APPENDIX 1 –
FLOTATION TEST REPORT

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK

Mintec

Sample:	Hannukainen, High-S Feed Type	Primary Grinding :	Mill: Lab BM
Project:	Rautajärvi (50401-10xxx)		Charge: 8 kg steel balls; 1.5 kg ore
Date:	30.-31.8.2017		Water: 0.9 liters
Author:	M. Kuusisto / A. Naumanen		
Test No.:	Test 0 Ore Type : High-S Feed (Lab)	Screen check :	BM product 40.7% -75 µm

Remarks: Ore feed 4.5 kg, **Crushed to - 1.4 mm [P(80) = 602 µm] for Primary grinding to P(80) = 148 µm**
Cu Rougher-Scavenger Flotation
Pyrite Rgh-Sca Flotation for the Cu Sca Tailing, followed by wet three-stage LIMS for the Pyrite Sca Flotation Tailing
Reverse Pyrrhotite Flotation for the LIMS Cleaned Magnetic Conc "WLC3" in two steps
All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	Reagents (g / ton of Fresh Test Feed) PAX				H_2SO_4	DF 233	SIPX	Flotanol C-7	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu (XRF) Rec%	Fe (XRF) %	Fe (XRF) Rec%	SiO_2 (XRF) %	SiO_2 (XRF) Rec%	MgO (XRF) %	MgO (XRF) Rec%	Al_2O_3 (XRF) %	Al_2O_3 (XRF) Rec%	CaO (XRF) %	CaO (XRF) Rec%	S (Eltra) %	S (Eltra) Rec%	S (XRF) %	S (XRF) Rec%	Satmagan %	Satmagan Rec%
Solution strengths :			5.0 %				50 %	1.0 %	5.0 %	100 %																										
Fresh Ore 3*1.5 kg																																				
- 1.4 mm	15																																			
		(Cu Rougher Flotation)					Natural pH				7.0		2500		6.7																					
		3	50																																	
		2								20																										
												3		1.7	5.7	10	CuRC																			
															5.7		CuRT																			
CuRT		(Cu Scavenger Flotation)									7.0		2500																							
		3	30																																	
		2								10																										
												3		1.7	5.5	8	CuSC																			
		Cu Rgh & Sca Flot'n products combined for chemical and screen analyses															CuRCSC	204.0	4.56	1.97	91.6	42.00	4.8	11.60	2.2	1.69	1.9	3.13	3.0	3.46	1.9	32.80	47.7	29.50	45.3	12.12	1.2
															5.5		CuST	4272.8	95.44	0.009	8.4	39.79	95.2	24.36	97.8	4.19	98.1	4.86	97.0	8.40	98.1	1.72	52.3	1.70	54.7	49.46	98.8
CuST		(Pyrite Rougher Flotation)									7.0		2500		5.5																					
							x								5.0																					
		3					x		100																											
		2					x			20																										
							x					3		1.7	5.0	10	PyrRC	116.1	2.59	0.077	2.0	43.80	2.8	13.00	1.4	1.68	1.1	3.58	1.9	3.54	1.1	29.90	24.8	27.30	23.9	15.00	0.8
							305								5.0		PyrRT	4156.7	92.85	0.007	6.3	39.68	92.4	24.67	96.4	4.27	97.0	4.90	95.1	8.54	97.0	0.93	27.5	0.99	30.9	50.42	98.0
PyrRT		(Pyrite Scavenger Flotation)									7.0		2500		5.0																					
							x								4.0																					
		3					x		50																											
		2					x			20																										
							x					3		1.7	4.0	10	PyrSC	47.7	1.07	0.076	0.8	35.60	1.0	23.50	1.1	3.35	0.9	6.22	1.4	6.81	0.9	14.10	4.8	14.00	5.0	18.88	0.4
							595								4.0		PyrST	4109.0	91.78	0.006	5.5	39.73	91.4	24.69	95.3	4.28	96.2	4.88	93.7	8.56	96.1	0.78	22.7	0.84	25.8	50.79	97.6
PyrST		(LIMS Roughing; pulp density ca. 30 wt.-% in LIMS Feed)										Wet LIMS 1					WLC1	2656.5	59.34	0.004	2.2	56.57	84.2	12.21	30.5	2.39	34.8	2.43	30.1	3.95	28.6	0.65	12.3	0.70	13.9	78.22	97.2
		Pump speed "170", Flow restrictor Ø 4 mm, "Selectivity" setting															WLT1	1452.5	32.45	0.010	3.3	8.91	7.2	47.50	64.8	7.72	61.4	9.37	63.6	17.00	67.4	1.01	10.5	1.09	11.9	0.62	0.4
WLC1		(1st LIMS cleaning)										Wet LIMS 2					WLC2	2478.1	55.35	0.003	1.7	59.96	83.2	9.76	22.7	2.00	27.1	1.96	22.6	3.03	20.5	0.64	11.4	0.69	12.8	83.74	97.1
																	WLT2	178.4	3.98	0.012	0.5	9.49	0.9	46.30	7.8	7.88	7.7	9.00	7.5	16.70	8.1	0.715	0.9	0.84	1.1	1.55	0.1
WLC2		(2nd LIMS cleaning)										Wet LIMS 3					WLC3	2420.8	54.07	0.003	1.5	61.15	82.9	8.88	20.2	1.85	24.5	1.80	20.3	2.69	17.8	0.65	11.1	0.69	12.5	85.65	97.0
																	WLT3	57.3	1.28	0.011	0.1	10.00	0.3	46.90	2.5	8.31	2.6	8.62	2.3	17.20	2.7	0.544	0.2	0.70	0.3	2.91	0.1
WLC3		(Reverse Rougher Flotation of Pyrrhotite)									2.5		1800		6.5																					
							x								5.0																					
		3					x	50	100																											
		2					x			20																										
							x					3		1.7	5.0	5	PoRC	23.2	0.52	0.043	0.2	54.10	0.7	9.74	0.2	1.75	0.2	2.26	0.2	2.82	0.2	15.60	2.6	14.20	2.5	47.46	0.5
							75								5.0		PoRT	2397.6	53.56	0.002	1.3	61.22	82.2	8.87	20.0	1.85	24.3	1.79	20.1	2.69	17.6	0.500	8.6	0.55	10.0	86.02	96.5
PoRT		(Reverse Scavenger Flotation of Pyrrhotite)									2.5		1800		5.0																					
							x								4.0																					
		3					x	25	50																											
		2					x			20																										
							x					3		1.7	4.0	5	PoSC	20.6	0.46	0.033	0.2	56.20	0.6	6.48	0.1	1.19	0.1	1.52	0.1	1.93	0.1	20.30	3.0	19.10	3.0	41.93	0.4
							190								4.0		PoST	2377.0	53.10	0.002	1.2	61.26	81.5	8.89	19.9	1.85	24.1	1.80	19.9	2.70	17.5	0.329	5.6	0.394	7.0	86.40	96.1
PoST		(Final LIMS cleaning for the Reverse Flotation cell product;										Wet LIMS 4					WLT4	56.2	1.26	0.008	0.1	10.00	0.3	47.40	2.5	8.65	2.7	8.26	2.2	17.50	2.7	0.283	0.1	0.398	0.2	4.40	0.1
		i.e. "Product dewatering LIMS treatment")																																		
												Magnetite Concentrate					WLC4	2320.8	51.84	0.002	1.1	62.50	81.2	7.96	17.4	1.69	21.5	1.64	17.8	2.34	14.8	0.330	5.5	0.394	6.9	88.39	95.9
		Combined Sulphur Bulk Product (= Pyrite & Pyrrhotite Concentrates)															SBulkConc	207.6	4.64	0.069	3.2	44.30	5.1	14.40	2.8	2.02	2.3	3.83	3.7	4.05	2.3	23.72	35.1	21.97	34.3	22.19	2.2
						Note :	All product Fe assays are Satmagan corrected										Calc. Feed	4476.8	100.00	0.098	100.0	39.89	100.0	23.77	100.0	4.08	100.0	4.78	100.0	8.18	100.0	3.13	100.0	2.97	100.0	47.76	100.0
																	Feed Assays	(4500)		0.091		38.70		24.90		4.62		5.15		7.86		3.12		3.14		44.33	
Totals	15	30	80				1165	75	300	110						48																					

