grand Central	95,275	135,000	230,275	150,000	80,275
Lucky Cuss	185,185	138,600	323,785	165,000	158,785

Dump	Milling Gross Value ($185/4.5) Au	Ag	Total	Prod. Cost (7.5)	Net Profit Before Tax
Tranquility	$305,990	$241,484	$ 547,474	$ 337,500	$209,974
Empire	243,460	215,663	459,123	337,500	121,623
Contention # 1	874,125	734,063	1,608,188	1,125,000	483,188
West Side	85,470	164,025	249,495	225,000	24,495
Grand Central	208,125	243,000	451,125	375,000	76,125
Lucky Cuss	297,665	497,475	795,140	412,500	382,640

Dump	Net Profit Before Tax		Net Profit Before Tax Monthly	
	H.L.	Milling	H.L.	Milling
Tranquility	$ 106,425	$ 209,974	$106,425	$58,326
Empire	58,795	121,623	58,795	33,784
Contention # 1	598,350	483,188	179,685	40,266
West Side	72,420	24,495	108,090	10,206
Grand Central	80,275	76,125	72,320	19,031
Lucky Cuss	158,785	382,640	130,152	86,964
	$1,075,050	$1,298,045		

From the above, perhaps an economic criteria for the heap leach vs. mill decision might be:

2. Monthly profit rate
1. Net profit difference

This could be shown as:

Dump	Net Profit Difference		
	Total	Ratio $\frac{(\text{Milling})}{(\text{H.L.})}$	Monthly $\frac{(\text{H.L.})}{(\text{Milling})}$
Tranquility	$103,549 (M)	1.97	1.82
Empire	62,828 (M)	2.07	1.74
Contention # 1	115,162 (H.L.)	0.81	4.46
West Side	47,925 (H.L.)	0.34	10.59
Grand Central	4,150 (H.L.)	0.95	3.80
Lucky Cuss	223,855 (M)	2.41	1.50

Therefore, from the net profit difference, the following are obvious:

1. Heap leach; Contention #1, West Side, and Grand Central

From the net profit ratio, the following are shown:

1. Two clusters of values, obvious heap leach (below unity) and about twice the net profit by milling

The monthly net profit ratio (H.L./Milling) shows:

1. A trade-off on the monthly cash flow and net profit difference on the Tranquility, Empire and Lucky Cuss

A present worth analysis of heap leaching the six economic dumps (375,000 tons) follows:

Month	PW (12%)	Income		Discounted Income	
		H.L.	Mill	Heap Leach	Mill
3	.974	$ 387,407	$ 148,500	$ 377,334	$ 144,639
6	.947	387,407	148,500	366,874	140,630
9	.920	300,886	148,500	276,815	136,620
12	.893	--	148,500	--	132,611
15	.869	--	148,500	--	129,047
18	.845	--	148,500	--	125,483
21	.821	--	148,500	--	121,919
24	.797	--	148,500	--	118,355
27	.776	--	148,500	--	115,236
30	.755	--	69,300	--	52,322
		$1,075,700	$1,405,800	$1,021,023	$1,216,862

Therefore, the discounted income is very nearly the same, without considering the differential in capital investment.

DUMP SAMPLING COMPARISONS

Cyanide VS AA

Dump Name		Austral Oil Au	Austral Oil Ag	Duval Au	Duval Ag	Sierra Au	Sierra Ag
Empire	us	-	-	-	-	.039	1.42
	s	.080	1.90	.085	1.39	.044	1.58
Tranquility	us	.031	1.42	-	-	.049	1.59
	s	-	-	.082	1.50	.070	2.10
Contention	us	.013	.87	-	-	.016	.90
	s	-	-	.058	1.02	.042	1.45
Little Joe (Grand Central)	us	.010	.60	-	-		
	s	-	-	.051	2.23		
Sulphuret	us	.022	.66	.030	.80		
	s	-	-	-	-		
Silver Thread	us	.025	1.33	-	-		
	s	-	-	.030	2.22		
Lucky Cuss	us	.040	2.98			.039	2.91
	s	-	-			.065	5.01
Toughnut	us	.009	.54			.013	1.52
	s	-	-			.027	2.82
Bonanza		-	6.00			-	5.74
State of Maine		-	4.50			-	3.90
Soltice		.004	2.80			-	3.4
N. Bonanza		.003	1.84			-	4.4
Joseph		-	1.02			-	1.30
Br. Jonathan		-	1.94			-	3.0

NOTE: us = unscreened
s = screened

New Pueblo CONSTRUCTORS Inc.
P. O. BOX 27566
TUCSON, ARIZONA 85726
4115 EAST ILLINOIS STREET — PHONE 748-8000
GENERAL CONTRACTORS AND HEAVY ENGINEERING

KARL G. RONSTADT
PRESIDENT

February 27, 1979

Mr. James Briscoe
S.E.A. Hydromet
4500 East Speedway Blvd.
Tucson, Arizona 85712

Dear Jim:

Confirming the conversation Dick Yaeger, you and I had yesterday I am enclosing copies of estimates for your precious metals project at Tombstone.

To summarize: Estimated costs for varying quantities with a Commander III crusher (16 X 48 jaw, 6' X 20' triple deck screen, triple 30" rolls, 700 hp engine and necessary support equipment), product crushed to 1/2" minus and stockpiled by stacking conveyor only. Excluded are facilities for blending in chemicals or additives

Minimum	150/Ton/Hour	200/Tons/Hour
30,000 Tons	$4.96/Ton	$4.39/Ton
100,000 Tons	3.45/Ton	2.91/Ton
1,000,000 Tons	2.70/Ton	2.14/Ton

Included in the preceding cost is amoritization of the crushing plant and associated conveyors to a maximum of $300,000, an allowance for an increase of 7% in wages over current wage schedules and one month's standby costs on crushing equipment of approximately $15,000.

As an alternative (on behalf of commencing the project and creating current cash flow for minimum expenditure) we have provided a second estimate which includes crushing approximately 30,000 tons to a maximum of 1 1/4". This would be done by a combination of a jaw crusher and an 855 Cedarapids Commander crusher. This equipment would be moved in sometime after March 15, crushing for approximately two weeks, stockpiling 30,000 tons by stacking conveyor and thereupon be removed. It is anticipated this 30,000 tons would be of the highest grade ore available and thereby accelerate cash flow on the project. The remaining course rock above 1/2" could be crushed to a finer dimension (1/2") at a later date. The estimated cost per ton for 30,000 tons would be $2.44/ton or $73,260.00.

Payment for costs incurred would be due 30 days after invoicing. These costs would include all direct costs plus 11% overhead and administration as contained and accounted for in New Pueblo's standard job cost accounting system. Method of defining costs would be in accordance with attached "Schedule of Project Costs".

We propose to take no profit on the project until such time as the cash flow of the project exceeds expenditures and necessary reserves at which time we would receive 10% of the net profit on the project as our share of the profits. Thus we are hereby offering to manage the costs of processing and stockpiling for minimum cost and overhead and participating in the net results as a 10% partner entitled to 10% of the net revenues or benefits. All expenditures concerning the processing and crushing would be subject to review by management of the project and accounting by both parties would be subject to audit as appropriate.

Your acceptance of this proposal by signature below and return of one copy will constitute agreement.

Very truly yours,

NEW PUEBLO CONSTRUCTORS, INC.

Karl G. Ronstadt, President

KGR/kb

Attachments: Two Cost Estimates (copies)
NPC Schedule of Project Costs

ACCEPTED BY:

_____

Date: _____

NEW PUEBLO CONSTRUCTORS, INC.
SCHEDULE OF PROJECT COSTS

Description	I Items Reimbursable At Cost, Including Direct Costs on Salaries & Wages	II Non-reimbursable Items Covered By Administrative & Overhead Charges
1. HOME OFFICE COSTS		
A. Executive Salaries & Expenses		X
B. Engineering		
1. Chief Engineer		X
2. Project Engineer	X	
3. Design Engineer	X	
4. Detail Draftsman	X	
5. Material Take-Off	X	
6. Estimating Engineer	X	
7. Specifications Engineer	X	
8. Critical Path Scheduling	X	
9. Engineering Clerk	X	
10. Secretarial Service	X	
11. O.A.B., Social Security and Other Payroll Tax	X	
12. Compensation Insurance, Public Liability and Similar Insurance	X	
13. Payroll and Accounting Expense		X
14. Sick Leave and Absence for Cause		X
15. Standby Salaries		X
16. Pensions		X
17. Proportional Cost of Light, Heat, Rent, etc.		X
18. General Supplies and Equipment		X
19. Personnel Procurement		X
20. Actual Cost of Copy Work	X	
21. Computer Service	X	
22. Overtime As Necessary		
22.1 Straight time portion of cost	X	
22.2 Premium portion of cost	X	
C. Project Management		
1. Project Manager	X	
2. Project Engineers	X	
3. Cost Engineers	X	
4. Stenographic and Clerical	X	
5. Expediters & Purchasing Clerk	X	
D. Central Accounting		
1. Chief Accountant and Staff		X
2. Field Auditor		X

Description	I Items Reimbursable At Cost, Including Direct Costs on Salaries & Wages	II Non-reimbursable Items Covered By Administrative & Overhead Charges
HOME OFFICE COSTS - cont'd		
E. Labor Relations Personnel		X
F. Construction Manager and Staff		X
G. Chief Purchasing Agent		X
H. General Office Expenses		
1. Traveling Expenses of above employees when on trips authorized by you	X	
2. Long Distance Telephone, Telegraph and Teletype	X	
3. Local Telephone Service		X
4. Rental on Business Machines		X
5. Group Insurance, Hospitalization		X
6. Parcel Post and Express	X	
7. Postage	X	
8. Depreciation, Repairs & Maintenance		X
9. Rent, Light, Heat, Taxes and Insurance		X
10. Office Supplies and Stationery		X
11. Forms required specially for a particular Customer	X	
12. Miscellaneous Items, such as Want Ads, Subscriptions, Dues, Catalogs, Bulletins		X
13. For monthly field service which includes project ledgers, cost report work sheets, cost reports, field payroll earnings records, quarterly reports, workmens compensation for field personnel.		X
2. MATERIALS, SUBCONTRACTS, AND CONSTRUCTION SUPPLIES COSTS		
A. Actual cost of all material and equipment, including transportation and unloading of same, whether purchased by you or by ourselves. All discounts and commissions are passed on to the Customer.	X	
3. Actual Manufacturing cost of any Equipment made in our shops. Equipment can be furnished at fixed prices.	X	

Description	I Items Reimbursable At Cost, Including Direct Costs on Salaries & Wages	II Non-reimbursable Items Covered By Administrative & Overhead Charges
MATERIALS, SUBCONTRACTS, AND CONSTRUCTION SUPPLIES COSTS - cont'd		
C. All Subcontracts	X	
D. All expendable materials and construction supplies, also water & electricity	X	
3. FIELD LABOR AND RELATED COSTS		
A. Salaries and Wages		
1. Field Superintendent of Construction	X	
2. Assistant Superintendent	X	
3. General Foreman	X	
4. Resident Engineer	X	
5. Chief Surveyor	X	
6. Instrument Men, Stakers & Rodmen	X	
7. Field Accountant and Staff	X	
8. Cost Analysis Engineer	X	
9. Timekeepers	X	
10. Field Purchasing Agent	X	
11. Warehousemen and Helpers	X	
12. Safety Engineer, Doctor & Nurses	X	
13. Watchmen and Guards	X	
14. Other necessary Non-Manual Field Employees	X	
15. Overtime pay for 3-A (1 to 14) above, in accordance with Established Policy and with your prior approval	X	
15.1 When Overtime is Worked, the overtime premium payroll will be a job cost.		
16. Vacation and Holiday allowances, in accordance with NPC policy	X	
17. Sick leave for monthly salary employees		X
B. Travel and living expense and subsistence for personnel 3-A (1 to 14) above, in accordance with NPC policy	X	
Social Security, Unemployment Insurance and Payroll Taxes applicable to Employees, 3-A (1 to 15) above.	X	
D. All Job Site Craft and common labor salaries, wages and fringe benefits as required by working rules of Unions having jurisdiction, including travel and premium pay allowances for field manual employees.	X	

Description	I Items Reimbursable At Cost, Including Direct Costs on Salaries & Wages	II Non-reimbursable Items Covered By Administrative & Overhead Charges
FIELD LABOR AND RELATED COSTS - cont'd		
D(a) When overtime is worked, the premium overtime payroll will be a job cost with no addition for Contractors burden or fee.		
(1) Labor for tie in of subcontract installations	X	
(1.1) Material for tie in of subcontract installations	X	
(2) Labor to install changes after start-up	X	
(2.1) Material needed to install changes after start-up	X	
E. Social Security, Unemployment Insurance and Payroll Taxes applicable to employees in 3-D.	X	
F. Workmen's Compensation; Liability, Property Damage, Builders Risk and other insurance as required.	X	
G. Cost of labor recruitment, testing and transportation to the Job Site.	X	
H. Cost of labor negotiations, specifically for this work as required.	X	
I. Cost of Engineers, Technicians, or Manufacturer's Specialists for installation and start-up.	X	
4. CONSTRUCTION EQUIPMENT AND TOOL COST		
A. Transportation and handling costs to move tools and equipment to and from the job.	X	
B. Purchase of major construction equipment.	X	
C. Rental of major construction equipment from others, at cost (outside rented equipment).	X	
D. Rental and transportation of any construction equipment, whether furnished by contractor or others. Rental rates for contractor owned equipment, if available, will be negotiated.	X	

Description	I Items Reimbursable At Cost, Including Direct Costs on Salaries & Wages	II Non-reimbursable Items Covered By Administrative & Overhead Charges
4. CONSTRUCTION EQUIPMENT AND TOOL COST - cont'd		
D(a) Normally NPC equipment "Use" rate will be charged. This rate includes all costs of ownership, and operation except operator labor. These rates are fueled & maintained, and are based on A.E.D. Rates. 50% of this rate will be charged for stand-by time. No charge will be made if equipment is stored or inoperative.		
E. Small Tools and Rigging	X	
F. Maintenance of outside rented equipment and tools, including renovating at end of job.	X	
G. Gas, Oil and other maintenance supplies on outside rented equipment only.	X	
5. MISCELLANEOUS JOB COSTS		
A. Temporary Construction Facilities	X	
B. Field Office, Furniture, Office Equipment	X	
C. Building Permits and Licenses	X	
D. Field Telephone & Telegraph	X	
E. Premium of Compensation Insurance, Public Liability and Property Damage, Automobile Public Liability and Property Damage, and any other insurance required for Field Payroll or Plant, job incurred only.	X	
F. Losses or Expenses not compensated by Insurance.	X	
G. Rental cars at cost.	X	
H. Sales, Use and Privilege Taxes (if any).	X	
I. All other direct cash outlays for job costs not specifically excluded.	X	
J. Outside consultants.	X	

Description	I Items Reimbursable At Cost, Including Direct Costs on Salaries & Wages	II Non-reimbursable Items Covered By Administrative & Overhead Charges
MISCELLANEOUS JOB COSTS - cont'd		
K. Inspection in Suppliers Shop or in Field. Includes travel time and travel and living expense.	X	
L. Cost of legal fees and expenses caused by Force Majeure.	X	
M. Cost of Performance Bond (if required).	X	

DESIGN

HEWLETT MANAGEMENT

R. F. HEWLETT
PHONE (702) 731-1601

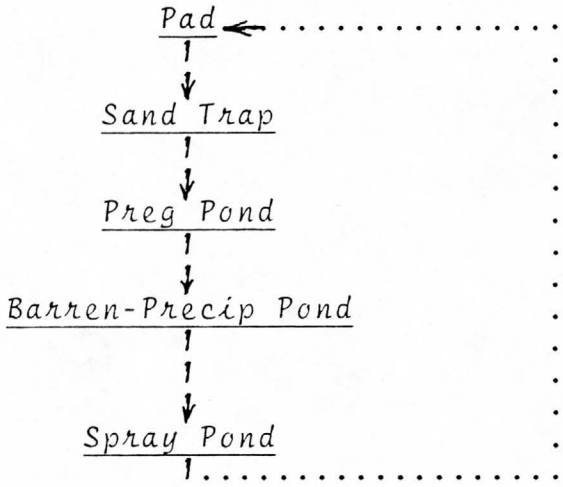
730 ROYAL CREST CIRCLE S.
APT. 438
LAS VEGAS, NEVADA 89109

PAD AND POND DESIGN

A pad and pond layout is shown for a Nevada mining property that I recently designed. Figure 1 shows the topography and claim boundaries. Notice that the entire pad and pond layout is restricted to one patented claim(less than 20 acres).

Figure 2 presents the pad and pond layout. Notice that the pads "wrap-around" the ponds and topography.

The pond layout utilizes the following design concept:



For any plant, whether Merrill-Crowe zinc precipitation, carbon, ion-exchange, or direct precipitation is used, adaquate settling is critical(and the most commonly made mistake). It is critical that a clear preg goes to the deaeration tower or it will foul the deaeration chamber and in any case it is not desireable to have slimes in the precip product because of the refinery deductions and confusion on gold-silver weight and moisture content.

Kewana #3 Survey

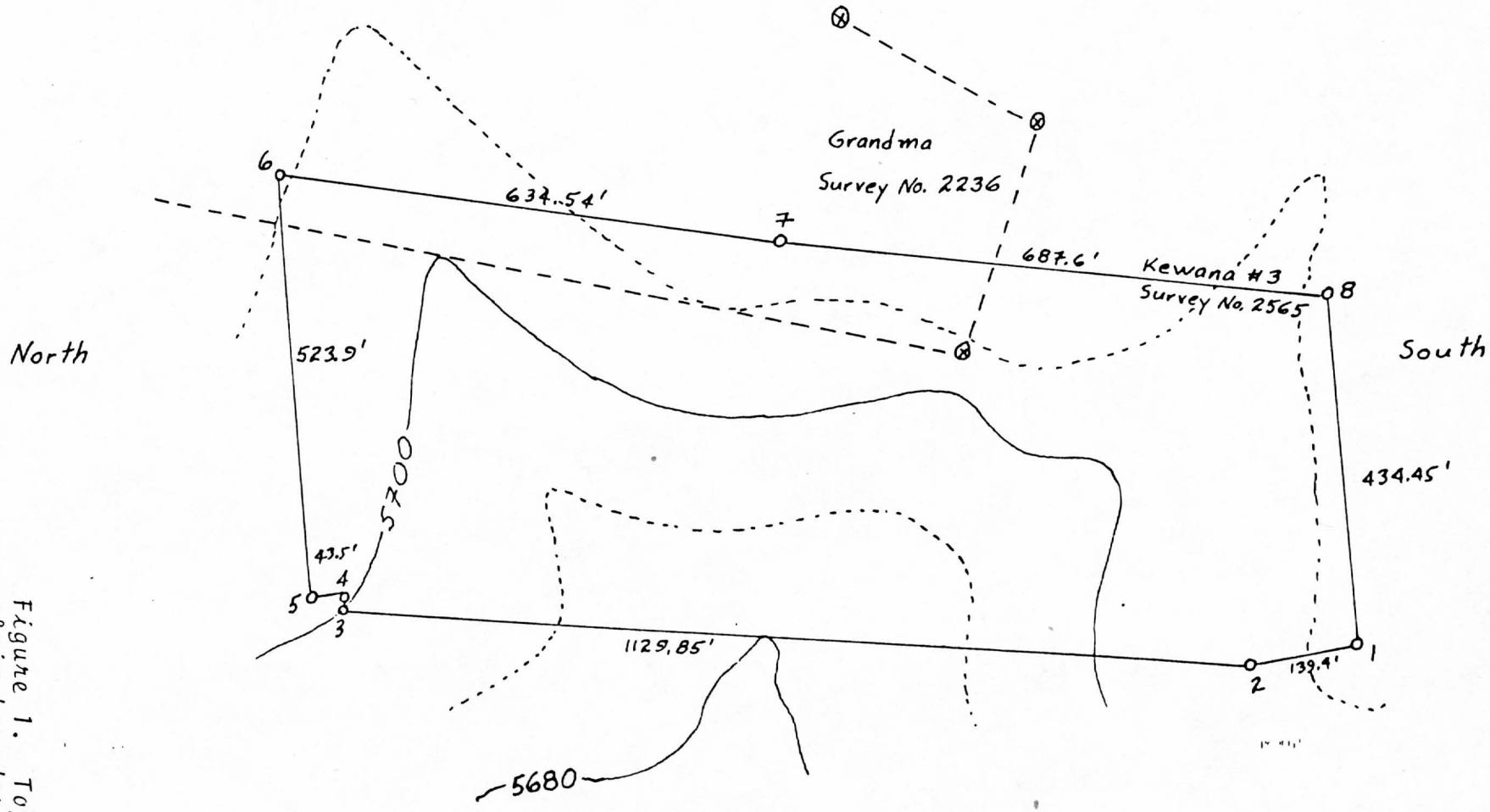


Figure 1. Topo and claim boundaries.

Kewana #3 Pad & Pond Layout

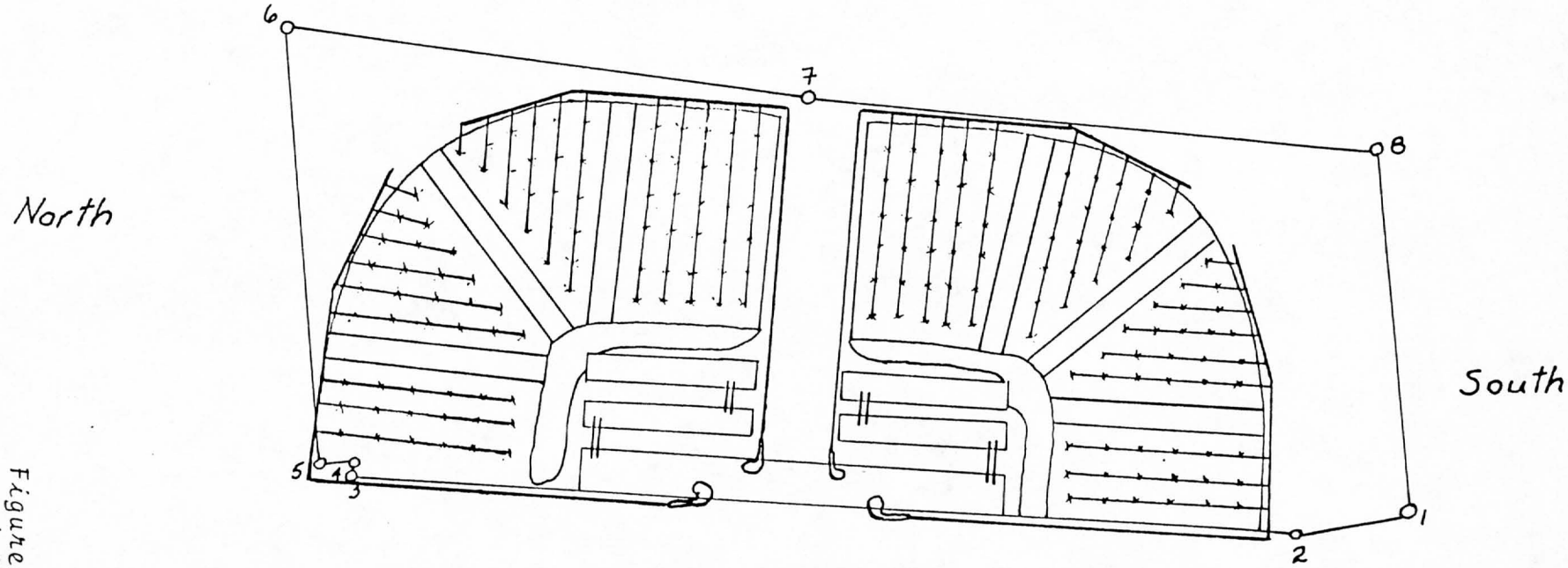


Figure 2. Pad and pond layout & spray manifold-lines-birds.

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Pad Capacity

Figure 2 shows the pad broken into 4 "ore-sectors". This is done to accommodate a 30-foot aisle between the ore heaps in case access to the heaps is required(at Goldfield, this was necessary to allow a crane with a clam-shell to "mix-up" the heap due to the extreme kaolinite content). Capacities are computed for 5 foot-lift heights:

Pad Location	Sector	Tons(5 foot lift height)
South	South	13,186 tons
South	East	17,218 "
North	North	13,186 "
North	East	17,218 "
	Total	60,908 tons

Total tonnage on the pad for various ultimate heights are:

Ultimate Height	Total tonnage on pad
5 '	60,908 tons
10 '	121,816 "
15 '	182,724 "
20 '	243,632 "
25 '	304,540 "
30 '	365,448 "
35 '	426,356 "
40 '	487,264 "
45 '	548,172 "
50 '	609,080 "

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Pad Construction

The time and equipment requirements for pad construction follows for the following paramenters:

A. Pad area.....480,000 sq. ft.
B. Pad construction material; "desert dirt", clay, or tailings(plus 1-foot deep)

1. Move and level 7200 cu. yds. material;

	Equipment	Number of 9 hr. working days
A.	1 dozer	12
	1 Cat 12E road blade	5
	1 35-ton truck(compacting)	5
	1 4000-gal water truck	5
B.	1 dozer	5
	1 Cat 12E road blade	5
	1 35-ton truck(compaction)	5
	1 4000-gal water truck	5
	2 35-ton trucks- 1 988 Loader	5
C.	1 scraper	5½
	1 4000-gal water truck	5½
	1 Cat 12E road blade	5½

2. To haul, process, and compact 4320 cu. yds.;

Equipment	Number of 9 hr. working days
2 35-ton trucks-1 988 Loader	5
1 dozer(leveling for trucks)	12 hrs.(1.3)
1 Cat 12E road blade	12
1 35-ton truck(compacting)	12
1 4000-gal water truck	5

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Summary for Pad Construction

Following are the requirements for pad construction:

Equipment	Total 9 hr. working days
2 35-ton trucks-1 988 Loader	10
1 dozer	6 1/3
1 Cat 12E road blade	17
1 35-ton truck(compacting)	17
1 4000-gal water truck	10

Pond Capacities

Following are the pond types, capacities, and specifications:

Location	Type	Capacity	Length	Width	Height
South	Preg	192,112 gal	200 '	34 '	6 '
South	Precip	192,112 "	200 '	34 '	6 '
North	Preg	192,112 "	200 '	34 '	6 '
North	Precip	192,112 "	200 '	34 '	6 '
Both N&S	Spray	1,107,188 "	500 '	50 '	10 '

Pond Construction

1. Four ponds(Preg and Precip); 1500 cu. ysd. each or
   6000 cu. yds. total excavation

Equipment	Number of 9 hr. working days
1 dozer	12
1 Cat 12E road blade	2
1 4000-gal water truck	4
2 35-ton truck-1 988 loader(haul 800 cu. yds. to seal ponds)	6 hrs.
1 dozer(spread clay)	3
1 988 Loader(compacting)	12 hrs.

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2. Spray pond; 7400 cu. yds. excavation

Equipment	Number of 9 hr. working days
1 dozer	7
1 Cat 12E road blade	1
1 4000-gal water truck	2
2 35-ton trucks- 1 988 loader(haul 500 cu. yds. to seal pond)	4 hrs.
1 dozer(spread clay)	1½
1 988 loader(compacting clay)	5 hrs.

3. Sand ditch; 400'X20'X10' sand ditch-3000 cu. yds. excavation

Equipment	Number of 9 hr. working days
1 dozer	6
1 Cat 12E road blade	1
1 4000-gal water truck	2
2 35-ton trucks-1 988 loader(haul 250 cu. yds. clay to seal ditch)	2 hrs.
1 dozer(spread clay)	1
1 988 loader(compacting)	5 hrs.

Summary of Pond Construction

Equipment	Number of 9 hr. working days
1 dozer	30½
1 Cat 12E road blade	4
1 4000-gal water truck	8
2 35-ton trucks-1 988 loader	1½
1 988 loader	2½

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Summary of Pad & Pond Construction

Equipment	Number of 9 hr. Working Days	Total Hours
1 dozer	37 days	333 hrs.
1 Cat 12E road blade	21 "	189 "
1 4000-gal water truck	18 "	162 "
35-ton truck(s)		
Compaction(1)	17 "	153 "
Hauling(2)	11½ "	103½ "
988 Loader		
Compaction	2½ "	22½ "
Loading	11½ "	103½ "

Equipment	No. Hours	Equip.$/hr.	Equip.$	Labor $($7/hr)
Dozer	333	$46	$15,318	$ 2,331
Road Blade	189	30	5,670	1,323
Water Truck	162	25	4,050	1,134
35-ton Truck	359	34	12,206	2,513
988 Loader	125	36	4,500	875
			41,744	8,176

Total= $ 49,920

Pad Construction Costs

Clay Pad-short haul(GOLDFIELD)..... $0.25/ft^2

Tailings-moderate haul(CRIPPLE CREEK)..... $0.65/ft^2

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EQUIPMENT COSTS

Item	Make	Year	Purchase Plan	Total Cost	Monthly
35-ton Truck	Cat. 769B	1976	Lease-Purchase (3 month comm.)	$ 121,600	$ 5,500
6-yd Loader	Cat. 988	1976	Lease-Purchase (3 month comm.)	$ 126,000	$ 5,750
Tractor-dozer	Cat. D8K	1976	Lease-Purchase (6 month comm.)	$ 157,631	$ 7,300
4-yd Loader	Cat. 977	1977	Purchase	$ 51,750	

COSTS

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HEAP LEACHING CASE HISTORY

Cripple Creek, Colorado

General Parameters

Altitude; 10,500
Season; 7 months (April-October)
Type of mining; Open-pit
Plant; Merrill-Crowe Zinc Precipitation

Specific Parameters

Ore tonnage to leach/month; 75,000
Stripping Ratio; 0.443 (W/O)
Tons Waste/month; 33,225
Total tons/month; 108,225

Mining Equipment

1- 988 Cat Loader
3- 769 Cat 35-ton Trucks
2- Drill w/compressors
1- D8K Cat Dozer w/ripper
1- Cat No. 12 Grader
3- Pick-ups, 3/4 ton
1- Water Truck

Personnel

General;		
	Project Manager	1
	Clerk	1.....2
Mining;		
	Foreman	2
	Surveyor	1
	Loader Operators	2
	Truck Drivers	6
	Drillers	4
	Blaster	1
	Helper-Sampler (drill)	1
	Dozer-Grader Operators	2
	Mechanics	2.....21
Leach Plant;		
	Operators	4
	Laborers	2.....6
Lab;		
	Assayor	1
	Helper	1...2

TOTAL.....31**********

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SUMMARY

Phase	Category	Cost	Percent
Pre-Production	Mining	$ 66,325	21.19 %
"	Pad Const.	117,322	37.48 %
"	Plant Const.	110,000	35.14 %
"	Gen. Admin.	7,400	2.36 %
"	Indirect	12,000	3.83 %
		$313,047	100.
Operations	Mining		57.86 %
"	Leaching		25.05 %
"	Gen. Admin.		12.91 %
"	Indirect		5.75 %
		$765,000*	100.

*For 6 months operation

Note: In the following break-down, I use actual costs for Pre-Production, and I have used a base of $1,000,000 for the operating cost break-down to facilitate percent to be computed and because most operations would operate for longer than June through November, resulting in operating costs greater than $765,000.

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PRE-PRODUCTION

Cost Categories-MINING

	$(Actual)	Percent
Mine Administration;		
120-Supervision Salaries	$ 2,750	
121-Wages	1,200	
122-Vehicle Expense	500	
123-Misc.	--	
	4,450	1.42 %
Sample Preparation & Assay;		
130-Salaries	4,900	
131-Wages	--	
132-Supplies	1,100	
133-Misc.	--	
	6,000	1.92 %
Mine Eng. & Dev. Drilling;		
140-Mine Engineering	8,000	
145-Development Drilling	8,000	
	16,000	5.11 %
Drilling;		
150-Wages, Operational	2,900	
151-Wages, M&R	750	
152-Operating Supplies	3,200	
153-Equipment Rental	2,500	
154-Equipment Relocation	1,800	
155-Site Preparation	1,000	
	12,150	3.88 %
Blasting;		
160-Wages, Operation	500	
161-Explosives & Misc.	7,500	
162-Equipment Rental	100	
	8,100	
		2.59 %

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PRE-PRODUCTION

Mining-Continued

	$(Actual)	Percent
Loading;		
170-Wages, Operating	$ 1,200	
171-Wages, M&R	300	
172-Operating Supplies	800	
173-Equipment Rental	2,875	
	5,176	1.65 %
Haulage;		
180-Wages, Operating	3,000	
181-Wages, M&R	850	
182-Road Construction	--	
183-Fuel	750	
184-Lubricants	--	
185-Tires & Tubes	--	
186-Truck Parts	--	
187-Equipment Rental	8,250	
188-Misc. Supplies	--	
189-Equipment Relocation	1,600	
	14,450	4.62 %
Dozing & Grading;		
190-Wages, Operating	--	
191-Wages, M&R	--	
192-Operating Supplies	--	
193-Equipment Rental	--	
194-Equipment Relocation	--	0.00 %
Pad Site Preparation;		
198-Construction	30,000	9.58 &
Pad Construction;		
601-Operating Labor	4,338	
603-Sampling	3,467	
604-Soil Tests	2,857	
605-Diesel Fuel & Lubricants	3,364	
606-Road Construction	135	
607-Contractor(Pad&Road)	37,299	
610-Pipe Lines	6,897	
611-Explosives	774	
612-Power	2,206	
615-Haulage Truck Rental	25,682	
617-Heavy Equipment Repairs	106	
620-Safety Supplies	164	
624-Misc. Supplies	33	
	87,322	27.89 %

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PRE-PRODUCTION

Precipitation Plant

	$(Actual)	Percent
200-Labor	$ 6,800	
201-Zinc Feeder	2,200	
202-Solution Sampler	1,100	
203-Filter Presses	12,300	
204-Pond Liner	8,000	
205-Flow Meter	1,600	
206-Sprinkler Heads (150)	750	
207-Plant Building	21,050	
208-Plant Pumps	4,700	
209-Vacuum Pump	2,350	
210-Motorized Butterfly Valve	600	
211-Welder Rental	450	
212-Plumbing Installation	275	
213-Plant Pipe & Flanges	1,700	
214-Level Control Probe	200	
215-Butterfly Valves	1,475	
216-Spray Pipe	1,200	
217-Welding Supplies	1,050	
218-Plant Lighting	700	
219-Fencing	8,000	
220-Pump Electrical Gear	1,000	
221-Misc. Plumbing Supplies	1,000	
222-Cyanide Pumps	1,000	
223-Misc. Plant Pump Supplies	500	
224-Vacuum Tank	1,500	
225-PVC Saddles	150	
226-Reagent Tanks (3)	4,000	
227-Safety Equipment	250	
228-Water	250	
	86,150	27.52 %

Administration;

240-Salaries, Supervision	7,300	
241-Wages	--	
242-Vehicle Expense	700	
243-Misc.	850	
248-Planning, Design, Etc.	15,000	
	23,850	7.62 %

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PRE-PRODUCTION

General Administration

	$ (Actual)	Percent
492-Insurance	$ 4,000	
495-Office Supplies	500	
497-Misc.	1,400	
401-Travel Expense	1,500	
	7,400	2.36 %

Indirect Cost

701-Tucson Overhead	4,000	
702-New York Overhead	8,000	
	12,000	3.83 %

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Unit Operating Costs

		$/tons mined	$/tons leached
Mining;			
	Administration	$ 0.04	$ 0.10
	Sample Preparation	.03	.09
	Drilling	.06	.18
	Blasting	.05	.15
	Loading	.08	.24
	Haulage	.23	.66
	Dozing	.08	.24
	Sub	.57	1.66
Leach Plant;			
	Labor	.04	.13
	Cyanide	.14	.40
	Water	.01	.03
	Power	.01	.02
	Other	.03	.09
	Sub	.23	.67
Gen'l, Admin, & Indirect;			
	G & A	.13	.37
	Tuc Overhead	.03	.07
	NY Overhead	.03	.09
	Sub	.18	.53
	Total	.98	2.86

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OPERATIONS

Cost Categories-MINING

	$/ $1,000,000	Percent
Mine Administration;		
120-Supervision Salaries	$ 19,608	
121-Wages	7,059	
122-Vehicle Expense	1,176	
123-Misc.	392	
124-Mine Eng.	7,843	
		3.61 %
Sample Preparation & Assay;		
130-Preparation & Assay	18,039	
131-Salaries	9,411	
131-Wages	1,961	
132-Supplies	784	
133-Misc.		3.02 %
Drilling;		
150-Wages, Operating	15,686	
151-Wages, M&R	1,569	
152-Operating Supplies	17,647	
153-Equipment Rental	26,667	
154-Equipment Relocation	--	
		6.16 %
Blasting;		
160-Wages, Operating	--	
161-Explosives & Accessories	51,242	
162-Equipment Rental	--	
		5.12 %
Loading;		
170-Wages, Operating	11,765	
171-Wages, M&R	--	
172-Operating Supplies	6,536	
173-Equipment Rental	66,667	
		8.50 %

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OPERATIONS

	$/ $1,000,000	Percent
Mining-Continued		
Haulage;		
180-Wages, Operating	$ 38,170	
181-Wages, M&R	2,353	
182-Road Construction	--	
183-Fuel	17,778	
184-Lubricants	2,353	
185-Tires & Tubes	10,458	
186-Truck Parts	3,137	
187-Equipment Rental	150,980	
188-Misc. Supplies	1,464	
189-Equipment Relocation	4,575	
		23.1 %
Dozing & Grading;		
190-Wages, Operating	24,837	
191-Wages, M&R	1,307	
192-Operating Supplies	4,575	
193-Equipment Rental	52,810	
194-Equipment Relocation	--	
		8.35 %
Leach Plant Operation		
Plant Administration;		
301-Supervision Salaries	14,118	
302-Vehicle Expense	1,373	
303-Misc.	392	
		1.59 %
Plant Operation;		
310-Operating Labor	30,588	
311-Anti-Scalent/Soda Ash	19,072	
312-Cyanide	138,562	
313-Power	6,667	
314-Water	10,196	
315-Filter Paper	4,314	
316-Tools	654	
317-Plumbing Supplies	784	
318-Pipe & Sprinklers	1,699	
319-Zinc	2,092	
320-Pumps	784	
321-Electric Motors	915	
322-Electric M&R	1,176	
323-Mechanical M&R	1,176	
324-Instrumentation	--	
		23.46 %

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OPERATIONS

General Administration

	$/ $1,000,000	Percent
472-Salaries, Supervision	--	
473-Cleical & Watchman	--	
488-Truck Rental	2,745	
489-Truck/Auto Expense	392	
490-Freight	3,137	
491-Assays	--	
492-Insurance	7,843	
493-Legal	7,843	
494-Telephone	2,353	
495-Office Supplies	392	
496-Employee Subsistence	4,706	
497-Misc.	1,961	
498-Reproduction/Printing	1,373	
499-Office Rent	--	
400-Sales Tax	13,333	
401-Travel Expense	6,275	
402-Interest Expense	--	
403-Royalty	--	
404-Bank Charges	314	
405-Employee Medical	9,412	
406-State Unemployment Tax	5,621	
407-Federal Unemplyment Tax	719	
408-Property Tax	7,843	
409-Employer Insurance	--	
410-Audit Fees	5,229	
411-Consultant's Fees	--	
420-Freight to Refinery	10,980	
421-Refining	20,131	
422-Representation(Umpire)	7,059	
423-Interest or Advances	9,412	12.91 %

Indirect

701-Tucson Overhead	26,144	
702-New York Overhead	31,373	
		5.75 %

T. ~~H~~ - Hewlett initial projection

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Geologist

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TOMBSTONE HEAP RE-PROCESSING BUDGET

Following is the capital investment required for re-processing the Tombstone Heap.

