

## APPENDIX: Oxidation and Dissolution of Refractory Gold Concentrate in Alkaline Hypochlorite Solutions

1. Characterization Results of the Flotation Concentrate
  - a. XRF Results

**Table 1.** XRF Analysis of the Flotation Concentrate

Elements	Flotation Concentrate Percent Composition
Ag	0.03
As	0.08
Cd	0.01
Cr	0.01
Cu	0.86
Fe	38.88
K	1.8
Mn	0.28
Pb	0.25
S	45.44
Si	10.95
Sr	0.02
Ti	0.22
Zn	1.17

- b. Particle Size Distribution

**Table 2.** Size and Percent Gold Distribution

Mesh No.	Micron Size	% Gold	% Passing	% Retained
100	149	18.5 %	77.7 %	22.3 %
120	125	10 %	69.2 %	30.8 %
140	105	16.4 %	56.1 %	43.9 %
200	74	25.7 %	27.8 %	72.2 %
325	44	15.9 %	9.3 %	90.7 %
400	37	7.7 %	3.0 %	97.0 %
-400		5.9 %		

2. Semi-quantitative analysis using XRD (assuming the two predominant phases in the ore)

**Table 3.** Semi-quantitative Analysis using Klug's Equation for Two-phases

Sample	Pyrite	Silica
Flotation Concentrate	65.9%	34.1%
Oxidation Residue	57.1%	42.9%

## 3. Screening Test Parameters

**Table 4.** Parameters for the Screening Tests

Parameter	Level	Value
Hypochlorite Concentration	-	0.11 moles
	+	0.22 moles
Oxidation Time	-	2 hours
	+	6 hours
Percent Solids	-	5%
	+	18%
Lixiviant Mix	-	Mixed
	+	Ca(OCl) <sub>2</sub> only

## 4. Oxidation Parameters

**Table 5.** pH Values

Setup	Initial pH	Final pH	OCl <sup>-</sup> moles
1	12.09	11.83	0.24
2	12.20	12.3	0.47
3	12.18	11.79	0.71
4	11.2	8.8	0.24
5	12.4	12.4	0.47
6	11.7	11.6	0.47
7	11.94	11.19	0.47
8	12.4	12.3	0.24
9	11.2	8.8	0.24
10	12.2	12.3	0.47
11	12.08	11.77	0.71
12	11.94	11.01	0.47
13	12.18	11.79	0.47
14	11.94	11.01	0.71
15	12.4	12.4	0.71

## 5. ANOVA Results of the Screening Tests

**Table 6.** Analysis of Variance for Screening Test 1

Source	Sum of Squares	Degrees of Freedom	Mean Square	F-value	p-value
Model	1365.62	3	455.21	12.13	0.0178
A [OCl <sup>-</sup> moles]	310.01	1	310.01	8.26	0.0453
B [Oxidation Time]	1052.95	1	1052.95	28.05	0.0061
AB	2.67	1	2.67	0.07	0.8030
Error	150.17	4	37.54		
Total	1515.79	7			

**Table 7.** Analysis of Variance for Screening Test 2

Source	Sum of Squares	Degrees of Freedom	Mean Square	F-value	p-value
Model	6203.02	3	2067.67	8.62	0.0321
A [% Solids]	2168.11	1	2168.11	9.04	0.0397
B [Lixiviant Type]	2589.29	1	2589.29	10.80	0.0303
AB	996.81	1	996.81	4.16	0.1111
Error	959.00	4	239.75		
Total	7162.03	7			

6. ANOVA Results of the Box-Behnken Experiment

**Table 8.** Analysis of Variance for Box-Behnken Experiment

Source	Sum of Squares	Degrees of Freedom	Mean Square	F-value	p-value
Model	13056.99	9	1450.78	9.52	0.012
A [Oxidation Time]	2850.50	1	2850.50	18.70	0.008
B [OCl <sup>-</sup> Concentration]	1395.19	1	1395.19	9.15	0.029
C [% Solids]	341.05	1	341.05	2.24	0.195
AB	235.56	1	235.56	1.55	0.269
AC	47.54	1	47.54	0.3119	0.601
BC	473.24	1	473.24	3.10	0.138
A <sup>2</sup>	1195.14	1	1195.14	7.84	0.038
B <sup>2</sup>	1416.38	1	1416.38	9.29	0.029
C <sup>2</sup>	6002.67	1	6002.67	39.38	0.002
Residual	762.20	5	152.44		
Lack of Fit	725.47	3	241.82	13.17	0.071
Error	36.73	2	18.36		
Total	13819.19	14			

**Table 9.** Analysis of Variance for Box-Behnken Experiment without Interaction Effects

Source	Sum of Squares	Degrees of Freedom	Mean Square	F-value	p-value
Model	12053.8	6	2008.96	10.62	0.002
A [Oxidation Time]	2850.5	1	2850.50	15.07	0.005
B [OCl <sup>-</sup> Concentration]	1395.2	1	1395.19	7.38	0.026
C [% Solids]	341.0	1	341.05	1.80	0.216
A <sup>2</sup>	1129.6	1	1129.64	5.97	0.040
B <sup>2</sup>	1345.0	1	1344.98	7.11	0.029
C <sup>2</sup>	5854.7	1	5854.72	30.95	0.001
Residual	1513.3	8	189.17		
Lack of Fit	1481.8	6	246.97	15.66	0.061
Error	31.5	2	15.77		
Total	13567.1	14			