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK Mintec

Sample:	**Hannukainen, High-S Feed Type**	**Primary Grinding :**	**Mill:** Mergan BM
Project:	Rautajärvi (50401-10296)		**Charge:** 22.5 kg steel balls; 5 kg ore
Date:	**4.-5.9.2017**		**Water:** 5.0 liters
Author:	M. Kuusisto / P. Seppälä		
Test No.:	**Test 1**	**Ore Type :** **High-S Feed (Lab)**	**Screen check :** **BM product 55.4% -75 µm**

Remarks: Ore feed 5 kg, **Crushed to - 1.4 mm [P(80) = 602 µm] for Primary grinding to P(80) = 109 µm**
Cu Rougher-Scavenger Flotation
Pyrite Rgh-Sca Flotation for the Cu Sca Tailing, followed by wet three-stage LIMS for the Pyrite Sca Flotation Tailing
Reverse Pyrrhotite Flotation for the LIMS Cleaned Magnetic Conc "WLC" in two steps
All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	PAX				H_2SO_4	DF 507	SIPX	Dow 250	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu (XRF) Rec%	Fe (XRF) %	Fe (XRF) Rec%	SiO_2 (XRF) %	SiO_2 (XRF) Rec%	MgO (XRF) %	MgO (XRF) Rec%	Al_2O_3 (XRF) %	Al_2O_3 (XRF) Rec%	CaO (XRF) %	CaO (XRF) Rec%	S (Eltra) %	S (Eltra) Rec%	S (XRF) %	S (XRF) Rec%	Satmagan %	Satmagan Rec%
			Reagents				(g / ton of Fresh Test Feed)													Grades and Recoveries (XRF MP-10, Eltra S, and Satmagan)																	
Solution strengths :			5.0 %				50 %	1.0 %	5.0 %	100 %																											
Fresh Ore 5 kg																																					
- 1.4 mm	25																																				
		(Cu Rougher Flotation)					Natural pH				7.0		2100		6.8																						
		3	50					25																													
		2								20																											
												3		1.5	5.5	10	CuRC																				
															5.5		CuRT																				
CuRT		(Cu Scavenger Flotation)									7.0		2100																								
		3	30					15																													
		2								10																											
												3		1.5	5.5	10	CuSC																				
		Cu Rgh & Sca Flot'n products combined															CuRCSC	314.8	6.33	1.54	94.7	43.90	7.0	10.90	2.9	1.54	2.4	2.93	3.9	3.09	2.4	32.30	65.3	30.00	63.4	13.80	1.9
															5.5		CuST	4658.1	93.67	0.006	5.3	39.56	93.0	24.58	97.1	4.19	97.6	4.86	96.1	8.62	97.6	1.16	34.7	1.17	36.6	48.59	98.1
CuST		(Pyrite Rougher Flotation)									7.0		2200		5.6																						
							x								5.0																						
		3					x		100																												
		1					x			20																											
							x					3		1.5	5.0	9	PyrRC																				
							295								5.0		PyrRT																				
PyrRT		(Pyrite Scavenger Flotation)									7.0		2200		5.0																						
							x								4.0																						
		3					x		50																												
		1					x			10																											
							x					3		1.5	4.0	10	PyrSC																				
							625																														
		Pyr Rgh & Sca Flot'n products combined															PyrRCSC	124.4	2.50	0.067	1.6	41.40	2.6	18.10	1.9	2.67	1.7	4.67	2.5	5.14	1.6	18.80	15.0	17.70	14.8	22.00	1.2
															4.0		PyrST	4533.7	91.17	0.004	3.6	39.51	90.4	24.76	95.2	4.23	95.9	4.87	93.6	8.72	96.1	0.67	19.6	0.72	21.9	49.32	96.9
PyrST		(LIMS Roughing + two Cleanings)										Wet LIMS 1 to 3					WLC	2506.6	50.40	0.002	0.9	64.33	81.4	6.44	13.7	1.36	17.0	1.35	14.4	1.94	11.8	0.63	10.2	0.56	9.5	88.65	96.3
		Pump speed "170", Flow restrictor Ø 4 mm, "Selectivity" setting															WLT	2027.1	40.76	0.007	2.8	8.82	9.0	47.40	81.5	7.78	78.9	9.21	79.2	17.10	84.3	0.724	9.4	0.91	12.4	0.69	0.6
WLC		(Reverse Rougher Flotation of Pyrrhotite)									2.5		1600		6.7																						
							x								5.0																						
		3					x	50	100																												
		2					x			20																											
							x					3		1.5	5.0	9	PoRC	44.8	0.90	0.026	0.2	58.80	1.3	5.81	0.2	1.00	0.2	1.35	0.3	1.57	0.2	17.40	5.0	15.50	4.7	51.59	1.0
							125								5.0		PoRT	2461.7	49.50	0.001	0.6	64.43	80.1	6.45	13.5	1.36	16.8	1.35	14.1	1.95	11.6	0.33	5.2	0.292	4.8	89.32	95.3
PoRT		(Reverse Scavenger Flotation of Pyrrhotite)									2.5		1600		5.0																						
							x								4.0																						
		3					x	30	50																												
		2					x			20																											
							x					3		1.5	4.0	9	PoSC	31.0	0.62	0.023	0.1	55.10	0.9	7.67	0.2	1.48	0.2	1.73	0.2	2.30	0.2	19.30	3.8	17.80	3.7	41.40	0.6
							145								4.0		PoST	2430.7	48.88	0.001	0.5	64.55	79.2	6.44	13.3	1.36	16.6	1.35	13.9	1.94	11.5	0.09	1.4	0.069	1.1	89.93	94.8
PoST		(Final LIMS cleaning for the Reverse Flotation cell product;										Wet LIMS 4					WLCT	37.1	0.75	0.005	0.0	9.87	0.2	47.60	1.5	8.65	1.6	8.30	1.3	17.50	1.6	0.213	0.1	0.302	0.1	3.73	0.1
		i.e. "Product dewatering LIMS treatment")																																			
												Magnetite Concentrate					WLCC	2393.6	48.13	0.001	0.5	65.40	79.0	5.80	11.8	1.25	15.0	1.24	12.6	1.70	9.9	0.085	1.3	0.065	1.0	91.27	94.7
		Combined Sulphur Bulk Product (= Pyrite & Pyrrhotite Concentrates)															SBulkConc	200.2	4.03	0.051	2.0	47.42	4.8	13.73	2.3	2.11	2.1	3.47	2.9	3.90	1.9	18.56	23.9	17.22	23.1	31.63	2.7
						Note :	All product Fe assays are Satmagan corrected										Calc. Feed	4972.9	100.00	0.103	100.0	39.84	100.0	23.71	100.0	4.02	100.0	4.74	100.0	8.27	100.0	3.13	100.0	3.00	100.0	46.39	100.0
																	Feed Assays	(5000)		0.091		38.70		24.90		4.62		5.15		7.86		3.12		3.14		44.33	
Totals	25	28	80				1190	120	300	100						57																					

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK Mintec

Sample:	**Hannukainen, VE2 Feed Type**	**Primary Grinding :**	**Mill:** Mergan BM
Project:	Rautajärvi (50401-10296)		**Charge:** 22.5 kg steel balls; 5 kg ore
Date:	**6.9.2017**		**Water:** 5.0 liters
Author:	M. Kuusisto / P. Seppälä		
Test No.:	**Test 2** **Ore Type :** **VE2 Feed (Lab)**	**Screen check :**	**Mergan BM product 44.8% -75 µm**

Remarks: Ore feed 5 kg, **Crushed to - 1.4 mm [P(80) = 602 µm] for Primary grinding to P(80) = 139 µm**
Cu Rougher-Scavenger Flotation
CuRCSC Regrinding in Lab Ball Mill, and 3-stage Recleaning Flotation for Cu Concentrate