Item	Expenditure
Initial Property Payment	$ 6,000
Geological Report	3,000
Lease Expenses	3,000
Engineering	4,000
Power Hook-Up Deposit	3,500
Electrical Wiring	2,500
Pump Installation	3,000
West Side Water Line	2,500
Office Support	2,500
Pre-Production Royalty	7,500
Consulting Fees	5,000
Spray Lines/Manifolds	3,000
Directional Rainbirds	200
Preg Pond Lining	400
Pad Preparation	15,000
Laboratory	10,000
Building	15,000
Office	2,500
Recovery Plants	10,000
Reagent Tanks	3,000
Crushing - Working Capital	40,000
Chemicals	15,000
Insurance and Bond	5,000
Management	6,000
Labor	10,000
	$177,600

However, an expenditure of about $80,000 is only required to generate the cash flow necessary for continued production. That budget follows:

Item	Expenses that could be delayed	Expenditure	$ needed up front
Initial Property Payment		$ 6,000	6000
Lease Expenses		3,000	
Geological Reports		3,000	
Engineering		4,000	
Power Hook-Up Deposit		3,500	
Electrical Wiring		2,500	
Pump Installation		2,000	
West Side Water Line		2,500	
Office Support		2,500	
Pre-Production Royalty		7,500	7500
Consulting Fees	5000	5,000	
Spray Lines/Manifolds		2,000	
Directional Rainbirds		200	
Preg Pond Liner		400	
Pad Preparation		2,000	
Laboratory	5000	5,000	
Building	2000	2,000	
Office	2500	2,500	
Recovery Plants		4,000	
Reagent Tanks		1,000	
Crushing Working Capital		5,000	
Chemicals		5,000	
Insurance and Bond		2,000	
Management	4000	4,000	
Labor		4,000	
	18,500	$80,600	12,500

must send ore to refinery by March 15, 1979.

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The projected cash flow is as follows, based on a 15 day delay in payment from the refinery:

Month	Net Operating Profit Before Tax		Crushing Rate
	Heap Slope Leach	Crushing	
April 15, 1979	$20,000	$ 10,000	25 TPD
May 15, 1979	30,000	40,000	200 TPD
June 15, 1979	35,000	40,000	200 TPD
July 15, 1979	15,000	80,000	400 TPD
Aug. 15, 1979	-	80,000	400 TPD
Sept. 15, 1979	-	120,000	600 TPD
Oct. 15, 1979	-	120,000	600 TPD
Nov. 15, 1979	-	600,000	3,000 TPD
Dec. 15, 1979	-	600,000	3,000 TPD
Jan. 15, 1980	-	600,000	3,000 TPD
"	"	"	"
"	"	"	"
"	"	"	"
Jan. 15, 1981	"	"	"

At this time, open-pit ore must be developed to continue at the above rate.

The payback schedule for a $100,000 investment out of 50% net operating profit is as follows:

Month	50% NOPBT Payback ($100,000)	
	Monthly	Cumulative
April	$15,000	$ 15,000
May	35,000	50,000
June	37,500	87,500
July	47,500	100,000

TOMBSTONE PROJECT

There are two separate aspects of the Tombstone Leaching Project. One is to spray the existing heap in order to generate an immediate cash flow and the other more involved phase is to crush the heap and heap leach the crushed ore.

A. Spray East Slope of Heap

The barren-precip pond would be used as a preg pond. Circulated would be:

Daily Solution Tonnage

GPM	1 Shift	2 Shifts	3 Shifts
50	100	200	300
100	200	400	600
150	300	600	900
200	400	800	1200

with sprinklers at 5 GPM:

GPM	No. Rainbird Sprinklers
50	10
100	20
150	30
200	40

= 12.50/t

At Nelson, the "heap weep" was 0.035 Au and 0.50 Ag (per ton solution). This would be $12.50 per ton solution. If we assume 1/2 that value, we would generate:

Daily Gross = $6.25/ton

GPM	1 Shift	2 Shifts	3 Shifts
50	$ 625	$1250	$1875
100	1250	2500	3750
150	1875	3750	5625
200	2500	5000	7500

Starting to spray on the northeast portion of the heap, where the height is 100 feet and with an angle of repose of 45°, the slope distance would be 140 feet. With a spray radius of 20 feet, a slope pattern of 6 lines horizontal along the slope with 8 rainbirds per line would result in 48 rainbirds. At 5 GMP, this would be 240 GPM or 1 ton solution per minute. The barren-precip pond would hold over 50,000 gallons or 200 tons of solution. Therefore, on start-up, less than 200 tons would be circulated as pre-treatment using NaOCl and lime.

Then, as the heap saturates and begins to weep, a "circulating solution balance" can be obtained and controlled in the barren-precip pond. It would take about 3 days to reach this balance. A precautionary measure would be taken so that if excessive "heap weepage" occurs, the excess would flow by gravity to the lower preg pond (about 200,000 gallons capacity).

For each slope increment treated, the following should be recovered:

Slope Surface Area of 6x8 birds = 140x180=25,000 ft^2

Assuming a 1/3 vertical penetration of solutions:

$$\text{Tonnage} = \frac{(1/2\ b\ h)}{3}\ \frac{(180')}{18.5} = 16{,}216 \text{ tons}$$

If we assume a grade 1/4 that of the "heap weep" from Nelson, a gold grade of .008 results in $2 per ton and a silver grade of .14 results in $1, or $3 per ton ore, or $48,000.

This could be recovered in about a week of circulation.

Notice that about 8 such increments exist along the northeast and east portions of the heap's slope.

The expected gross would then be from $48,000 to $384,000. From a risk point-of-view, it is safe to project $50,000, which would more than pay for the initial capital investment.

Required capital investment for the slope leach is as follows:

A.	Power hook-up		$2400	
B.	Electric		2000	
C.	Pump installation/electric		1000	
D.	Water line installation		2040	
E.	Spray lines/manifolds		100	
F.	Directional rainbirds		80	
G.	Preg pond		100	
H.	Laboratory		100	
I.	Building		200	
J.	Plants		2200	
K.	Tanks		1000	
L.	Chemicals			
	1. Resin-SR-3	100#	650	
	2. Lime	1000# (.087)	87	
	3. Salt			
	4. NaOCl	5-55 gal	247.50	
	5. $Na_2S_2O_3$	300#	73.80	
	6. NaCN	1000#	561.50	
	7. Na_2S	400#	99.20	
	8. Powd. Zinc	100#	66.20	
M.	Insurance and bond		4500	1785.20
N.	Management		4000	
O.	Labor		2000	
P.	Misc.		1495	
			$25,000	

B. Crushing and Leaching of Heap

Crushing would be done to 1/2 inch and "Induced Percolation Substances" would be added to accelerate the leaching rate and maximize the recovery. It has been estimated that a $10 per ton ore profit can be generated. Following are the computed net operating profit before taxes for the heap re-processing:

Crushing Rate	Monthly Net Operating Profit	Crushing Duration	yrs
200 Tons per Day	$ 40,000	250 months	
400 "	80,000	125 "	
600 "	120,000	83.3 "	6.9
1000 "	200,000	50 "	4.1
3000 "	600,000	16.7 "	1.4

Following are recent samples taken from the heap, grouped by screen size and mineral:

Ore Type	Troy Oz./Ton Au	Troy Oz./Ton Ag	Value* Au	Value* Ag	Total Value
Clay	.041	.26	$10.25	$1.95	$12.20
Fines	.086	.29	21.38	2.18	23.56
Large	.038	.53	9.38	3.94	13.32
Manganese	.155	1.44	38.75	10.80	49.55

see analysis @ au of [illegible] g/t.

The above were weighted by their respective weight percentage (15%, 25%, 40% & 20%) and the average value ($250 Au & $7.50 Ag*) is $22.95. Assuming a 65% recovery, the resulting ore value would be $15.00 The operating costs will be under $5.00 per ton ore, yielding a net operating profit before taxes of $10.00 per ton ore.

The following illustration presents the recent sampling results.

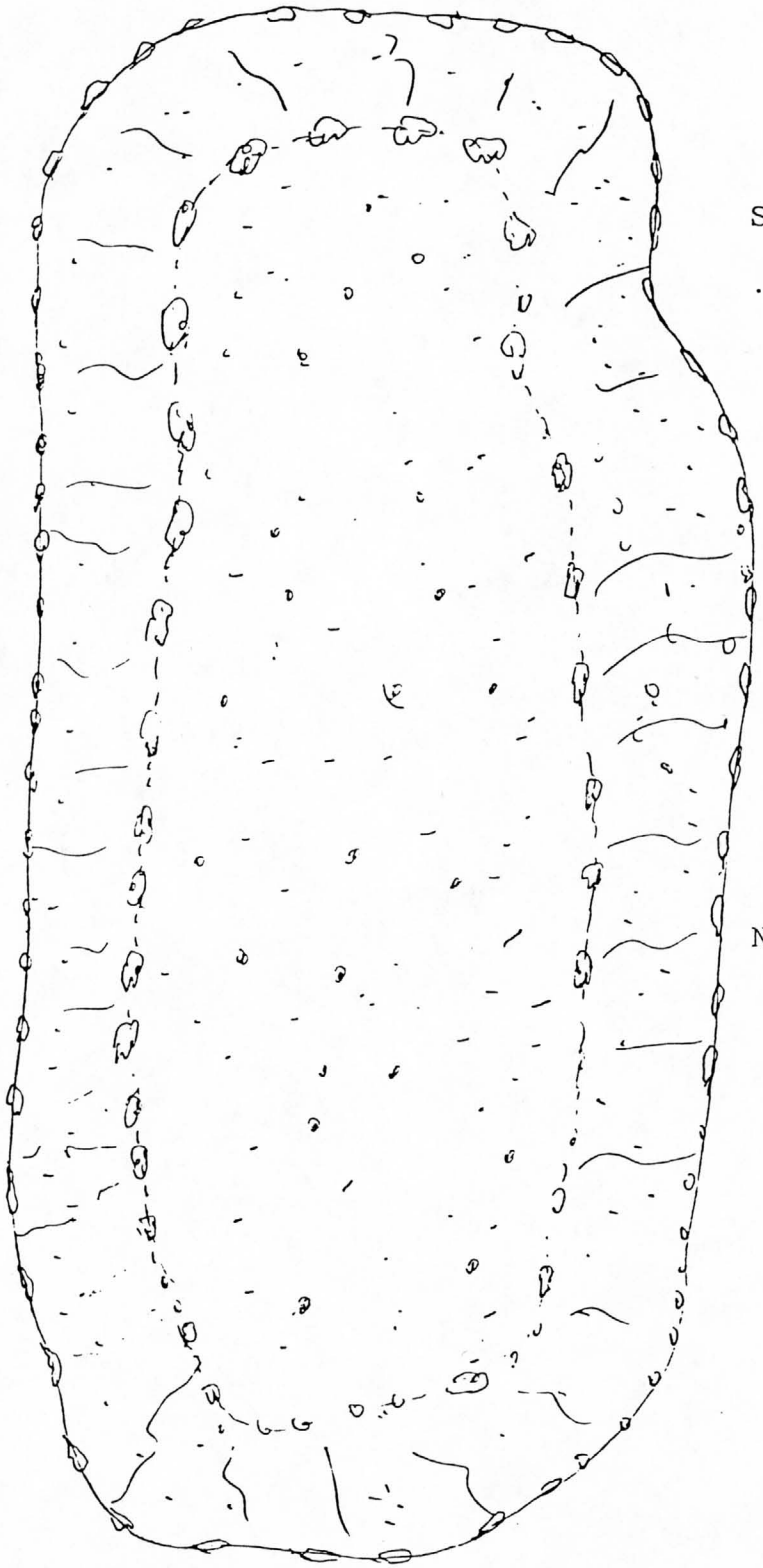
never below .1 ag 2991 US Bureau of mines

SOUTHEAST CLAY
.021 Au/.12 Ag

SOUTHWEST CLAY
.060 Au/.36 Ag

SOUTH FINES
.120 Au/.42 Ag

SOUTH LARGE
.042 Au/
.57 Ag



SOUTH MANGANESE

.150 Au/1.89 Ag

TOMBSTONE "HEAP"
****
Assays of ore types
and sizes.....

NORTH MANGANESE

East .177 Au/1.98 Ag

West .138 Au/.45 Ag

NORTH CLAY
.042 Au/.30 Ag

NORTH FINES
.051 Au/.15 Ag

NORTH LARGE
.033 Au/.48 Ag

3/79

METALLURGICAL TESTING

Tombstone problem ore types classified by leaching characteristics are as follows:

1. High-iron and clay; eastern portion of District from the Empire to Grand Central along the Contention Dike.
2. Sulfide ores
3. Argentojarosite
4. Manganese carbonate-oxide minerals
5. Silicious interstitial minerals
6. Carbonaceous ores
7. Oxidized sulfide ores.

These ore types cause serious precious metal recovery problems when using cyanide.

In addition to the chemical-mineralogical problems caused by these ore types, physical problems that cause poor recovery when '71 Minerals leached the heap are:

1. Clays and fines caused blinding and would not percolate.
2. Coarse ores could not leach into the rock; values locked inside the rock were not exposed to leaching.

Screen analysis of various coarse and fine fractions of the ore from all of the dumps appears in the ore reserve section. Notice that there are good values in the coarse; it is economical to crush and re-leach; "IPS" will yield high recovery of the crushed ore.

Cyanide

Ore from the Contention area(no manganese) was sampled and one split was digested with acid(aqua regia) and an equal split was digested with cyanide. Results from 24 tests show that cyanide recovered only 35% of the precious metal values(see the following table). Careful study of these results show that the acid digest recovered about 6½ fold more gold than the cyanide digest. However, the cyanide digest recovered 1¼ fold more silver than the acid digest. This is due to:

A. Cyanide does not break down the encapsulating carbonates that prevent the gold from complete leaching.

B. Acid breaks down silicious gold ores that cyanide does not chemically attack.

C. Acid breaks down gold-limonite-clay complexes that are only slightly effected by cyanide.

D. Silver nitrate formed with aqua regia is partially precipitated by the chlorine ion(from the hydrochloric acid);silver cyanide complex is more stable than the gold chloride complex.

Manganiferous ores were leached with cyanide and aqua regia. Emerald ores were the very fine ore, and showed that cyanide leached only 11% of the gold leached by the acid.

Sodium thiosulfate

Sodium thiosulfate is an effective solvent for silver. Following are the results:

Concentration (gr/l)	Silver Leached (t.oz./ton ore)	Troy Oz. Ag Gr. Hypo per liter
20	1.33	.067
10	1.23	.123
5	1.00	.200
2½	.73	.292
1¼	.48	.384
.625	.32	.512
.3125	.22	.704

3/79

TOMBSTONE
Solvent Comparison

Sample Location	ACID Aqua Regia Gold	ACID Aqua Regia Silver	BASE Cyanide Gold	BASE Cyanide Silver
	Precious Metal Recovery (t.oz./ton ore)			
1-Heap/Dump	.105	.24	.003	.15
2-No. Ramp(N)	.075	.30	.009	.27
3-No. Ramp(S)	.090	.42	.030	.45
4-Dump	.075	1.14	.009	1.56
5-Dump,small	.090	1.02	.024	1.65
6-Dump,larger	.180	.69	.015	1.08
7-Dump, LN.	.150	1.05	.015	3.75
8-Large Dump	.150	.30	.009	.36
9-Dump-south	.150	.30	.012	.06
10-N. end pad	.075	.21	.009	.24
11-Y-gate	.267	.54	.015	.27
12-PT;west	.081	1.05	.030	1.98
13-PT;W/M	.048	2.67	.015	1.02
14-PT;M	.120	1.68	.015	2.76
15-PT;E	.075	1.02	.027	1.17
16-PT;Rojo	.075	.99	.003	.24
17-L.Cont(S)	.207	1.95	.057	3.48
18-L.Cont(N)	.120	.93	.012	.69
19-P.Shaft(E)	.120	.24	.018	.27
20-P.Shaft(W)	.072	.27	.027	.48
Flora Morrison	.264	.69	.006	.09
Tailings	.096	.84	.030	1.20
Cont.Dump(W)	.120	1.74	.024	1.26
Cont.Dump(E)	.102	1.08	.039	2.28
	.121	.89	.018	1.12

This is very similar results to that produced previously with Tombstone ores(see Metallrgical Testing Section).

Also, notice the similar leaching rates and recoveries of Hypo and cyanide.

It was also shown that a weak Hypo solution and cyanide in combination leached about the same amount of silver, but Hypo and cyanide leached 150% more gold than cyanide.

Using .5 grams/liter Hypo leach solution, we have obtained for many days a .25 t.oz. silver preg, which conforms with our leaching tests.

Halide-Sodium Hypochlorite System

Halide-sodium hypochlorite systems have been proven an effective solvent for Tombstone ores. Also, a halide-sodium hypochlorite system is a very effective pre-treatment prior to cyanidation.

For all Tombstone ores, pre-treatment with NaCl-NaOCl increases the gold and silver recovery by over 200%.

The following graph presents silver solubility test results for Tombstone silver ore in a 3% NaOCl solution with various amounts of salt(chloride ion). It is obvious that salt is important for our pretreatment.

Refractory Silver Minerals

Silver Sulfide Ores;

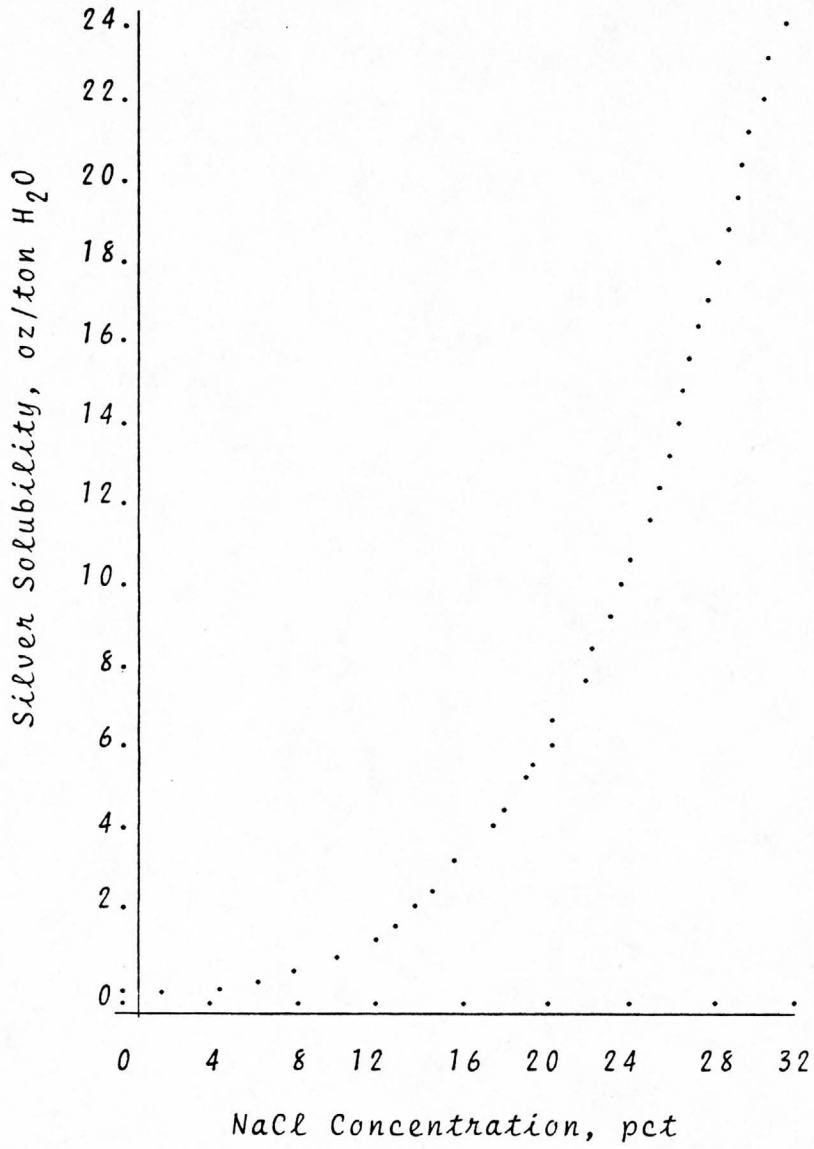
Silver sulfide minerals can be converted to soluble silver chlorides by sodium hypochlorite-brine leaching system. Argentite is leached in an oxidizing brine by:

$$Ag_2S + 4OCl^- = 2AgCl + SO_4^{=} + 2Cl^-$$

Silver chloride is soluble in either a cyanide solution as a cyanide complex or in a brine solution containing excess chloride ion as the tetrachloro complex, as:

(1). $AgCl + 2CN^- = Ag(CN)_2^- + Cl^-$

(2). $AgCl + 3Cl^- = AgCl_4^{-3}$



Solubility of silver ores from Tombstone in a 3% NaOCl solution with varying NaCl.

Manganiferous Ores;

There are basically two oxide manganese minerals, as:

Mn Valence	Formula
II	MnO
IV	MnO_2

In order to dissolve the above, the following acids are required:

Mn(IV) ..... Reducing Acid ----- H_2SO_3

Mn(II) ..... Any Acid ----- H_2SO_4

The reaction for such a system can be expressed as follows:

$$MnO_2 + SO_2 + MnSO_4$$

Solid Gas Aquous

$$H_2O + SO_2 + \tfrac{1}{2} O_2 = H_2SO_4$$

Gas Gas Aquous

Also, the oxide iron minerals would be soluble in an acid media:

$$Fe_2O_3 + 6H^+ = 2Fe^{+3} + 3H_2O$$

Manganiferous Ore Testing

Following are tests made with Emerald ore:

Test ID	H_2SO_4 Consumption	Est. Mn	% Silver Recovery	% Gold Recvr.
Em-1	287 #	1%	85%	88%
Em-2	245 #	2%	85	89
Em-3	230 #	1%	80	84
Em-4	306 #	4%	51	65

This resulted in:

Test ID		#H_2SO_4/Oz. Ag	$$H_2SO_4$/Oz. Ag
Em-1		76.74	$0.244
Em-2		48.74	.155
Em-3		82.14	.261
Em-4		222.22	.707
	Ave.	113.19	.360

Therefore, the amount of only silver liberated by a ton of sulfuric acid is over $15 per $1 spent for acid. With the gold content, over $20 in precious metals is recovered per $1 spent for H_2SO_4.

PRE-TREATMENT

"Pre-Treatment" has come to mean anything done to an ore before cyanidation. However, it may not be required or desireable to use cyanide as the final gold solvent.

Common "problem ores" at Tombstone are as follows:

A. Ore with precious metal values more uniformly distributed within the competent rock than on fractures (or fracture planes). This is only a problem for heap leaching; crushing can now be done for maximum value liberation and IPS is used to enable excellent perculation during heap leaching.

B. Dump or other ores with clay and fines that inhibit percolation in heap leaching; IPS allows percolation.

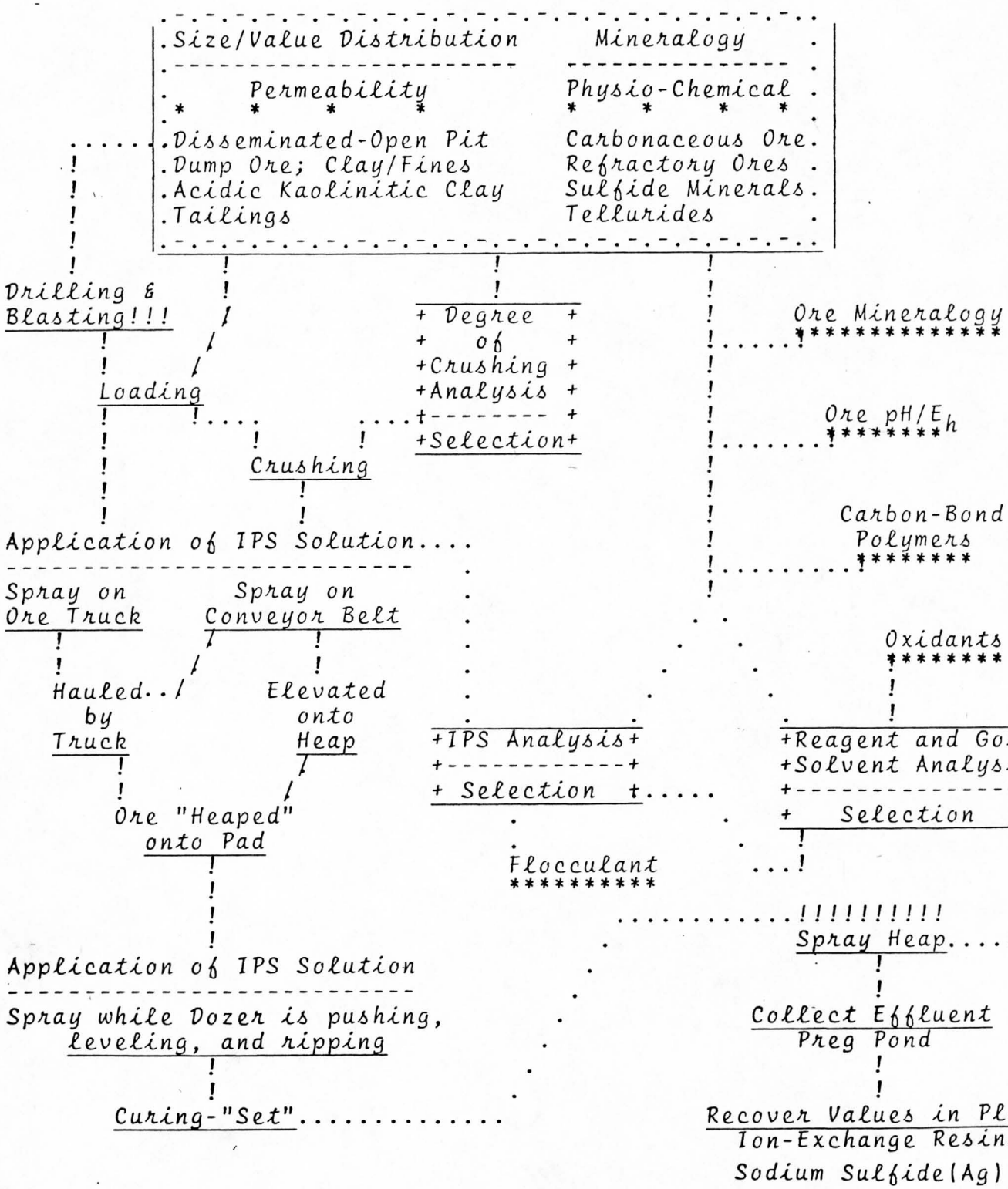
C. Acidic kaolinitic clays (common along the Contention Dike) are real pH problem for using cyanide, as well as the poor percolation in heap leaching problem. IPS solves the percolation problem, while non-cyanide solvents are by far more economic.

D. Montmorillinite clays are common at Tombstone because they form in limestone environments (see Clay Technology section at end of "IPS"/next chapter). These clays cause blinding.

E. The oxygen has been consumed in the heap by copper forming a cuprous cyanide complex. Also, the height of a 100 feet contributes to the depletion of oxygen lower in the heap as solutions percolate in depth.

F. Manganiferous ores have gold and silver "locked" mineralogically.

PRE-TREATMENT of Various Problem Precious Metal Ores for HEAP LEACHING



Carbonaceous and Reducing Ores

The organic material in the Tombstone ores creates a problem similar to Tombstone gold and silver ores that are in an oxygen deficent environment in the heap (reducing environment).

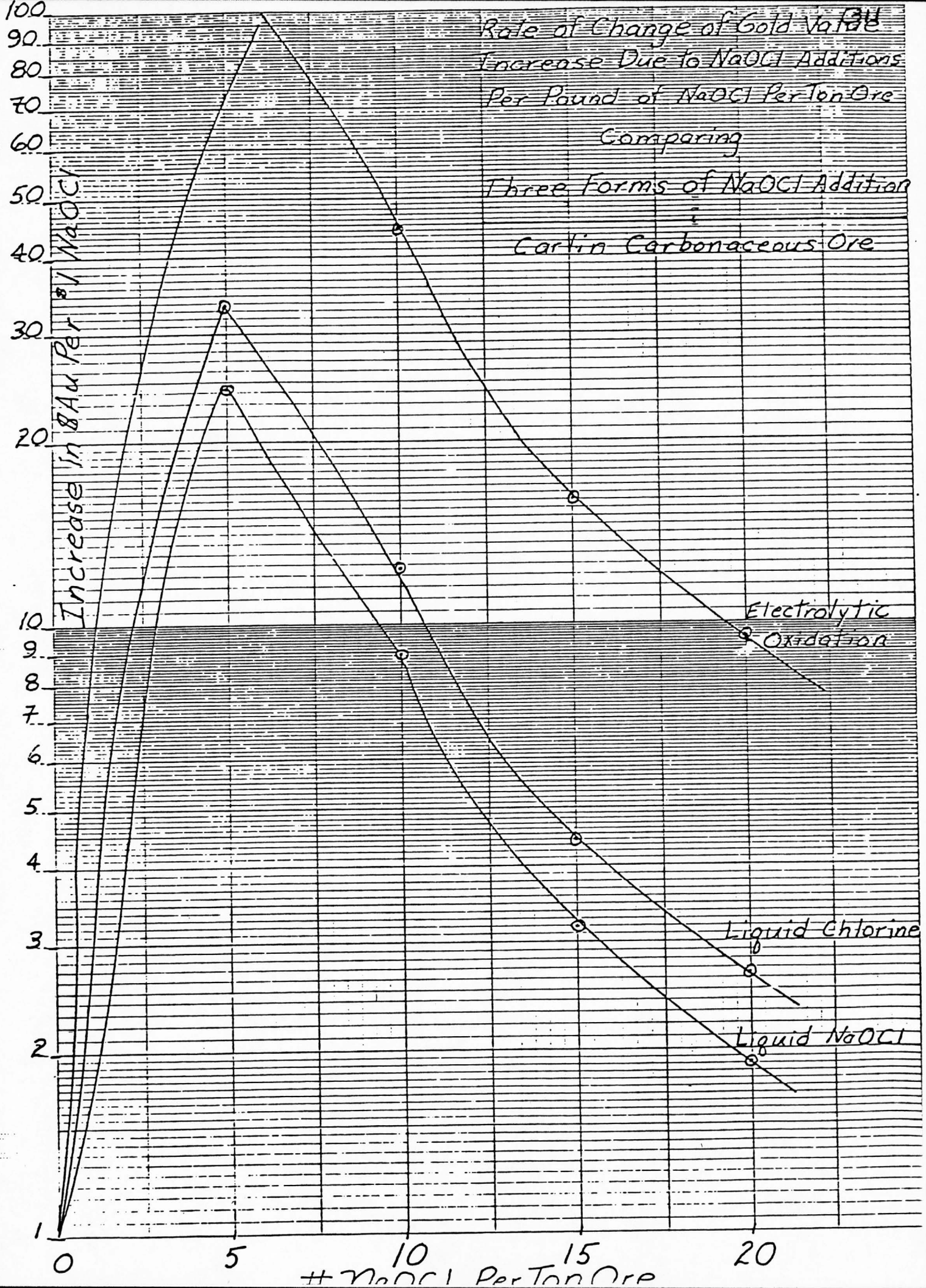
The degradation of organic substances buried in fine-grained sedimentary rocks depends upon the depth of burial and the Geothermal Gradient. This temperature-time relationship is also affected by the exhaustion of available oxygen, lowering the E_h of the sediment. The oxidation reaction takes place faster than the decarboxylation of this organic matter, making oxidation a better choice of pre-treatment than chemical break-down. Total dehydrogenation of organic (carbon bond) substances results in graphite. Other substances produced are fats, carbohydrates, proteins, and amino acids.

The problem basic to the leaching of carbonaceous and reducing ores is that when cyanide is used, the gold-cyanide complex ($Au(CN)_2^-$) is absorbed by the carbon components in the ore. Most tests run on carbonaceous ores show that only about 30% of the gold can be extracted by using a cyanide leach. Because this is on crushed and pulverized ore for mill treatment, that recovery (30%) makes milling uneconomical. Carbonaceous limestones and shales at Tombstone exhibit this phenomeon.

Newmont has applied a technique developed by the U.S. Bureau of Mines at their Carlin gold mine. They use sodium hypochlorite as an oxidant. I have used hypochlorite for this same purpose for the last several years, and it is clearly one pre-treatment reagent that is effective on reducing and other carbonaceous ores. In fact, the use of salt (NaCl) as a source of chlorine was used for gold leaching before the development of cyanide (pre-1900). There are three ways to add hypochlorite to an ore for pre-treatment, which are:

1. Add sodium hypochlorite directly in solution
2. Add liquid chlorine directly
3. Add hypochlorite by in situ generation

The following figure presents the increase in gold value due to the hypochlorite pre-treatment for Carlin carbonaceous ores. Note that in addition to showing the response of the ore to pre-treatment, I have compared the economics of the three methods of pre-treatment using hypochlorite.


Rate of Change of Gold Value Increase Due to NaOCl Additions Per Pound of NaOCl Per Ton Ore
Comparing
Three Forms of NaOCl Addition
Carlin Carbonaceous Ore
Increase in $Au Per # NaOCl
Electrolytic Oxidation
Liquid Chlorine
Liquid NaOCl
NaOCl Per Ton Ore
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
0
5
10
15
20

The application of sodium hypochlorite is sensitive to pH, as is illustrated by the following two figures. Notice that for the Carlin ore, the amount of lime added is as important as the amount of hypochlorite, in fact it can be more important.

The Carlin carbonaceous ore have been analyzed as follows:

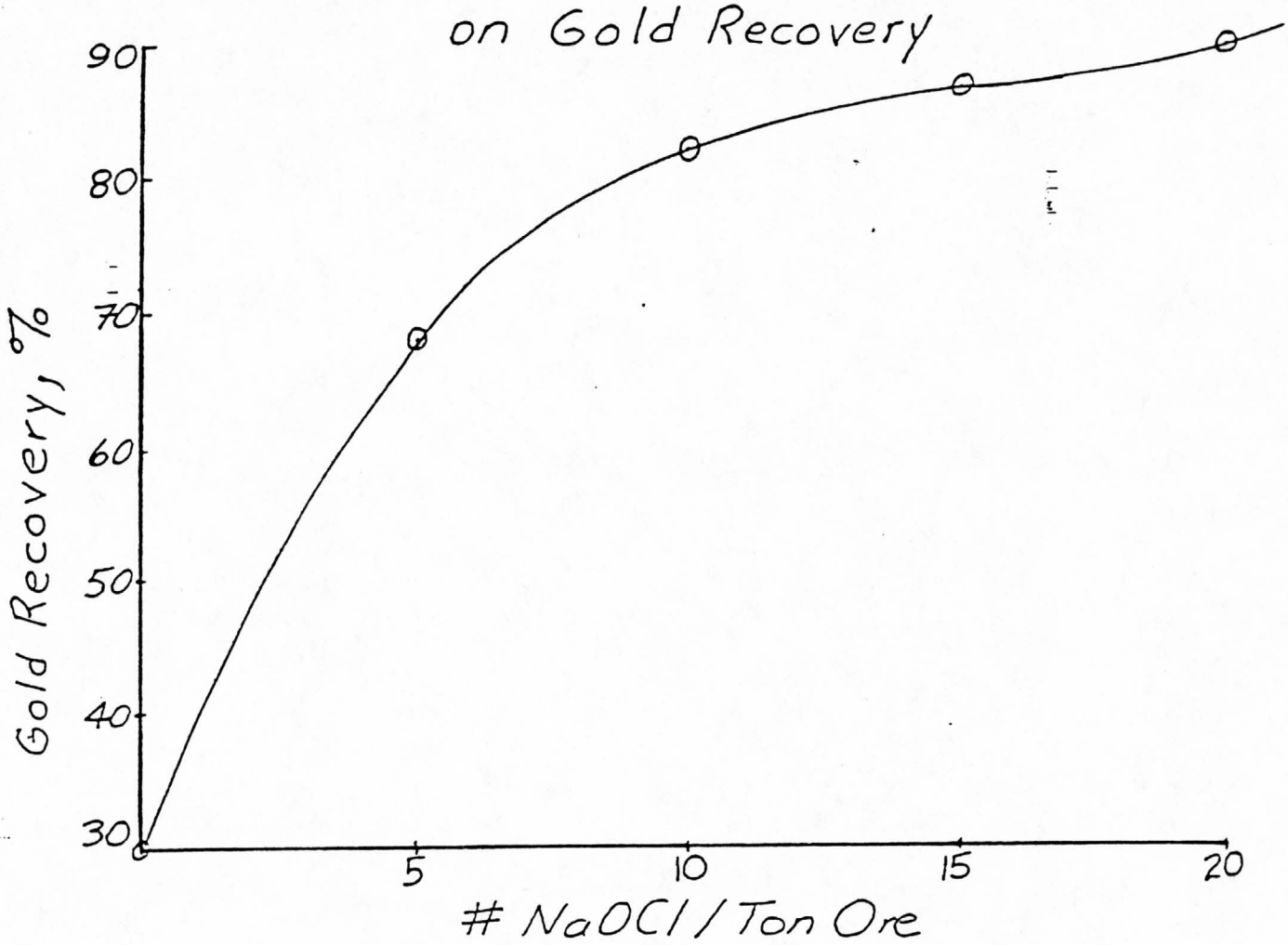
Ore Category	Ore Type	Organic Carbon	Au, t.oz./ton
I	Carbonaceous	0.60 %	.40
II	"	.45 %	.19
III	"	.42 %	.33
IV	Oxidized-sl. C	.06 %	.20

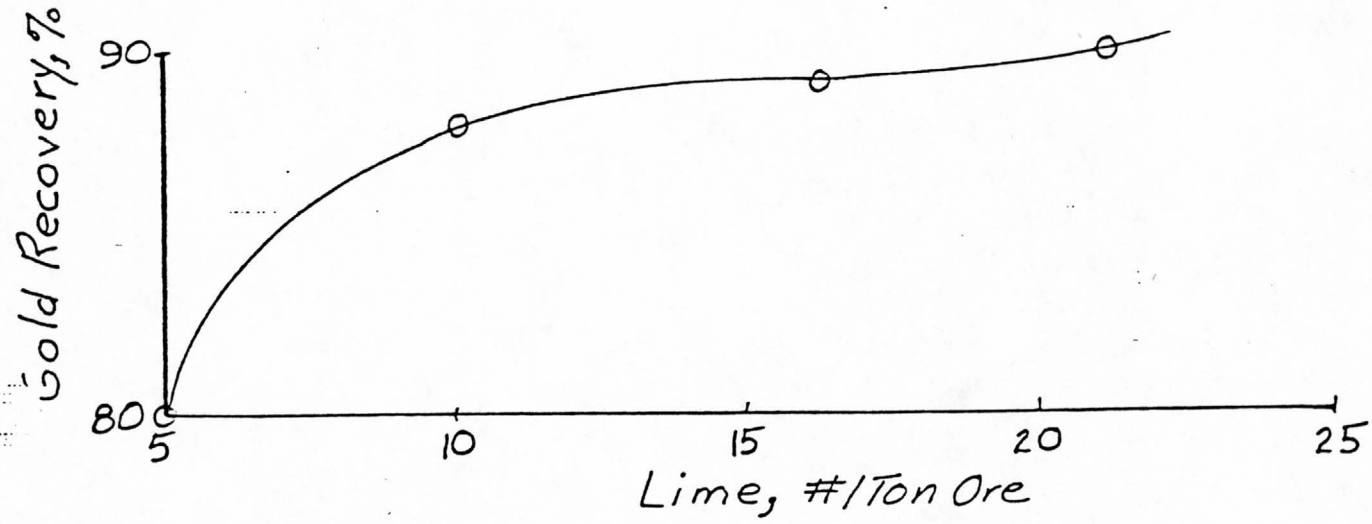
These have all responded differently to hypochlorite, but all with positive results. Testing is the only way to quantify the response of any pre-treatment reagent/solvent.

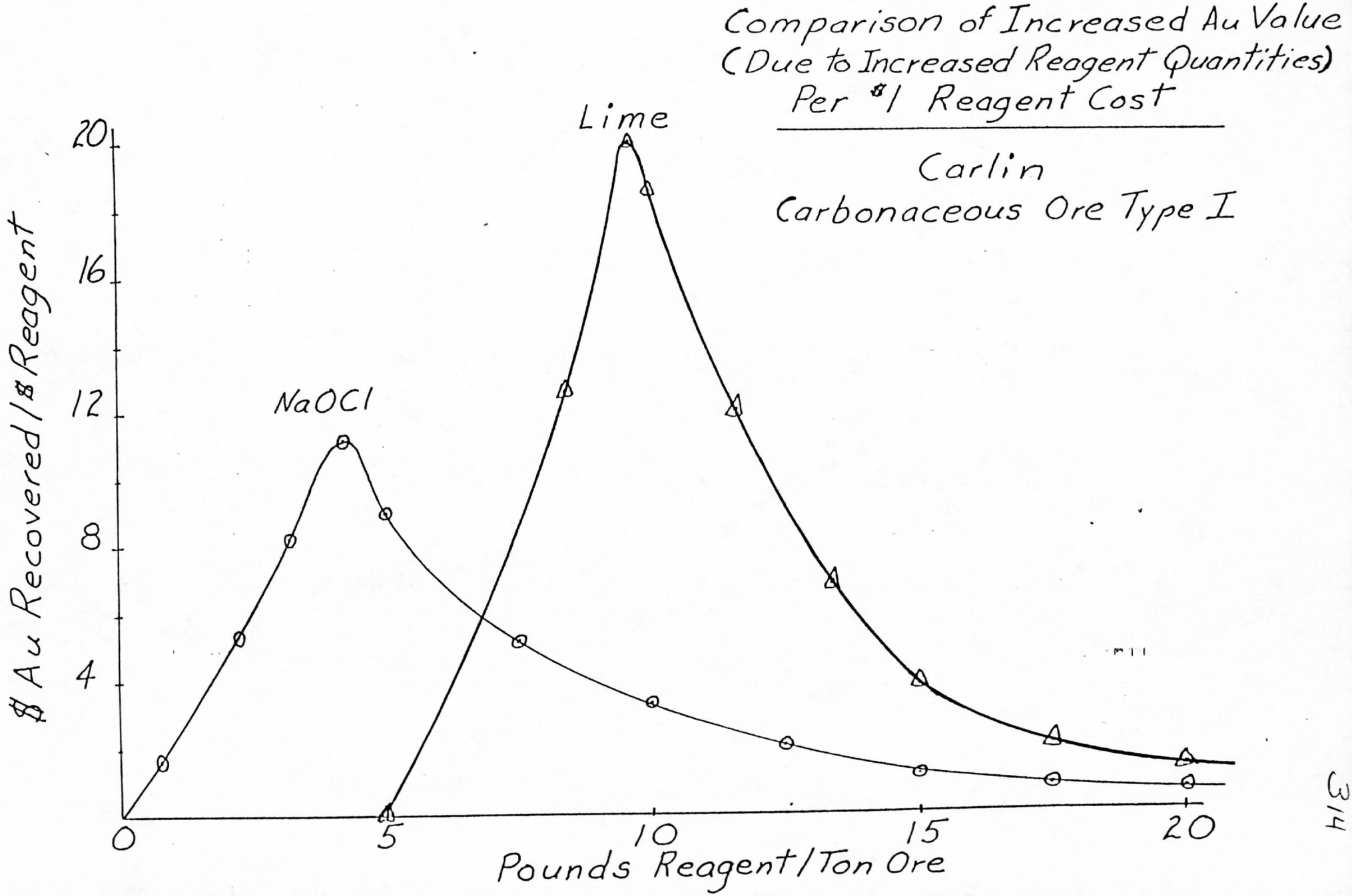
Notice that in the last illustration that the response of two Carlin ore types is presented. It is obvious that the type III would have a better response because hypochlorite is a much stronger oxidant in more acid pH's; under a pH of 7 the oxidation potential of hypochlorite is much greater and chlorine is released which is a solvent for gold. The only restriction for carbonaceous ores is that they usually are in limestones, which consume acid. Notice that the Carlin carbonaceous ore type I has a natural buffered pH at 9; hypochlorite response is stopped at a pH of 9 due to the liberation of hydroxyl ions on fine grinding.

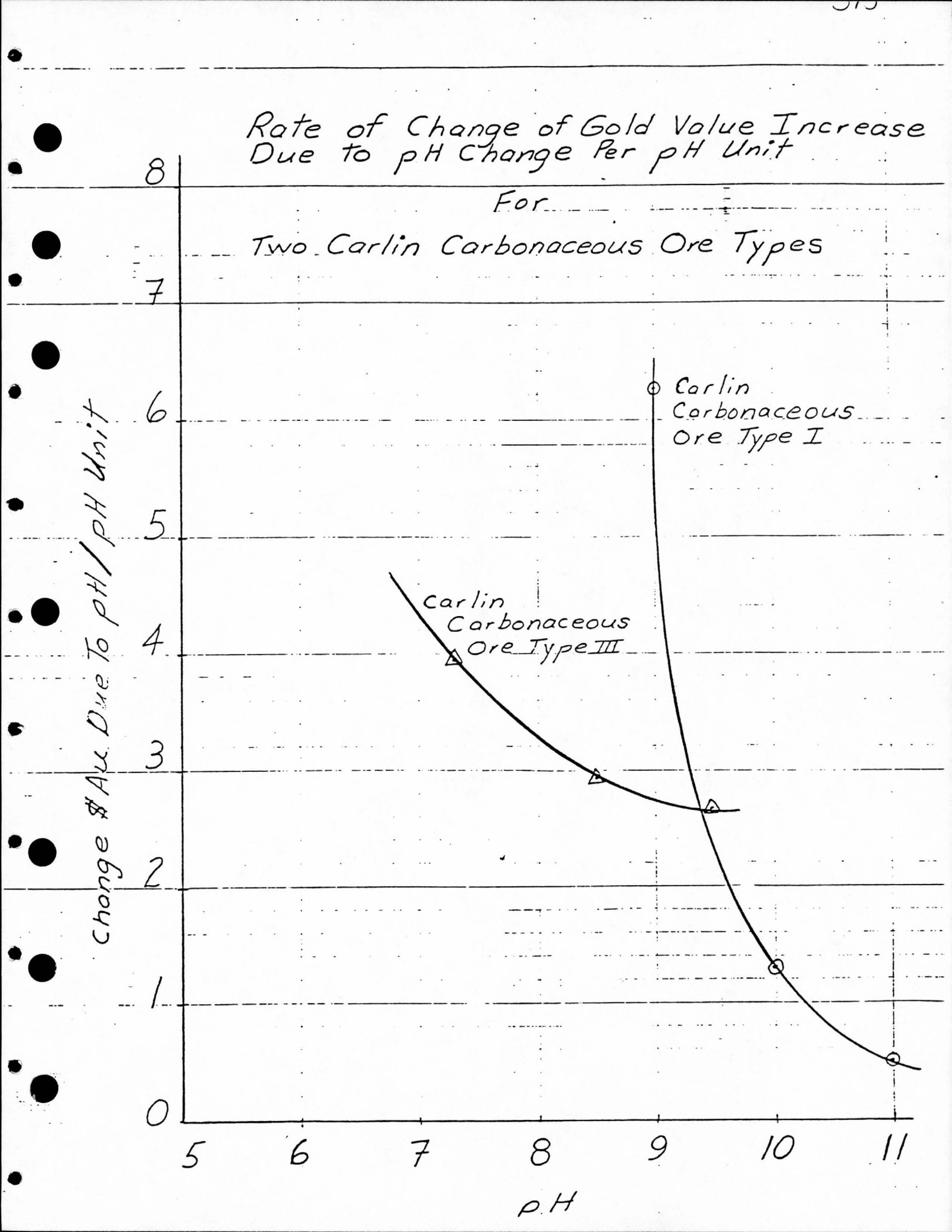
Due to my discussion of hypochlorite, it is obvious that some benefit can be obtained on the Tombstone ores using OCl^- as a pre-treatment reagent. However, testing will quickly quantify the economics of all reagents and solvents that would be used in the pre-treatment of the Tombstone ore, whether for milling or heap leaching.

Effect of Quantity of NaOCl & Lime on Gold Recovery






Comparison of Increased Au Value
(Due to Increased Reagent Quantities)
Per $1 Reagent Cost
Carlin
Carbonaceous Ore Type I
Lime
NaOCl
$ Au Recovered / $ Reagent
20
16
12
8
4
0
5
10
15
20
Pounds Reagent / Ton Ore


Rate of Change of Gold Value Increase
Due to pH Change Per pH Unit
For
Two Carlin Carbonaceous Ore Types
Carlin
Carbonaceous
Ore Type I
Carlin
Carbonaceous
Ore Type III
Change $Au Due To pH / pH Unit
pH
0
1
2
3
4
5
6
7
8
5
6
7
8
9
10
11

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BASIC METALLURGY

Pre-Treatment

A. Oxidized Sulfides

Sulfuric acid is formed when water is circulated over the ore on the heap. The amount of oxidized sulfides present determines the increase in acidity due to the addition of water(circulation). For example, the pH of the "leaching-water-source" could start at 6 and then lower to 5 due to the H_2SO_4 formed in the circulation solution.

An effective utilization of the acid solution as a solvent is by adding salt.

The $H_2SO_4 + NaCl = HCl + Na_2SO_4$

The formation of HCl is useful as follows;

1. There are numerous silver compounds that are soluble in acids and not NaCN

2. The ore then consumes the acid and the pH becomes more basic.

B. Un-Oxidized Sulfides

Acid pre-treatment solvents that dissolve silver sulfides are;

Mineral	Solvent
Argentite	HCl
Acanthite	H_2SO_4
Both of above	NAOCl

SILVER COMPOUNDS SOLUBLE IN ACID SOLUTIONS BUT NOT CYANIDE

Name	Formula
Silver acetylide	Ag_2C_2
" orthoarsenate	Ag_3AsO_4
" orthoarsenite	Ag_3AsO_3
" benzoate	$AgC_7H_5O_2$
" bromate	$AgBrO_3$
" carbonate	Ag_2CO_3
" chlorate	$AgClO_3$
" perchlorate	$AgClO_4$
" ferricyanide	$Ag_3Fe(CN)_6$
" fluride	AgF
" fluosilicate	$Ag_2SiF_6 \cdot 4H_2O$
" fulminate	$Ag_2C_2N_2O_2$
" iodate	$AgIO_3$
" mercury iodide(ic)	$2AgI \cdot HgI_2$
" nitrate	$AgNO_3$
" nitrite	$AgNO_2$
" nitroprusside	$Ag_2Fe(CN)_5NO$
" peroxide	Ag_2O_2
" palmitate	$AgC_{16}H_{31}O_2$
" metaphosphate	$AgPO_3$
" propionate	$AgC_3H_5O_2$
" salicylate	$AgC_7H_5O_3$
" selenide	Ag_2Se
" sulfate	Ag_2SO_4
" (Pyrargyrite)	Ag_3SbS_3
" (Proustite)	Ag_3AsS_3

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C. Base Metals

Copper oxide minerals (including sulphates, carbonates, etc.) are soluble in both sulfuric and hydrochloric acids. It is very important not to get copper in the zinc-precipitation system because copper retards silver precipitation (replacement) and the refinery will penalize for copper content.

Lead salts interfer with the zinc precipitation from a cyanide solution.

These will settle during the acid phase, but enough settling time must be allowed.

Solvent Selection

A. Sodium chloride (NaCl)

Use of salt was discussed in pre-treatment. Free chlorine ion is very important for good dissolution of silver and gold. Higher recovery is obtained in the cyanide phase by using weak salt solutions.

B. Sodium thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$)

Sodium thiosulfate is a very effective solvent for silver. I have extensively utilized "hypo" on a commercial scale at Tombstone for leaching underground and circulating to the plant at 60 GPM for about 6 months. Hypo does not interfer with cyanide; they can be used together. Hypo can be used in a pH range of 3 to 12. For numerous reasons, Hypo should be used in very weak solutions; its dissolution rate for silver and its decomposition rate. Also, sunlight effects Hypo. However, it can very effectively and economically be utilized.

Following are the results of composite halide silver ores (Tombstone, Reville, Packard, & Candelaria) that have been tested with Hypo.

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C. Sodium hypochloride (NaOCl)

Sodium hypochloride is an effective solvent for oxide minerals as gold and silver. Also, it is a good oxidant and a strong base; in a 14% solution the pH is 12.5. Sodium hypochloride is a good solvent to use in the pre-treatment phase because if it follows the use of salt, the oxidation acts like HNO_3 in changing the valence and gold(as well as silver) dissolves-just like aqua regia.

Utilization of NaOCl as an oxidant and source of free chlorine prior to the cyanide phase is very effective because gold and silver chloride complex is dissolved by the more stable cyanide complex. Also, the addition of oxygen increases the dissolution rate of gold and silver in cyanide; it has been shown that 6 ppm oxygen is necessary for the most efficient dissolution rate. Also, the dissolution rate drops off very rapidly with decreasing amounts of oxygen.

D. Cyanide (NaCN)

Cyanide is the most commonly used gold and silver solvent. Dissolution rates for silver are much slower than for gold, and it was pointed out that oxygen is necessary.

Elsner's fundamental cyanid-silver equations are:

<u>Halides</u> $2Ag + 4NaCN + O + H_2O = 2AgNa(CN)_2 + 2NaOH$

<u>Sulfides</u> (1) $Ag_2S + 5NaCN + O + H_2O = 2NaAg(CN)_2 + NaCNS + 2NaOH$

(2) $Ag_2S + 4NaCN = 2NaAg(CN)_2 + Na_2S$

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Basic silver-cyanide problems and their solution are:

Basic Problem	Solution
Slow dissolution rate	Stronger solutions and good perculation-lower vertical lifts on the heap; adds oxygen. Pre-Treatment with acid solvents. Add oxidants.
Oxygen requirement	Above, plus spray(as rainbird); monitor preg at base of heap-keep at 6 ppm free oxygen.
Sulfates of iron; ppt. silver in heap	Decompose with lime
Sulfide solutions ppt Ag	Add $Pb(C_2H_3O_2)_2$ - allow to settle
Soluble Pb salts interfer with Zn precipitation	Precipitate and settle with acid pH--design large settling ponds
Silver sulfides are hard to dissolve with CN	Pre-treatment with NaCl and NaOCl
Tetrahedrite, sulf-antimonides, and sulf-arsenides are hard to dissolve in CN	Pre-treatment with NaCl, H_2SO_4, $FeCl_3$, and NaOCl
Oxidized Zn & Cu oxides, carbonates, and hydrates and soluble sulfides--- cause high CN consumption	Numerous pre-treatment; basically acid with NaCl and NaOCl

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Economic Analysis

To determine the optimum selection of solvents, various bench-shaker tests should made followed by barrel leach tests. These are as follows:

1. Silver dissolution rate per solvent
2. Optimum solvent concentration.

Suggested initial test increments for each solvent are:

Solvent	Solvent Concentration Increments
Sod. thiosulfate	1/2. 3/4, 1, 2, 5 grams/liter
Sod. chlorite	1, 2, 5, 10, 20 grams/liter
Sod. hypochlorite	5, 10, 20, 50 ml/liter of 14 % soln.
Ferric chloride	1/4, 1/2, 1, 5 grams/liter
Aqua regia	5, 10, 20, 50 ml/liter
Cyanide	1/2, 3/4, 1, 1.5, 2 grams/liter
HCl	5, 10, 20 ml/liter
HNO_3	5, 10, 20 ml/liter

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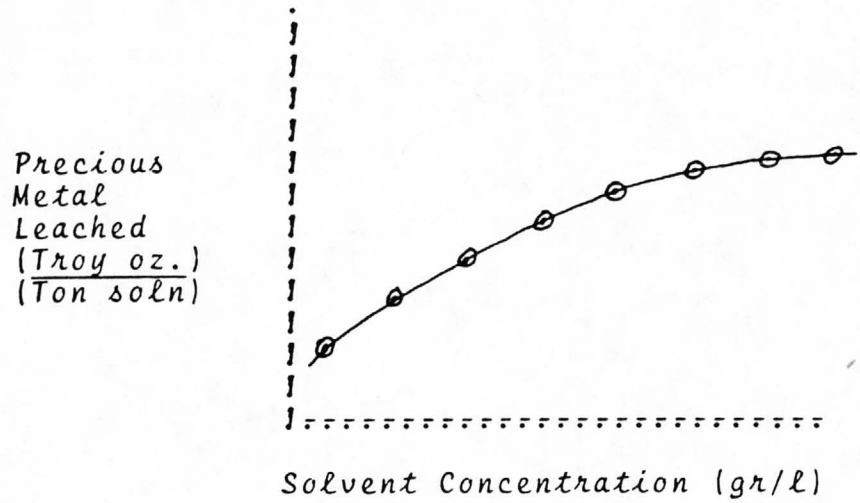
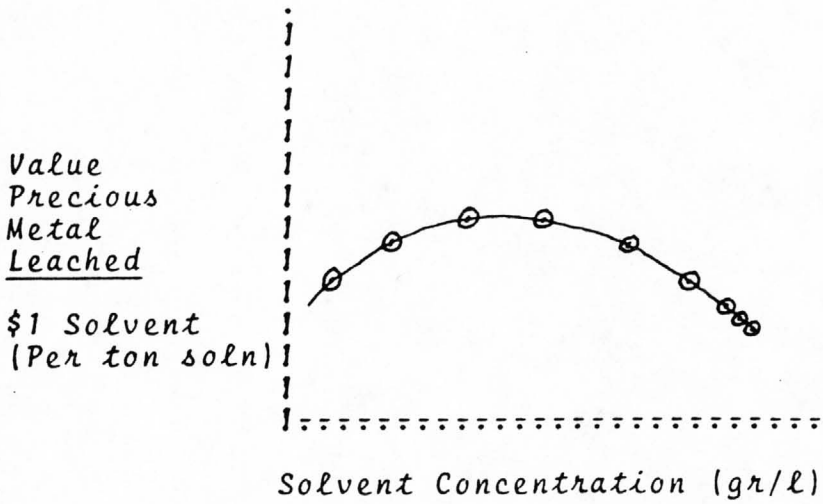
SOLVENT ECONOMIC ANALYSIS





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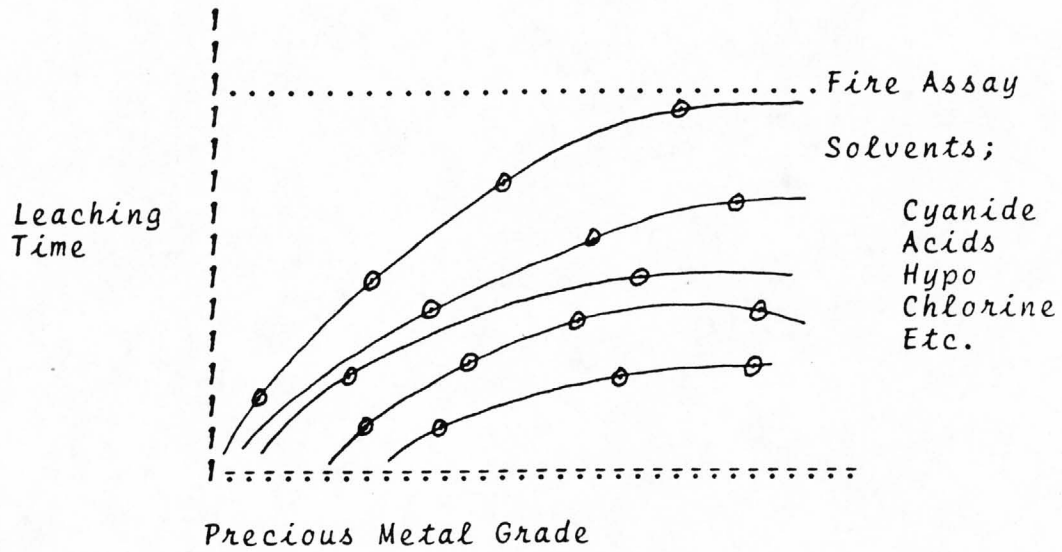
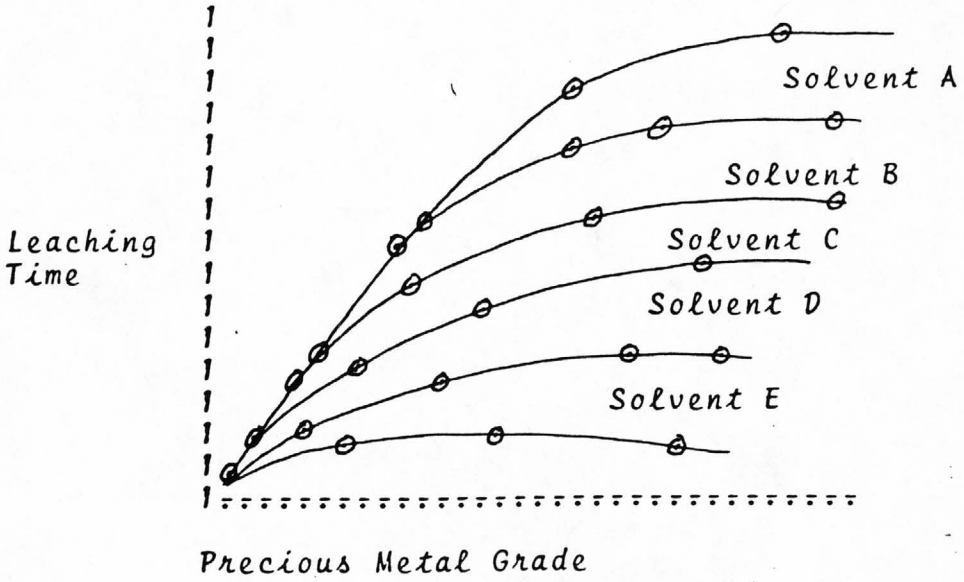
SOLVENT STATIC & DYNAMIC ANALYSIS





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Solvent & Reagent Costs

Solvent or Reagent	Supplier	Form Price;22 ton load	Unit Price
Ferric Chloride	Sierra(R)	Liq.-42 Be-55 gal drums(625#) $21/100wgt.	$ 0.21/#
Sodium Chloride	"	Pellets- 50#/$2.88 625# drum-delivered	.16/#
Sodium Chloride	Parsons(SP)	Cry.- 22 ton truck; $3/ton + $6/ton(GF)	$.0045/#
Sodium Sulfide	Sirerra(R)	Flake-20 ton lots Del. WS	.195/#
Lime	" (P)	Hydrated-22 ton lots-Del. WS $134.43/ton	.067/#
Lime	" (P)	Processed CaO-$37/ton(P)+$5.12/200 miles	.021/#
Caustic	"	Flake Na_2O-500# drum Del. WS	.185/#
Zinc	"	Powd. Merrillite-$68.32/cwt Del. WS	.6832/#
Sodium Cyanide	"	Pellets- Del. WS	.44/#
CaOCl(HTH)	"	Cry. 70%- 1000# lot WS	.70/#
Lead Acetate	"	Powd. 333# WS	$2.34/#
Sodium Thiosulfate	"	100# bags- 22 ton lot Del. WS	.1625/#
Sodium Hypochlorite	"	Liq.- 14%(Cl^-) 55 gal drums Del. WS	.90/gal

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In order to determine the optimum solvent economics, testing must be performed at a comparitive economic concentration, as:

Solvent	Quantitiy for $0.20/ton solution
Cyanide	0.23 gr/ℓ
Sodium Chloride	22. gr/ℓ
Sodium Hypochlorite	421. mℓ/ℓ
Sodium Thiosulfate	.62 gr/ℓ
Ferric Chloride	.48 gr/ℓ
Calcium Hypochlorite	.14 gr/ℓ

Leaching Tests

It was shown in a previous report(June 23, 1978) that the Tombstone ore treated showed the following results:

1. "Natural shooting" of the ore resulted in;
   A. Proper fragmentation for good perculation
   B. Maximum exposure of ore-minerals
2. Ore contained some silver sulfides, and they;
   A. Leach slowly in NaCN
   B. Will leach more completely with an acid pre-tre-tment
3. Leaching rate is good due to a large percentage od Horn Silver.

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Screen Analysis:

Screen Size	Leached Ag Value (t. oz.)/ton
+ 2½ inches	0.25 oz./ton ore
2 "	.80
1½ "	1.10
1 "	1.40
½ "	1.90
¼ "	2.55
1/8 "	3.50
- 1/8 "	6.30

Comparative Leaching Rate and Recovery Rates:

Time	Per Cent Leached		
	Reville	Candelaria	Tombstone
24 hrs.	31 %	83 %	24 %
48 "	65 %	94 %	32 %
72 "	85 %	99 %	43 %
96 "	91 %	100 %	58 %
120 "	98 %		74 %
144 "	99 %		82 %
168 "	100 %		99 %

BARREL TEST RESULTS

Cyanide leach

Test 1:
open pit area

Date	Atom. Adsorp. Au	Atom. Adsorp. Ag
10/14	.004	
	.007	
	.010	
	.015	
	.025	
10/15	.032	
	.042	
	.103	
	.283	
10/18	.308	
	.337	
	.341	
10/19	.490	

Leaching Rate

Date	Au Leached/day
10/14	.025
10/15	.258
10/18	.058
10/19	.149

Test 2:
open pit area

Date	Atom. Adsorp. Au	Atom. Adsorp. Ag
10/7	.007	
	.010	
	.036	
	.044	
10/8	.052	
	.067	
	.075	
10/9	.084	
	.095	
	.100	
10/10	.165	
	.174	
	.180	
10/11	.200	
	.207	
	.222	
10/12	.240	
	.270	
10/15	.301	
	.306	
	.355	
	.379	
	.392	
10/18	.427	
	.431	
	.500	

Leaching Rate

Date	Au Leached/day
10/7	.044
10/8	.031
10/9	.025
10/10	.080
10/11	.042
10/12	.050
10/15	.120
10/18	.108

LIME-CAUSTIC-SODA ASH

Protective Alkilinity

Into three large beakers 500 ml. H_2O was added. Then enough sulphuric acid was added to bring the pH to 2.5(2 ml. H_2SO_4).

Amount of Base Added	pH Lime	pH Caustic	pH Soda Ash
1/4 gr.	3	2.5	2.5
1/2 gr.	5	3.5	5.75
3/4 gr.	8.5	6	6.5
1 gr.	11	8.5	8.5
1 1/4 gr.		11	9.5
1 1/2 gr.			10.5
1 3/4 gr.			11

$$\#/\text{gal.} = \frac{1 \text{ gr. lime}}{500 \text{ ml.}} = \frac{2 \text{ gr. lime}}{\text{liter}} \frac{(3.7853 \text{ liter})}{\text{gal.}} \frac{(\ \#\ )}{453.6 \text{ gr.}} = \frac{.017\ \#}{\text{gal.}}$$

$$\#\text{ lime in south acid pond} = \frac{.017\ \#}{\text{gal}} (1{,}000{,}000 \text{ gal}) = 17{,}000\ \#$$

$$\#\text{ lime/ton ore} = \frac{17{,}000\ \#\text{ lime}}{24{,}000 \text{ tons ore}} = 0.7\ \#\text{ lime/ton ore}$$

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TOMBSTONE
METALLURGICAL TESTING

SILVER-SODIUM THIOSULFATE

In order to quantify the effectiveness and economics of sodium thiosulfate($Na_2S_2O_3 \cdot 5H_2O$) as a solvent for silver halides, samples of high-grade silver ore(+7 oz./ton) were collected and analyzed.

Procedure

1. Standard solutions were made with 1,4,10,21,30,40, & 50 grams sodium thiosulfate per liter water
2. 50 ml of each standard solution was placed in a flask with 20 grams of -40 to +64 mesh ore
3. Each flask of "hypo" standard and ore was hand shaken for increments of ½ minute; shaking was uniform
4. After each period of agitation, the flask was allowed to settle for 1½ minutes. Then a Silver determination was made with the AA
5. The flask was then sealed and steps #3 and 4 were repeated until 12 readings were made; 6 minutes of agitation.

Results

1. Leaching rate
2. Silver recovery per gram "hypo"
3. Silver recovery per "hypo" cost
4. Value silver per $1 "hypo".

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METALLURGICAL TESTING

Results of
Sodium Thiosulfate Leaching
of Silver
****

TROY OUNCES AG LEACHED PER TON SOLUTION

Agitation Time (Minutes)	Grams Sodium Thiosulfate per liter						
	1	4	10	21	30	40	50
0.5	.14	.30	.47	.74	1.60	2.63	2.90
1.0	.20	.50	.86	1.37	2.87	3.80	4.30
1.5	.25	.68	1.29	2.04	3.15	4.06	4.60
2.0	.32	.87	1.62	2.44	3.85	4.90	5.58
2.5	.36	.99	1.93	2.83	3.97	4.73	5.53
3.0	.41	1.24	2.20	3.15	4.12	4.80	5.61
3.5	.46	1.33	2.58	3.35	4.18	4.80	5.70
4.0	.55	1.57	2.79	3.69	4.30	4.90	5.70
4.5	.57	1.65	2.95	3.99	4.40	4.82	5.60
5.0	.67	1.90	3.26	3.99	4.39	4.80	5.70
5.5	.69	1.95	3.60	4.14	4.44	4.95	5.80
6.0	.75	2.02	4.12	4.50	4.50	4.90	5.85

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METALLURGICAL TESTING

Silver-Sodium Thiosulfate

Leaching Rate

INCREMENTAL TROY OUNCES AG LEACHED (PER TON SOLN.) PER ½ MINUTE INTERVAL

Grams Sodium Thiosulfate Per Liter	Agitation Time, Minutes											
	Initial ½	1	1½	2	2½	3	3½	4	4½	5	5½	6
1	0.14	0.06	0.05	0.07	0.04	0.05	0.05	0.09	0.02	0.10	0.02	0.06
4	0.30	.20	.18	.19	.12	.25	.09	.24	.08	.25	.05	.07
10	0.47	.39	.43	.33	.31	.27	.38	.21	.16	.31	.34	.52
21	0.74	.63	.67	.40	.39	.32	.20	.34	.30	.00	.15	.36
30	1.60	1.27	.28	.70	.12	.15	.06	.12	.10	.00	.04	.06
40	2.63	1.17	.26	.84	-.17	-.10	-.10	.00	-.08	.00	.15	-.05
50	2.90	1.40	0.30	0.98	-.05	0.03	0.09	0.00	-.10	0.00	0.10	0.05

The above results show the following:

A. Initial "hypo" contact with the silver minerals is the most effective

B. Additional silver is leached with each time increment at low "hypo" concentrations

C. Silver is precipitated out of solution at high "hypo" concentrations.

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METALLURGICAL TESTING

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Silver-Sodium Thiosulfate

Silver Recovery Per Gram "Hypo"

The weight per test solution of water, hypo, and ore is computed:

Grams Hypo Per Liter	Wgt. Hypo & H_2O Per Liter	Wgt. 50 ml H_2O	Wgt. 50 ml Hypo
1	1001 gr.	49.95 gr	.05 gr
4	1004 "	49.80 "	.20 "
10	1010 "	49.50 "	.50 "
21	1021 "	48.97 "	1.03 "
30	1030 "	48.54 "	1.46 "
40	1040 "	48.08 "	1.92 "
50	1050 "	47.62 "	2.38 "

From these computations, the recovered Silver per gram Hypo per ton of solution is computed.

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METALLURGICAL TESTING

Silver-Sodium Thiosulfate

OUNCES AG PER TON SOLUTION RECOVERED PER GRAM HYPO

Gr Hypo per Liter	Agitation Time, Minutes											
	½	1	1½	2	2½	3	3½	4	4½	5	5½	6
1	.14	.20	.25	.32	.36	.41	.46	.55	.57	.67	.69	.75
4	.08	.13	.17	.22	.25	.31	.33	.39	.41	.48	.49	.51
10	.05	.09	.13	.16	.19	.22	.26	.28	.30	.33	.36	.41
21	.04	.07	.10	.12	.13	.15	.16	.18	.19	.19	.20	.21
30	.05	.10	.11	.13	.13	.14	.14	.14	.15	.15	.15	.15
40	.07	.10	.10	.12	.12	.12	.12	.12	.14	.12	.12	.12
50	.06	.09	.09	.11	.11	.11	.11	.11	.11	.11	.11	.12

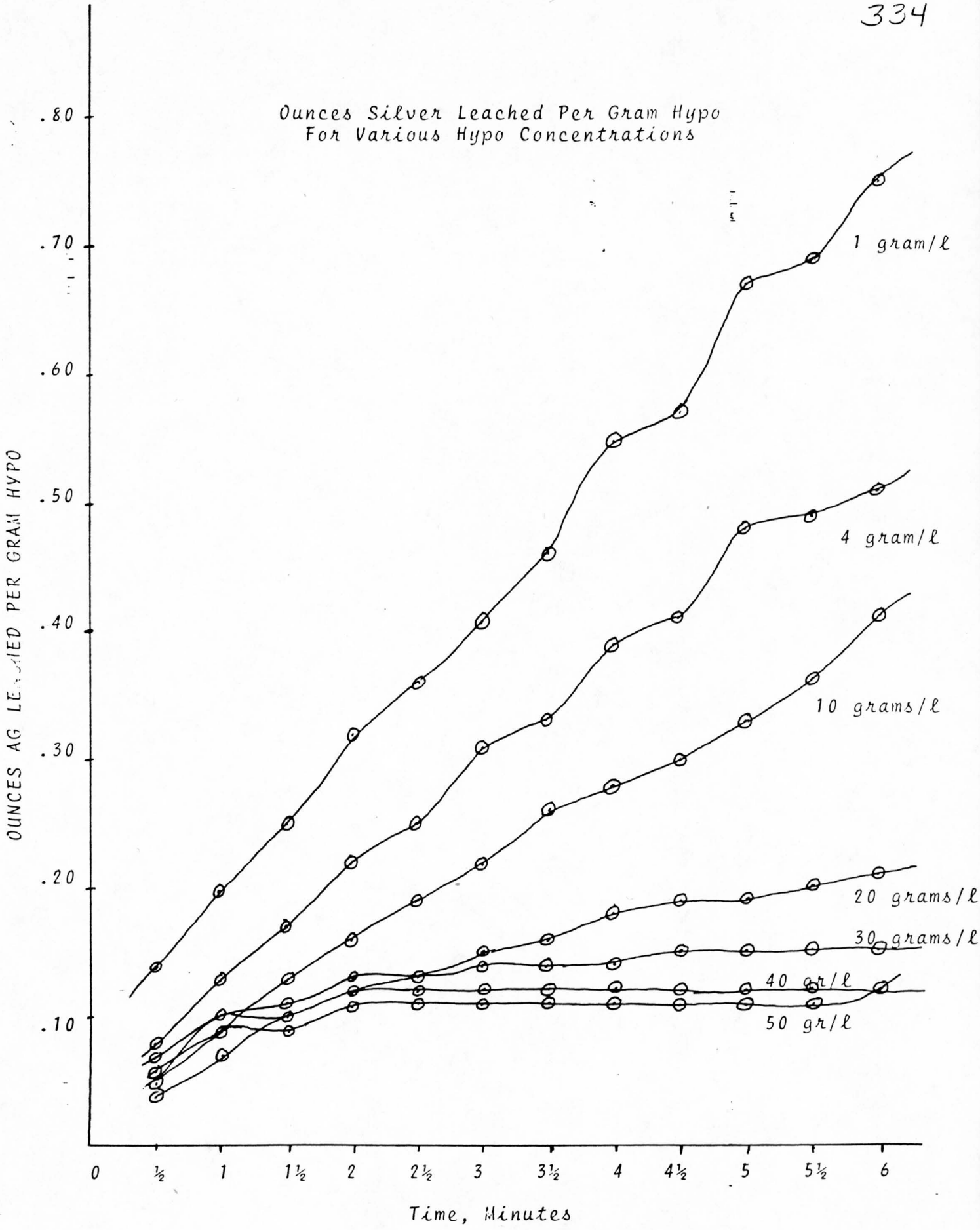
These results have been plotted on the graph on the following page.