All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	PAX	CMC FF-BDA	SEX	$Ca(OH)_2$	H_2SO_4	DF 507	SIPX	Dow 250	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu (XRF) Rec%	Fe (XRF) %	Fe (XRF) Rec%	SiO_2 (XRF) %	SiO_2 (XRF) Rec%	MgO (XRF) %	MgO (XRF) Rec%	Al_2O_3 (XRF) %	Al_2O_3 (XRF) Rec%	CaO (XRF) %	CaO (XRF) Rec%	S (Eltra) %	S (Eltra) Rec%	S (XRF) %	S (XRF) Rec%	Satmagan %	Satmagan Rec%
			Reagents (g / ton of Fresh Test Feed)																	Grades and Recoveries (XRF MP-10, Eltra S, and Satmagan)																	
Solution strengths :			5.0 %	1.0 %	5.0 %	100 %	50 %	1.0 %	5.0 %	100 %																											
Fresh Ore 5 kg																																					
- 1.4 mm	**15**																																				
		(Cu Rougher Flotation)					**Natural pH**				**7.0**		2500		**6.8**																						
		3	**50**					**25**																													
		2								**20**																											
												3		1.5	5.7	8	**CuRC**																				
															5.7		**CuRT**																				
CuRT		**(Cu Scavenger Flotation)**									**7.0**		2500																								
		3	**30**					**15**																													
		2								**20**																											
												3		1.5	5.7	8	**CuSC**																				
		Cu Rgh & Sca Flot'n products combined for regrinding & cleaning															**CuRCSC**	384.2	7.69	**1.10**	**92.9**	43.06	8.6	11.08	3.4	1.62	2.7	2.88	4.2	3.40	3.3	28.75	76.2	26.00	70.0	17.56	3.0
															5.7		**CuST**	4609.2	92.31	0.007	7.1	38.00	91.4	26.20	96.6	4.92	97.3	5.43	95.8	8.24	96.7	0.747	23.8	0.93	30.0	47.00	97.0
CuRCSC	**30**	**(Lab BM regrinding to end up at P(80) = 39 µm for Cu cleaner flotation)**																																			
		(Cu 1st Cleaning)					**Natural pH**				**2.5**		1500		**7.7**																						
						280									**11.4**																						
		5		**10**																																	
		3			**10**																																
		2								**10**					11.2																						
												3		1.5	10.4	9	**CuCC1**	175.7	3.52	2.29	88.5	40.05	3.7	6.43	0.9	0.84	0.6	1.74	1.2	1.98	0.9	42.33	51.3	36.91	45.4	3.47	0.3
															9.6		**CuCT1**	208.5	4.18	0.096	4.4	45.60	5.0	15.00	2.5	2.27	2.0	3.84	3.1	4.60	2.4	17.30	24.9	16.80	24.5	29.44	2.7
CuCC1		**(Cu 2nd Cleaning)**									**1.5**		1100		10.0																						
						125									**11.7**																						
												2		manual	11.1	10	**CuCC2**	102.8	2.06	3.72	84.3	39.09	2.1	4.32	0.4	0.59	0.3	1.16	0.5	1.40	0.4	45.54	32.3	38.91	28.0	1.40	0.1
															10.7		**CuCT2**	72.9	1.46	0.261	4.2	41.40	1.6	9.39	0.5	1.21	0.4	2.56	0.7	2.80	0.5	37.80	19.0	34.10	17.4	6.37	0.2
CuCC2		**(Cu 3rd Cleaning)**									**1.5**		1100		10.9																						
						145									**11.9**																						
							Copper Concentrate					**1.5**		manual	11.8	7	**CuCC3**	46.0	**0.92**	**7.91**	**80.2**	37.60	0.9	2.98	0.1	0.42	0.1	0.80	0.1	0.98	0.1	45.10	14.3	38.80	12.5	**0.73**	**0.0**
															11.8		**CuCT3**	56.8	1.14	0.328	4.1	40.30	1.2	5.41	0.2	0.72	0.2	1.45	0.3	1.74	0.3	45.90	18.0	39.00	15.5	1.95	0.0
						Note :	**All product Fe assays are Satmagan corrected**										**Calc. Feed**	4993.4	100.00	**0.091**	100.0	**38.39**	100.0	**25.04**	100.0	**4.67**	100.0	**5.23**	100.0	**7.87**	100.0	**2.90**	100.0	**2.86**	100.0	**44.73**	100.0
																	Feed Assays	(5000)		**0.091**		**38.70**		**24.90**		**4.62**		**5.15**		**7.86**		**3.12**		**3.14**		**44.33**	
Totals	**45**	**20**	**80**	**10**	**10**	**550**		**40**		**50**						**42**																					

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK Mintec

Sample:	**Hannukainen, VE2 Feed Type**	**Primary Grinding :**	**Mill:** Mergan BM
Project:	Rautajärvi (50401-10296)		**Charge:** 22.5 kg steel balls; 5 kg ore
Date:	**8.-11.9.2017**		**Water:** 5.0 liters
Author:	M. Kuusisto / P. Seppälä		
Test No.:	**Test 3** **Ore Type :** **VE2 Feed (Lab)**	**Screen check :**	**BM product 55.4% -75 µm**