The following graph makes the following conclusions obvious:

A. Lowest concentrations of "hypo" are the most efficent

B. Lowest concentrations of "hypo" do not load-up with Ag

C. High concentrations of "hypo" are in-efficient, due to induced chemical precipitation and the possible chemical de-composition of the "hypo".


Ounces Silver Leached Per Gram Hypo
For Various Hypo Concentrations
OUNCES AG LEACHED PER GRAM HYPO
.80
.70
.60
.50
.40
.30
.20
.10
0
½
1
1½
2
2½
3
3½
4
4½
5
5½
6
Time, Minutes
1 gram/ℓ
4 gram/ℓ
10 grams/ℓ
20 grams/ℓ
30 grams/ℓ
40 gr/ℓ
50 gr/ℓ

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METALLURGICAL TESTING

Silver-Sodium Thiosulfate

Economics

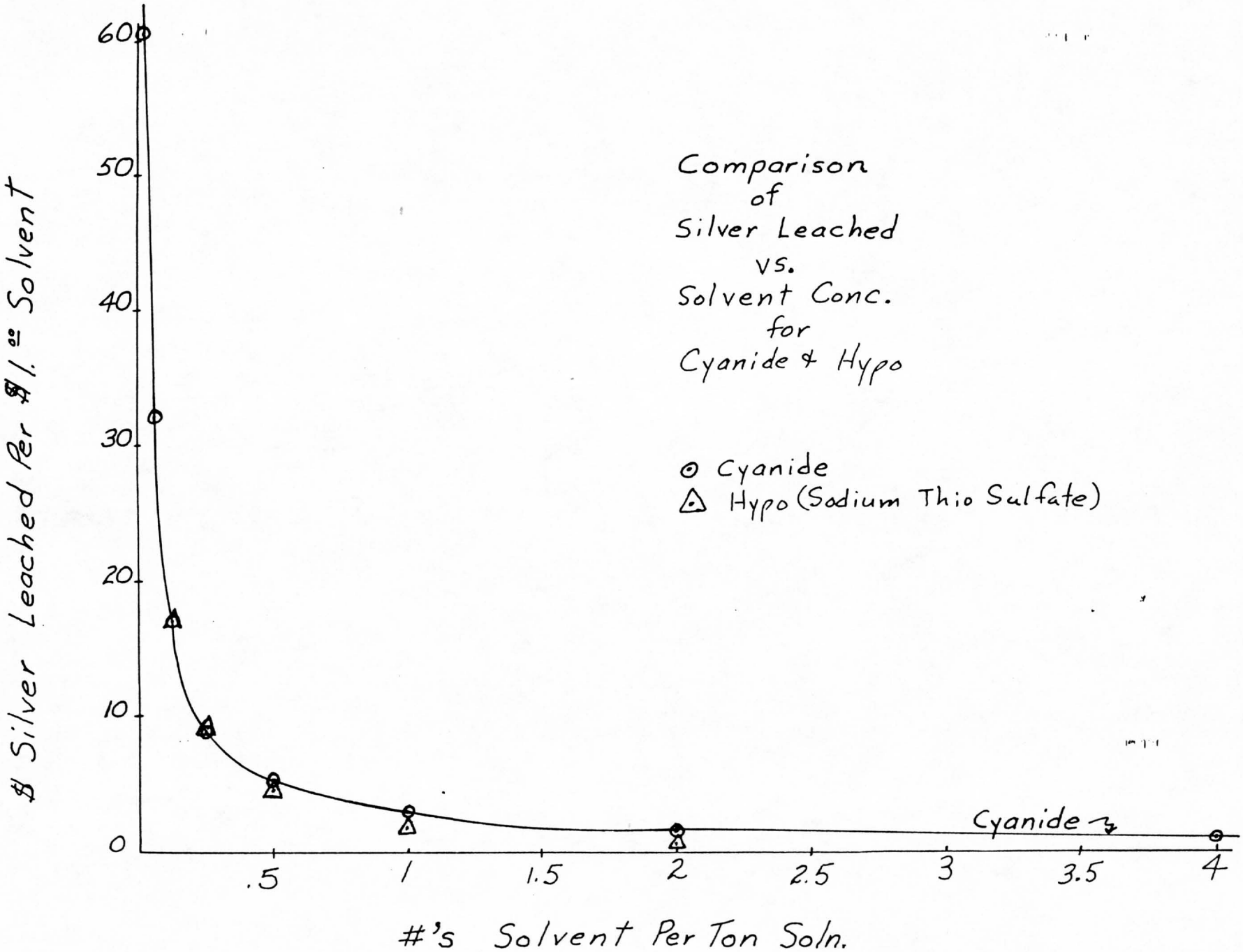
The value of the silver recovered is computed from;

$$\text{Ounces Ag Per 50 ml Solution} = \frac{\text{Ounces Ag}}{\text{Ton Soln.}} \times \frac{\text{Tons Soln.}}{\text{Gr } H_2O/\text{ton}} \times \frac{\text{Gr } H_2O}{50 \text{ ml}}$$

$$\text{Where; Gr } H_2O/\text{ton } H_2O = \frac{240 \text{ gal}}{\text{ton}} \times \frac{8.331 \#}{\text{Gal } H_2O} \times \frac{453.6 \text{ gr}}{\#}$$

VALUE OF LEACHED SILVER AND PER $1 HYPO

Gr Hypo / l H_2O	T. Oz. Ag / 50 ml soln.	Value Ag @ $5.00	Cost Hypo @ 18¢/#	Ag Recovery $ 1 Hypo
1	.0000413	$.0002065	$.00002	$10.33
4	.0001109	.0005544	.0000794	6.98
10	.0002248	.001124	.0001984	5.67
21	.0002429	.0012145	.0004087	2.97
30	.0002408	.0012039	.0005794	2.08
40	.0002597	.0012985	.0007619	1.70
50	.0003071	.0015354	.0009444	1.63


Comparison
of
Silver Leached
vs.
Solvent Conc.
for
Cyanide & Hypo
Cyanide
Hypo (Sodium Thio Sulfate)
Cyanide
% Silver Leached Per #/. ∞ Solvent
#'s Solvent Per Ton Soln.
0
10
20
30
40
50
60
.5
1
1.5
2
2.5
3
3.5
4

Gold Dissolution Rates
(Milligrams Gold Dissolved Per Hour

Equal quantities of gold foil were weighed and allowed to dissolve in various solvents to determine the dissolution rates. After the time to dissolve was observed, the quantity of gold dissolved was checked by titration. Therefore, the rate of dissolution was computed (milligrams Au/Hour), and the dissolution rate cost (milligrams Au/$1 Solvent Cost per ton solution). These results are presented to illustrate:

1. The dissolution rate of cyanide is very slow compared to other halide solvent systems.
2. The relative cost of cyanide compared to halide systems is much higher (for cyanide).
3. Halide system solvents are economic for pre-treatment applications to carbonaceous ores.

Basic to the above is the concept that aurous chloride is insoluble in water but is soluble in sodium chloride. This is based on the following:

A. The initial reaction between chlorine and gold is;

$$2\ Au + Cl_2 = 2\ AuCl$$

B. The rate of solution of the gold is controlled by the rate at which the insoluble aurous chloride film is removed from the surface by the following;

$$AuCl + Cl_2 + Cl^- = AuCl_4$$

and $$AuCl + Cl^- = AuCl_2^-$$

C. The aurous chloride ion is later oxidized to the auric state, but in dilute chlorine solutions this is not the rate-controlling reaction.

Sodium Cyanide

This standard leach solvent produces the following dissolution rates:

Solvent Concentration; # / ton solution	Milligrams Au Dissolved Per Hour
5	2.4
1	3.0
.2	.36

Sodium Chloride-Chlorine System

A standard-brine-solution was prepared using 58.86 pounds of salt (NaCl) per ton solution. This provides an excess chlorine ion. Into this standard brine solution were added various amounts of liquid chlorine. Following are the Au dissolution rates:

Solvent Concentration; # / ton solution	Milligrams Au Dissolved Per Hour
.118	.18
.236	7.2
2.36	108.

Additional tests were made with brine solutions and liquid chlorine because of the application of chlorine to make hypochlorite for carbonaceous ores. An equal amount of gold foil was dissolved in various combinations of concentrations of chlorine and salt. The time to dissolve the gold was divided by the cost of the solvent (per ton solution) to yield a time-of-dissolution vs. cost relationship that allows direct comparison because of the standardization of all of the variables. The plot of these data are presented in the following illustration.

Sodium-Chloride-Chlorine-H_2SO_4 System

The same standard-brine-solution was used with 58.86 pounds of salt (NaCl) per ton of solution. Into this solution were added various amounts of liquid chlorine and sulphuric acid. Following are the Au dissolution rates:

Solvent Concentrations; # / ton solution		Milligrams Au Dissolved Per Hour
Cl_2	H_2SO_4	
.118	5.	7.8
.118	14.	8.4
.236	5.	16.2
2.36	14.	108.6

Chlorine Solution

Two different liquid chlorine solutions were prepared with the following results:

Solvent Concentration; # / ton solution	Milligrams Au Dissolved Per Hour
.874	3.6
4.0	20.4

Chlorine-H_2SO_4 System

Various sulphuric acid concentrations were added to chlorine solutions, with the following results:

Solvent Concentration; # / ton solution		Milligrams Au Dissolved Per Hour
Cl_2	H_2SO_4	
.874	1.6	9.
.874	16.	21.8
.874	20.	37.2

Analysis of Various Gold Solvents

Rank	Solvent Concentration; #/ton soln. Reagent A	Reagent B	Reagent C	Dissolution Rate; Mg. Au/Hr.	Dissolution Mg. Au Per $1 Solvent(s)
1	60. Br_2	50. KBr		222.0.	94.9
2	4. Cl_2	16. HCl		225.6	74.2
3	60. Br_2	40. NaCl		960.	60.
4	4. Cl_2	4. $CaCl_2$		40.8	60.
5	4. Cl_2			20.4	51.
6	2.36 Cl_2	58.86 NaCl		108.	41.7
7	.874 Cl_2			3.6	40.
8	4. Cl_2	1. Br_2		19.2	30.
9	.874 Cl_2	1. H_2SO_4		9.	22.5
10	2.36 Cl_2	14. H_2SO_4	58.86 NaCl	108.6	15.7
11	60. Br_2			110.4	7.7
12	.874 Cl_2	16. H_2SO_4		31.8	6.3
13	.874 Cl_2	20. H_2SO_4		37.2	6.3
14	1. NaCN			3.	4.8
15	.236 Cl_2	5. H_2SO_4	58.86 NaCl	16.2	4.1
16	4. Cl_2	40. NaF		21.	2.8
17	.118 Cl_2	5. H_2SO_4	58.86 NaCl	7.8	2.0
18	5. NaCN			2.4	1.9
19	4. Cl_2	40. Na_2SO_4		19.8	1.5
20	.118 Cl_2	14. H_2SO_4	58.86 NaCl	8.4	1.3
21	.2 NaCN			.36	1.3
22	.118 Cl_2	58.86 NaCl		.18	.1

Chlorine Solutions

Various solvents were mixed with chlorine solutions, with the following results:

Solvent Concentration; # / ton solution		Milligrams Au Dissolved Per Hour
Cl_2	Other	
4.	1. Br_2	19.2
4.	4. $CaCl_2$	40.8
4.	16. HCl	225.6
4.	40. Na_2SO_4	19.8
4.	40. NaF	21.

Bromine Solutions

Various solvents were dissolved in bromine solutions with the following results:

Solvent Concentration; # / ton solution		Milligrams Au Dissolved Per Hour
Br_2	Other	
1.	4. Cl_2	19.2
60.	-	110.4
60.	40. NaCl	960.
60.	50. KBr	2220.

Ionac SR-3 Resin for Noble Metals and Mercury Recovery

Ionac SR-3 is a macroporous chelating resin which is highly selective for precious metals such as gold and others of the platinum group as well as for mercury and methyl-mercury compounds.

Other base metals such as iron, copper, lead, etc. do not react at all with this resin and do not interfere with the selective process. The noble metals are very strongly attached to the resin, yet their recovery presents no difficulty.

Applications

Precious metals are completely removed from solutions containing them (from very high to extremely low concentrations) on passing the solutions through a column of Ionac SR-3.

Use of Ionac SR-3 is recommended for noble metal extraction from ores and wastes, the separation of noble from base metals, the recovery of spent catalysts, the concentration of very dilute solutions containing noble metals and the refining of noble metals.

In addition, Ionac SR-3 is applicable to the removal of mercury(and methyl-mercury) compounds in pollution control.

Example

One microgram of gold dissolved in one liter of slightly acidified water was completely recovered with the aid of Ionac SR-3. Furthermore, even after adding hundreds of milligrams of nickel and copper to the solution, precious metal recovery was complete to the exclusion of the other metals.

Ionac SR-3 also quantitatively collects methyl mercury and inorganic mercury compounds. Both forms are collected from solutions of pH 1-9.

Typical Characteristics

Physical Form: White, macroporous beads
Supplied: Regenerated
Nominal Mesh Range: -16 + 55
Moisture Content: 45% - 55%
Shipping Weight: 750-850 g/l

Capacities

Gold: 150 g/l
Platinum: 65 g/l
Palladium: 58 g/l
Iridium: 25 g/l
Mercury: 150 g/l

General Instructions for Use

1. The pH of the solution coming into contact with the resin should prefereably be adjusted to between 0.5 and 2.5.

2. Adsorption of noble metals or of mercury is carried out at room temperature using conventional ion exchange column techniques. Minimum bed depth should be 750 mm and the flow rate about 10-20 bed volumes per hour.

3. The recovery of the noble metals from the resin is possible in two ways:

   a. Ignition -- Slowly roasting the exhausted resin in air at 900 - 1000° C. leaves the metal in a very pure metallic form.

   b. Elution -- Eluting immediately after adsorption with a 5% aqueous solution of thiourea to which 5 ml/liter of HCl has been added yields a solution from which the metal can be recovered by reduction. When elution is applied, the resin can be reused for many cycles.

4. The elution of the mercury can be also accomplished by treating the resin with 4% sodium sulfide at a level of 200 g Na_2S per liter of resin.

   Following the elution, it is necessary to regenerate the resin by treatment with 10% hydrochloricc acid at a level of 100 g HCl per liter of resin.

TOMBSTONE
Process Chemistry

Activity	Solvent	Reagent.	Recovery Method Ag	Recovery Method Au
A. Spray Side Slopes	(1) $Na_2S_2O_3$	None	Powd. Zn	Na_2S
	(2) NaCN	Lime	Na_2S	Resin
B. Crush & Leach No. Ramp	(1) $Na_2S_2O_3$	None	Powd. Zn	Na_2S
	(2) CN	Lime	Na_2S	Resin
C. Crush & Leach Heap (Low-Mn)	(1) NaCℓ	NaOCℓ	Na_2S	Resin
	(2) CN	Lime	Na_2S	Resin
D. Crush & Leach Heap (High-Mn)	(1) NaCℓ	NaOCℓ	Na_2S	Resin
	(2) $Na_2S_2O_3$	-	Powd. Zn	Na_2S
	(3) CN	Lime	Na_2S	Resin
E. Leach heap In Situ	(1) H_2SO_4	None		
	(2) NaCℓ	"	Powd. Zn	Resin
	(3) NaOCℓ	"		
	(4) NaCN	Lime	Na_2S	Resin

"IPS"

INDUCED PERCOLATION

The use of an "Induced Percolation Substance" (IPS) to agglomerate clays and fines greatly enhances the porosity by creating a hard and completely porous agglomerated mass.

In general, Induced Percolation should be used for all heap leaching ores; the technique was originally developed for tailings. Various ores thoroughly tested are Goldfield and Packard tailings, Packard dump and open-pit ore, Tonopah silver ore, Goldfield and Florida Canyon gold ores, and Tombstone open pit, dump, and tailings.

Benefits of IPS are:

1. Percolation increase
2. Percent recovery increase
3. Leaching rate increase
4. Percent slimes in preg pond is minimized
5. Solvent consumption is reduced.

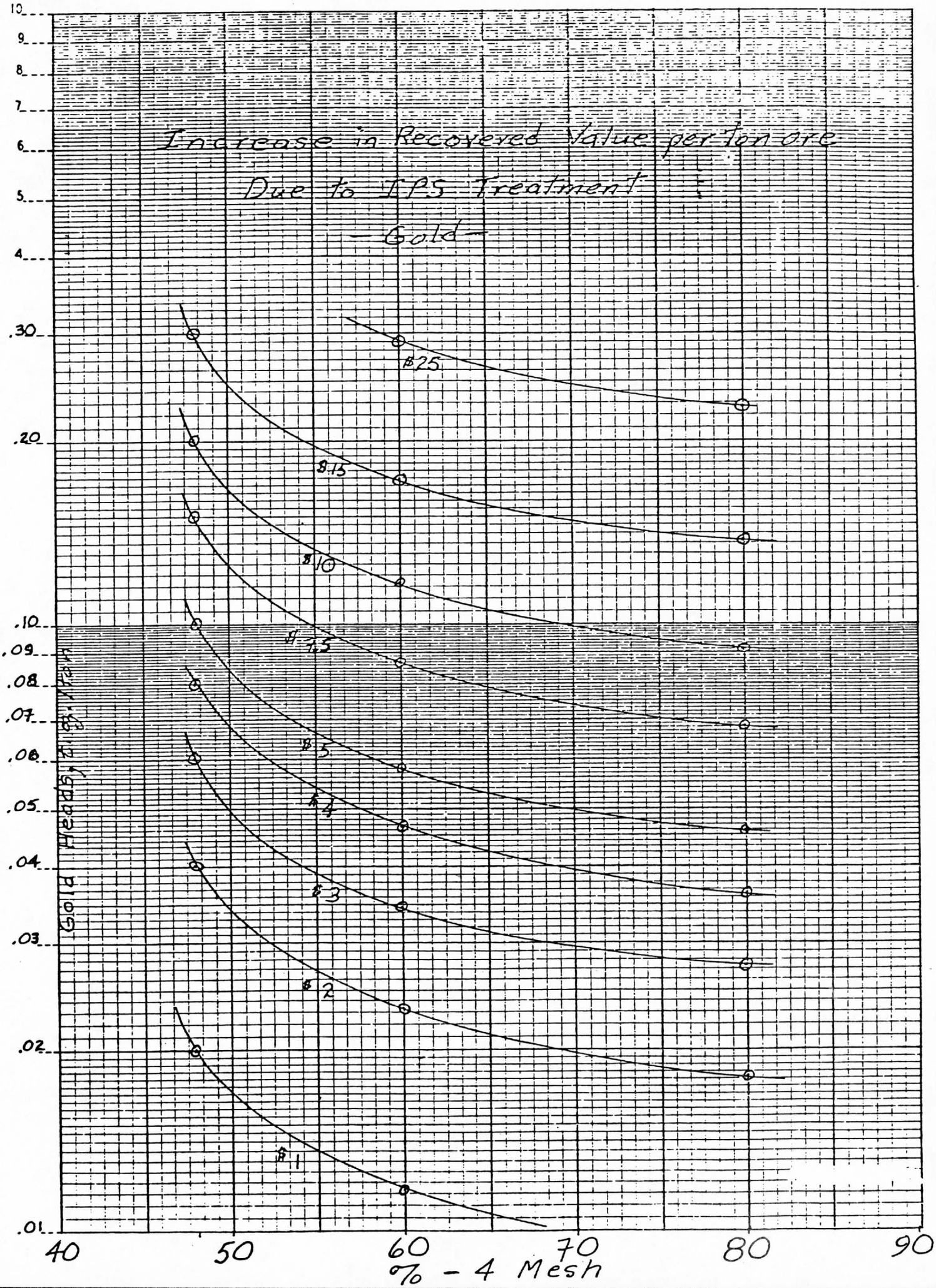
The costs of applying IPS should not exceed $0.50/ton ore. This would apply to tailings. The increased gross value due to IPS treatment ranges from 60 to 35 dollars per dollar IPS cost.

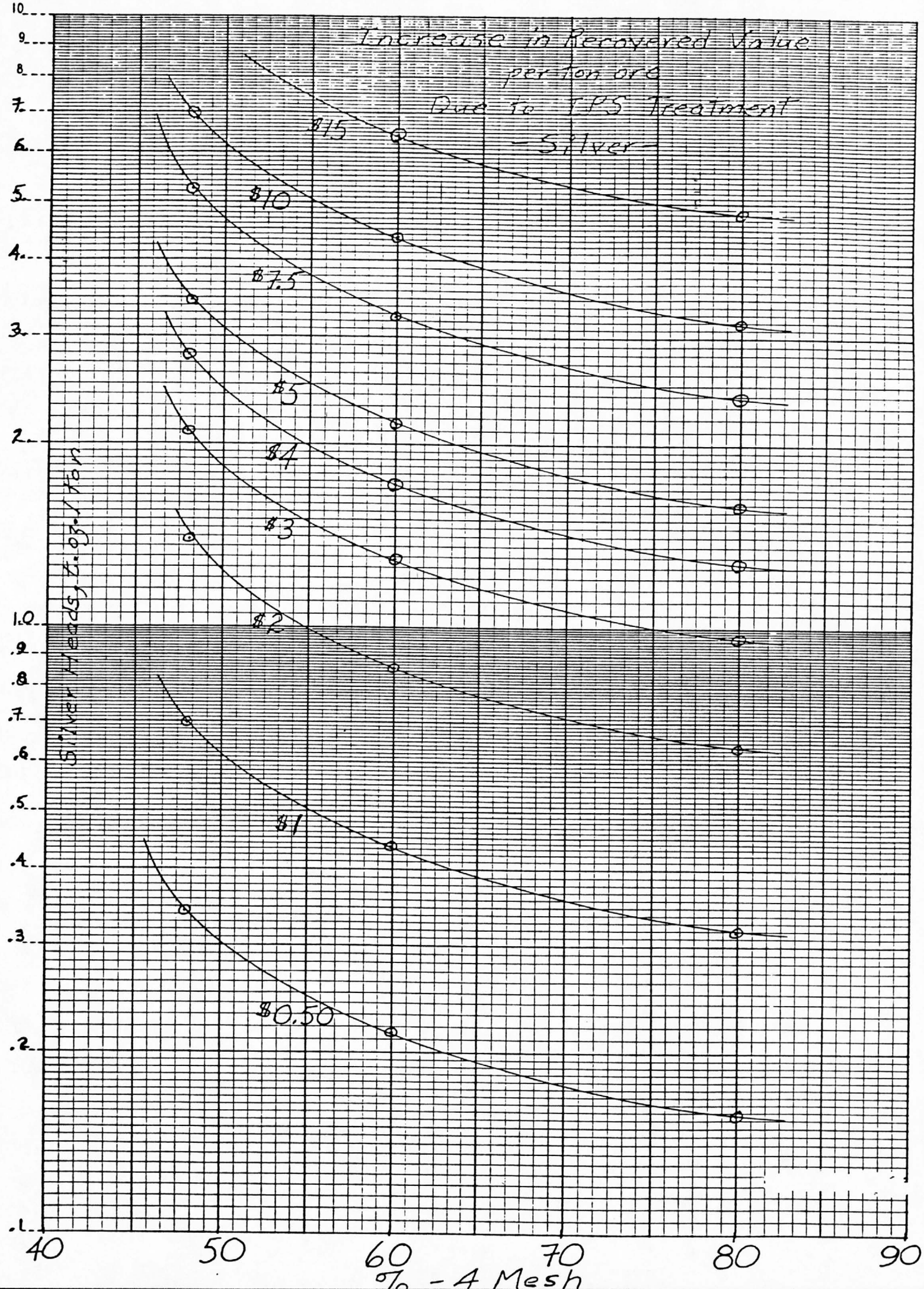
The absolute change (increase) in percolation and consequent recovery due to the use of an IPS can be summarized by the following:

Type of Ore Deposit	Absolute Increase	Per Cent Minus 4 Mesh		
		48%	60%	80%
Gold and Silver	Percolation	45	61	80
Gold	Recovery	25	43	55
Silver	Recovery	26	42	57

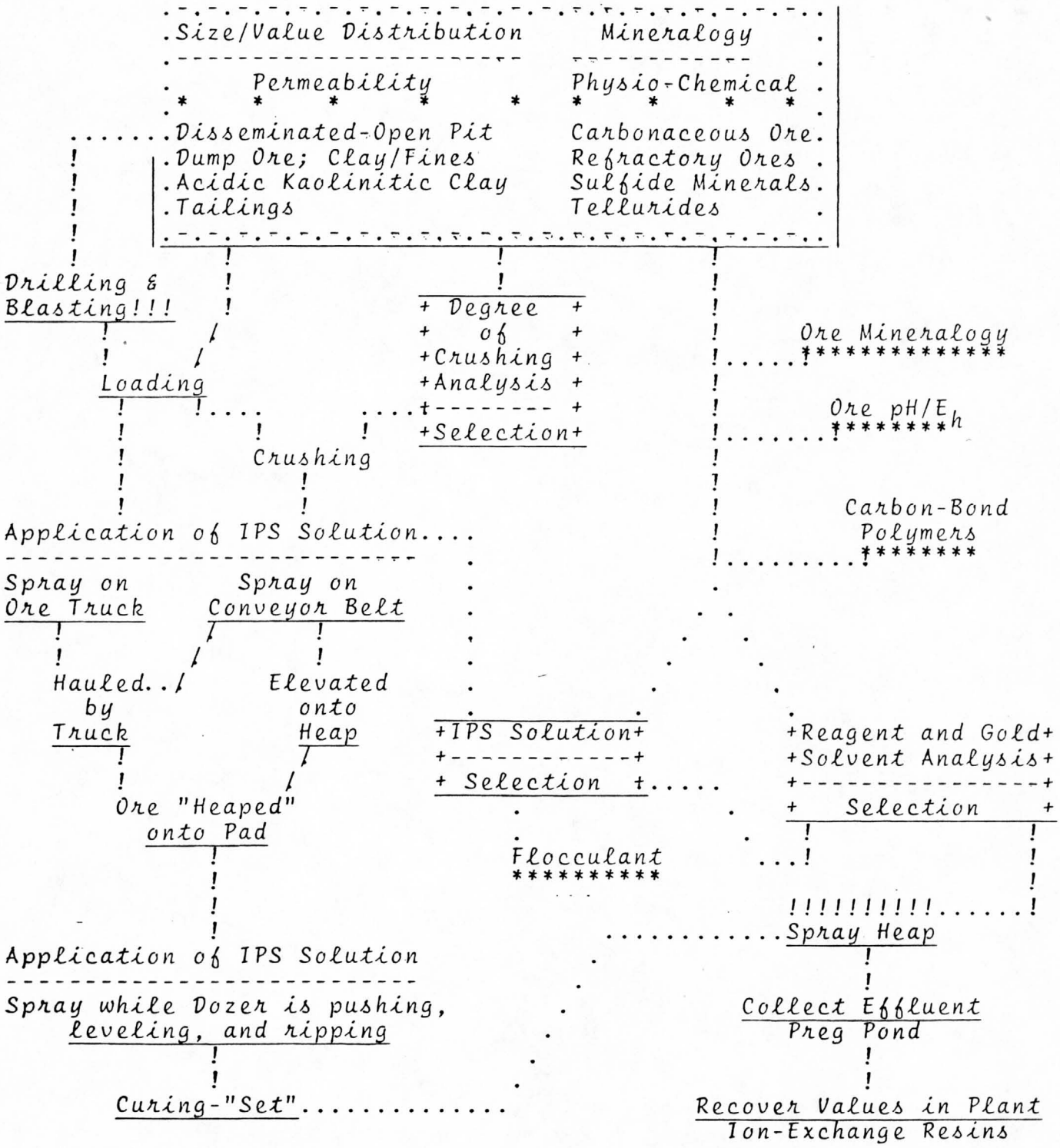
The increase in recovered value per ton of ore due to IPS treatment is presented in the following graphs for gold and silver ores.

Notice a positive correlation between the per cent minus 4 mesh and the increase in percolation due to IPS. This rule-of-thumb is very useful for computing the predicted increase in percolation and recovery for various ore types and screen analysis. The methodology for utilization of "Induced Percolation Substances" is presented following the gold and silver increased recovery graphs.


Increase in Recovered Value per Ton ore
Due to IPS Treatment
— Gold —
$25
$15
$10
$7.5
$5
$4
$3
$2
$1
Gold Heads, Ozs./Ton
10
9
8
7
6
5
4
.30
.20
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
40
50
60
70
80
90
% - 4 Mesh
FREDERICK POST COMPANY
311TR260 SEMI-LOGARITHMIC 2 5" CYCLES


Increase in Recovered Value per ton ore
Due to TPS Treatment
- Silver -
$15
$10
$7.5
$5
$4
$3
$2
$1
$0.50
Silver Heads, oz./ton
10
9
8
7
6
5
4
3
2
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
40
50
60
70
80
90
% - 4 Mesh
FREDERICK SCHUL COMPANY
311TR260 SEMI-LOGARITHMIC 2 5" CYCLES

PRE-TREATMENT of Various Problem Precious Metal Ores for HEAP LEACHING



PERCOLATION TESTS

Examination of the surface geology at Tombstone indicates that some of the ore will not percolate very well if the blasting is too heavily loaded with prills. Some of the ore will percolate very well; silicified shale, argillite, etc., will either rip or "blast" very easily and will also percolate due to cleavage planes developed during mineralization. However, where there is intense argillation, the developed clays will cause blinding if they are not pre-treated before leaching.

Pre-treatment is a simple technique for clay or fines that trades a small additional initial cost for much higher costs later and a much faster percolation and hence recovery rate. It is therefore very desireable to pre-treat for better percolation to maximize recovery and minimize the leaching period. This is especially useful for a gold deposit with such a high-valued pregnant solution.

Following are the generalized percolation results from the Tombstone tailings. It must be recognized that this represents the very worst case; the drill-hole blasting will not produce all fines, as the tailings represent. However, the study of these tailings in a cyanide-lime solution yields data concerning the effect the fines will have on blinding and relates to the amount of settling required in the preg pond. In addition, a study of the waste dumps determines the parameters of the worst open pit ore.

Notice in table 1 that there are some very poor percolation materials in the upper portion of drill-hole number 2. This "initial stripping waste" (for the initial north pit) will obviously make very good pad material (see later section) if "over-blasted".

Also observed in table 1 are the facts relating to percolation problems the fines will produce in some of the ore intervals. Obviously it is necessary to blast very lightly; load the blast-holes lightly with prills.

It must be pointed out that one of the additional benefits of pre-treatment of the ore to induce percolation is that the fines will be bound together by the "soil cement" and therefore minimize the slimes that would get into the preg pond.

Table 1
DRILL-HOLE PERCOLATION TESTS

Percolation	Drill-Hole		DH Interval	Remarks
Very Bad	TDC-2	(4)	15-20'	Iron Glob-Colloidal
	TDC-9	(35)	170-175'	"
	TDC-9	(36)	175-180'	"
	TDC-24	(11)	50-55'	"
	TDC-36	(19)	90-95'	"
	TDC-36	(20)	95-100'	"
Poor	TDC-2	(5)	20-25'	Slight Separation
	TDC-2	(13)	60-65'	"
	TDC-9	(38)	155-160'	"
	TDC-24	(14)	65-70'	"
	TDC-36	(24)	115-120'	"
	TDC-36	(25)	120-125'	"
Fair	TDC-2	(7)	30-35'	Clear Separation
	TDC-2	(9)	40-45'	"
	TDC-2	(16)	75-80'	"
	TDC-2	(20)	95-100'	"
	TDC-2	(27)	130-135'	"
	TDC-9	(31)	150-155'	"

The above percolation study is a summary of a study made for all logs based on the geology for each drill hole. This percolation study (Table 1) was made from the rotary drill-hole cuttings, which represents the worst case; the blasted ore will not be all fines. A correlation of the cuttings and the blasted ore follows:

Percolation Correlation

Drill-Hole Cuttings	Blasted Ore	Percentage of Ore for Each Percolation Category
Fair	Good	35 %
Poor	Fair	30
Very Bad	Poor	35

Procedure

The use of an induced percolation substance (IPS) to agglomerate clays and fines to greatly enhance the porosity to allow leaching of the total agglomerated mass is a new technique.

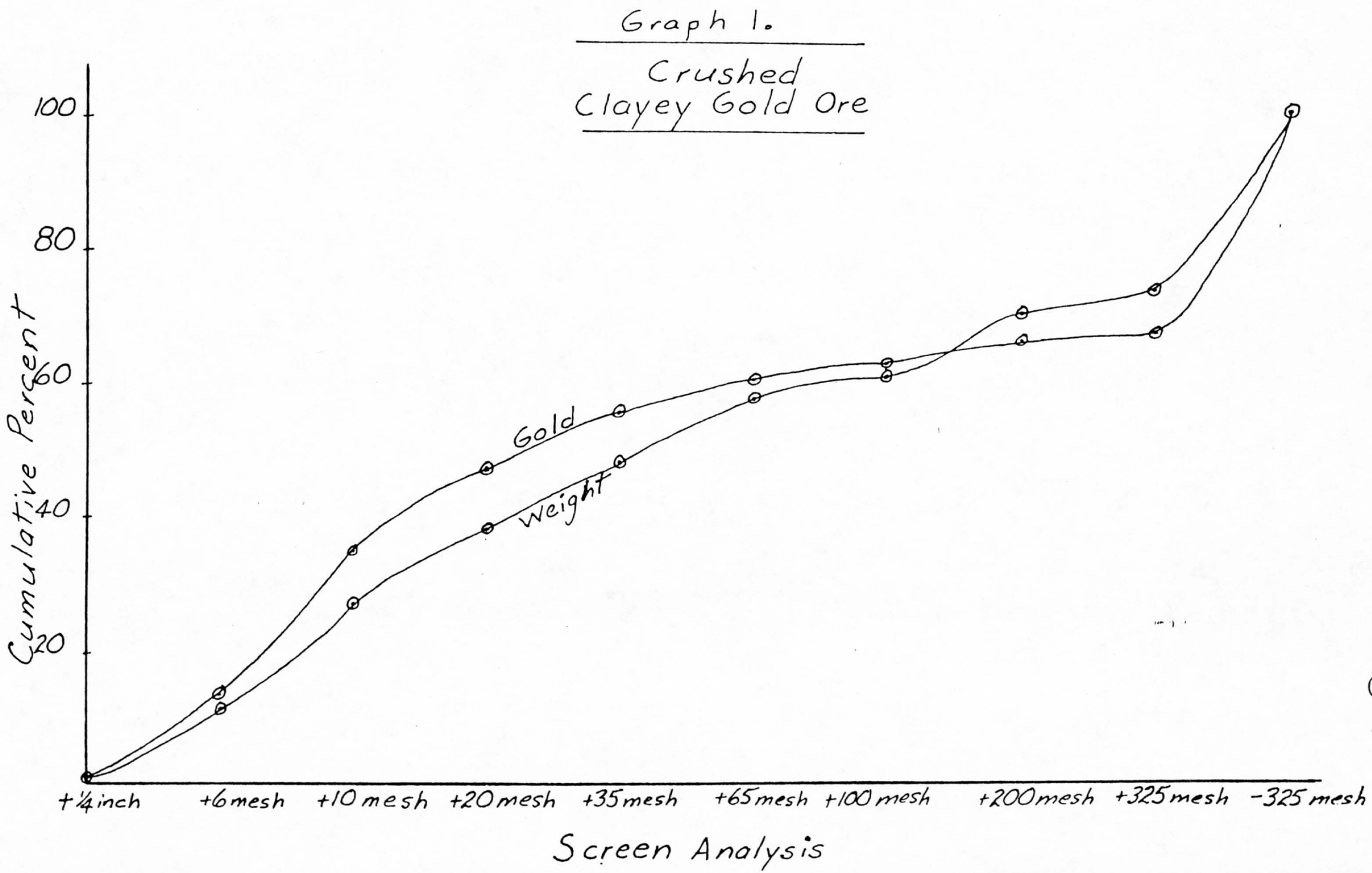
Modifications of the basic technique has resulted in even more spectacular results applied to the Tombstone deposit than has been obtained on other ores. Basic modifications initiated by the author are to introduce "TriCalcium Silicates and TriCalcium Aluminates" into the system. The resulting agglomerated mass is hard but completely porous. Another change implemented by the author is to use a standard cyanide leach solution for the "wetting-curing" process, which greatly accelerates the leaching process, or a pre-treatment hypochlorite-halide systems.