Remarks: Ore feed 5 kg, **Crushed to - 1.4 mm [P(80) = 602 µm] for Primary grinding to P(80) = 109 µm**
Cu Rougher-Scavenger Flotation; CuRCSC Regrinding; 4-stage Cleaner Flotation for Copper Concentrate
Pyrite Rgh-Sca Flotation for the Cu Sca Tailing, followed by wet three-stage LIMS for the Pyrite Sca Flotation Tailing
Reverse Pyrrhotite Flotation for the LIMS Cleaned Magnetic Conc "WLC" in two stages, plus Dewatering LIMS
All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	Reagents (g / ton of Fresh Test Feed) PAX	CMC FF-BDA	SEX	$Ca(OH)_2$	H_2SO_4	AP 3418A	DF 507	SIBX	Dow 250	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu Rec%	Fe (XRF) %	Fe Rec%	SiO_2 (XRF) %	SiO_2 Rec%	MgO (XRF) %	MgO Rec%	Al_2O_3 (XRF) %	Al_2O_3 Rec%	CaO (XRF) %	CaO Rec%	S (Eltra) %	S (Eltra) Rec%	S (XRF) %	S (XRF) Rec%	Satmagan %	Satmagan Rec%
Solution strengths :			5.0 %	1.0 %	5.0 %	100 %	50 %	1.0 %	5.0 %	5.0 %	100 %																											
Fresh Ore 5 kg																																						
- 1.4 mm	25																																					
		(Cu Rougher Flotation)					**Natural pH**					**7.0**		2500		**7.0**																						
		3	**25**					**10**																														
		2									**20**																											
													3		1.5	5.7	8	**CuRC**																				
																5.7		**CuRT**																				
CuRT		**(Cu Scavenger Flotation)**										**7.0**		2500		5.9																						
		3	**10**					**5**																														
		2									**10**																											
													3		1.5	5.7	7	**CuSC**																				
		Cu Rgh & Sca Flot'n products combined for regrinding and cleaning																**CuRCSC**	246.4	4.94	1.72	93.2	41.00	5.1	12.31	2.5	1.76	2.1	3.28	3.4	3.90	2.3	30.15	47.8	28.30	47.0	11.86	1.3
																5.7		**CuST**	4737.0	95.06	0.006	6.8	39.60	94.9	24.48	97.5	4.16	97.9	4.83	96.6	8.57	97.7	1.71	52.2	1.66	53.0	48.37	98.7
CuRCSC	**30**	**(Lab BM regrinding to end up at P(80) ~ 39 µm for Cu cleaner flotation)**																																				
		(Cu 1st Cleaning)					**Natural pH**					**2.5**		1500		**8.0**																						
						265										**11.5**																						
		5		**20**																																		
		3			**10**																																	
		2									**10**					11.2																						
													3		1.5	10.8	8	**CuCC1**	110.2	2.21	3.35	81.6	41.50	2.3	5.89	0.5	0.85	0.5	1.60	0.7	2.06	0.5	42.32	30.0	38.79	28.8	3.55	0.2
																10.5		**CuCT1**	136.2	2.73	0.389	11.7	40.60	2.8	17.50	2.0	2.49	1.7	4.64	2.7	5.39	1.8	20.30	17.8	19.80	18.2	18.59	1.1
		(Cu 2nd Cleaning)										**1.5**		1100		9.8																						
						135										**11.8**																						
													2		manual	11.7	11	**CuCC2**	55.6	1.12	6.24	76.6	41.01	1.2	2.74	0.1	0.42	0.1	0.75	0.2	1.11	0.1	46.76	16.7	41.93	15.7	0.96	0.0
																11.6		**CuCT2**	54.6	1.10	0.413	5.0	42.00	1.2	9.10	0.4	1.29	0.3	2.47	0.6	3.04	0.4	37.80	13.3	35.60	13.1	6.18	0.1
		(Cu 3rd Cleaning)										**1.5**		1100		11.2																						
						100										**11.9**																						
													1.5		manual	11.8	7	**CuCC3**	27.3	0.55	12.11	72.9	38.52	0.5	2.17	0.0	0.37	0.0	0.56	0.1	1.05	0.1	43.71	7.7	39.46	7.3	0.70	0.0
																11.8		**CuCT3**	28.3	0.57	0.59	3.7	43.40	0.6	3.28	0.1	0.46	0.1	0.92	0.1	1.16	0.1	49.70	9.1	44.30	8.5	1.21	0.0
		(Cu 4th Cleaning)										**1.5**		1100		10.9																						
						115										**11.9**																						
							Copper Concentrate						**1.5**		manual	11.8	8	**CuCC4**	18.6	**0.37**	**16.50**	**67.6**	35.30	0.3	**1.93**	**0.0**	0.34	0.0	0.51	0.0	0.90	0.0	41.00	4.9	36.40	4.6	**0.69**	**0.0**
																11.8		**CuCT4**	8.7	0.17	2.75	5.3	45.40	0.2	2.68	0.0	0.43	0.0	0.68	0.0	1.37	0.0	49.50	2.8	46.00	2.7	0.73	0.0
CuST		**(Pyrite Rougher Flotation)**										**7.0**		2500		5.7																						
							x									**5.0**																						
		3					x			**100**																												
		2					x				**20**																											
							x						**3**		1.5	**5.0**	7	**PyrRC**																				
							325									5.0		**PyrRT**																				
PyrRT		**(Pyrite Scavenger Flotation)**										**7.0**		2500		5.0																						
							x									**4.0**																						
		3					x			**50**																												
		1					x				**20**																											
							x						**3**		1.5	**4.0**	7	**PyrSC**																				
							685																															
		Pyr Rgh & Sca Flot'n products combined																**PyrRCSC**	78.6	1.58	**0.097**	**1.7**	32.70	1.3	24.70	1.6	3.51	1.4	6.38	2.1	7.31	1.4	17.80	9.0	17.10	9.1	10.92	0.4
																4.0		**PyrST**	4658.4	93.48	0.005	5.1	39.72	93.6	24.48	95.8	4.17	96.5	4.81	94.5	8.59	96.3	1.44	43.2	1.40	43.9	49.00	98.4
PyrST		**(LIMS Roughing + two Cleanings)**											**Wet LIMS 1 to 3**					**WLC**	2584.8	51.87	0.002	1.0	63.98	83.7	6.57	14.3	1.36	17.4	1.39	15.2	1.93	12.0	1.25	20.8	1.08	18.8	87.75	97.8
		Pump speed "175", Flow restrictor Ø 4 mm, "Selectivity" setting																WLT	2073.5	41.61	0.009	4.1	9.47	9.9	46.80	81.6	7.68	79.0	9.06	79.3	16.90	84.3	1.68	22.4	1.80	25.2	0.69	0.6
WLC		**(Reverse Rougher Flotation of Pyrrhotite)**										**2.5**		1600		6.6																						
							x									**5.0**																						
		3					x		**100**	**200**																												
		2					x				**20**																											
							x						**3**		1.5	**5.0**	8	**PoRC**	136.6	2.74	0.025	0.8	58.60	4.0	4.87	0.6	0.84	0.6	1.16	0.7	1.39	0.5	21.50	18.9	18.60	17.1	45.40	2.7
							150									5.0		**PoRT**	2448.3	49.13	0.000	0.2	64.28	79.6	6.66	13.7	1.39	16.9	1.41	14.5	1.96	11.6	0.121	1.9	0.102	1.7	90.11	95.1
PoRT		**(Reverse Scavenger Flotation of Pyrrhotite)**										**2.5**		1600		5.0																						
							x									**4.0**																						
		3					x		**50**	**100**																												
		1					x				**20**																											
							x						**3**		1.5	**4.0**	8	**PoSC**	21.6	0.43	0.026	0.1	46.20	0.5	18.60	0.3	3.77	0.4	3.80	0.3	5.77	0.3	4.56	0.6	4.77	0.7	50.21	0.5
							165									4.0		**PoST**	2426.7	48.70	0.000	0.1	64.44	79.1	6.56	13.4	1.37	16.5	1.38	14.2	1.93	11.3	0.082	1.3	0.060	1.0	90.47	94.6
PoST		**(Final LIMS cleaning for the Reverse Flotation cell product;**											**Wet LIMS 4**					WLCT	29.1	0.58	0.006	0.0	10.00	0.1	47.40	1.2	8.58	1.2	8.32	1.0	17.50	1.2	0.223	0.0	0.330	0.1	3.79	0.0
		i.e. "Product dewatering LIMS treatment")																																				
													Magnetite Concentrate					**WLCC**	2397.6	**48.11**	**0.000**	**0.1**	**65.10**	**79.0**	**6.06**	**12.2**	1.28	15.2	1.30	13.2	1.74	10.0	**0.080**	**1.2**	0.057	0.9	**91.52**	**94.6**
		Combined Sulphur Bulk Product (= Pyrite & Pyrrhotite Concentrates)																**SBulkConc**	236.8	**4.75**	0.049	2.6	48.87	5.9	12.71	2.5	1.99	2.3	3.13	3.1	3.76	2.1	**18.73**	**28.5**	16.84	26.9	34.39	3.5
						Note :	**All product Fe assays are Satmagan corrected**											**Calc. Feed**	4983.4	100.00	**0.091**	100.0	**39.67**	100.0	**23.88**	100.0	**4.04**	100.0	**4.75**	100.0	**8.34**	100.0	**3.12**	100.0	**2.98**	100.0	**46.56**	100.0
																		Feed Assays	(5000)		**0.091**		**38.70**		**24.90**		**4.62**		**5.15**		**7.86**		**3.12**		**3.14**		**44.33**	
Totals	**55**	**38**	**35**	**20**	**10**	**615**	**1325**	**15**	**150**	**450**	**120**						**79**																					

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK Mintec

Sample:	Hannukainen, VE2, Pilot Derrick U/S	**Primary Grinding :**	**Mill:** Pilot RM & BM
Project:	Rautajärvi (50401-10296)		**Charge:**
Date:	13.-14.9.2017		**Water:**
Author:	M. Kuusisto / P. Seppälä		
Test No.:	Test 4 — **Ore Type :** VE2 Feed (Pilot)	**Screen check :**	Derrick Screen Mesh # 215 microns