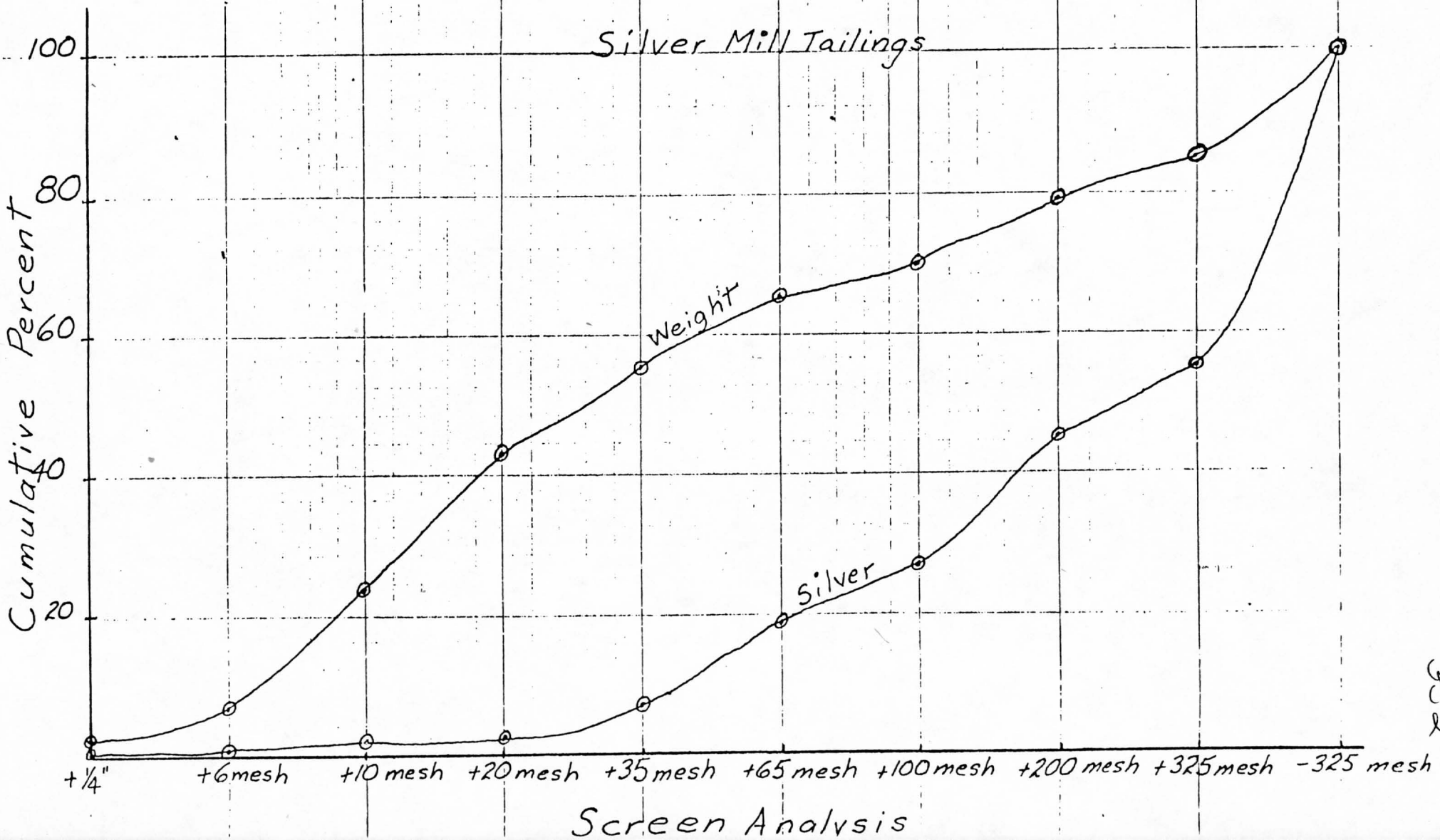
SCREEN ANALYSIS

The screen analysis for various size categories is shown in graphs #1 and #1A. Notice that due to crushing (rotary drilling), a close relationship exists between the weight percent and gold-value percent size-distribution. This points out that "induced percolation" would be very effective for getting the values out of the fine fraction; maximization of recovery results from adequate contact of CN and Au in all size fractions, especially in the fines that normally form impermeable "balls" that "lock-up-the-gold-values".

ORE TYPE & CHEMICAL COMPOSITION

The Tombstone ore is slightly basic and requires very little lime/caustic for pH control (protective alkalinity). Chemically, there are numerous clay products in the ore, basically as products of alteration. This furnishes an excess of alumina which requires an excess of hydrated lime for the clay-lime balance. Also, the silica (free) content is not very high, due to the basic lack of silica (free) in the original shale member. Silicification as an alteration product did not furnish "free" silica into the system. There are a great "excess" of iron oxides; limonite and ferric gel-silicate-kaolinite/montmorillinite complexes.


Graph 1.
Crushed
Clayey Gold Ore
100
80
60
40
20
Cumulative Percent
Gold
Weight
+¼ inch
+6 mesh
+10 mesh
+20 mesh
+35 mesh
+65 mesh
+100 mesh
+200 mesh
+325 mesh
-325 mesh
Screen Analysis


Silver Mill Tailings
Weight
Silver
Cumulative Percent
100
80
60
40
20
+1/4"
+6 mesh
+10 mesh
+20 mesh
+35 mesh
+65 mesh
+100 mesh
+200 mesh
+325 mesh
-325 mesh
Screen Analysis

352

COMPACTED DENSITY

The optimum amount of moisture to add is directly related to the "maximum compacted density" as determined by the standard compaction tests made for highway-pad-soil and other permeability testing procedures.

The concept basic to determining the optimum moisture content for compaction and the resulting compacted density is to compact the test material with varying amounts of moisture into the same known volume (test vessel) and weigh the amount of material that was compacted into the known volume. This yields the "compacted density" and the optimum moisture content is that with the "highest compacted density".

Following is the procedure:

A. Test Vessel Data
   1. Volume
   2. Weight

B. Prepare material with varying moisture contents
   1. Weigh 4 pounds material
   2. Calculate desired moisture content & add H_2O
   3. Mix well

C. Compaction
   1. Add "moist material" in 2-inch lifts & compact
   2. Continue until compacted above collar

D. Separate collar-cut/scrape to top of test vessel

E. Weigh

F. Check "moisture content" computation by weight wet and dry and re-weigh

Following are the results for one example:

A. Test Vessel Data

1. Volume;
   a. Diameter = 3 15/16 inches
   b. Height = 4 9/16 inches
   c. Volume =

$$\pi r^2 h$$

$$= 3.1415927 \left(\left(\frac{3\ 15/16}{2}\right)(1/12)\right)^2 \left(\frac{4\ 9/16}{12}\right)$$

$$= 0.0321507 \text{ ft}^3$$

2. Tare weight = 10.380 # or 4708 grams

B. Moisture Preparation (for 4 #'s dry sample);

Required PerCent Moisture-Dry	Ml. H_2O-% Dry for 4 lbs. (1814 gm.)
7	127
8	145
9	163
10	181
11	200
12	218
13	236
14	254
15	272

C. Compaction Test Results

# Wet	% Moisture (Total)	# Net Dry Wgt.	Compacted Dens. Dry #/Ft^3
3.820 #	6.54 %	3.57 #	111.04
3.870	7.40	3.58	111.46
3.910	8.24	3.59	111.59
4.092	9.07	3.72	115.73
4.220	9.91	3.80	118.25
4.237	10.72	3.78	117.65
4.253	11.50	3.76	117.07
4.270	12.28	3.75	116.50
4.200	13.04	3.65	113.60

The results are presented in figure 1, which follows.

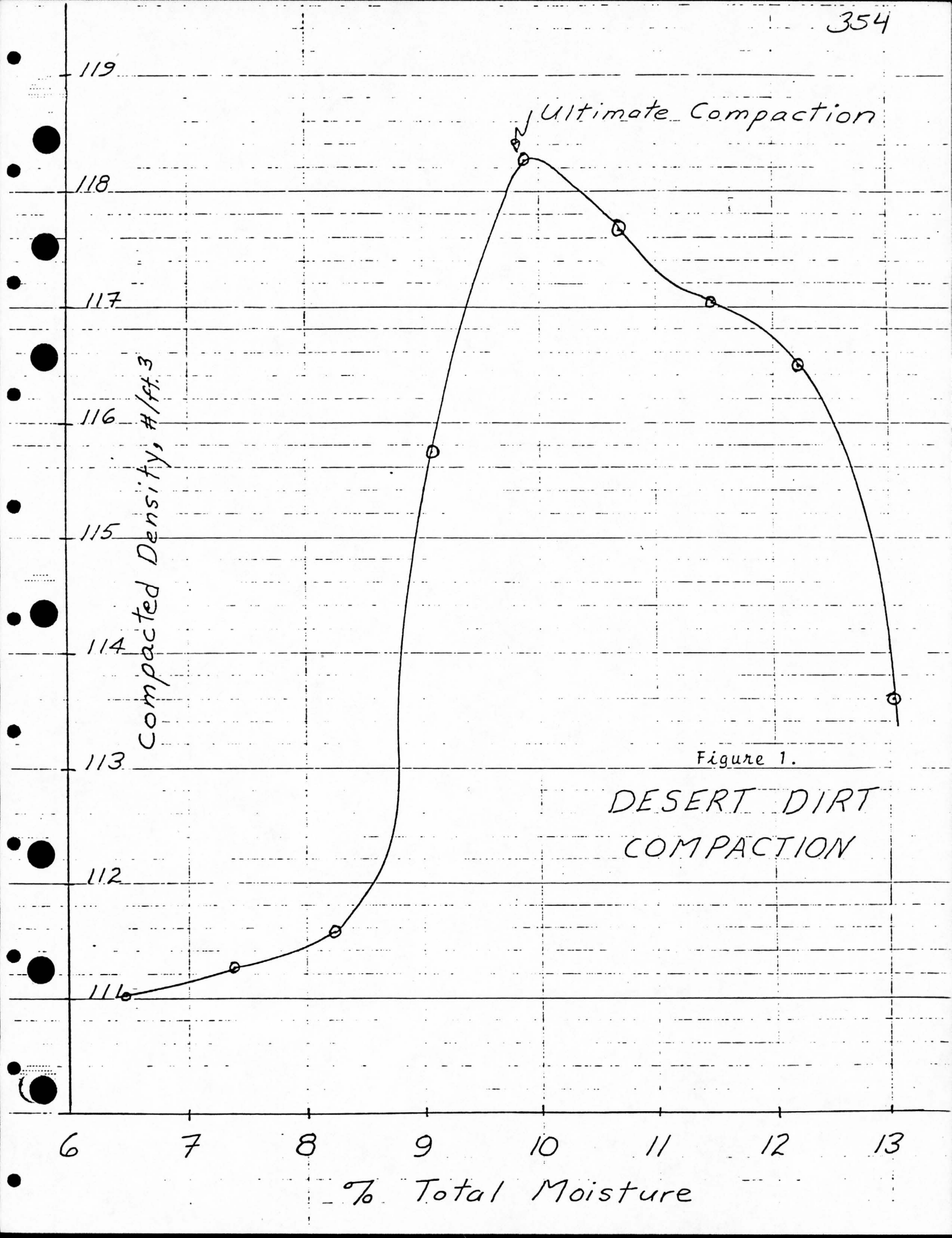


Figure 1.

DESERT DIRT COMPACTION

Local "soil materials" are compared for their maximum compacted density as a guide to determining the optimum moisture content required for determining the optimum moisture-content soil-cement flow rate relationship.

Compacted densities compared locally are from the Florida Canyon area and the "Packard" area, 30 miles to the southwest. The "Packard" material is used as a comparison because of its similar clay composition and screen analysis.

Results of compaction tests in their order of increasing density are as follows (see figure 2):

A. Packard tailings
B. Florida Canyon "crushed ore"-rotary drill-hole cuttings
C. Packard desert dirt
D. Florida Canyon surface waste-clayey material (DH F-2)
E. Packard sub-soil

Notice that the Florida Canyon "waste" is a better pad material than used for a heap-leaching project at Packard (Florida Canyon Pad Material vs. Packard Tailings, which was used for the pad at the Packard property).

From the above results, it is obvious that about 10 % by weight is the optimum moisture content for preparing the "Induced Percolation Material".

TYPES OF IP SUBSTANCES

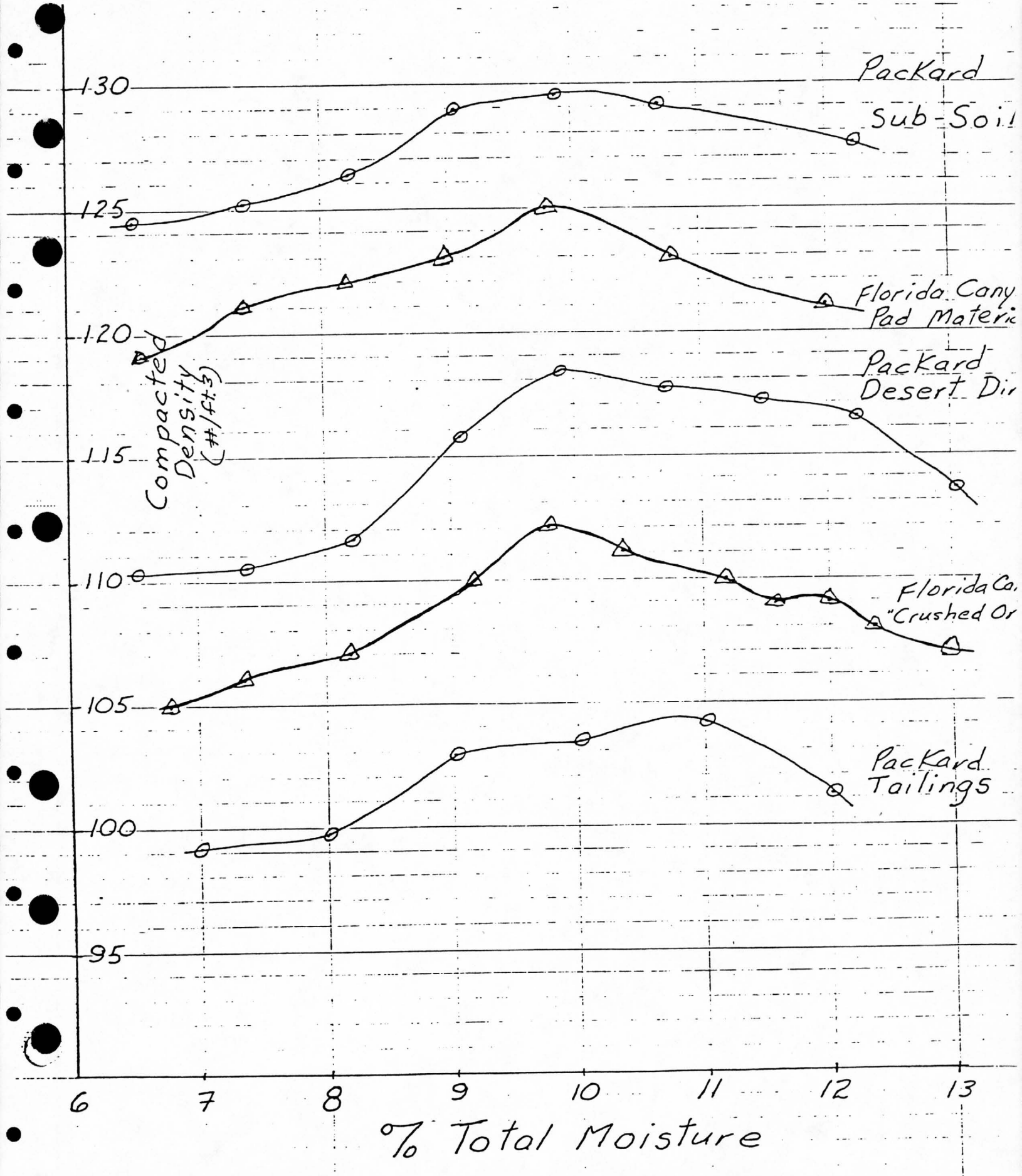
Basic substances that create induced percolation are:

1. Lime (Agricultural, dehydrate, and hydrated)
2. Portland Cement (Types I, II, III, IV, & V)
3. Flocculants (Polyethylene oxide, polymers, etc.)
4. Halides
5. Diatamaceous Earth

The amount of lime (CaO) required for various percolation flow rates are presented in Table 2:

Figure 2.

Compaction Tests



PACKARD MINE

COMPACTION & PERMEABILITY TESTS

Desert Dirt

General Description

"Desert Dirt" was collected along the road and compaction tests were made using the material as it exists-unscreened (the largest coarse was 1-1/2 inches).

Clay Swelling

There has been no rain for four months. The desert dirt was dried for 24 hours with no moisture loss, indicating a very dry condition. The pan + sample weight before and after drying was 6.241 #, with the pan weight = 1.885 #.

The moisture retained in the clay lattice by the clay in the desert dirt after 24 hours drying is computed as follows:

Prepared % Moisture-Dry Weight	Calculated % Moisture, Total	Pan & Sample Weight Wet	Pan & Sample Weight Dry	PerCent Retained Moisture
7	6.54	5.730	5.450	12.0 %
8	7.40	5.750	5.409	17.6
9	8.24	5.790	5.429	12.8
10	9.07	6.048	5.642	9.1
11	9.91	6.049	5.609	8.2
12	10.72	6.050	5.577	7.2
13	11.50	6.051	5.544	6.3
14	12.28	6.052	5.512	5.3
15	13.04	6.053	5.479	4.4

Table 2
DEHYDRATED LIME VS. LEACH FLOW

Amount of Lime	Flow Rate (Gal/Hr/Ft^2)	Rate of Change Gal/Hr/Ft^2/# Lime
0	.5	
0.5	1.12	1.24
1	1.78	1.32
2	2.94	1.16
3	4.00	1.06
4	5.60	1.60
5	5.96	.36
6	6.72	.76
7	7.36	.64
8	7.78	.42
9	8.17	.39
10	8.58	.41
11	8.71	.13
12	8.83	.12
13	8.96	.13

Notice that the optimum amount of dehydrated lime is about 4 pounds/ton ore. Hydrated lime was also tested with better success (required less hydrated lime/ton ore). However, the best and most economical results were obtained by using hydrated lime and "Portland-type cement".

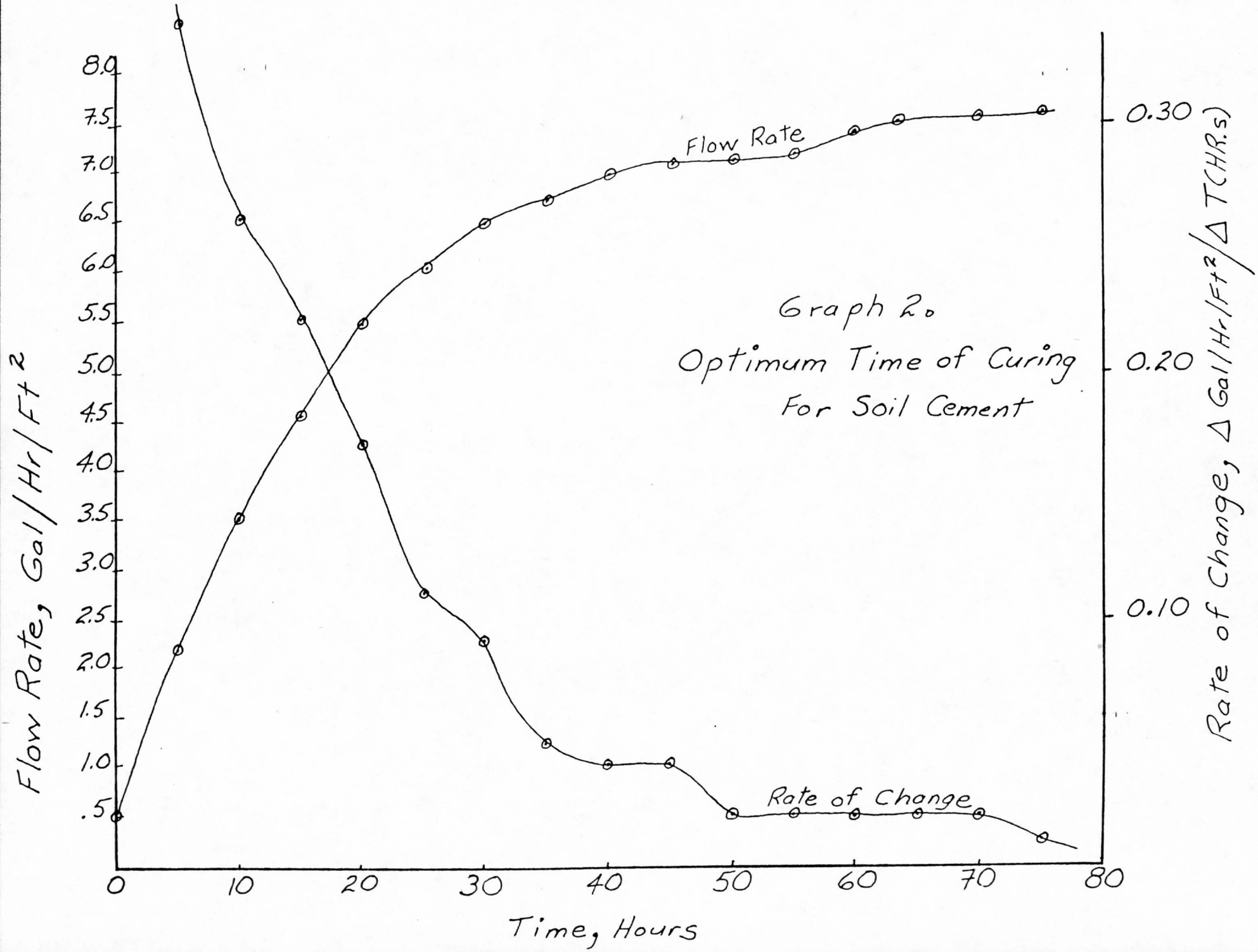
PROPORTIONING ANALYSIS

The above proper amounts of the IP substances are combined according to their screen analysis and chemical composition to produce the proper plasticity index.

CURING TIME

The optimum "curing time" for the Tombstone soil-cement is shown in graph 2. Notice that after 35 hours, the rate of change of the flow rate is very minimal.

The above described procedure is summarized in the illustration following graph 2.


Flow Rate, Gal/Hr/Ft²
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0
10
20
30
40
50
60
70
80
Time, Hours
Rate of Change, Δ Gal/Hr/Ft²/Δ T(HRs)
0.30
0.20
0.10
Flow Rate
Rate of Change
Graph 2.
Optimum Time of Curing
For Soil Cement

INDUCED PERCOLATION SUBSTANCES

ORE TYPE
****

Acid Basic

Clay
Tailings

TYPES OF IP SUBSTANCES
****

Lime
Agricultural
Dehydrated
Hydrated

Portland Cement
Type I
Type II
Types III, IV, V

Diatamaceous Earth
Flocculants
Halides

ORE CHEMICAL COMPOSITION
****

Silica
Alumina
Silicates
Iron Oxides
CaO & MgO

PROPORTIONING ANALYSIS
****

Plasticity Index
Screen Analysis

CURING
******

Time
Method

ECONOMIC ANALYSIS
****

Maximize;

Percolation
Heat of Hydration
Recovery Rate of
Precious Metals

Minimize;

Disintegration
"Set Time"
Cost per Ton

SOLUTION QUANTIFICATION
****

Compacted Density
Application Techniques
Solvent(s)

Results

Agglomeration of the ferric aluminum silicates (limonitic clays) occurred with the agglomeration (soil cement) possessing excellent porocity. The optimum level for each of the parameters is as follows:

Parameter	Optimum Level	Remarks
Ore Chem Comp.		
Clay	Excess H_2O	About 9 % extra
Clay	Excess Hydrated Lime	Extra pound
Ferric Oxides	Excess Hydrated Lime	With above 1-1/2 #
Moisture Content	10 % by weight	Allow for clay swelling
IP Substances		
Hydrated Lime	10 #/ton ore	Max.; varies for consi
Portland Type II	3 #/ton ore	or screen analysis
Flocculant	.02 #/ton ore	Depends on above
Diatamaceous Earth	4 #/ton ore	

ECONOMIC ANALYSIS

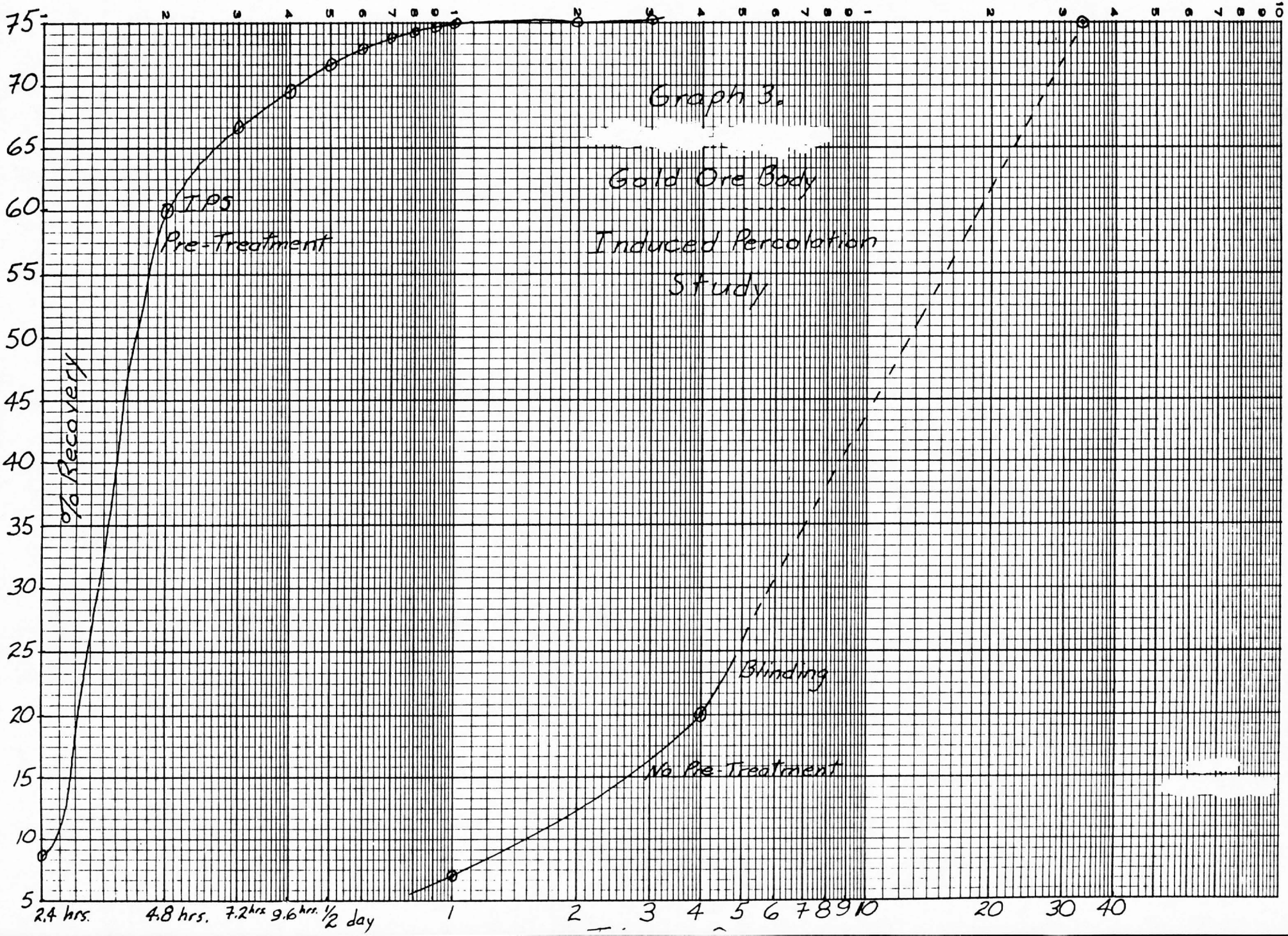
The following table (3) presents the results of the induced percolation study for Tombstone ore. The results all indicate the very great economic advantage of treating to some degree (depends on natural percolation-screen analysis) all ore from the property.

Graph 3 presents the summary of the percent recovery for various leaching periods for treated vs. un-treated ore. Notice that IPS treatment results in total leaching (recovery) in one day versus a projected 33 day leach for the untreated ore. This is to say that after blinding in four days, additional dozing, ripping, and other very costly secondary recovery methods <u>may</u> result in as much recovery as the IPS treated ore obtained, but it would take 33 days vs. one day.

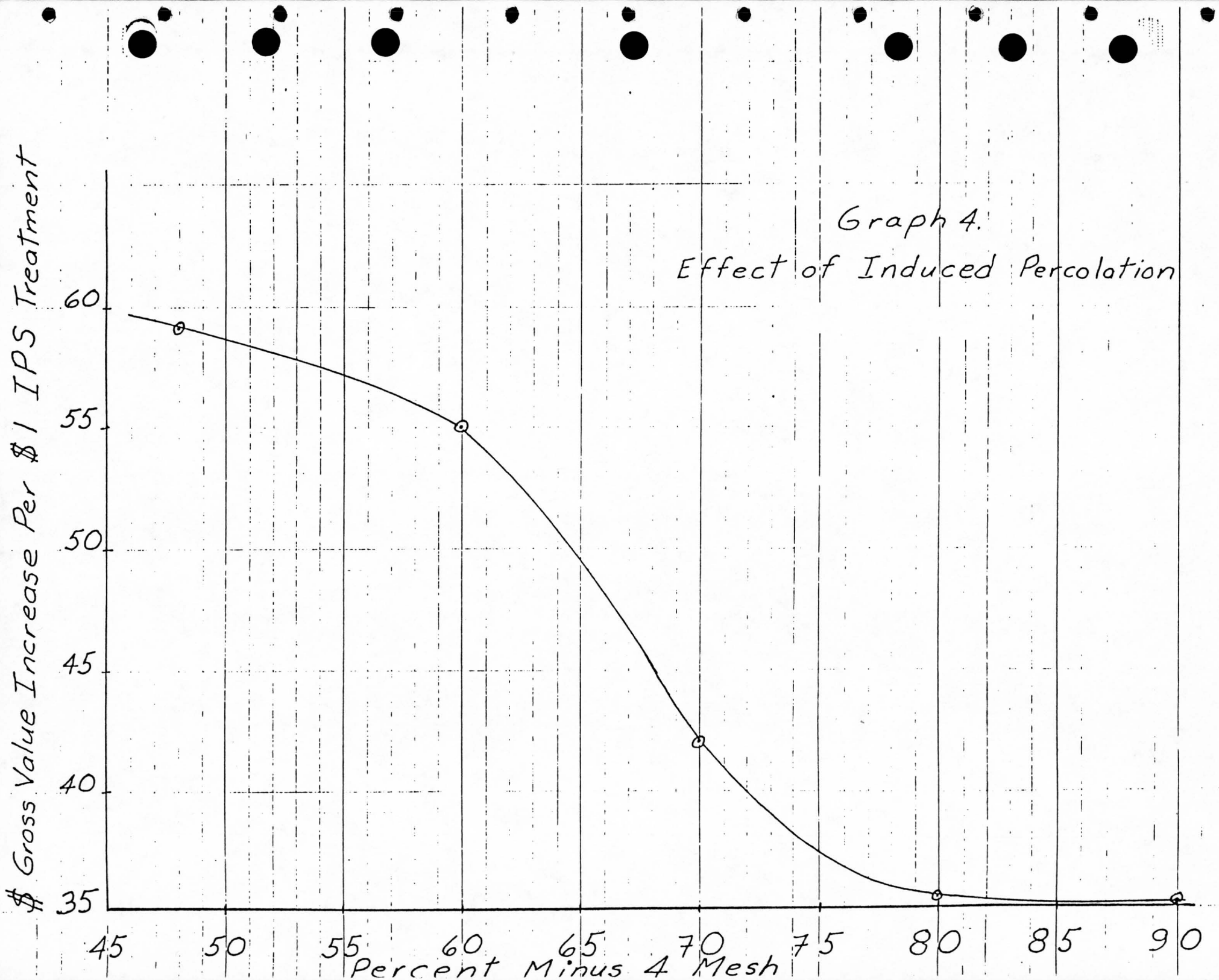
Graph 4 presents the results of the use of IPS, showing the gross value increase due to IPS per $dollar IPS treatment. It is shown that greater increase in gold value resulted in modest application for coarser material than all fines.

Table 3
ECONOMIC ANALYSIS
INDUCED PERCOLATION
Tombstone

PARAMETER	PERCOLATION		
	Good	Fair	Poor
% Minus 4 Mesh	48 %	60 %	80 %
% Tonnage	35 %	30 %	35 %
% Recovery;			
Treated	75 %	75 %	75 %
Un-Treated	50 %	32 %	20 %
Gross Value/Ton;			
Treated	$12.20	$12.20	$12.20
Un-Treated	8.13	5.21	3.25
Difference	4.07	6.99	8.95
Quantity/Ton;			
Hydrated Lime	1/2 #	1 #	2 #
Portland II	1/2 #	1 #	2 #
Flocculant	.01 #	.01 #	.02 #
IPS - Cost;			
Hydrated Lime	$ .037	$ .074	$ .148
Portland II	.021	.043	.085
Flocculant	.010	.010	.020
	.068	.127	.253
$ IPS Increase (GV)			
$ IPS Treatment	$59.9	$55.0	$35.4


FREDERICK COMPANY
311TR384 SEMI-LOGARITHMIC 3 3-1/3" CYCLES
Graph 3.
Gold Ore Body
Induced Percolation
Study
% Recovery
IPS
Pre-Treatment
Blinding
No Pre-Treatment
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
2.4 hrs.
4.8 hrs.
7.2 hrs.
9.6 hrs.
1/2 day
1
2
3
4
5
6
7
8
9
10
20
30
40

363


Graph 4.
Effect of Induced Percolation
$ Gross Value Increase Per $1 IPS Treatment
60
55
50
45
40
35
45
50
55
60
65
70
75
80
85
90
Percent Minus 4 Mesh

BARREL LEACH TESTS

Wgt. (Dry) Ore 49.5# (A)
Wgt. Barrel + Tray _____ (B)

Un-Treated Ore

Lime added (gr.) 2 gr -> pH + 10.5

Time	Total Wgt. (A+B+Soln.)	Wgt. Soln.	AA/Ton Soln. Au	AA/Ton Soln. Ag	(Wgt. Soln.) / (Wgt. Ore)	Au Per	Ag ton ore
4		64.08#	.002	. -	1.295	.002	. -
8	BLINDING	65.36	.002	. -	1.320	.003	. -
12	BLINDING	62.18	.004	. -	1.256	.005	. -
24	Blinding	65.11	.005	. -	1.315	.006	. -
96	Severe Blinding	64.48	.012	. -	1.303	.016	. -
Not The Same	Added Hyd. Lime	65.37	.043	. -	1.321	.057	. -

BARREL LEACH TESTS

Wgt. (Dry) Ore 40.0 (A)
Wgt. Barrel + Tray _____ (B)

"IPS" Pre-Treatment

Lime added (gr.) 2 gr - pH = 10.5

Time	Total Wgt. (A+B+Soln.)	Wgt. Soln.	AA/Ton Soln. Au	AA/Ton Soln. Ag	(Wgt. Soln.) / (Wgt. Ore)	Au Per ton ore	Ag Per ton ore
.1 Day		63.40 #	.004	. -	1.585	.007	. -
.2 "		61.46 #	.032	. -	1.5365	.049	. -
.3 "		64.20 #	.034	. -	1.605	.054	. -
.4 "		63.96 #	.035	. -	1.599	.056	. -
.5 "		62.10 #	.038	. -	1.5525	.059	. -
.6 "		62.83 #	.038	. -	1.57075	.059	. -
.7 "		62.63 #	.038	. -	1.56575	.060	. -
.8 "		61.25 #	.039	. -	1.53125	.060	. -
.9 "		61.75 #	.040	. -	1.54375	.061	. -
1 Day		62.30 #	.039	. -	1.5575	.061	. -

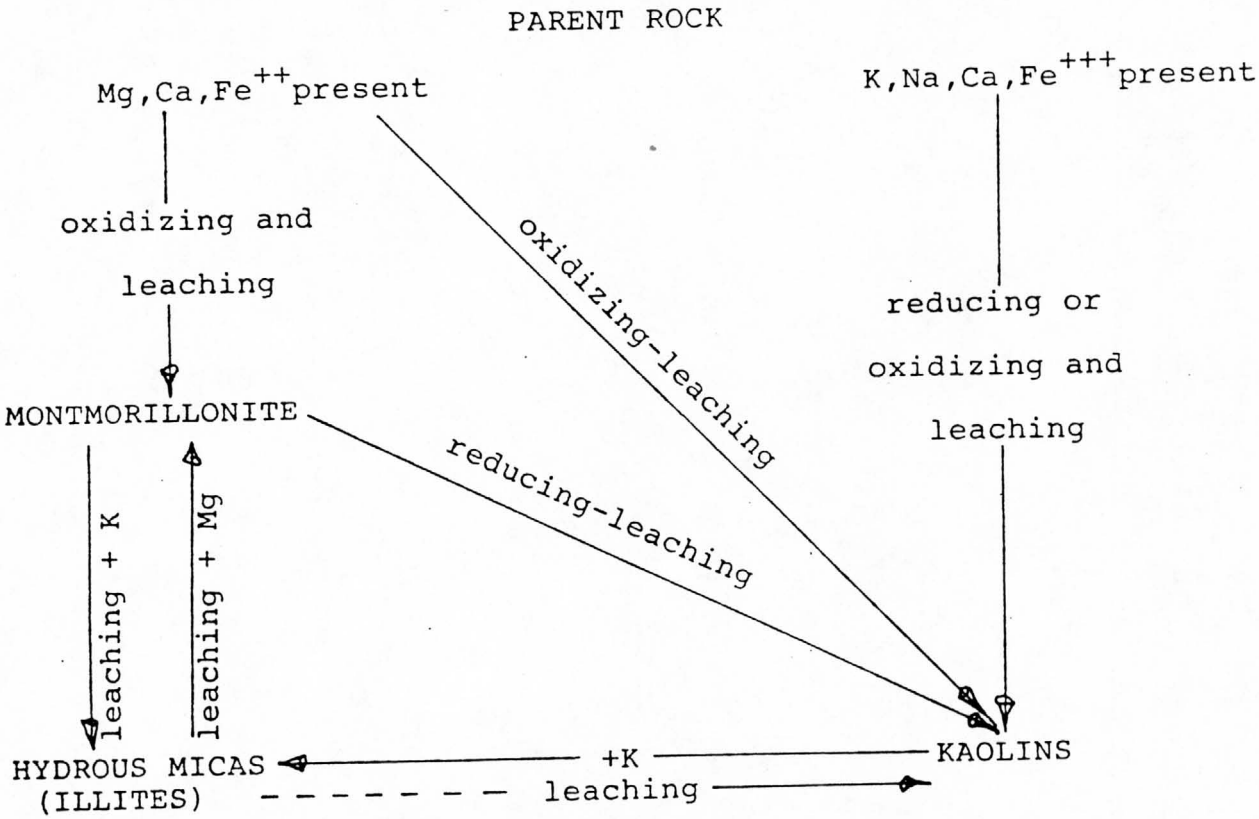
CLAY TECHNOLOGY

R.F.Hewlett
June 28, 1977

Clay minerals commonly formed are:

1. Kaolins
2. Montmorillonites
3. Illites(Hydrous Micas).

Starting from any parent rock, the clay minerals develop under specific environmental conditions as shown below:



The previous diagram illustrates the following:

1. Clay minerals are very sensitive to small changes in the composition, temperature, and pH of their surroundings(excellent indicator minerals)
2. Clay minerals are not stable end products of weathering but are part of a system existing in dynamic equilibrium with its components. The rate at which many of the clay minerals react to environmental changes is often very rapid.
3. Kaolinite characteristically develops in an acid environment often produced by organic acids or the oxidation of sulphide minerals. Also, strong leaching under neutral conditions where the bases have been removed from the rocks develops kaolinite.
4. Montmorillonite minerals develop under a wide range of conditions.
5. Illites are the dominant clay minerals in marine sediments, but they also occur in certain soils derived from marine shales.