Remarks: Derrick U/S product (without chemicals !) for lab concentration testing
Cu Rougher-Scavenger Flotation; CuRCSC Regrinding; 3-stage Cleaner Flotation for Copper Concentrate
Pyrite Rgh-Sca Flotation for the Cu Sca Tailing, followed by wet three-stage LIMS for the Pyrite Sca Flotation Tailing
Reverse Pyrrhotite Flotation for the LIMS Cleaned Magnetic Conc "WLC" in two stages, plus Dewatering LIMS
All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	PAX	CMC FF-BDA	SEX	$Ca(OH)_2$	H_2SO_4	AP 3418A	DF 507	SIBX	Dow 250	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu (XRF) Rec%	Fe (XRF) %	Fe (XRF) Rec%	SiO_2 (XRF) %	SiO_2 (XRF) Rec%	MgO (XRF) %	MgO (XRF) Rec%	Al_2O_3 (XRF) %	Al_2O_3 (XRF) Rec%	CaO (XRF) %	CaO (XRF) Rec%	S (Eltra) %	S (Eltra) Rec%	S (XRF) %	S (XRF) Rec%	Satmagan %	Satmagan Rec%
			Reagents (g / ton of Fresh Test Feed)																Grades and Recoveries (XRF MP-10, Eltra S, and Satmagan)																			
Solution strengths :			5.0 %	1.0 %	5.0 %	100 %	50 %	1.0 %	5.0 %	5.0 %	100 %																											
Derrick U/S slurry from the pilot test work																																						
		(Cu Rougher Flotation)					Natural pH					15.0		2500		5.8		Notes :	Too low natural pH level, causing pyrite to float together with chalcopyrite !!																			
		3	17					7	7																													
		2									13.5								Pulp density strongly decreased for chalcopyrite and pyrite flotations !																			
													8		1.5	5.8	2																					
		2									13.5																											
													8		1.5	5.8	12	CuRC																				
																5.9		CuRT																				
CuRT		(Cu Scavenger Flotation)										15.0		2500		5.9																						
		3	7					3.5	3.5																													
		2									13.5																											
													8		1.5	5.0	6	CuSC																				
		Cu Rgh & Sca Flot'n products combined for regrinding and cleaning																CuRCSC	276.6	7.06	1.61	88.9	42.45	8.6	10.80	2.8	1.44	2.4	2.85	3.6	3.39	2.6	32.02	57.0	29.41	53.8	11.89	2.2
																5.0		CuST	3639.0	92.94	0.015	11.1	34.12	91.4	28.57	97.2	4.42	97.6	5.87	96.4	9.71	97.4	1.83	43.0	1.92	46.2	39.95	97.8
CuRCSC	30	(Lab BM regrinding for Cu cleaner flotation)																																				
		(Cu 1st Cleaning)					Natural pH					2.5		1500		7.5																						
						315										11.6																						
		5		13.5																																		
		3			13.5											11.5																						
		2									7					11.2																						
													3		1.5	10.8	11	CuCC1	100.9	2.58	3.35	67.5	41.50	3.1	4.18	0.4	0.56	0.3	1.11	0.5	1.48	0.4	44.60	29.0	40.04	26.7	2.63	0.2
																9.6		CuCT1	175.7	4.49	0.61	21.4	43.00	5.6	14.60	2.4	1.94	2.1	3.85	3.1	4.48	2.2	24.80	28.1	23.30	27.1	17.20	2.0
		(Cu 2nd Cleaning)										1.5		1100		6.9																						
						150										11.8																						
													1.5		manual	11.6	10	CuCC2	39.3	1.00	7.45	58.4	39.61	1.1	1.32	0.0	0.19	0.0	0.37	0.1	0.66	0.1	47.58	12.0	41.51	10.8	0.62	0.0
																11.5		CuCT2	61.6	1.57	0.74	9.1	42.70	1.9	6.01	0.3	0.80	0.3	1.59	0.4	2.01	0.3	42.70	16.9	39.10	15.9	3.92	0.2
		(Cu 3rd Cleaning)										1.5		1100		10.4																						
						170										11.9																						
							Copper Concentrate						1.5		manual	11.8	8	CuCC3	15.5	0.40	16.50	51.0	34.40	0.4	1.00	0.0	0.13	0.0	0.27	0.0	0.483	0.0	43.70	4.4	36.30	3.7	0.54	0.0
																11.8		CuCT3	23.8	0.61	1.56	7.4	43.00	0.8	1.53	0.0	0.23	0.0	0.43	0.0	0.77	0.1	50.10	7.7	44.90	7.1	0.67	0.0
CuST		(Pyrite Rougher Flotation)										15.0		2500		5.7																						
							x									5.0																						
		3					x			102																												
		2					x				27																											
							x						8		1.5	5.0	7	PyrRC																				
							50									5.0		PyrRT																				
PyrRT		(Pyrite Scavenger Flotation)										15.0		2500		5.0																						
							x									4.0																						
		3					x			51																												
		1					x				27																											
							x						8		1.5	4.0	7	PyrSC																				
							645																															
		Pyr Rgh & Sca Flot'n products combined																PyrRCSC	92.1	2.35	0.149	2.7	34.00	2.3	22.60	1.9	2.80	1.6	5.97	2.5	6.47	1.6	21.60	12.8	21.00	12.8	9.75	0.6
																4.0		PyrST	3546.8	90.58	0.012	8.4	34.13	89.1	28.72	95.3	4.46	96.0	5.87	94.0	9.79	95.8	1.32	30.2	1.42	33.4	40.73	97.2
PyrST		(LIMS Roughing + two Cleanings)											Wet LIMS 1 to 3					WLC	1628.7	41.59	0.002	0.7	63.47	76.1	7.07	10.8	1.45	14.3	1.44	10.6	2.13	9.6	0.84	8.8	0.79	8.5	87.97	96.4
		Pump speed "175", Flow restrictor Ø 4 mm, "Selectivity" setting																WLT	1918.2	48.99	0.020	7.7	9.21	13.0	47.10	84.5	7.02	81.7	9.63	83.4	16.30	86.2	1.73	21.4	1.96	24.9	0.62	0.8
WLC		(Reverse Rougher Flotation of Pyrrhotite)										2.5		1600		6.5																						
							x									5.0																						
		3					x		67	135																												
		2					x				13.5																											
							x						3		1.5	5.0	1																					
		1					x				13.5																											
							x						3		1.5	5.0	9	PoRC	69.7	1.78	0.042	0.6	55.10	2.8	7.95	0.5	1.46	0.6	1.74	0.5	2.45	0.5	18.40	8.3	17.30	8.0	43.02	2.0
							145									5.0		PoRT	1559.0	39.81	0.000	0.1	63.85	73.2	7.03	10.3	1.45	13.7	1.42	10.0	2.12	9.1	0.054	0.5	0.053	0.5	89.98	94.4
PoRT		(Reverse Scavenger Flotation of Pyrrhotite)										2.5		1600		5.0																						
							x									4.0																						
		3					x		34	67																												
		1					x				27																											
							x						3		1.5	4.0	10	PoSC	13.2	0.34	0.031	0.1	48.20	0.5	18.20	0.2	3.47	0.3	3.96	0.2	5.51	0.2	1.39	0.1	1.51	0.1	58.49	0.5
							160									4.0		PoST	1545.8	39.48	0.000	0.1	63.98	72.8	6.94	10.0	1.43	13.4	1.40	9.8	2.09	8.9	0.042	0.4	0.040	0.4	90.25	93.8
PoST		(Final LIMS cleaning for the Reverse Flotation cell product;											Wet LIMS 4					WLCT	20.3	0.52	0.009	0.0	9.97	0.1	47.40	0.9	8.49	1.0	8.38	0.8	17.60	1.0	0.244	0.0	0.288	0.0	4.56	0.1
		i.e. "Product dewatering LIMS treatment")																																				
													Magnetite Concentrate					WLCC	1525.5	38.96	0.000	0.0	64.70	72.6	6.40	9.1	1.34	12.4	1.31	9.0	1.88	7.9	0.040	0.4	0.037	0.4	91.39	93.8
		Combined Sulphur Bulk Product (= Pyrite & Pyrrhotite Concentrates)																SBulkConc	175.0	4.47	0.098	3.4	43.47	5.6	16.43	2.7	2.32	2.5	4.13	3.3	4.80	2.3	18.81	21.2	18.06	20.9	26.67	3.1
						Note :	All product Fe assays are Satmagan corrected											Calc. Feed	3915.6	100.00	0.128	100.0	34.71	100.0	27.31	100.0	4.21	100.0	5.66	100.0	9.26	100.0	3.97	100.0	3.86	100.0	37.96	100.0
																		Feed Assays			0.138		30.90		30.70		4.91		6.74		9.56		3.68		4.00		30.57	
Totals	30	41	24	14	14	635	1000	10.5	111.5	355	155.5						83																					

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK Mintec

Sample:	Hannukainen, VE2, Pilot Flot'n Feed	Primary Grinding :	Mill: Pilot RM & BM
Project:	Rautajärvi (50401-10296)		Charge:
Date:	14.-15.9.2017		Water:
Author:	M. Kuusisto / P. Seppälä		
Test No.:	Test 5	Ore Type :	VE2 Feed (Pilot)
Screen check :	Derrick Screen Mesh # 215 microns		

Remarks: Flotation Feed after Conditioning (containing chemicals !) for lab concentration testing
Cu Rougher-Scavenger Flotation; CuRCSC Regrinding; 4-stage Cleaner Flotation for Copper Concentrate
Pyrite Rgh-Sca Flotation for the Cu Sca Tailing, followed by wet three-stage LIMS for the Pyrite Sca Flotation Tailing
Reverse Pyrrhotite Flotation for the LIMS Cleaned Magnetic Conc "WLC" in two stages, plus Dewatering LIMS
All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	PAX	CMC FF-BDA	SEX	$Ca(OH)_2$	H_2SO_4	AP 3418A	DF 507	SIBX	Dow 250	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu (XRF) Rec%	Fe (XRF) %	Fe (XRF) Rec%	SiO_2 (XRF) %	SiO_2 (XRF) Rec%	MgO (XRF) %	MgO (XRF) Rec%	Al_2O_3 (XRF) %	Al_2O_3 (XRF) Rec%	CaO (XRF) %	CaO (XRF) Rec%	S (Eltra) %	S (Eltra) Rec%	S (XRF) %	S (XRF) Rec%	Satmagan %	Satmagan Rec%
			Reagents (g / ton of Fresh Test Feed)																		Grades and Recoveries (XRF MP-10, Eltra S, and Satmagan)																	
Solution strengths :			5.0 %	1.0 %	5.0 %	100 %	50 %	1.0 %	5.0 %	5.0 %	100 %																											
Flotation Feed slurry from the pilot test work (after Conditioning, thus including reagents)																																						
		(Cu Rougher Flotation)					Natural pH					15.0		2500		5.8																						
						920										8.0		Notes :	pH raise to slightly alkaline, in order to prevent flotation of pyrite along with chalcopyrite within Cu flotation !																			
		3	21					10.5	10.5							7.8			Pulp density strongly decreased for chalcopyrite and pyrite flotations !																			
		2									21					7.6																						
													8		1.5	7.3	8	CuRC																				
																7.0		CuRT																				
CuRT		(Cu Scavenger Flotation)										15.0		2500		7.0																						
						140										8.0																						
		3	10.5					5.25	7							7.9																						
		2									21					7.8																						
													8		1.5	7.8	8	CuSC																				
		Cu Rgh & Sca Flot'n products combined for regrinding and cleaning																CuRCSC	319.8	9.06	1.30	90.6	41.38	11.7	11.23	3.5	1.47	3.0	2.98	4.3	3.57	3.3	30.92	70.6	28.36	69.1	12.57	3.4
																7.8		CuST	3208.6	90.94	0.013	9.4	31.16	88.3	31.20	96.5	4.68	97.0	6.63	95.7	10.38	96.7	1.28	29.4	1.26	30.9	35.70	96.6
CuRCSC	30					280													(Lab BM regrinding for Cu cleaner flotation; 1 gram slaked lime added into the mill)																			
		(Cu 1st Cleaning)					Starting pH					2.5		1500		9.6																						
						250										11.6																						
		5		21																																		
		3			21											11.4																						
		2									10.5					11.2																						
													3		1.5	11.0	8	CuCC1	196.1	5.56	2.05	87.9	42.69	7.4	5.50	1.0	0.69	0.9	1.51	1.3	1.85	1.1	40.23	56.3	36.61	54.7	6.56	1.1
																10.6		CuCT1	123.7	3.51	0.102	2.8	39.30	4.3	20.30	2.4	2.70	2.2	5.31	3.0	6.30	2.3	16.17	14.3	15.30	14.4	22.11	2.3
		(Cu 2nd Cleaning)										1.5		1100		10.5																						
						190										11.8																						
													1.5		manual	11.5	10	CuCC2	124.4	3.52	3.04	82.8	41.65	4.6	2.95	0.4	0.37	0.3	0.83	0.5	1.07	0.4	45.51	40.4	40.65	38.5	2.76	0.3
																11.2		CuCT2	71.7	2.03	0.323	5.1	44.50	2.8	9.92	0.7	1.25	0.6	2.68	0.9	3.19	0.7	31.08	15.9	29.60	16.2	13.14	0.8
		(Cu 3rd Cleaning)										1.5		1100		11.2																						
						160										11.9																						
													1.5		manual	11.8	13	CuCC3	57.2	1.62	5.91	74.0	40.30	2.0	1.40	0.1	0.20	0.1	0.40	0.1	0.64	0.1	47.70	19.5	41.88	18.2	1.18	0.1
																11.7		CuCT3	67.2	1.90	0.60	8.8	42.80	2.5	4.27	0.3	0.52	0.2	1.20	0.4	1.44	0.3	43.65	20.9	39.60	20.3	4.10	0.2
		(Cu 4th Cleaning)										1.5		1100		11.0																						
						195										12.0																						
							Copper Concentrate						1.5		manual	11.9	6	CuCC4	34.3	0.97	9.25	69.4	38.10	1.2	0.88	0.0	0.12	0.0	0.25	0.0	0.326	0.0	46.92	11.5	40.60	10.6	0.67	0.0
																11.9		CuCT4	22.9	0.65	0.91	4.6	43.60	0.9	2.18	0.0	0.32	0.0	0.62	0.1	1.10	0.1	48.86	8.0	43.80	7.6	1.95	0.0
CuST		(Pyrite Rougher Flotation)										15.0		2500		7.3																						
							x									5.0																						
		3					x			158																												
		2					x				42.5																											
							x						8		1.5	5.0	7	PyrRC																				
							720									5.0		PyrRT																				
PyrRT		(Pyrite Scavenger Flotation)										15.0		2500		5.0																						
							x									4.0																						
		3					x			79																												
		1					x				21																											
							x						8		1.5	4.0	8	PyrSC																				
							675																															
		Pyr Rgh & Sca Flot'n products combined																PyrRCSC	159.8	4.53	0.090	3.1	32.40	4.6	25.70	4.0	3.34	3.4	6.53	4.7	7.61	3.5	17.54	20.0	15.80	19.2	12.70	1.7
																4.0		PyrST	3048.9	86.41	0.009	6.2	31.09	83.7	31.49	92.6	4.75	93.5	6.63	91.0	10.52	93.2	0.43	9.4	0.50	11.6	36.90	94.9
PyrST		(LIMS Roughing + two Cleanings)											Wet LIMS 1 to 3					WLC	1294.0	36.67	0.003	0.8	62.01	70.9	8.29	10.3	1.71	14.2	1.80	10.5	2.41	9.1	0.36	3.3	0.311	3.1	86.16	94.0
		Pump speed "175", Flow restrictor Ø 4 mm, "Selectivity" setting																WLT	1754.9	49.74	0.014	5.4	8.30	12.9	48.60	82.2	7.00	79.3	10.20	80.6	16.50	84.1	0.490	6.1	0.64	8.6	0.58	0.9
WLC		(Reverse Rougher Flotation of Pyrrhotite)										2.5		1600		6.9																						
							x							1700		5.0			Shear Conditioning at very high solids and using higher rotor speed, trying to get good dispersion between pyrrhotite and magnetite !																			
		3					x		105	211																												
		2					x				21																											
							x						3	1600	1.5	5.0	1		Froth bed found to be very thin ! ==> Frother dosage doubled.																			
		1					x				21																											
							x						3	1600	1.5	5.0	7	PoRC	25.0	0.71	0.035	0.2	50.70	1.1	12.40	0.3	2.38	0.4	2.63	0.3	3.96	0.3	15.55	2.8	13.60	2.6	42.97	0.9
							175									5.0		PoRT	1269.0	35.96	0.002	0.7	62.23	69.8	8.21	10.0	1.69	13.9	1.78	10.2	2.38	8.8	0.056	0.5	0.048	0.5	87.01	93.1
PoRT		(Reverse Scavenger Flotation of Pyrrhotite)										2.5		1600		5.0																						
							x									4.0																						
		3					x		52.5	105																												
		1					x				42								Frother dosage doubled																			
							x						3		1.5	4.0	7	PoSC	13.1	0.37	0.031	0.1	46.30	0.5	19.60	0.2	3.81	0.3	4.16	0.2	6.18	0.2	1.09	0.1	1.08	0.1	56.77	0.6
							175									4.0		PoST	1255.9	35.59	0.002	0.6	62.39	69.2	8.09	9.8	1.67	13.5	1.76	9.9	2.34	8.5	0.045	0.4	0.038	0.4	87.33	92.5
PoST		(Final LIMS cleaning for the Reverse Flotation cell product;											Wet LIMS 4					WLCT	16.6	0.47	0.007	0.0	9.82	0.1	46.80	0.8	8.41	0.9	8.12	0.6	17.50	0.8	0.340	0.0	0.309	0.0	4.59	0.1
		i.e. "Product dewatering LIMS treatment")																																				
													Magnetite Concentrate					WLCC	1239.3	35.12	0.002	0.5	63.10	69.1	7.57	9.0	1.58	12.6	1.67	9.3	2.14	7.7	0.041	0.4	0.034	0.3	88.44	92.4
		Combined Sulphur Bulk Product (= Pyrite & Pyrrhotite Concentrates)																SBulkConc	197.9	5.61	0.079	3.4	35.63	6.2	23.61	4.5	3.25	4.1	5.88	5.2	7.05	4.1	16.20	22.9	14.55	21.9	19.44	3.2
						Note :	All product Fe assays are Satmagan corrected											Calc. Feed	3528.4	100.00	0.130	100.0	32.09	100.0	29.39	100.0	4.39	100.0	6.30	100.0	9.76	100.0	3.97	100.0	3.72	100.0	33.60	100.0
																		Feed Assays			0.138		30.90		30.70		4.91		6.74		9.56		3.68		4.00		30.57	
Totals	30	39	32	21	21	2135	1745	15.8	175.0	553	200.0						83																					