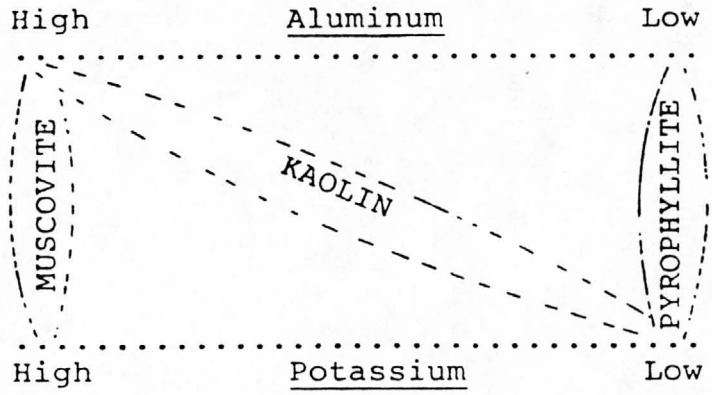
<u>Kaolinite</u> ($Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$)

Synthetic modes of formation:

Temp.	Time	Solvent	Substance
320°C	24 hrs.	o.5N HCl	Orthoclase($KAlSi_3O_8$)
16	96 "	dil. HF	"
300	250 "	o.5-1.oN HCl/H_2SO_4	"

The pH ranges of formation are:

ACID	NEUTRAL	BASIC
Kaolin	Kaolin	Montmorillonite
********	******	**********
Ions with alkali metals(Li,Na,K,Rb,Cs)	'Free of 'Alkali 'Metals	Alkali:Al_2O_3:SiO_2 .o2-1: 1 : 4
(4.5-5.2 pH with opt. range 4.8-5.0)		Alkali's can be;
High Al/SiO_2ratio & Potassium Conc.		NaOH, KOH, $Ca(OH)_2$



CLAY MINERAL SPECIES

1. Micaceous Clay Minerals

   a. Kaolinite Group

      Dioctahedral
      - Kaolite
      - Halloysite, $2H_2O$
      - Hydrated halloysite, $4H_2O$
      - Nacrite
      - Dickite

   b. Montmorillonite Group

      Dioctahedral
      - Montmorillonite
      - Beidellite
      - Nontronite

   c. Hydrous Mica Group

      Dioctahedral
      - Illite
      - Pinite
      - Glauconite
      - Celadonite
      - Brammalite

   d. Mixed Layer Group

      - Anauxite
      - Bravaisite
      - Vermiculite-chlorite
      - Kaolinite-nontronite
      - Montmorillonite-illite

Synthetic Formation

MONTMORILLONITE:

Montmorillonite + $KHCO_3$(10%) + H_2O ---> Orthoclase

Add heat in gold-lined pressure bomb (KAcid Carbonate)

ALUNITE:

A. $H_2SO_4 + K_2SO_4 + Na_2SO_4))_{.01M} + NH_4SO_4$ --> Alunite

60-90% Alunite in 7 days at 200°C

B. 50g $AlSO_4$ + $((H_2SO_4 + K_2SO_4 + Na_2SO_4))_{.05M}$ ---> Alunite

50-99% Alunite in 100 days at 100°C

HALLOYSITE:

Kaolinitic clay + $SO_4^{--}))$ ---> Halloysite

Within carbonate rocks;
therefore a pH change

KAOLIN:

Solfataric Action: ((Alkali)) + SO_2 + S_2 + HCl ---> Kaolinte
Metal
Soln.

Solubilities

A. Mullite ($3Al_2O_3 \cdot 2SiO_2$) is slightly soluble in cold H_2O

B. Montmorillonite Groups disolve in a weak acid soln.
(0.01 - .04% H^+)

Decompositions

A. Kaolin

$$\text{Kaolin} + H_2SO_4 \text{))}_{\text{strong}} \longrightarrow SiO_2 + AlSO_4$$

Properties of $Al_2(SO_4)_3$;

A. White powder
B. Soluble in cold H_2O - 31.3 gr/100 ml (o)
C. Soluble in hot H_2O - 98.1 gr/100 ml (100)
D. Slightly sol. in dil. acid and alcohol

Ionization

Calcium from soil colloids*

Clay + NaOH + $Ca(OH)_2$ ---> change in clay lattice;

Therefore, kaolinite + NaOH + $Ca(OH)_2$ ---> Montmorillinite

(Gives up ionized "salts")

Permeability

Calcium - saturated clays tend to be granular & comparatively pervious with Ca; Na clays are highly dispersed and impervious

Base Exchange

Influences pH:

A. Ca clays if free from $CaCO_3$ are 7
B. Na clays are highly alk. - +10
C. Rain with dis. CO_2 is acid(H^+) and H ions replace Na and form dil. soln.s of $NaHCO_3$-Na_2CO_3 or NaOH; resulting in increased alkalinity of Na clays
D. Mix; Na clay + $CaCO_3$ ---> alkiline upon leaching

(Ca^{++} replaces Na^{++} + Na_2CO_3
Also, Mg replaces Na...

Ion Exchange

Clays can be considered as multivalent polyelectrolytes in ion exchange reactions. The key for each of the major crystal structure groups are the distribution of charges in the lattice.

Members of the kaolin group have as a site of exchange reactivity the structural hydroxyl ions along the lateral surfaces and those formed by the hydration of silica at the broken edges of the crystals.

Montmorillonite clay groups are the most active in terms of ion exchange reactivity per unit weight. Either magnesium substitutes for aluminum or aluminum for silicon.

Illite group of clay minerals fix potassium irreversibly.

Processes that occur in an aqueous clay-electolyte interaction:

A. Ion exchange
B. Work of swelling
C. Water transfer
D. Donnan exclusion of anions
E. Complex ion formation
F. Incomplete dissociation
G. Ion pair formation
H. Molecular adsorption
I. Change in solution volume.

Clay Strucure Stabilization

Polar organic compounds play two important roles in soil structure:

1. Weakening the potentially strong cohesive bonds between clay particles(thus permitting formation into aggregates)
2. Linking clay particles together through mutual adsorption of such compounds by two or more clay particles.

Compounds very important in soil structures are polyuronides and polysaccharides. They are readilly adsorbed by clay molecules.

To produce a permeable clay, Na^{+} must be replaced with Ca^{++} (to produce flocculation). Colloids in non-alkali soils tend to flocculate. Both Ca^{++} and H^{+} ions produce flocculation and absorption of most polar organic molecules causes complete flocculation. (Soil structure changes are in degree of expression of cohesive forces between already flocculated clay particles).

Organic matter modifies the plasticity of clays by utilizing its bulk and adsorptive capacity to adsorb water and insulate or coat clay particles, and by direct adsortion the polar organic compounds modify cohesive forces and bind clay particles together so they are not free to move and thus are less plastic.

Impermeable Soil Conditioning

Polmethracrylates and other correctives for impermeable clays include amino compounds and Krilium-like compounds(polymers).

In general, Krilium-like molecules are large anions and polyanions adsorb on Kaolinites. Amino compounds are large cations and polycations adsorb on Montmorillonite and Beidellic clays.

The Krilium-like molecules are adsorbed by hydrogen bonding. Some of these made by Monsanto Chemical are:

A. CRD 186; a Ca-saturated Krilium
B. CRD 189; a Na-saturated Krilium.

One observation made is that 0.1% of a Krilium-type compound is equivalent to a 2% calcium hydroxide solution in reducing swelling pressure and increased stability. However, higher percentages of calcium hydroxide produced more significant results.

Ammonium ion and phosphate fixation are commonly utilized for soil fixation. Kaolinite and halloysite can adsorb phosphate ions by replacement of hydroxyl groups on the surface of the clay.

The adsorbed phosphate ions on kaolinite could be replaced by arsenate ions. The anion exchange capacity is about equal to the cation exchange capacity. Both the phosphate and arsenate ions are tetrahedral in form like silica, and evidently can attach themselves to the broken edge of the silica sheet and act as an electrically unbalanced silica tetrahedron. A negative anion adsorption is developed for chloride, sulfate, and ferrocyanide in montmorillonite minerals. Formate ions are also adsorbed by H-montmorillonite by treating with formic acid.

DESIGNED TESTING PROCEEDURE

Pre-Treatment

A. Basic

1. CaO (lime)

   Add 1,2,3,4,&5 #lime/ton ore and note effect on perculation.

2. $Ca(OH)_2$

   Add 1,2,3,4,&5 # calcium hydroxide/ton ore and note the effect on perculation

B. Acid

1. H_2SO_4

   Add 1,2,3,4,&5 # H_2SO_4/ton ore and note effect on perculation.

Leaching

A. Basic

1. Pretreatment with lime
2. CaCN

B. Basic

1. Pretreatment with lime
2. NaCN

C. Acidic

1. Pretreatment with H_2SO_4 (1-5#/ton ore)
2. HTH

D. Acidic-Basic

1. Pretreatment with H_2SO_4
2. HTH

* After no more Au/Ag leaches

3. Neutralize with lime to 10.5
4. CaCN

E. Basic-Acidic

1,2 Lime & CaCN or NaCN

* After no more Au/Ag leaches

3,4 H_2SO_4 & HTH

SUMMARY

HEWLETT MANAGEMENT

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PHONE (702)359-1069

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Sparks, Nevada 89431

TOMBSTONE

Tombstone represents an opportunity to produce precious metals with a minimum capital investment. This is due to the following:

1. Extensive previous sampling;

   A. Surface drilling
   B. Underground drilling
   C. Underground sampling

2. An existing heap of one-million tons that can be re-processed utilizing recent "heap leaching innovations"

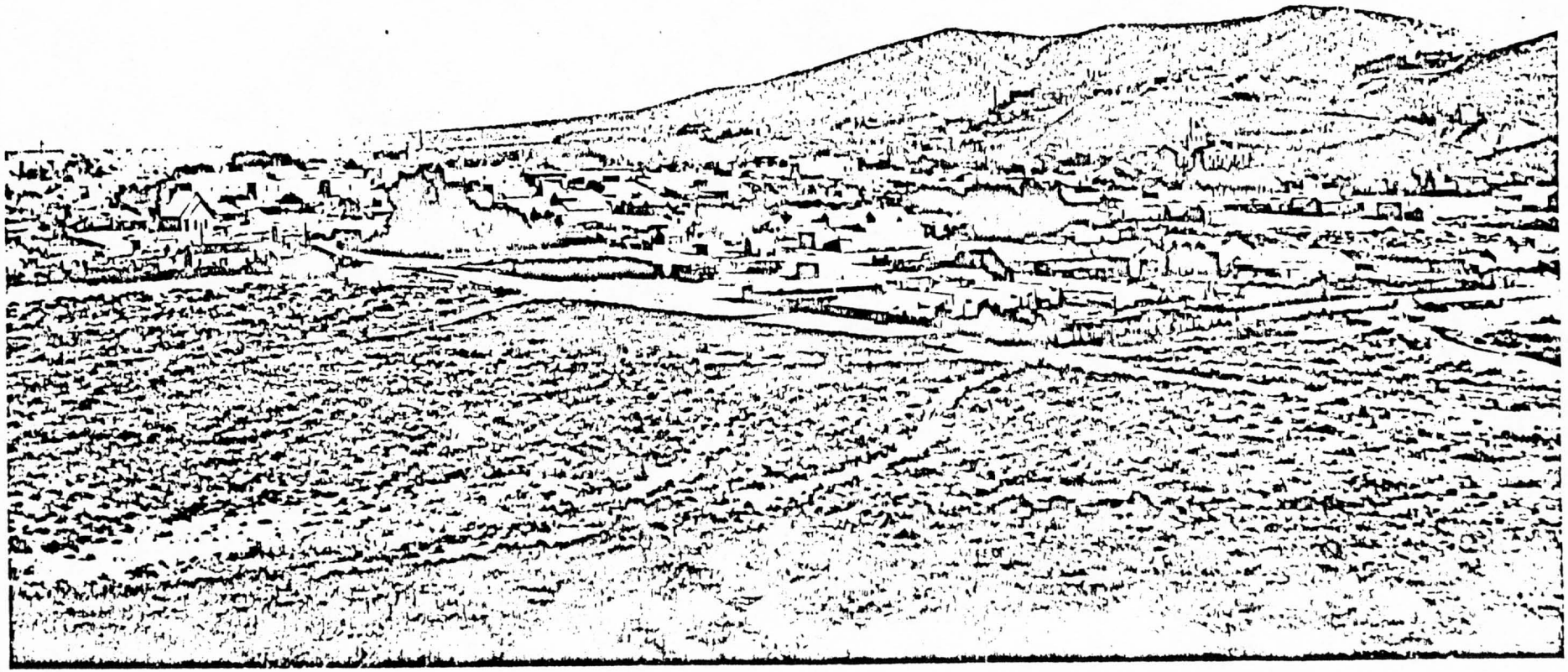
3. Proven open-pit ore targets for development of open-pit ore reserves.

Potentials are estimated as follows:

Activity	Net Operating Profit
Heap re-processing	$ 3,250,000
Open Pit;	
Gob	18,821,000
"New Ore"	133,480,000
Underground	100,000,000

The most important fact to recognize is that due to the authors knowledge of the Tombstone District and heap leaching, the following activity sequence is possible:

A. Initiate re-processing of heap
B. Heap leaching profit finances;
   1. Continued heap leaching to net over $3,000,000 in one year
   2. Exploration/development of open pit ore-for heap leaching over three years (based on results-feasibility)
   3. Exploration of underground.



TOMBSTONE (1880's)

HEWLETT MANAGEMENT

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TOMBSTONE

Tombstone, Arizona is in south-east Arizona in Cochise County, about 75 miles from Tucson. Following are a summary of past production and a discussion concerning the potential of the Tombstone Mining District.

DISCOVERY

In 1877, Ed Schieffelin left Camp Huachuca and went prospecting in the area east of the San Pedro River. He was warned against the Apaches by "All you'll ever find in those hills, Ed, is going to be your tombstone." An unusual rock formation attracted his attention, and he took some samples to his brother, Al, at the Signal Mine. Dick Gird assayed his samples, and the three formed a partnership. The town was named after the warning made to Ed Schieffelin. The initial discovery by Schieffelin is unknown, but he latter discovered and staked the Lucky Cuss. Soon the discovery was known and prospectors poured into Tombstone.

EARLY MINING

Outcropping ledges and fissures of high-grade ore made early mining easy, because the development could basically be done in ore. All original mines were developed by sinking on outcropping ore; the Goodenough Incline is an excellent example of early mining. Large tonnages of high-grade ore was mined on the surface from the apexes of anticlinal structures that predominate in the vicinity of the Toughnut Mine. Also, the "Million Dollar Stope" is on the south side of town, which has caved and remains as a "Glory Hole".

Subsequent mining was concentrated on the anticline structures which generally plunge easterly, fissures, replacement beds and veins, and along the contacts of the near vertical dikes that strike north-south through the district. These structures were pursued down to the water table and laterally for considerable distances. Many unknown structures were disclosed as a result, and blind ore bodies discovered and mined.

Photo on the next page shows underground mining in the Tombstone District in 1904. Notice that the mining is in a preferential limestone horizon; this is typical of the Goodenough and Toughnut mines.

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PRODUCTION

Early production is difficult to determine because of the following:

1. Mines that shipped directly to the numerous custom mills that operated in the Tombstone District kept no records.

2. High-grade ore was not milled locally but sent directly to the smelter(common of the plus 80 ounce silver).

3. Early mines with their own mills kept poor records.

4. Portions of mines were leased and very poor records were kept by the leasors.

5. Price fluctuations made production records kept in dollars difficult to relate back to the ore grades.

6. Smelters would cheat the miners by reporting lower grades and commonly not pay(or report) for the gold content.

7. "High-grading" was practiced which reduced the grade.

It is reported that 1,635,639 tons of ore was mined. The computed grades were as follows:

Average Silver grade = 20.67 t.oz./ton

Average Gold grade = .133 t.oz./ton

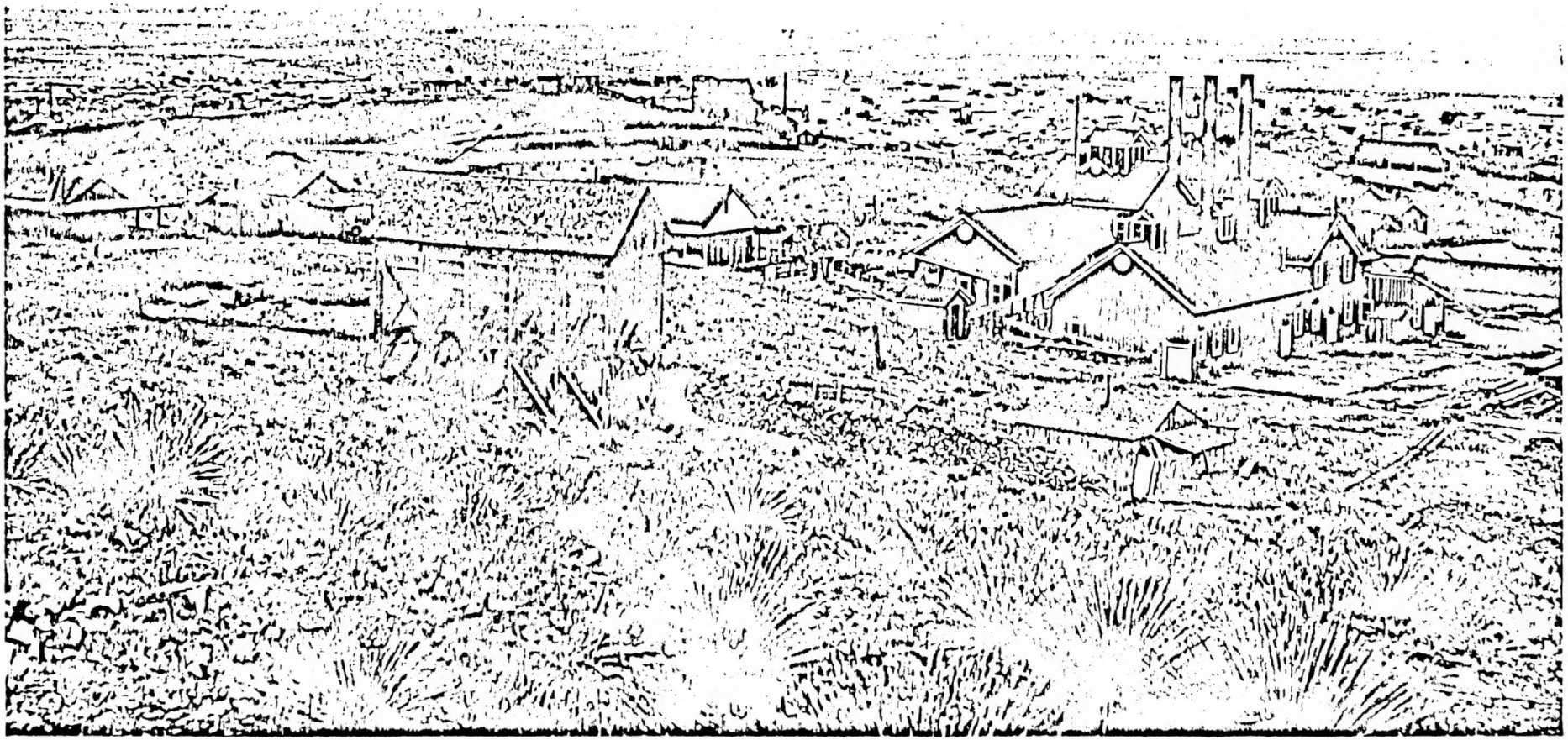
The yearly production is shown on the following page(table 1).

The actual value of the Tombstone production at today's prices are:

Actual Tombstone Production = $ 38 million

Present Value of Production = $225 million

Dr. C. J. Sarle reports the Tombstone production as $ 79 million. In any event, the production was significant at that period of time.



— GRAND CENTRAL MILL(1884) —

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Table 1.
TOMBSTONE PRODUCTION

Year(s)	Tonnage	Au Heads	Ag Heads
1879-1880	55,567	.094	34.00
81	128,452	.072	43.00
82	131,296	.075	34.00
83	75,249	.125	34.00
84	33,582	.262	34.00
85	31,736	.286	34.00
86	25,885	.333	34.00
87	14,500	.383	34.12
88	14,511	.453	34.00
89	5,512	.548	34.00
90	13,537	.416	34.00
91	15,362	.479	34.00
92	13,573	.315	34.00
93	14,127	.258	34.00
94	11,213	.258	34.00
95	11,213	.258	34.00
96	11,213	.258	34.00
1897-1901	135,608	.114	15.00
1902-1906	224,602	.114	15.00
07	48,444	.114	15.00
08	51,266	.080	6.97
09	27,123	.084	7.44
1910-1920	232,219	.090	12.11
1921-1930	266,330	.090	10.32
1931-1936	53,619	.269	17.47
	1,635,639	.133	20.67

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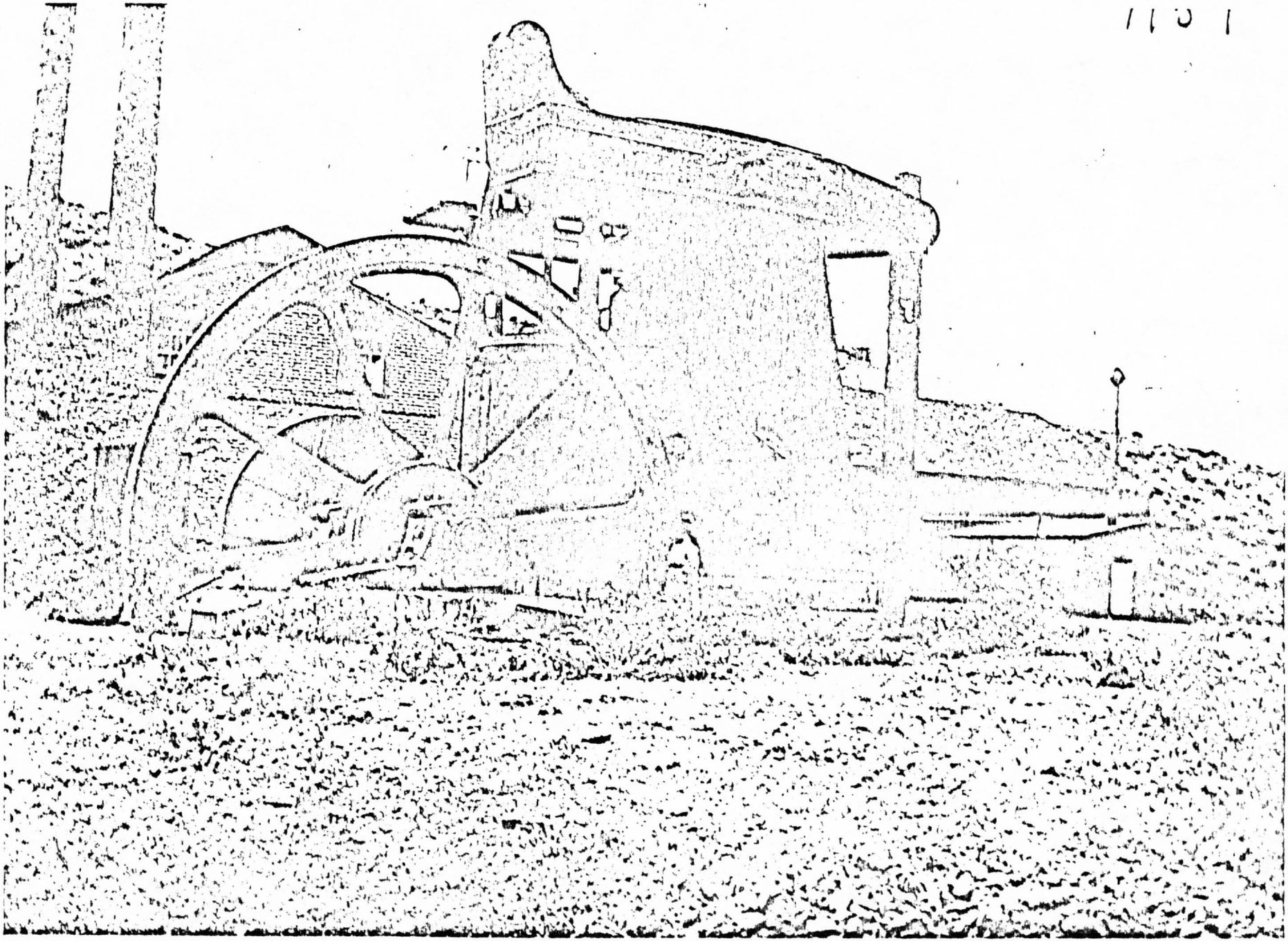
Following are the production by mine:

Mine	Date	Tons	Au	Ag
Northwest	July '89 to '90	274	.141	87.1
"	June '90 to '91	458	.215	67.1
"	June '91 to '92	1,413	.35	87.8
"	June '92 to '93	1,427	.18	87.1
Toughnut	June '91 to '92	1,102	.55	88.5
"	June '92 to '93	2,096	.61	55.5
"	Apr. '20 to '25	5,203	.17	27.45
Empire	Apr. '20 to '23	159	.240	13.48
Tranquility	Apr. '20 to '23	1,978	.320	22.46
Silver Thread	Apr. '20 to '23	4,738	.270	25.47
"				
West Side	Apr. '88 to '89	632	1.794	84.40
"	Apr. '20 to '25	1,238	.560	38.58
West Side-	June '90 to '91	1,105	1.380	73.30
Sulphuret	June '91 to '92	1,490	1.130	66.50
"	June '92 to '93	1,184	.82	48.60
Sulphuret	Apr. '89 to '90	500	1.931	84.80
Contention	Apr. '20 to '23	3,639	.198	13.57
Head Center	Apr. '20 to '23	1,738	.200	14.50
Grand Central	Apr. '20 to '23	1,438	.140	13.75
Lucky Cuss	Apr. '88 to '89	3,253	.576	41.10
"	Apr. '89 to '90	2,488	.466	44.60
"	June '90 to '91	2,271	.740	54.90
"	June '91 to '92	2,684	.460	43.60
"	June '92 to '93	3,729	.110	25.20
"	Apr. '20 to '21	5,560	.056	16.92
Oregon	Apr. '20 to '21	3,866	.013	23.00
Promter	Apr. '20 to '21	9,688	.017	16.50
Emerald	Apr. '20 to '21	119	.010	8.00
Bunker Hill	Apr. '20 to '21	100	.035	15.45



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CLOSING OF THE MINES

It was generally assumed that the water encountered in the mines was the reason for the closing of the Tombstone mining operations. However, the mines controlled the water level in the Pump Shaft; the mines are all interconnected with the Pump Shaft. In fact, I have talked to miners that went as far as Gleason to warn the miners there when the pumps were shut down after the fire in the pump house.
In general, the development of new ore was overlooked when the Bonanza ores were being mined. Also, leasers would "rob pillars" and in general leave the workings in an unsafe condition.
When development costs were then related with lower-grade ores, uncertainty would exist concerning the economics of further underground development away from the main workings and this was further complicated by lower gold and silver prices;silver was under $1.25/t.ounce.
Financing of the operations contributed to the complexity;when no working capital was available from an operation, it would take time to make additional financial arrangements.
When the pump house burnt down and new Cornish pumps were required (see opposite page), it would have to take over one year to bring them "around the Horn". Then, when the mines flooded and the price of noble metals was still very low, all groups gave up and the mines remained closed.

GEOLOGICAL HISTORY

Quartz latite porphyryr(Uncle Sam Porphyry) intruded the Naco and Bisbee limestone, shale, chert, sandstone, and quartzite formations. These sedimentary formations had previously been folded and faulted by tectonic activity, causing some doming. Along these zones of weakness the intrusives followed, including andesite porphyry and rhyolite porphyry dikes. Then a series of steeply dipping north-northeast fissures developed, perhaps due to the final intrusion of Schieffelin granodiorite. Subsequent to this episode and related to magmatic segregation of gold, silver, copper, manganese, lead, zinc, and other minerals was the migration of the mineralizing solutions along the various faults, fissures, joints, breccia zones, and open bedding planes until exsolution occured producing the mineralized structures observed in the district. Every structure occuring within the strucurally induced syncline is mineralized at some point and some throughout their entire extent.

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STRUCTURES AND HOST ROCKS

The most productive ore deposits in the Tombstone District exhibit a preferential order of priority to structures and host rocks. Of highest priority are the porous or broken limestone capped by shale or other impermeable units.
Following are the relationships of structures and host rocks in order of their importance on productive mineralization:

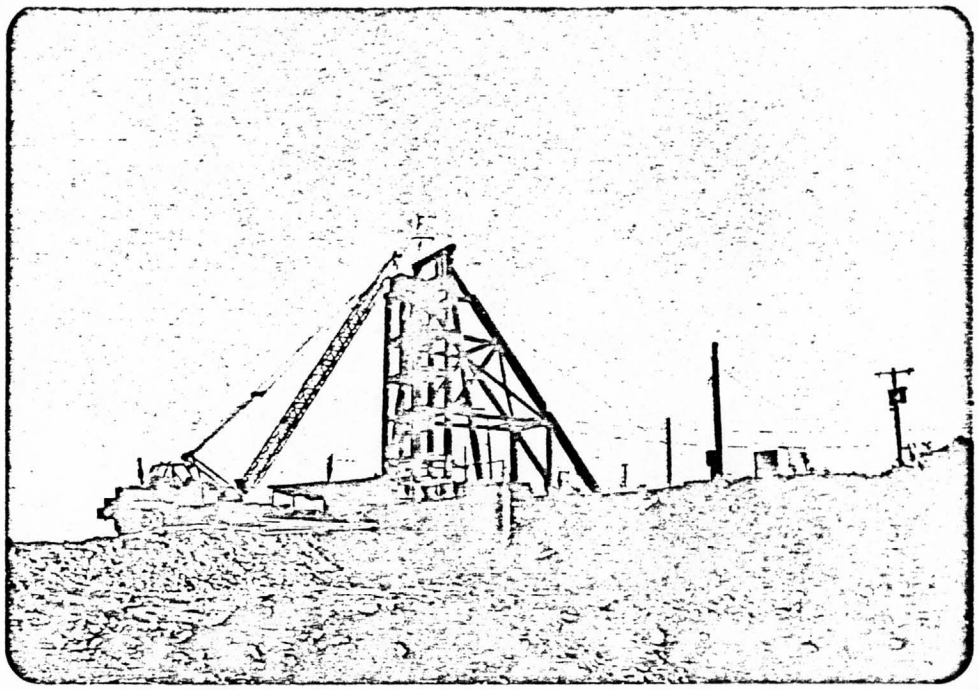
MINERALIZING STRUCTURES
****

Northeast fissures
North-south dike fissures
Other faults
Anticlines and rolls

HOST ROCK
****

Fault breccia & gouge
Blue limestone
Novaculite
10'/6' limestone
Bisbee shales/ss.
Naco limestone
Dike material

Increasing
Decreasing



WEST SIDE MINE: Source of water for 5 year heap leaching operation. Crane being used to lower submersible pump after repairs to the lagging in the shaft. When problems would come up, the City was very nice and would always allow us to use City water.

The author and others were underground a great deal, especially when we were leaching underground, and noted over the years that the water level changed only about 5-10 feet(lowered) by pumping at about 100 GPM.

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WATER TABLE

The water table at present is approximately 4115 feet above sea level or about 500 feet below the surface. It was known that the gold-silver values continued undiminished for short distances below the water table and there is good evidence that the values continue into the sulfide zone many hundreds of feet in depth below the water table. In general, the water table has not changed very much from the level during mineralization.

In an effort to exploit the ore under the water table, numerous attempts were made to dewater the Tombstone mines. All attempts seemed destined for failure because only temporary success resulted due to political hassles, carelessness, mechanical failures and caving ground forced the suspension of pumping. As was mentioned previously, the Pump shaft was sank to the 1,000 foot level and the water level was controlled for a short period of time.

During the period of de-watering, it was proven that the ore continues downward wherever it has been pursued. In the Contention, Grand Central, Luck Sure, Emerald, West Side, and Silver Thread mines it was found that the ore not only continues below the water table, but that the gold and silver increases in grade, especially the gold. In addition, good values in lead, zinc, and mangnaese sulfides are increasing in value. This is also shown by deep diamond drill-holes.

The initial de-watering was accomplished at a rate of 4500 GPM to keep the 1000 foot level dry, and a steady gain was made to de-water the Tombstone Basin. About 2100 GPM would de-water to the 800 foot level. With modern pumps, the cost of de-watering would not be very expensive.

The water underground is not fit to drink due to the town of Tombstone dumping their sewage into old mine shafts. This was an advantage when the author needed water for a recent heap-leaching operation and leached underground because the author pointed out that the water was already contaminated. However, if water would be sold, as to Tucson, a treatment plant would be neccessary; a treatment plant would be required for Tombstone water for consumption at Tucson. The author has looked into the possibility of selling underground Tombstone water to Tucson, and it is now possible with the twp-year old decision that water can be transported from one basin to another basin. The City of Tucson have said they were interested in the water, and would buy it at Tombstone;Tucson would pay for transporting the water and a treatment plant.

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PREVIOUS EXPLORATION

Maps made during the early mining period may still be available to some extent. The author has seen a number of them, and it would be easy to acquire(or copy) any available maps if a project were initiated. The author has been offered the opportunity to copy numerous maps, but at the time it was not necessary.

The earlest exploration was conducted by Eagle Pitcher(in the 30's). The author has been told that the data can be copied, but also (by Eagle Pitcher) that they got very poor core recovery due to their drilling method, and if they wanted drill-data from Tombstone. they would re-drill the same locations.

Newmont spent a great deal of money on surface drilling(core) and underground development. Much of their data is in Appendix A. Also, their core is in the core shed by the Empire mine. The author had it re-boxed where necessary and stacked in sequence; the roof was also patched and made water tight. The most interesting drill holes were #7 and #9. Data not included in this report could possibly be obtained from one of the Nebraska "farmer" owners. Bill Hight's address is as follows:

Mr. William Hight
1824 North Broadwell
Grand Island,
Nebraska(68801)

When Newmont began exploration/development in Tombstone, they formed a company, the Tombstone Development Company. After Fred Searles died, Newmont dropped their precious metal projects (Tombstone and Goldfield) and sold the company to Bill Hight and various other friends of Bill's(Frank Gallup, John Nefelt, etc.). They leased it to 71 Minerals. Height, et. al., paid $160,000 for the 90 odd claims, most of which are patented. They would have taken an end-price of $250,000 at the time of the 71 Mineral lease, but I could not convience my two partners to add that to the lease. As it turned out, Hight, et. al., were paid more than $250,000 in royalties.

Duval spent a short time in Tombstone. Their data is included in the Appendix.

ASARCO drilled at least three deep holes in the breccia pipe area north of the Charlston Lead Mine. The holes were between 4-5,000 feet deep and intersected weak copper mineralization.

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RECENT ACTIVITIES

71 Minerals was formed by the author to process the dumps at Tombstone. A recent discussion of the operation is found in the back "pocket". Also, the author was very interested to conduct exploration in the whole District, but this activity was restricted by the author's other partners who were only in the limited partnership business and not familiar with mining. However, as a result, considerable knowledge was gleaned with the limited exploration conducted by the author and some very prestigious geologists.

Important exploration conducted by 71 Minerals were as follows:

1. Detailed lithologic, alteration, and structural mapping of the Missy and Fox claims.

2. Underground examination of a large number of workings in the District.

3. Drilling in the Toughnut-Empire-Skip Shaft-Tranquility area(shallow reverse-circulation).

4. Mapping and drilling in the Robbers Roost breccia pipe area on the Charlston road.

5. Mapping and sampling(back-hoe and dozer) of the District as a whole.

6. Drilling and sampling on TMR claims.

Perhaps the greatest advantage of the above exploration is the intimate knowledge gained about the District by Messrs. Briscoe, Spear, and Hewlett. This is to say that "District knowledge" is an exlporation factor that is a requisite for successful discovery.

The results of the 71 Minerals exploration will be discussed on an individual mine basis in the future potential section.

Therefore, another asset will be discussed in detail-the heap at Tombstone which can be re-processed.

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Extensive sampling was conducted on every dump in the District. This was done with back-hoe trenches. Channel samples were taken in intervals not to exceed 20 feet; sample intervals conformed with changes in the nature of the dump material. Screen analyses were made and it was found that even though screening up-graded the ore, it was still economic to take the entire dump with out screening. An analysis of crushing was conducted by the author at the same time, and it was concluded that crushing would about break-even at those lower precious metal prices (compared with present prices), especially because "IPS" had not been developed by the author at that time. Therefore, at that time, crushing liberated a great deal of values, but the fines created reduced the precolation and hence the recovery, loosing everything gained by crushing.