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK Mintec

Sample:	**Hannukainen, VE2, Pyrite ClnConc1**	**Primary Grinding :**	**Mill:** Pilot RM & BM
Project:	Rautajärvi (50401-10296)		**Charge:**
Date:	**20.9.2017**		**Water:**
Author:	M. Kuusisto / P. Seppälä		
Test No.:	**Test 6** **Ore Type :** **VE2 Feed (Pilot)**	**Screen check :**	

Remarks:

2-Stage Cleaner Flotation for the Pyrite ClnConc1
Sample slurry taken from the pilot test work Sept. 20th 2017 around 10:00AM

All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	PAX	CMC FF-BDA	SEX	$Ca(OH)_2$	H_2SO_4	AP 3418A	DF 507	SIBX	Dow 250	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu (XRF) Rec%	Fe (XRF) %	Fe (XRF) Rec%	SiO_2 (XRF) %	SiO_2 (XRF) Rec%	MgO (XRF) %	MgO (XRF) Rec%	Al_2O_3 (XRF) %	Al_2O_3 (XRF) Rec%	CaO (XRF) %	CaO (XRF) Rec%	S (Eltra) %	S (Eltra) Rec%	S (XRF) %	S (XRF) Rec%	Satmagan %	Satmagan Rec%
			Reagents (g / ton of Fresh Test Feed)																		**Grades and Recoveries (XRF MP-10, Eltra S, and Satmagan)**																	
Solution strengths :			**5.0 %**	**1.0 %**	**5.0 %**	**100 %**	**50 %**	**1.0 %**	**5.0 %**	**5.0 %**	**100 %**																											
Pyrite ClnConc1 slurry from the pilot test work																		**PyrCC1**	1601.8	100.00	1.64	100.0	45.18	100.0	0.95	100.0	0.09	100.0	0.29	100.0	0.151	100.0	51.21	100.0	44.52	100.0		#DIV/0!
PyrCC1		**(Pyrite 2nd Cleaning)**					**Starting pH**					**4.0**		1600		**5.3**																						
							x									**4.0**																						
							x						**3**		1.5	4.0	8	**PyrCC2**	1394.1	87.04	1.65	87.5	44.52	85.8	0.68	62.4	0.06	60.8	0.21	62.1	0.090	51.8	52.78	89.7	45.81	89.6		#DIV/0!
							370									4.0		**PyrCT2**	207.6	12.96	1.58	12.5	49.60	14.2	2.77	37.6	0.27	39.2	0.86	37.9	0.56	48.2	40.70	10.3	35.80	10.4		#DIV/0!
PyrCC2		**(Pyrite 3rd Cleaning)**					**Starting pH**					**4.0**		1600		4.5																						
							x									**4.0**																						
							x	**Pyrite Cleaner Concentrate**					**3**		1.5	4.0	8	**PyrCC3**	1145.4	**71.50**	1.47	64.0	44.20	70.0	0.53	39.7	0.05	40.0	0.16	38.9	0.061	28.9	**53.60**	**74.8**	46.60	74.9		#DIV/0!
							135									4.0		**PyrCT3**	248.8	15.53	2.48	23.5	46.00	15.8	1.39	22.6	0.12	20.9	0.44	23.2	0.222	22.9	49.00	14.9	42.20	14.7		#DIV/0!
																		Calc. Feed	1601.8	100.00	**1.64**	100.0	**45.18**	100.0	**0.95**	100.0	**0.09**	100.0	**0.29**	100.0	**0.151**	100.0	**51.21**	100.0	**44.52**	100.0		#DIV/0!
														Sept. 20th at 6.30-8.30AM				Feed Assays			**1.72**		**45.10**		**0.92**		**0.09**		**0.28**		**0.147**		**47.90**		**44.40**		**3.48**	
														Sept. 20th at 8.30-10.30AM				Feed Assays			**2.25**		**45.20**		**0.97**		**0.09**		**0.31**		**0.162**		**49.00**		**44.30**		**0.56**	
Totals							**505**										**16**																					

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK Mintec

Sample:	**Hannukainen, VE2, Pyrite RghTails**	**Primary Grinding :**	**Mill:** Pilot RM & BM
Project:	Rautajärvi (50401-10296)		**Charge:**
Date:	**20.9.2017**		**Water:**
Author:	M. Kuusisto / P. Seppälä		
Test No.:	**Test 7** **Ore Type :** **VE2 Feed (Pilot)**	**Screen check :**	

Remarks:

Scavenger Flotation for the Pyrite Rougher Tails
Sample slurry taken from the pilot test work Sept. 20th 2017 around 2:00PM