TOMBSTONE DUMP ASSAYS

*=t.oz./ton
**=%/ton

Dump	Tonnage	Au*	Ag*	Pb**	Cu**	Zn**	Mo**	Mn**
Empire	45,000	.044	1.67	.78	.07	-	.015	-
Tranquility	45,000	.058	1.92	.99	.09	-	.008	-
Toughnut	50,000	.029	2.82	.50	.05	-	.009	-
St. of Maine	15,000	.006	3.35	-	-	-	-	-
Contention	230,000	.051	1.60	.50	.03	.40	.001	-
Lucky Cuss	55,000	.039	3.35	1.04	.07	.76	.001	-
Emerald	70,000	.015	3.61	1.12	.28	-	.015	-
Herschel	13,185	.025	3.17	.30	.07	-	-	-
Ingersol	14,646	.041	4.01	.32	.04	1.44	.001	-
Old Guard	11,413	.021	2.68	.30	.04	.54	-	.58
Little Joe	20,000	.051	2.23	.03	.01	.01	.001	-
Sulphuret	6,000	.043	1.05	.31	.03	.18	.005	-
Silver Thread	16,000	.030	2.22	.65	.03	-	.006	-
Bunker Hill	38,000	.021	3.39	1.25	.19	2.00	.005	-
Boss	5,000	.037	2.39	.46	.09	.45	-	-
Comet	30,000	.030	1.56	.19	.03	-	.001	-
Defence	26,000	.025	2.01	.39	.03	1.21	-	-
Oregon	15,000	.003	4.17	.71	.14	-	-	7.95
Promter	4,000	.005	3.63	.80	-	-	-	6.90
Rattlesnake	5,000	.010	2.80	.58	.07	-	-	-
Silver Plume	25,000	.014	1.03	.21	.03	-	.006	-
West Side	60,000	.019	1.62	.59	.05	-	.006	-
Grand Central	100,000	.050	2.05	1.19	.01	.16	.001	-
Telephone	5,000	.027	1.98	-	-	-	-	-
Northwest	6,000	.037	1.75	-	-	-	-	-
	910,244	.037	2.26					

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TOMBSTONE DETAILED COST ESTIMATE

Following are the details of the cost estimates discussed by cost item determined February 11 through 21, 1979.

Power Hook-Up

Arizona Public Service provides the power. Contacted were:

Dave (Bisbee) 432-2281
Max Bishop 432-2281

I met with Dave on Wednesday and Max on Friday. Their estimated costs for the same service as 71 Minerals were:

Plant	West Side
$1800	$600

The above estimate is approximately what they will formally quote, provided we show good faith, longevity, and a reasonable financial statement for responsibility.

Therefore the estimated cost:

Plant	$1800
West Side Pump	600
	$2400

Required is a letter to:

Mr. Max Bishop
Arizona Public Service
P.O. Drawer J
Bisbee, Arizona 85603

A. Length of operation - 5 years

B. Hours per day
   1. West Side: 8 hours per day for first several weeks - then intermittant
   2. Plant: 8 hours per day for first three months then 16 hours per day and three shifts in 6 months

C. Days per week - 5

D. Name and address of responsible party

2. Electrical - General:

A. Bill Magee - Tombstone; general wiring

B. Pete Milword - Tombstone; Jimmy Hart's landlord - lives there - reported to be good

C. Cochise Electric - Sierra Vista; licensed contractor - but more expensive than above.
Estimated costs are $2,000

3. Pump Installation/Electrical

Ralph Van Arsdale has arranged to come to Tombstone on March 2 and 3 due to his daughter's wedding. I talked with him (by phone) on Wednesday and he will go over each pump and make his recommendations concerning specific pumps, configurations, etc.

Then electrical wiring will be required.

Estimated costs are $1,000.

4. PVC Pipe Installation:

A. Water line - West Side

71 Minerals dug a back-hoe trench from the plant to the West Side and "strung" a 3 inch PVC line. The City of Tombstone bought the pipe and removed it, but had to cut it for removal. I talked with Joe Perrodi on Friday and he thought the City may sell the pipe back, but on Saturday I talked with Tom Pitcher (457-3497) who is the City Engineer and he said he needs the pipe.

On Tuesday I contacted:

Carlson Brick
3670 E. Speedway
Tucson, AZ (325-3369)

Their price quote for 3 inch PVC (Schedule 40) was $74.66/100 foot and we need 2,000 feet, which they have in stock. We would also need 4 cans each of cleaner and PVC glue.

I could not make a deal with Charley and Louise Escapule for "Tombstone Services" but they said they would make their AA available.

Therefore, I talked with Dusty Escapule concerning him laying the pipe. Dusty Escapule, P.O. Box 1103, Tombstone, AZ 85638 (457-3429). My estimate is that it would take him and a helper 3 days and he would probably charge $6 + $4 per hour

($10/hr)(8)(3 days) = $240

Back-hoe; cleaning
Trench and dirt back
over pipe 10 hrs ($25/hr) = $250

Therefore the cost estimate is:

Pipe (2,000 ft) ($75/ft)	$1500
Cleaner and Glue	50
Pipe laying labor	240
Back hoe	250
	$2040

B. Spray lines/manifolds

All necessary spray lines and manifolds are on the property. Cost of moving and connecting lines are only labor, estimated at $100.

5. Directional rainbirds:
20 @ $4 = $80
(Melnor - Yellow Front - Sierra Vista)

6. Preg Pond:
Minor work must be done to utilize the barren-precip pond between the plant and the heap as our preg pond. This would also save much money in pumping from the old preg pond back to the heap.

Estimated Cost: $100

7. Pad:

An extension of the pad from the existing heap toward to plant must be made in order to initiate re-processing of the heap.

An initial area of 100 feet by 400 has been selected. Desert dirt will be compacted into an impermeable pad 12 inches thick.

Tonnage of pad material is:

$$\frac{100' \times 400' \times 1'}{20\ ft^3/ton} = 2000 \text{ tons}$$

George Jewitt has a 20 ton dump truck and Dusty Escapule has a 10 ton truck.

If I would have George Jewitt load and haul, it would take 100 loads. The desert dirt would come from south of the heap of 2500 feet.

Assume a mile round trip and an average of 10 MPH, or a cycle time of 6 minutes. Therefore, the required pad material could be hauled in about two days.

George Jewitt is anxious for our tailings and dump ore to process in his plant (100 TPD). If we would pay $1 per ton, then we would owe George Jewitt $2000 in tailings or dump ore.

Pad preparation with a blade would take one day. We could rent Bobby Cowen's blade for $25 per hour with Dusty Escapule operating.

The operation sequence would be:

A. Pad preparation - blade

B. "Dirt" haulage;
   1. Initial 4 inch lift
      a. water with sprinklers
      b. compact with loaded trucks
   2. Next 4 inch lift
      a. water with sprinklers
      b. compaction
   3. Last 4 inch lift
      a. water with sprinklers
      b. compaction

The cost summary is:

Trucks and loader.....	Assume trade
Labor (D. Escapule).....	
4 days @ $50/day.....	$200
Blade.....	
(6 hrs +4+4+4) 18 ($25/hr).....	450
	$650

If caliche can be located, it will be worked into the pad material after each lift. Otherwise, lime can be used.

8. Laboratory:

George Jewitt wants to make a deal which he has done to exchange lab work for tailings or dump ore.

Eocene has a lab in town (Lucky Cuss Apts) and they have a AA (was in 71 Minerals plant), shakers, etc.

Therefore, with the lab supplies and equipment I have, only minor supplies will be required.

Esimated cost: $100

9. Building:

The "Gun Company" has the 71 Minerals plant building rented. We will need a small building for the plant.

Estimated cost: $200

10. Plants:

To save plant costs, no deaeration will be used. ?

Process Chemistry:

A. NaCl - NaOCl System;

1. Silver

a. $Ag_2S + 4OCl^- = 2\ AgCl + SO^=_4 + 2Cl^-$

b. $AgCl + 3\ Cl^- = Ag\ Cl^{-3}_4$

c. Recovery*

1. Silver tetrachloro complex precipitated by Na_2S

2. Silver tetrachloro complex changed to cyanide complex and then Na_2S or Zn precipitation or reduction

2. Gold

$2\ Au = Cl_2 = 2\ AuCl$

$AuCl + Cl_2 + Cl^- = AuCl_4$

and $AuCl + Cl^- = AuCl^-_2$

Recovery*

1. Aurous chloride recovered on ion-exchange resins

2. Aurous chloride changed to cyanide complex and recovered on ion-exchange resins or zinc reduction

B. $Na_2S_2O_3$ System;

$AgCl + Na_2S_2O_3 = Ag_2S$

Recovery*

Recovered or powdered zinc without deaeration

Each filter is a 50-65 GPM Hayward Filter, yielding over 200 GPM.

Costs are:

4 filters @ $275	$1100
Feeder	200
Pipe (PVC)	100
4 valves @ $150	600
Labor	200
	$2200

11. Tanks:

Reagent tanks are required

Estimated cost: $1000

12. Crushing:

Karl Ronstadt of New Pueblo Contractors and Dick Yagger met with me on Wednesday. Following are their estimates:

150 tons per hour crushing rate (1 shift - 24,000 tons/month)
Monthly rate;

Rental (jaw rolls, elevators/ conveyors 988 Loader		$20,000
Labor	16,000	
Misc.	4,000	
	$40,000	

Therefore the cost would be from $1.67 to $2.00 per ton crushed.

Their estimated crushing rates are:

Inch Opening	TPH
5/8	200
1/2	150 - 100

In general, in the range down from 3/4 inch, you lose 100 TPH for each 1/8 inch size reduction.

It was further their estimate that to come in and set-up they would need 1-1/2 months expenditures in advance, or $60,000.

In general, they expressed doubt in whether a cash flow would result as I projected and I do not think they want to finance the costs themselves for a profits interest.

In addition to the crushing operating costs plus set-up, there are the following costs (one shift basis)

Crushing Rate	Weekly IPS* Cost	Weekly IPS** Tons	
25 TPH } - 600T PL/ mth	$ 1,500	5	
50 TPH }	3,000	10	
100 TPH	6,000	20	
150 TPH 1200	9,000	30	4 1/4 to prove
375 TPH x 8 hrs = 3000/+ PD	22,500	75	1/4 year to prove

* $1.50 per ton ore
** 10#/ton ore

To evaluate what is a reasonable initial crushing rate consider:

A. Gross value/ton = $15

B. No delay in precious metal payment

C. IPS cost of $1.50/ton

D. Gen cost $1.50/ton

			Weekly			
			Operating Costs		Net Op. Profit	
Crushing Rate/Hr	Daily Tons	Weekly Tons	Crushing Costs/Ton		Crushing Costs/Ton	
			Gilbert $0.75	Ronstadt $2.00	Gilbert $0.75	Ronstadt $2.00
25	200	1,000	$3,750	$5,000	$11,250	$10,000
50	400	2,000	$7,500	$10,000	$22,500	$20,000
100	800	4,000	$15,000	$20,000	$45,000	$40,000
150	1200	6,000	$22,500	$30,000	$67,500	$60,000
375	3000	15,000	$56,250	$75,000	$168,750	$150,000

From the above, it is obvious that a crushing rate over 50 tons per hour would cost too much for operating costs. ?

Because it seems that Ronstadt's preliminary estimate is entirly too high - I contacted:

Mr. Jack Gilbert
A.J. Gilbert Construction Co.
P.O. Box 5288
Bisbee, Arizona
Office: 432-2078
Home: 432-3946

Mr. Jack Gilbert is going to make us a proposal within two weeks. His comments were that his cost for crushing 1000 tons per day would be the same as crushing 3000 tons per day to 1/2 inch. A general comment was that the costs for the 3000 tons per day would be under $.075 per ton crushed. However, the previous table showing the capital requirements for a high crushing rate is to great at this time. It would take at least six months to be ready for such a high crushing rate operating expense. X

I am also getting an estimate from:

Leonord Maddux
Maddux Crushing
Douglas, Arizona
364-7564

In the Tombstone area, there are a number of smaller crushers available:

A. George Jewitt	50 TPH Jaw
B. TMR	50 TPH Jaw 50 TPH Cone
C. 71 Minerals	50 TPH Jaw 70 TPH Cone
D. Dusty Escapule	50 TPH Jaw 70 TPH Cone

George Jewitt paid $2800 for his 50 TPH Jaw Crusher and conveyors.

Charley Escaupule talked with a fellow at Octave, Arizona who paid $5,000 for a 10 TPH Jaw and Cone Crusher with elevators/conveyors and a stacker.

The best soluton seems to be to start with Dusty Escapule and his equipment:

10 ton dump truck
Back hoe - loader
2 Jaw Crushers (25 & 50 TPH) - 25 TPH
Conveyor belts

His backhoe - loader has a capacity of 2 tons. By setting the crusher close to the NW corner of the heap, a cycle time of 5 minutes would result and with a coarse ore bin with a hopper, the 2-ton loader could heap up with the crusher.

The cost of using Dusty Escapule's backhoe - loader and crusher would not exceed $1 per ton crushed.

Note: Dusty estimated 40 tons/hr - 320/TPD, which would be

$$\frac{(\$25/hr)}{40\ tons/hr} = \$0.625/ton$$

For the grizzly and "IPS" feeders, I would estimate $1000

13. Chemicals:

A. Lime, processed ($.021/#)

B. Lime, hydrated ($0.12/#) - Copper States

C. Lime, stack dust (65% CaO) ($14/ton + freight) - Paul Spur, Douglas

D. Cement ($0.04/#)-$3.75/94# - Grant Road Lumber

E. Fly ash ($0.01)-$20/ton - Western Ash, Phoenix

F. Diatamaceous Earth ($.10/#)

G. Salt ($.005 - .16/#)

H. NaOCl ($.90/gal) - Hill Chemical

I. $Na_2S_2O_3$ ($0.18/#) - Hill Chemical

J. NaCN ($0.44/#)($0.56/#) - Small Lots - McKesson

K. Na_2 S ($0.195/#)

L. Resin ($6.50/#....100#...$650)

M. Powdered Zinc ($.68/#)($0.662/#) - Merrillite-McKesson

14. Insurance and Performance Bond:

Insurance - annual $3,000

Performance Bond (annual)

($10/$1000) (150,000) = $1500

RESINS

Basic Parameters: SR-3

A. Gold Loading;
Resin capacity = 150 gr/l
Resin density = 800 gr/l

Basis: 1 l

$$\frac{150 \text{ gr Au}}{800 \text{ gr Resin}} = 18.75\% \text{ by weight}$$

B. Resin Cost;

$$\frac{\$SR\text{-}3}{gr} = \frac{\$Price}{ft^3} \frac{(3.53\ ft^3)}{(100\ l)} \frac{(1)}{(800\ gr)}$$

Quantity	Price	Price SR-3 Gr	Price SR-3 #
Min. 50 ft^3	$200/$ft^3$	$0.0088255	$4.003
10-10 #	$6.50/#		

C. Ignition Economics:

Basis; 1 l SR-3 Resin

Gold Value (150 gr)(1/32)($250) = $1171.88
Pounds Resin/l = 1.764

Price SR-3	Cost Resin/l	$ Value Au / $ Resin
$4/#	$ 7.05	$166.22
6.50/#	11.46	102.26

D. SR-3 Summary Per Pound:

1. Price..... $6.50
2. Value Au loaded;

$$\frac{\$Au}{\#SR\text{-}3} = \frac{(150\ gr\ Au)(1\ SR\text{-}3)(453.6\ gr)}{(1\ SR\text{-}3)(800\ gr)(\#)} \cdot \frac{(\$250\ Au)(t.\ oz.)}{(t.\ oz)(32\ gr.)}$$

$$= \$664.45$$

3. Au loaded;

2.658 t. oz.

IONAC CHEMICAL
SYBRON CORPORATION
BIRMINGHAM, NEW JERSEY 08011
609 893-1771

IONAC SR-3 RESIN FOR NOBLE METALS AND MERCURY RECOVERY

407

Ionac SR-3 is a macroporous chelating resin which is highly selective for precious metals such as gold and others of the platinum group as well as for mercury and methyl-mercury compounds.

Other base metals such as iron, copper, lead, etc. do not react at all with this resin and do not interfere with the selective process. The noble metals are very strongly attached to the resin, yet their recovery presents no difficulty.

APPLICATIONS

Precious metals are completely removed from solutions containing them (from very high to extremely low concentrations) on passing the solutions through a column of Ionac SR-3.

Use of Ionac SR-3 is recommended for noble metal extraction from ores and wastes, the separation of noble from base metals, the recovery of spent catalysts, the concentration of very dilute solutions containing noble metals and the refining of noble metals.

In addition, Ionac SR-3 is applicable to the removal of mercury (and methyl-mercury) compounds in pollution control.

EXAMPLE

One microgram of gold dissolved in one liter of slightly acidified water was completely recovered with the aid of Ionac SR-3. Furthermore, even after adding hundreds of milligrams of nickel and copper to the solution, precious metal recovery was complete to the exclusion of the other metals.

Ionac SR-3 also quantitatively collects methyl mercury and inorganic mercury compounds. Both forms are collected from solutions of pH 1-9.

TYPICAL CHARACTERISTICS

Physical Form: White, macroporous beads
Supplied: Regenerated
Nominal Mesh Range: -16 + 55
Moisture Content: 45% - 55%
Shipping Weight: 750-850 g/l

CAPACITIES

Gold: 150 g/l
Platinum: 65 g/l
Palladium: 58 g/l
Iridium: 25 g/l
Mercury: 150 g/l

12-14-76

GENERAL INSTRUCTIONS FOR USE

1. The pH of the solution coming into contact with the resin should preferably be adjusted to between 0.5 and 2.5.

2. Adsorption of noble metals or of mercury is carried out at room temperature using conventional ion exchange column techniques. Minimum bed depth should be 750 mm and the flow rate about 10-20 bed volumes per hour.

3. The recovery of the noble metals from the resin is possible in two ways:

   3.1 Ignition -- Slowly roasting the exhausted resin in air at 900-1000° C. leaves the metal in a very pure metallic form.

   3.2 Elution -- Eluting immediately after adsorption with a 5% aqueous solution of thiourea to which 5 ml/liter of HCl has been added yields a solution from which the metal can be recovered by reduction. When elution is applied, the resin can be reused for many cycles.

4. The elution of the mercury can be also accomplished by treating the resin with 4% sodium sulfide at a level of 200 g Na_2S per liter of resin.

   Following the elution, it is necessary to regenerate the resin by treatment with 10% hydrochloric acid at a level of 100 g HCl per liter of resin.

SYBRON | Ionac

July 24, 1978

Mr. Richard F. Hewlett
HEWLETT MANAGEMENT
730 Royal Crest Circle S.
Apartment 438
Las Vegas, Nevada 89109

Dear Mr. Hewlett,

In regards to your letter of July 10, I am sending to you under separate cover samples of Ionac SR-3 and ASB-1. For precious metal recovery, Ionac SR-3 is primarily used in solutions with a pH of 1 to 9, while Ionac ASB-1 is suited for more alkaline waters.

In terms of pricing, the minimum order for Ionac SR-3 is 50 cu.ft. at $200 a cu.ft. Shipment is FOB Birmingham, New Jersey. Availability is 8 to 10 weeks if the material is not in stock. For sample quantities of 10 to 100 lbs., the price is $6.50 per pound. The price for Ionac ASB-1 is $116.65 per cu.ft.

For recovering of the precious metals, the most efficient method has been to burn the resin. I have enclosed bulletins on both these resins and if we can be of any further assistance, please contact us again.

Sincerely,

Dwight T. Tamaki

Dwight T. Tamaki
Assistant Product Manager,
Ion Exchange

DTT/sek
Enc.

T, Project -
3/79 cost proposal

410

TOMBSTONE PROJECT

Tom Schloss

TOMBSTONE
Immediate Expenses

Category	Activity	Quote	Estimate
Power	APS Hook-Up(Deposit);		
	West Side Water Pump	$ 800	
	Old '71 Min. Plant	2,400	
	Office	50	
	Box & Meter Loop		$ 600
	Electrician		500
	Cable		1,000
	Switches & Elec. Misc.		500
	Pump pannel/Installation		1,000
Water Line	3-inch PVC;3,000 feet	2,250	
	Installation	300	
PVC Fittings	Tees, Manifolds, etc.		100
Sprays	Directional rainbirds		80
Preg Pond	Liner & labor		100
Lab	Chemicals		100
Building	Trailer(40X8')-2 months + $215 Monthly rent=$135	500	
Plant	4-50 GPM filter/recovery units		2,500
Tank	1350 gallon	350	
Chemicals	Start-Up solvents & reagents		2,432
Moving	Lab equipment & office		1,500
Labor	Leaching & crushing		2,000
Management	RF Hewlett, et.al. Sal/Expenses		4,000
Office	Reports & support		900
Misc.	Processing, freight, etc.		1,038
		6.650	18,350

Total= $25,000

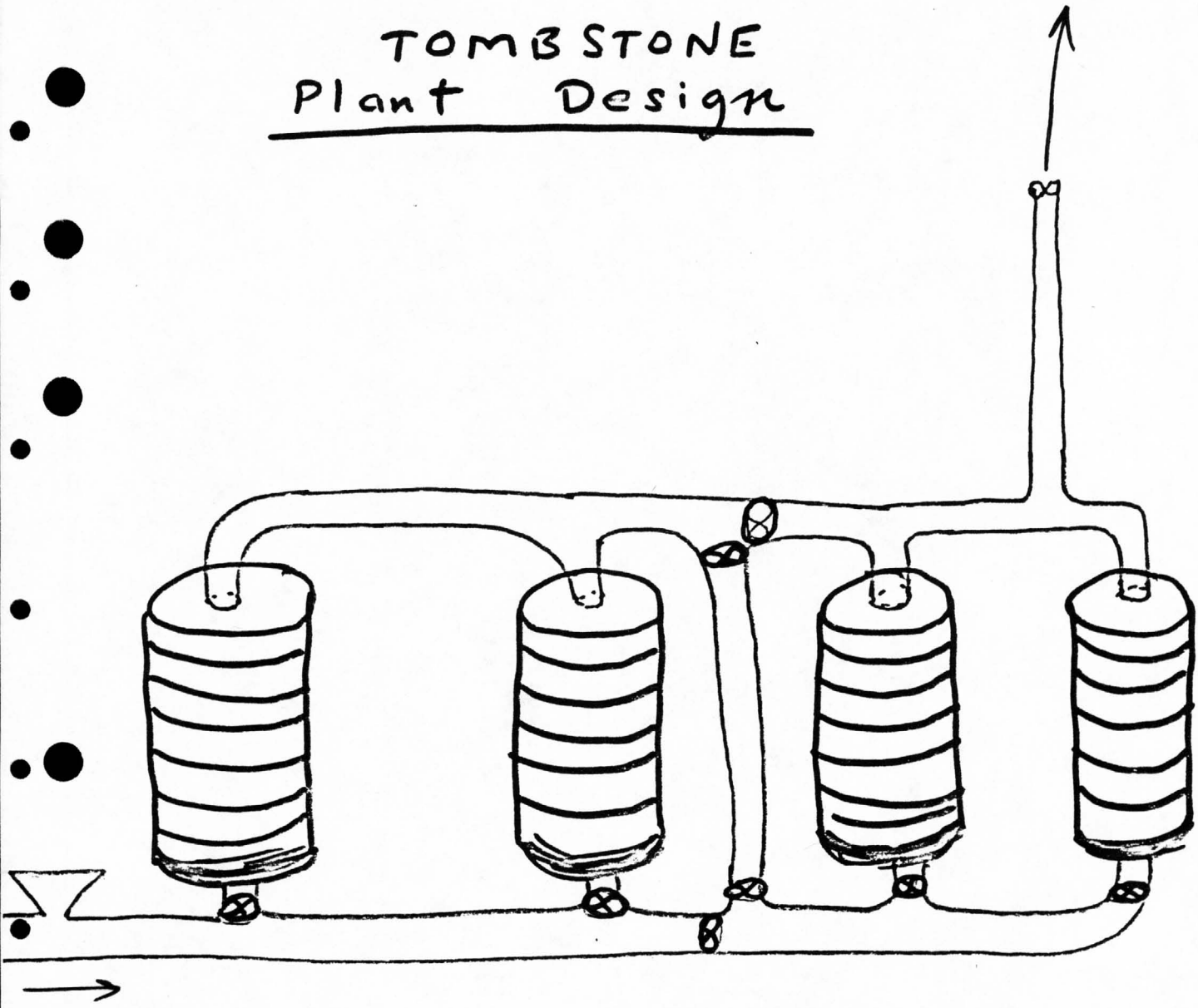
TOMBSTONE
Start-Up Chemicals

Name	Quantity	Unit Price	Total Price
SR-3 Resin (Ion-Exchange)	100 #	$ 6.50/#	$ 650
Lime-Paul Spur Processed(CaO)	20 tons	$14/ton	280
	Haul..	$25/hr	100
Sodium Hypochlorite (NaOCl-14% soln.)	5-55 gal.bbl.	$0.90/gal	248
Sodium cyanide (NaCN)	1000 #	$0.5615/#	562
Sodium sulfide (Na_2S)	400 #	$0.248/#	99
Zinc dust (Merrillite)	300 #	$0.662/#	199
Sodium thiosulfate ($Na_2S_2O_3 \cdot 5\ H_2O$)	300 #	$0.246/#	74
			$ 2,211

TOMBSTONE
Process Chemistry

Activity	Solvent	Reagent	Recovery Method Ag	Recovery Method Au
A. Spray Side Slopes	(1) $Na_2S_2O_3$	None	Powd. Zn	Na_2S
	(2) NaCN	Lime	Na_2S	Resin
B. Crush & Leach No. Ramp	(1) $Na_2S_2O_3$	None	Powd. Zn	Na_2S
	(2) CN	Lime	Na_2S	Resin
C. Crush & Leach Heap (Low-Mn)	(1) NaCℓ	NaOCℓ	Na_2S	Resin
	(2) CN	Lime	Na_2S	Resin
D. Crush & Leach Heap (High-Mn)	(1) NaCℓ	NaOCℓ	Na_2S	Resin
	(2) $Na_2S_2O_3$	-	Powd. Zn	Na_2S
	(3) CN	Lime	Na_2S	Resin

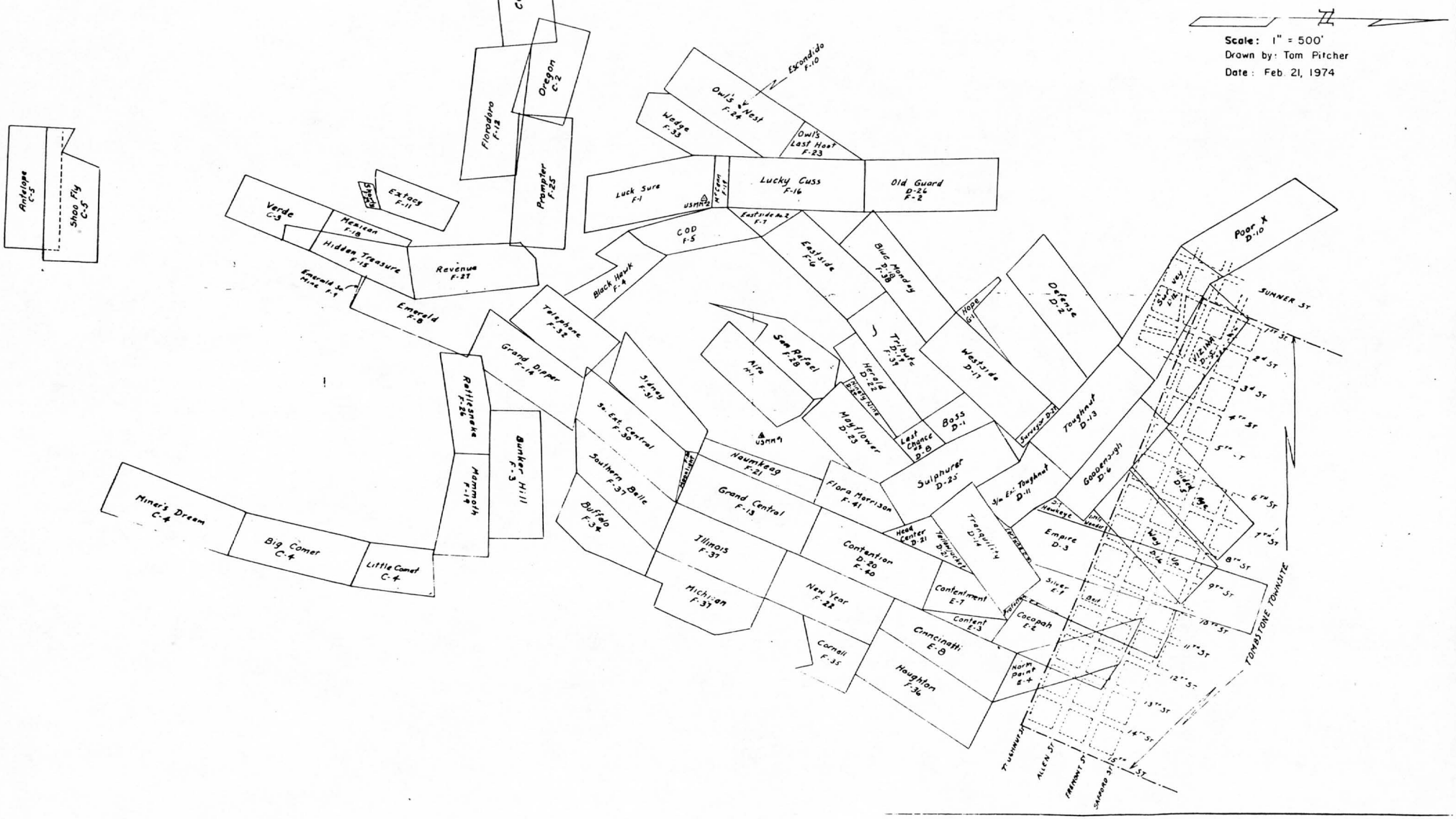
TOMBSTONE
Plant Design



⊗ 3-Way Valves

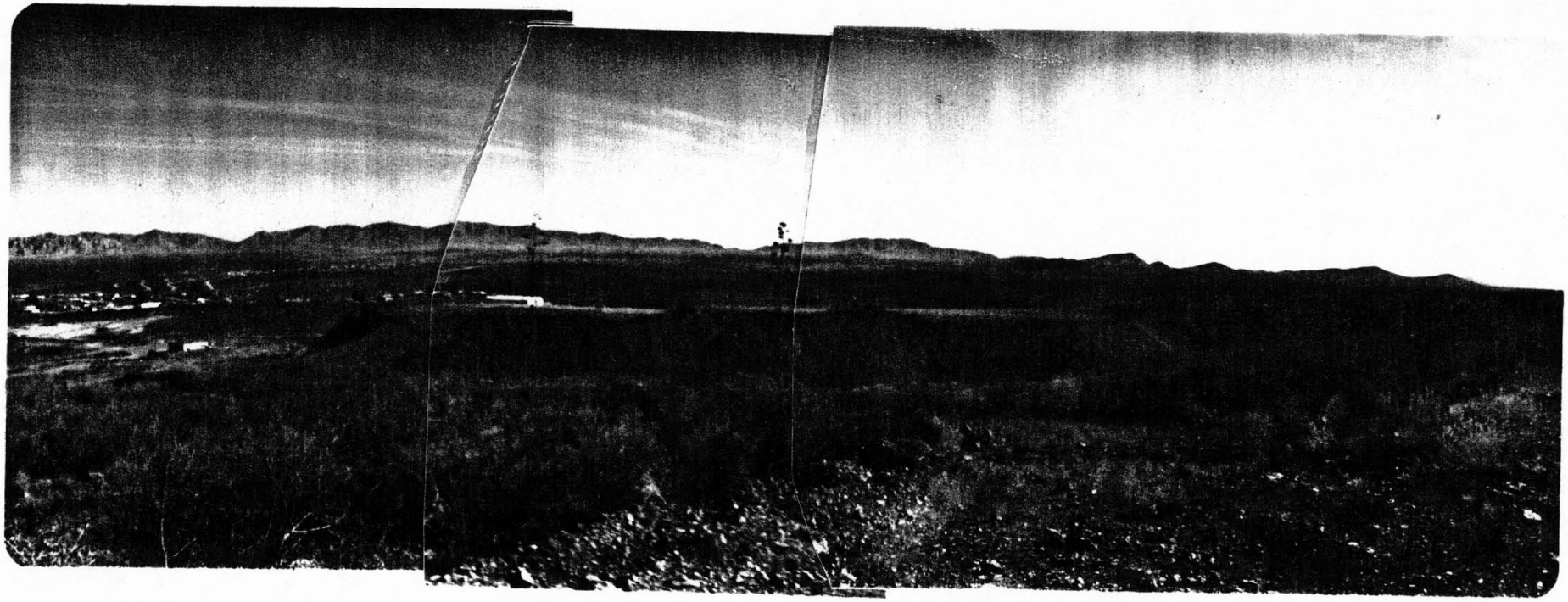
Each filter has a capacity of 50 GPM

PATENTED MINES
OF
TOMBSTONE DEVELOPMENT COMPANY
IN
TOMBSTONE MINNING DISTRICT



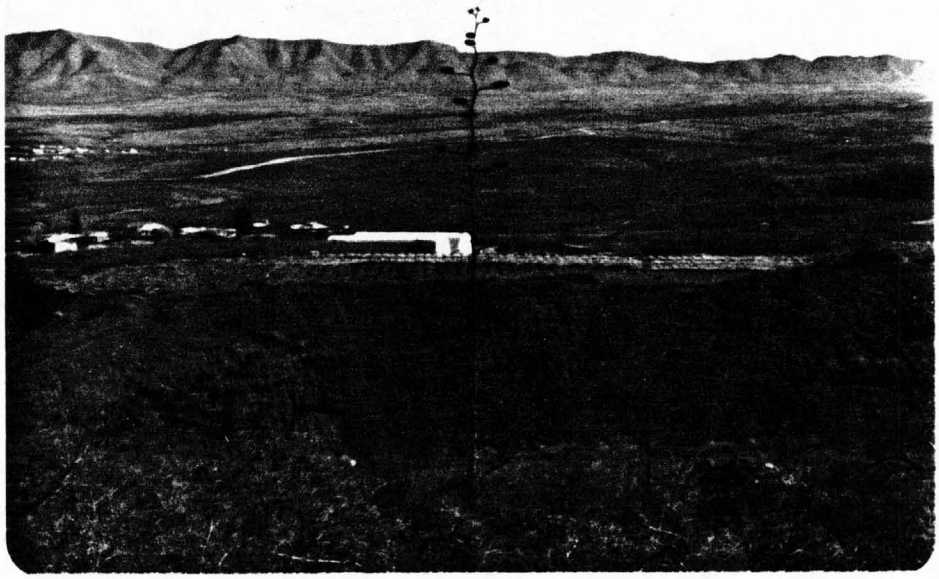
Report 4/11/79

SUMMARY

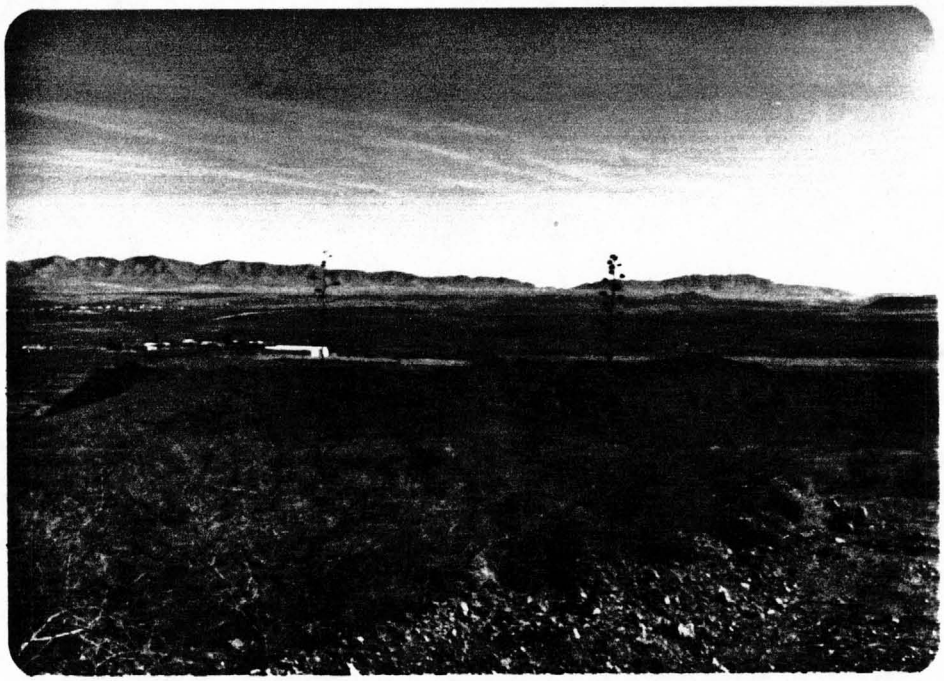


Tombstone Heap

North Ramp and 71 Minerals Plant



North Ramp showing "ripped & dozed" section



North Ramp

South Ramp

GENERAL

TOMBSTONE

April 10, 1979

Following are a summary of the various activities and their status in the Tombstone Heap Leaching Operation.

Lease

The lease must be signed very soon, as last Friday I recieved another call from Bill Hight wanting a copy of the signature page and first page. He also wanted to know what the operation was to be called.

Also, the advanced minimum royalty of $7,500/month starts on May 1;it must be paid promptly.

Precious Metal Sales

Mr. Tom Schloss is working on who we will be buying our gold and silver. We expect this report soon.

Product-in-kind

Mr. Schloss is also working on this matter and will be reporting on this soon-coupled with a visit to Grand Island.

Insurance

Presently we have coverage through Jim Briscoe's policy that covers him and his staff on any property that they are working;exploration is covered with his policy. It provides for $500,000 bodily injury and $100,000 for property damage. I have increased the property damage portion to $500,000 for an annual fee of $153(see enclosed letter that follows).

71 Minerals Building

No progress can be made in occupying the old 71 Minerals building untill perhaps August.

Land Status

No money has been budgeted for lease payments to the State of Arizona. We could have leased portions of three sections, but $2/acre was required, or over $1900 plus a surity bond.
The proceedure that will be followed untill the leaching produces a cash flow is to keep applying for a permit and hope someone else does not get the leases.

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RECEIVED MAR 24 1979

Tucson Realty & Trust Co.

Allan A. Dochtermann
Assistant Vice President

March 23, 1979

Mr. Richard Hewlitt
Southwestern Exploration Associates, Inc.
4500 East Speedway, Suite 14
Tucson, Arizona 85712

Dick:

To follow-up our phone conversation, the cost, on an annual basis, to increase the Property Damage portion of your General Liability Policy from the present limit of $100,000 to alternate limits of $250,000 or $500,000 would be $71.00 or $153.00 respectively. This, of course, is based on the salary estimations presently showing on the policy.

Does this cover SEA?

In addition, per Jim's letter of March 6, 1979 regarding a Performance Bond on your Tombstone properties, I explained to Chris that as far as we can tell after discussing this with several companies, a Performance Bond would not be the answer to your problems and indeed, a Performance Bond would not cover your liability. Instead a personal financial guarnaty is what they are in fact looking for.

Please let me know at your convenience the limits of liability you wish to carry.

Thanks,

Allan

Allan
Assistant Vice President
AAD:jo

0712

0-418 (2)

Governmental Requirements

Contacted concerning our heap leaching activities at Tombstone are the following:

1. Mr. R. E. Riley
   Sub District Mgr.
   M.S.H.A., DOL
   2721 No. Central Ave.
   Suite 900 Telephone: 261-3232
   Phoenix, AZ (85004)

2. Office of the State Mine Inspector
   7th Floor
   New Capital Building
   1700 W. Washington Telephone: 255-5971
   Phoenix, AZ (85007)

3. Ron Holly
   Education & Training
   M.S.H.A., DOL
   500 Date Street
   Boulder City, Telephone: 702-293-1033
   Nevada (89005)

Following is a letter to M.S.H.A.
Also enclosed is the correspondence concerning previous leaching with sodium thiosulfate. Following the Hypo correspondence are the M.S.H.A. requirements.

Power

The water-pump has been connected for some time, and recently APS connected our three-phase 440 V. service. We purchased a 3 KVA transformer(440 V. to 220). This is adaquate for our 2-2 horsepower pumps, but not any larger pumps. The wiring has been completed and all three boxes installed. The pumps use 220 V. single phase and have been operating since last Thursday.

Water Line

The water line was completed a week ago and the pond filled with water. The submersible pump develps a discharge of 50 gallons per minute-2800 feet from the West Side shaft. The pond was filled in 5 hours and this resulted in 15,000 gallons or 62.5 tons of water for spraying.

4/26

Consultants in:
- Hydrometallurgical recovery
- Heap and conventional leaching
- Precious and base metals
- Uranium/Vanadium
- Tungsten
- Worldwide Mobilization

Division of
Southwestern Exploration Associates

4500 E. Speedway, Suite 14
Tucson, Arizona 85712
(602) 795-6097

Richard F. Hewlett
Vice President and General Manager
Chemical Engineer
Mining Engineer

S.E.A. Hydromet, Inc.

April 5, 1979

Mr. R. E. Riley
Sub District Mgr.
M.S.H.A., DOL
2721 No. Central Ave.
Suite 900
Phoenix, AZ (85004)

letter don't explain what. what was it? Any problems?

Dear Mr. Riley:

I called today and was directed to Mr. Tweety of your office. The purpose of my call is to inform your office of our intent to conduct heap leaching in the future at Tombstone, Arizona.

Presently, we are preparing to conduct tests on the same leaching facility that '71 Minerals used for many years. We would use the same pad and pond system and the same monitoring proceedure.

However, we will not be using cyanide. We will be testing on a very small scale the use of sodium thiosulfate($Na_2S_2O_3 \cdot 5H_2O$), which is also known as photographers Hypo. You may recall that we experimented on the use of hypo for leaching underground in 1976. Mr. William H. Shafer of the Bureau of Water Quality Control, Arizona Department of Health Services spent considerable time evaluating the toxic(or non-toxic) qualities of Hypo and finally came to the following conclusion:

what else will be use any pesticide, herbicide?

> "Shafer said laboratory tests show a person would have to drink at one time 300 gallons of Hypo at the proposed concentration for the solution to be toxic".
>
> (See enclosed newspaper clipping).

However, we will not use as high a concentration of Hypo as reported in the Tombstone Epitaph. We will be using under one pound per ton of solution, or .05%.

I have been told that '71 Minerals "killed the cyanide" in the heap with sodium hypochlorite. As a precaution, we will add more sodium hypochlorite to be sure that we do not have any cyanide in our circulating solutions. I will check for cyanide content with the standard silver nitrate and potassium iodide titration. However, I realize that some cyanide will be detected by titration that will not be free or available cyanide;it is combined with copper and with zinc as zincates. If I have any doubts concerning the cyanide concentration, I will have a "free cyanide" determination made by the distillation method.

Our initial tests will be made with water in order to obtain a "water-solution balance" to make sure that the ponds and pad do not leak. I will inform your office of the results of our tests as soon as they are completed.

I have contacted Mr. Ron Holly's office concerning the required training our employee's will recieve. He will forward information concerning the training period and course of instruction.

I would appreciate receiving any other information or advise concerning various regulations related to heap leaching.

Thank you for your help in this matter.

Sincerely yours,

Richard F. Hewlett

Richard F. Hewlett

From The Town
Too Tough
To Die

The Tombstone Epitaph.

L XCVII No. 8 TOMBSTONE, ARIZONA, July 9, 1978

428

RICHARD F. HEWLETT
President

NANNINI'S FINANCIAL CENTER
7110 NORTH ORACLE ROAD, SUITE 213
TUCSON, ARIZONA 85704
602 / 297-2566

July 8, 1976

Mr. William H. Shafer
Manager, Monitoring Section
Bureau of Water Quality Control
Arizona Department of Health Services
Phoenix, Arizona 85007

Dear Mr. Shafer,

The following is a progress report on our preparation for our "water balancing" test:

A. Our leaching test area is in the Upper Bisbee formation in interbedded limestone and shales (see figure 1). Our test zone in the Toughnut Incline is in the Blue Limestone member. This member was exposed on the surface and contained high grade zones within the dipping limestone member (see figure 2). The ore zone is on the flanks of an anticline and therefore dips about 35° to 45° (see figure 3). The proximity of the test zone in the folding is shown in figure 4. Notice the shale-limestone-novaculite interbedding. This is also seen in figure 5. Figure 5 shows the blue limestone area underlain by novaculite which is very competent.

The area of interest has been thoroughly mapped for geological fractures (see figure 6). Notice that no fractures have been found in our test area. Another interesting feature in the Toughnut area is that the last pulse of mineralization was calcite filling fractures.

B. Water Sampling: See the following report by Ed Speer.

c. Hypo-reaction products:
Samples of the hypo solution after leaching the gob have been submitted to the State Health Department as well as fresh water from the West Side shaft, that is presently flooding 300 vertical feet of gob (that is below the water table). Fresh water has also been furnished and has been circulated in dry gob for one week.

D. Water Leaching Test Area:
Figure 7 shows a generalized cross-section of the gob area and the lower test area. Our collection site has been selected at the end of a stope in a drift we have sealed (see figure 8).

E. Solution Collection System:
Two drifts that end have been selected as primary collections and overflow storage. These drifts are shown in figure 9. Water has been allowed to flood the drift to a depth of six inches and it is completely sealed with the combination of competent rock and fines (this is what is expected in the gob area). However, the collection and overflow ponds have been lined with bentonite, and then a plastic liner. The plastic liner is held back from the ribs by cardboard. A dam has been constructed to trap all the solutions further down the drift to the West Side in case both dams would fail, so that no solutions would get to the ground water table.

F. Test Area:
Figure 10 shows a plan map of the gob in the incline and our test area at the lower end. Our initial test area contains 715 tons of gob and drains through a raize directly into our collection pond. This is a closed system and we can monitor for any solution leaks under the gob area in our drifts on the 300 level. Use of dye would also indicate where we would be leaking and these fractures would be sealed. However, we have found no fractures that could cause any leaking. We are presently applying a very small amount of water to allow the fines to seal any microfractures that didn't show in the back.

G. "Water Balancing Monitor"
We have 3 flowmeters that will tightly control the water balance that is necessary to be sure of no leaks in the system (see figure 11). The flowmeters are positioned as follows:

1. Flow (volume) of fresh make-up water from West Side
2. Flow (volume) of spray solution (water)
3. Flow (volume) of solution (water) to the plant

Our "hypo" leaching test results show a relatively rapid leaching rate; so we will send the pregnant solution to the plant very soon after it flows into the collection pond, and this will accomplish two things:

1. Greatly reduce any danger of losing some pregnant hypo;

2. Greatly reduce the storage requirements underground.

Specifically for 715 tons of gob we will need:

1. 10 per cent in wetting the gob or 715 tons (this will remain in the gob for inventory);
2. One ton of water per 50 tons of gob or 14.3 tons to be circulated per day.

This is a total requirement of water of about 20 tons.

H. Eventual Hypo Leaching:
After the "water balance" has proven we are not losing any solutions, we would propose to add hypo as follows:

1. Initial circulation would be at a hypo concentration of one pound hypo per ton of water.
2. First returns will be assayed for gold and silver and the hypo concentration will be determined by titration. Additional hypo will be added to maintain one pound per ton until the gold and silver values are high enough to start sending to the plant.
3. Then the hypo strength will be gradually increased to determine if additional gold and silver is recorded. Our test results indicate that in about two weeks, all "hypo recoverable" gold and silver would be leached and at that time we would stop leaching in that area.

During the two weeks of hypo leaching, we will collect ground water samples on a weekly basis and submit the water for analysis through the Inspection Committee. After our leaching, two weeks, we will request another inspection to fully assess the hypo leaching underground.

Sincerely yours,

Richard F. Hewlett

Richard F. Hewlett

RICHARD F. HEWLETT
President

NANNINI'S FINANCIAL CENTER
7110 NORTH ORACLE ROAD, SUITE 213
TUCSON, ARIZONA 85704
602 / 297-2566

Memo

To: R. F. Hewlett

Subject: Water sampling-Tombstone Area

From: Ed Speer

Date: June 2, 1976

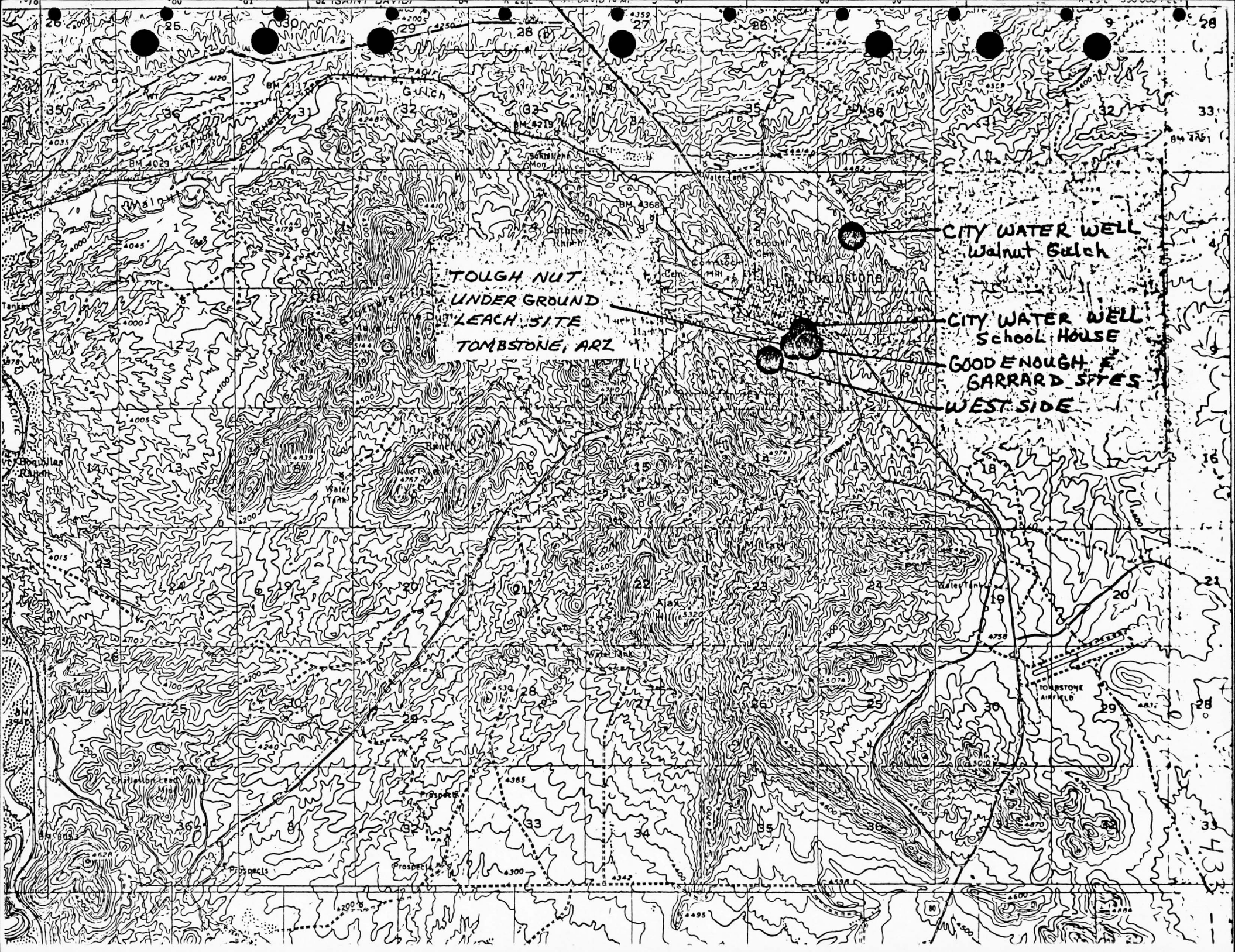
The enclosed map shows sites where water samples were collected by myself, Jerry Doherty, and Frank Mikan on June 1, 1976. The samples were submitted to the state Health Department in Phoenix by myself on June 2, 1976. The sample descriptions are as follows:

A. Tombstone City Water Well at school house
B. Tombstone City Water Well along Walnut Gulch
C. Water-table at West Side Shaft
D. Water table in Girard Stope (Sulphuret incline)
E. Percher Water table on Good Enough incline

The city water well at the school house is approximately 1000 feet northeast of the leach site, while the well on Walnut Gulch is about 1 1/4 miles to the northeast. The sample from the westside shaft is from the ater table approximately 1500 feet southwest of the leach site. A sample was collected only 350-400 feet north of the leach site from a perched water table near the Good Enough incline. The last sample was collected from the water table in the Girard stope near the bottom of the Sulphuret incline and approximately 500 feet southeast of the leach site.

These sample sites should give adequate control for our water monitoring program. Fluorescein dye is on hand and will be used to trace any movement of water away from the leach site. Of course analysis of the water samples will establish any pollution caused by the leaching.

Ed Speer


TOUGH NUT
UNDER GROUND
LEACH SITE
TOMBSTONE, ARZ
CITY WATER WELL
Walnut Gulch
CITY WATER WELL
School House
GOOD ENOUGH &
GARRARD SITES
WEST SIDE
Tombstone
Walnut Gulch
Pax Ranch
Tombstone Airfield
Prospects
Water Tank

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ARIZONA DEPARTMENT OF HEALTH SERVICES

Division of Environmental Health Services

UL H. CASTRO, Governor
SUZANNE DANDOY, M.D., M.P.H., Director

May 4, 1976

Mr. Bert C. Romero
State Mine Inspector
705 West Wing
State Capitol Building
Phoenix, AZ 85007

RE: 71 Minerals - underground leaching operations - Toughnut Mine

Dear Mr. Romero:

The Bureau of Water Quality Control has reviewed the proposal for the underground application of sodium thiosulfate, hypo, or sodium hyposulfite and finds the following:

1. That sodium thiosulfate at the proposed concentrations or as might reach a groundwater supply is not considered to be toxic in and of itself;

2. That there is a significant difference in the assessment of potential groundwater pollution as made by 71 Minerals and this Bureau. 71 Minerals asserts that pollution potential is very low and that water recovery tests will verify this position. The nature of sodium thiosulfate and the selectivity of its action are also cited as reasons for low pollution potential. The Bureau of Water Quality Control asserts that the proposed operation is very risky and that potential for groundwater pollution is high. Extensive flooding of existing mining shafts coupled with highly fractured geologic strata make it almost certain that any leakage from the leaching operation will have direct access to the groundwater supply. The Bureau concedes that water recovery testing may indicate that leaching operations can be successful if properly supervised;

5.

3. That the Bureau of Water Quality Control does not have adequate staff to supervise the leaching operations to insure that contamination of groundwater supplies can not occur;

3. 4. That contamination of the groundwater supply will more likely be the result of reaction products rather than from sodium thiosulfate in its original form;

5. That the quality of the sodium thiosulfate solution and water after passing through the leaching zone are not known;

4. 6. That it is not possible to estimate the impact on groundwater supplies with available existing data;

4. 7. That water levels in the Toughnut mine, Westside mine, Silverthread mine, Contention mine, and the two wells owned by the City of Tombstone should be identified using a common bench mark;

8. That the strike and dip of the major fracture zones in the leaching area should be identified;

4. 9. That a water quality monitoring program is needed to identify existing quality and trends. A method to detect movement of potential pollutants prior to reaching the water table should be part of the monitoring system;

5 10. That adequate records need to be maintained to determine recovery of all solutions pumped;

11. That the project as proposed may be in violation of U. S. Public Law 93-523, the "Safe Drinking Water Act";

12. That the State of Arizona has no groundwater quality standards that apply;

13. That an adequate environmental assessment has not been completed. That such an assessment should evaluate impact on groundwater supplies and the availability of other water supplies for Tombstone. That there is no authority to require such an impact statement;

14. That the City of Tombstone is highly dependent upon existing groundwater supplies;

15. That the City of Tombstone is highly concerned with industrial development within and adjacent to the City, and should be made aware of any development with a potential impact on the City water supply.

16. That the city planning guide recognizes the need for development that complements " . . . both adjacent activities and the overall pattern of community development";

17. That the proposed leaching process may be unique and a desirable non-toxic leaching process such that it could become an asset to the City of Tombstone;

18. That large-scale testing on a surface dump would be desirable prior to actual underground leaching;

Based on these findings, the Bureau of Water Quality Control recommends that 71 Minerals be allowed to conduct a water recovery test subject to the following conditions:

1. That prior to the actual water recovery test, a surface test will be conducted using water and a sodium thiosulfate solution (equivalent to 7 pounds sodium thiosulfate per ton of water) as leaching solutions. They should be applied to materials representative of the underground leaching areas and they should be applied in such a manner as to be representative of both application rates and contact times. Samples of the product solutions should be submitted to the State Laboratory for examination;

2. That prior to the water recovery test, an underground inspection of the leaching areas should be conducted, if possible, by representatives of the Bureau of Water Quality Control, the Arizona Water Commission, the State Mine Inspector's office, the Arizona Bureau of Mines, the Cochise County Health Department, representatives of the City of Tombstone and representatives of the SouthEastern Arizona Governments Organization, the designated water quality planning agency;

3. That prior to the water recovery test, a public meeting is to be held to discuss the process and evaluate potential hazards to the water supply. Such a meeting should be conducted by the Bureau of Water Quality Control;

4. That prior to the water recovery test, 71 Minerals should submit plans and specifications satisfactory to the Bureau of Water Quality Control to insure that the pumping system is adequate, that water or solution from any rupture in the piping system will be contained to prevent leakage to any shaft that might intercept the groundwater directly or indirectly, and that there is a system for positive metering of all solutions applied and recovered;

5. That the actual water recovery test be observed by representatives of all concerned parties;

6. That adequate records be kept of all solutions applied and recovered;

7. That results of all water testing be reviewed prior to approval to apply any chemical agents such as sodium thiosulfate;

8. That water samples of recovered water be collected and submitted to the Arizona State Laboratory for analyses;

9. That a monitoring program satisfactory to the Bureau of Water Quality Control be maintained by 71 Minerals with results to the Bureau as may be specified;

10. That any approval for the water recovery test does not constitute approval for the application of any chemical leaching agent;

11. That approval by the Bureau of Water Quality Control to apply a chemical leaching agent will in part be dependent upon but not limited to the satisfactory completion of the test conditions and the satisfactory assessment of problems associated with the proposed leaching operation.

Your concern and action in this matter is appreciated. Should you have any questions, please feel free to contact this office.

Sincerely,

Wm. H. Shafer, Jr., P.E.
Manager, Monitoring Section
Bureau of Water Quality Control

WHS:mh
cc: 71 Minerals - Mr. Hewlett
Venture Mining Co., Ltd. - Mr. Darrah
Arizona Water Commission - Mr. Briggs
Arizona Bureau of Mines - Mr. Rabb
Arizona Land Department - Mr. Allen
Cochise County Health Department
City of Tombstone
SEAGO
U. S. Geological Survey - Mr. Babcock
EPA

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ARIZONA DEPARTMENT OF HEALTH SERVICES

Division of Environmental Health Services

L H. CASTRO, Governor
SUZANNE DANDOY, M.D., M.P.H., Director

July 29, 1976

Mr. Richard F. Hewlett
President
Sierra Metals
Nannini's Financial Center
7110 North Oracle Road, Suite 213
Tucson, AZ 85704

Dear Mr. Hewlett:

Approval to conduct water balance tests on 715 tons of gob located in the Toughnut Incline at the 300-foot level is hereby granted, subject to the following conditions:

1. Please submit a water balance or accounting procedure prior to water balance test. This should include any forms to be used and a sample of calculations to be used. It might be helpful to show the balance on the water applied to date.

2. Results of the water test must be reviewed prior to actual leaching, using hypo-solution.

3. This approval for water testing does not imply approval for "hypo" leaching.

Mr. Rabb of the Bureau of Mines and Mr. Lindeman of our office, plan to observe the water tests while under way, sometime during the week, beginning August 2. 10:00 a.m. 8/4/76 Methods for calculating the water balance should be available to them at that time. This is in addition to the forms and calculations to be sent to our Phoenix office.

Your suggestion that operations be reviewed by an outside consultant is reasonable. Any professional, registered with the State Board of Technical Registration would likely be acceptable.

Your continued cooperation in this matter is appreciated.

Sincerely,

William H. Shafer, Assist. Chief
Technical Services & Support
Bureau of Water Quality Control

WHS:cp

cc: Cochise County Health Department
City of Tombstone
State Mine Inspector, Mr. Romero
Bureau of Mines, Mr. Rabb
Arizona Water Commission, Mr. Osborn
Southern Regional Office, Tucson
EPA, Region IX, Virginia Hammer

Briscoe (11-15-48)

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James A. Briscoe, President
Registered Professional
Geologist

Southwestern Exploration Associates, Inc.

November 15, 1978

Mr. Dwight Lee
FAMCO
120 Sylvan Avenue
Englewood Cliffs, New Jersey 07632

Re: Proposal for Establishing a Mineral Resources Exploration Fund

Dear Mr. Lee,

After our meeting this summer, I have outlined what I believe is a viable structure for a mineral exploration venture, which very profitably returns the capital of the investors, as well as the efforts of the originators. My proposal, with applicable attachments and back-up data, follows below.

My long term personal objective in mineral exploration is to not only locate profitable ore bodies, but to retain a portion of the income derived from such discoveries for myself, my family, and my employees.

To meet these long term objectives, I have worked very hard and diligently in pursuing my career and, over the last five years, in designing and creating Southwestern Exploration Associates in its' present form. For reasons I have discussed with you, I believe Southwestern Exploration Associates Inc., has the

ability and motivation to be more effective in finding mineral exploration targets than most, if not any other, exploration groups. In order to reach our objectives, the SEA machinery must be fueled with the proper amount of capital over a reasonable period of time. It is this mechanism that is the next important step in completing my long-range objectives.

Working against the discovery of any mineral commodity, including both oil and minerals, are a variety of factors. Though numerous details may be added, these factors could be summarized:

1. The small relative size (and hence the reason for the extreme value) of naturally occurring mineral commodities.

2. The expense of locating and testing to determine the commerical viability of these occurrences, which are generally hidden below soil, rock, or other cover.

3. Competition for the discovery of these commodities.

The odds for or against making such discoveries have been intensely researched in the field of petroleum exploration, but less so in the field of mineral exploration. Attachment 1 is a probability chart showing the likelihood of making discoveries in petroleum. It is clear from this chart and also makes common sense that, as the number of tests increases, the probability of discovery also increases. It is also axiomatic that, as the number of tests increase, the cost too must go up. It is here that expertise comes into play, in that the more expert the explorationist, the fewer tests that are necessary before discovery, and hence the lower the cost of exploration success and discovery. As I have already stated, it is my belief that SEA Inc. is as good, if not better, than the upper percentile of

companies exploring for mineral deposits. Thus, in my plan for successful exploration, it remains only to make probabilities work for, rather than against us.

I'm sure you would agree with the truism that "the one who controls a property calls the shots regarding that property." This is axiomatic in the exploration business because ore deposits are where they are in nature, and no amount of investment in engineering, technology, or wishful thinking will move an ore deposit one foot from the location in which it now exists. Thus, whoever owns the property over that deposit controls its ultimate destiny. Put another way, without control of ore-bearing lands, regardless of how much mining expertise or money a mining company (or oil company, for that matter) might have, unless they can locate new mining properties, their existing mines (or oil wells) will eventually be depleted. Therefore, mining companies (or oil companies) must deal with the owners of the surface and mineral rights of new ore deposits. Thus, the key leverage point is discovery and acquisition of such properties before they can be discovered and acquired by the competition. This is the forte of Southwestern Exploration Associates Inc.

Of course, the exploration task is not easy. But, this is where my expertise lies - that is why I am able to succeed in business as a consultant and we as a consulting firm. Identifying, evaluating, and testing mineral zones is what I have done, what we are doing, and what we will continue to do. The trick, of course, is to make this capability pay off without the financial heft of a large company. The key again is the identification of, and control of, mineral land over potential ore bodies. When the presence of a viable exploration drilling target has been demonstrated in a manner sufficient to convince their technical

personnel, major companies will advance the capital for the extensive test work to confirm reserves, as well as the capital for mine plant construction. In exchange, they will require a majority interest and control of the operating company. For us the first requirment is identification of the mineral potential, while the second is control of the mineral land. Then it is our choice as to which company and which price is sufficient reward for the property position.

In order to insure that probability works for us (rather than succumb to 'gamblers ruin' from too few trys), it is important to make numerous exploration tests over a reasonable time frame. In order to assure an adequate number of tests within a realistic time frame, I recommend exploration progams over twelve separate areas encompassing the western United States. Each would be funded by exploration partnerships in an amount of $1.3 million, to be expended over a period of four years.

Another axiom related to exploration probability is "don't put all your eggs in one basket." Each exploration project area will probably be funded by separate exploration partners, and it cannot be assured that the exploration success ratio will be the same for each area. To insure the most equitable distribution of profits, the partners in each exploration area should also earn a percentage of the rewards from all of the other exploration areas. In order to do this, I propose Resource Exploration Associates Inc. or REA Inc. for short, be established. This company would be the general partner for the exploration partnerships, but would be jointly owned by all of the limited partners, and by the originators, You or your company and James A. Briscoe, (Attachment 5). The ownership ratio would be 51 (25-1/2 and 25-1/2 you and Briscoe) - 49% non-voting shares held by the limited partners. Ten percent of all the limited partnership money would be paid to REA Inc. for their 49% ownership. Sixty percent of this money would be paid as sales

commissions (or 6% of the total partnership funds), while 40% would be retained by REA Inc. for expenses and operating capital. Proceeds from mineral discoveries (Attachment 2) would first repay the investment of the partners in the successful regions, and then would be paid 60% to the successful partners, and 40% to REA Inc. Since all of the partners will in combination own 49% of REA, 49% of the 40% will be distributed to all of the limited partners including those who may have not experienced successful discoveries in their exploration regions. In this way, the law of probabilities can be made to work for all of the participants so that those who have the good fortune to have invested in a particularly successful area will profit most, but all of the profits will be distributed in some measure to all investors.

In this manner, some $14,400,000 ($0.3m x 4 years x 12 regions) will be invested in exploration over a period of eight years (Attachment 2 and 6). We can use past performance (Appendix III), my personal knowledge, and published reports to predict that established companies, including mining firms, petroleum companies, power companies, and others, will invest $194.4 million in additional exploration funds in return for majority interest in the mineral targets generated by our exploration programs during the four-year period of exploration for the 12 exploration regions. Combined with the investors' $14.4 million, the total investment in exploration is $208 million. Statistics compiled by Walthier (1978) suggest that it requires $16.2 million of invested capital for a mining company to make a discovery of a productive mineral deposit. I believe SEA can do <u>substantially</u> better than this success ratio; however, using Walthier's figures, 12.8 mineral deposits should result from the proposed program.

What will be the value of these discoveries? - this we can only roughly estimate. For calculation purposes let us assume that each discovery will have an average gross metal value of $500 million - a small to medium sized ore deposit (see Appendices I & II, prepared by S.N. Craft). Some discoveries might be substantially larger and some could be considerably smaller, but a $500 million gross value is a reasonable figure. Also, we will assume that the partners will retain in all of these properties a 5% NSR (net smelter returns) royalty, which is approximately equivalent to 5% of the gross-contained metal value. It then follows that $500 million x 12.8 discoveries x 5% is equal to a return of $320 million. Since the partners orginally invested some $16 million, their return on investment would be $304 million. It must be pointed out that these royalties would be paid over possibly a large number of years. Offsetting this is the fact that, historically, metal prices increase and ore reserves tend to increase so that the eventual yield might be much greater. Depletion allowances would also apply to these royalties, and individual owners always have the option of selling their advance royalties for a discounted present worth.

The partners would take a 60% distribution of the $304 million or $182.4 million. Forty percent would be payable to REA Inc. or $121.6 million. Forty nine percent of the $121.6 million or $59.6 million would be distributed to all limited partners, including those who may have not experienced success in their exploration region.

This should assure all investors a respectable return on their capital. The originating partners, you or your company and James A. Briscoe, would share on a 25.5% basis each or a total of $31 million for each originating owner.

By this mechanism, both investors and principals are rewarded for their expertise and capital. As you can see, by referring to the

probability chart, and the number of exploration tries described in Attachment 2, probability for success is the in the 99th percentile.

Several factors make this a particularly good time to invest in this type of a mineral exploration program.

SEA, in contrast to most producing companies, explores with the objective of locating any profitable mineral commodity. Most production companies explore for specific commodities generally divided by departments, i.e. the copper companies explore for copper and molybdenum while some are also involved in precious metal exploration and uranium exploration through separate departments set up for this purpose. The oil companies emphasize uranium with subordinate work in copper and molybdenum. Electric utilities are now strongly supporting uranium exploration but have no interest in the other commodities. Thus, the exploration effort is fractionated and, even when a commodity which might be of interest to another company is identified by a company who has no interest in that particular commodity, it is simply ignored. The base and precious metal and uranium deposits are interlocked in their occurrence in nature and, regardless of what company politics, infrastructure or current raw material needs are, it is, for all practical purposes, impossible to explore for one commodity without inadvertantly running across the others. As an independant, SEA has contacts with a variety of companies, knows their objectives, and can connect with the proper purchaser for the discovered deposit. The cost of exploration and identification can thus be spread amongst a variety of potential mineral type discoveries.

The energy crisis has created a drastic price increase in uranium. This price increase has resulted in the activation by the newly created Department of Energy (D.O.E.) of the N.U.R.E.

(National Uranium Resource Evaluation) program. With a budget in the range of three billion dollars, the N.U.R.E. program has the objectives of evaluating the potential uranium resources in the United States by the year 1984. To implement this project, an intensive program of geologic, geophysical, and geochemical studies has been instituted, and information from these studies has already begun to flow into the private sector. Because of the interrelationship of the natural occurrence of uranium with base and precious metal deposits, this data is equally important in the exploration for precious and base metals as it is in uranium. Because most uranium exploration geologists have no knowledge or interest in base and precious metal exploration and evaluation, and vice versa for the base and precious metal exploration geologists, I believe that most companies will not take full advantage of this wealth of information. This is not the case with SEA. We have set up, through our Literature Research Department, the mechanics for evaluating this type of data and are well prepared to make use of it for locating gold, silver, molybdenum, lead, zinc, mercury, and geothermal deposits, as well as uranium deposits. Thus, the exploration programs will be able to take advantage of data never before available.

The current trend and the economic climate is equally important and exciting. Examining the graphs for uranium, molybdenum, silver, gold, tin and tungsten - Attachments 7, 8, 9, 10, 14, and 15 it is obvious that we are in a period of price increases for these commodities that has not been seen in decades. In the case of silver and gold, the prices are at a level (and increasing in relation to the Wholesale Price Commodity Index) that they have not been at since 1890. This indicates that these metals are again becoming so valuable that small underground deposits which, for all practical purposes, stopped production at the start of World War II (for economic reasons as well as the Gold Closing Act, Law - 208 instituted by F.D.R.) will now become profitable

to operate. I do not believe this fact is yet evident to most mining companies. It is clearly indicated, however, by our proprietary graphs. Recognition of this will have two effects. First, by acting rapidly we will be able to tie up exploration targets of this type before most of the competition has time to react. Secondly, small targets will require less capital to put into production and lower the overall exploration risk with potentially high rates of return. Further, the high precious metal prices will also enhance the profitability of bulk tonnage gold and silver deposits, the existance of which has been only recognized within the last ten to twelve years, and the exploration for which I am thoroughly familiar.

The emergence of China as a consuming nation (indicated by recent contracts and loan agreements with Japan and other countries) I believe will have a very strong impact on the worldwide supply and demand situation for mineral commodities creating an increased and sustained upward pressure on metal prices.

This combination of factors, influencing both prices and the potential for discovery of new mineral deposits, has not been seen for many decades (if ever) and gives the opportunity for great profit for those who act upon it.

Very truly yours,

James A. Briscoe

JAB/sjo
Attachments
PE78
1751

Attachments

1. Probability chart
2. Flow chart Scenario depicting the results of a year in the four year Exploration Program
3. Predicted Cash Flow calculations resulting from the Scenario Attachment 2
4. Map of Proposed Exploration Areas
5. Proposed Formation and Operation Format for Resource Exploration Associates, Inc.
6. Investment Cash Flow Chart for the Exploration Program
7. Activities Diagram of the Exploration Phase and Development Phase of the Program
8. Graph of Uranium Price 1952 to 1978
9. " " Molybdenum " 1930 to 1978
10. " " Silver " 1850 to 1978
11. " " Gold " 1790 to 1978
    " " Wholesale Commodities Price Index 1850 to 1978
12. " " Copper Price 1850 to 1978
13. " " Lead " 1850 to 1978
14. " " Zinc " 1850 to 1978
15. " " Tin " 1910 to 1978
16. " " Tungsten " 1910 to 1978

Appendices

Appendix I	Uranium Exploration, an Exciting Past and Profitable Future by S.N. Craft, SEA Librarian
Appendix II	A Brief History of Silver Mining in the Western United States - 1859 to 1970 by S.N. Craft, SEA Librarian
Appendix III	Gold: A Brief History of Exploration and Mine Development
Appendix IV	J.A. Briscoe - Exploration Track Record 1965 - 1978

Attachment 3

Predicted Cash Flow Calculations Resulting from the Scenario Attachment 2

I Total capital contributed by major company Joint Venture Partners through the development drilling stage for each Exploration Region over 4 years

$4,050,000 x 4 years x 12 regions = $1.944 x 10^8

II Total capital contributed to exploration by the Limited Partners over 12 regions over 4 years

$300,000 x 4 years x 12 regions = $0.144 x 10^8

III Total Capital contributed by major company Joint Venture Partners and Limited Partners

= I + II = $1.944 x 10^8 + $0.144 x 10^8 = 2.08 x 10^8

IV Calculated Discoveries at estimated cost of $16.2 million per discovery

208,000,000 ÷ 16,200,000 = 12.8 deposits

V Value of discoveries assuming a $500 million gross metal value of ore body & 5% NSR Royalty

$500 mill x 12.8 x 5% = $320 million

Attachment 5

Proposed Formation of General Partnership Vehicle
RESOURCE EXPLORATION ASSOCIATES, INC.

I Ownership

Your Company	25 1/2%	(50% voting stock)
James A. Briscoe	25 1/2%	(50% voting stock)
Limited Partners	49%	(0 voting stock)

II Operation

A. REA Inc. - General Partnership
B. REA will contract all exploration work to SEA Inc.
   1. SEA agrees to re-invest 50% of its profit from the REA Inc., contracts, back into the exploration programs

III Purchase of Interest in REA by Limited Partners

A. 10% of Total investment will go to REA Inc. for purchase of stock
   1. Ratio of ownership will remain constant
      49% Limited Partners - no voting rights
      51% you & Briscoe - equal split voting rights
   2. Distribution of Profits from each Exploration Region Limited Partnership will be distributed
      a. 100% to Limited Partners till payback
      b. 60% to Limited Partners thereafter
      c. 40% to General Partner (REA Inc.)
   3. Distribution of Dividends from 40% of Exploration Region Partnership.
      Profits Distribution
      a. 49% to all Limited Partners all programs
      b. 51% to you & Briscoe

IV Distribution of Proceeds to REA Inc.

A. Commissions
   1. 60% of cash received (6% of Gross Limited Partner Contribution) will be paid in sales commissions
   2. Potential Commissions =
      $1.33mm x 12 programs x 10% x 60% = $957,600
B. Operating Capital
   1. 40% of cash received (4% of Gross Limited Partnership Contribution) will be used to run REA Inc.
   2. Potential Operating Capital =
      $1.33mm x 12 programs x 10% x 40% = $638,400

Additional Budgetary Attachments

Attachment	
1	A game plan in the form of a project schedule showing feasible starting dates and operations throughout the course of the four-year proposed project
2	A detailed budget ledger sheet
3	A brief summary on how property (ie. mineral rights) are obtained
4	S.E.A. Inc. Management chart
5	S.E.A. Photo Inc. Management chart
6	S.E.A. Minerals Exploration Division Management chart
7	A listing of current personnel with attached partial list of clients