All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	PAX	CMC FF-BDA	SEX	$Ca(OH)_2$	H_2SO_4	AP 3418A	DF 507	SIBX	Dow 250	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu (XRF) Rec%	Fe (XRF) %	Fe (XRF) Rec%	SiO_2 (XRF) %	SiO_2 (XRF) Rec%	MgO (XRF) %	MgO (XRF) Rec%	Al_2O_3 (XRF) %	Al_2O_3 (XRF) Rec%	CaO (XRF) %	CaO (XRF) Rec%	S (Eltra) %	S (Eltra) Rec%	S (XRF) %	S (XRF) Rec%	Satmagan %	Satmagan Rec%
			Reagents (g / ton of Fresh Test Feed)																		**Grades and Recoveries (XRF MP-10, Eltra S, and Satmagan)**																	
Solution strengths :			**5.0 %**	**1.0 %**	**5.0 %**	**100 %**	**50 %**	**1.0 %**	**5.0 %**	**5.0 %**	**100 %**																											
Pyrite RghTails slurry from the pilot test work																		**PyrRT**	683.1	100.00	0.028	100.0	30.13	100.0	31.08	100.0	4.98	100.0	6.83	100.0	9.55	100.0	2.48	100.0	2.49	100.0		#DIV/0!
PyrRT		**(Pyrite Scavenging)**					**Starting pH**					**4.0**		1600		5.2																						
							x									**4.0**		**Notes :**	**No foaming after the first frother dosage**																			
		1					x				**72.5**					4.0			**==> Collector and more frother added**																			
		2					x			**218**						4.0			**Froth bed very thin !!**																			
		1					x				**72.5**					4.0																						
							x						**3**		1.5	4.0	8	**PyrSCC**	34.8	5.10	0.219	39.5	39.90	6.8	17.70	2.9	2.31	2.4	4.57	3.4	5.02	2.7	24.00	49.4	21.50	44.0		#DIV/0!
							1335	**Pyrite Scavenger Tailing**								4.0		**PyrSCT**	648.2	**94.90**	0.018	60.5	29.60	93.2	31.80	97.1	5.12	97.6	6.95	96.6	9.79	97.3	**1.32**	50.6	1.47	56.0		#DIV/0!
																		Calc. Feed	683.1	100.00	**0.028**	100.0	**30.13**	100.0	**31.08**	100.0	**4.98**	100.0	**6.83**	100.0	**9.55**	100.0	**2.48**	100.0	**2.49**	100.0		#DIV/0!
														Sept. 20th at 6.40AM				Feed Assays			**0.023**		**30.50**		**31.70**		**5.02**		**6.94**		**9.87**		**2.08**		**2.46**		**33.58**	
Totals		**4**					**1335**			**218**	**145**						**8**																						

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK
Mintec

Sample:	Hannukainen, VE2, Pyrite RghTails	Primary Grinding :	Mill: Pilot RM & BM
Project:	Rautajärvi (50401-10296)		Charge:
Date:	20.9.2017		Water:
Author:	M. Kuusisto / P. Seppälä		
Test No.:	Test 8 — Ore Type : VE2 Feed (Pilot)	Screen check :	

Remarks:
Scavenger Flotation for the Pyrite Rougher Tails
Sample slurry taken from the pilot test work Sept. 20th 2017 around 2:00PM
All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	PAX	CMC FF-BDA	SEX	$Ca(OH)_2$	H_2SO_4	AP 3418A	DF 507	SIBX	Dow 250	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu Rec%	Fe (XRF) %	Fe Rec%	SiO_2 (XRF) %	SiO_2 Rec%	MgO (XRF) %	MgO Rec%	Al_2O_3 (XRF) %	Al_2O_3 Rec%	CaO (XRF) %	CaO Rec%	S (Eltra) %	S Rec%	S (XRF) %	S Rec%	Satmagan %	Satmagan Rec%
			Reagents (g / ton of Fresh Test Feed)																		Grades and Recoveries (XRF MP-10, Eltra S, and Satmagan)																	
Solution strengths :			5.0 %	1.0 %	5.0 %	100 %	50 %	1.0 %	5.0 %	5.0 %	100 %																											
Pyrite RghTails slurry from the pilot test work																		PyrRT	890.5	100.00	0.028	100.0	30.73	100.0	30.73	100.0	4.93	100.0	6.81	100.0	9.31	100.0	2.57	100.0	2.38	100.0		#DIV/0!
PyrRT		(Pyrite Scavenging)					Starting pH					4.0		1600		5.5																						
							x									4.0		Notes :	Pretty poor foaming																			
		2	278				x									4.0			Froth bed very thin !!																			
		1					x				111					4.0																						
							x						3		1.5	4.0	8	PyrSCC	56.0	6.28	0.170	38.8	40.20	8.2	17.70	3.6	2.36	3.0	4.50	4.1	5.140	3.5	22.20	54.4	20.90	55.1		#DIV/0!
							1185	Pyrite Scavenger Tailing								4.0		PyrSCT	834.6	93.72	0.018	61.2	30.10	91.8	31.60	96.4	5.10	97.0	6.97	95.9	9.59	96.5	1.25	45.6	1.14	44.9		#DIV/0!
																		Calc. Feed	890.5	100.00	0.028	100.0	30.73	100.0	30.73	100.0	4.93	100.0	6.81	100.0	9.31	100.0	2.57	100.0	2.38	100.0		#DIV/0!
														Sept. 20th at 6.40AM				Feed Assays			0.023		30.50		31.70		5.02		6.94		9.87		2.08		2.46		33.58	
Totals		3	278				1185				111						8																					

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK
Mintec

Sample:	**Hannukainen, VE2, CuRghTails "CuEJ3"**	**Primary Grinding :**	**Mill:** Pilot RM & BM
Project:	Rautajärvi (50401-10296)		**Charge:**
Date:	**26.9.2017**		**Water:**
Author:	M. Kuusisto / P. Seppälä		
Test No.:	**Test 9**	**Ore Type :** **VE2 Feed (Pilot)**	**Screen check :**

Remarks:
3-Stage Wet LIMS for the CuRghTails "CuEJ3"
4-Stage Pyrite Rougher Flotation for the WLIMS Non-Mags Tails
CuRT3 Sample slurry taken from the pilot test work Sept. 26th 2017
All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	Reagents (g / ton of Fresh Test Feed)				H_2SO_4			SIBX	Dow 250	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu (XRF) Rec%	Fe (XRF) %	Fe (XRF) Rec%	SiO_2 (XRF) %	SiO_2 (XRF) Rec%	MgO (XRF) %	MgO (XRF) Rec%	Al_2O_3 (XRF) %	Al_2O_3 (XRF) Rec%	CaO (XRF) %	CaO (XRF) Rec%	S (Eltra) %	S (Eltra) Rec%	S (XRF) %	S (XRF) Rec%	Satmagan %	Satmagan Rec%
Solution strengths :							**50 %**			**5.0 %**	**100 %**																										
CuRghTails slurry ("CuEJ3") from the pilot test work																																					
CuRT3		**(LIMS Roughing + two Cleanings)**											**Wet LIMS 1 to 3**					WLC	1095.1	34.71	0.007	10.9	60.40	77.7	8.91	9.1	1.79	12.6	1.94	9.2	2.61	8.0	2.18	37.2	2.19	35.8	79.75	98.5
		Pump speed "175", Flow restrictor Ø 4 mm, "Selectivity" setting																**WLT**	2059.9	65.29	0.030	89.1	9.22	22.3	47.05	90.9	6.60	87.4	10.15	90.8	15.85	92.0	1.96	62.8	2.09	64.2	0.63	1.5
WLT		**(Pyrite Rougher-1)**					**Starting pH**					**4.0**		1750		**5.3**																					
							x									**5.0**																					
		3					x			**50**						5.0																					
		2					x				**20**					5.0																					
							x						**3**		1.5	5.0	6	**PyrRC1**	58.3	1.85	0.380	31.6	21.50	1.5	33.20	1.8	4.15	1.6	8.37	2.1	10.10	1.7	16.10	14.6	14.80	12.9	0.73	0.0
							140									5.0		**PyrRT1**	2001.6	63.44	0.020	57.4	8.86	20.8	47.45	89.0	6.67	85.8	10.20	88.7	16.02	90.3	1.55	48.2	1.72	51.3	0.63	1.4
PyrRT1		**(Pyrite Rougher-2)**										**4.0**		1750		5.0																					
							x									**4.0**																					
		3					x			**50**						4.0																					
		1					x				**20**					4.0																					
							x						**3**		1.5	4.0	7	**PyrRC2**	77.6	2.46	0.112	12.4	18.80	1.7	35.70	2.6	4.41	2.2	8.90	3.0	10.80	2.4	11.00	13.3	11.40	13.2	0.67	0.1
							495									4.0		**PyrRT2**	1924.0	60.98	0.016	45.0	8.46	19.1	47.93	86.4	6.76	83.6	10.25	85.7	16.23	87.9	1.17	34.9	1.33	38.1	0.62	1.4
PyrRT2		**(Pyrite Rougher-3)**										**4.0**		1750		4.0																					
							x									**4.0**																					
		3					x			**50**						4.0																					
		1					x				**20**					4.0																					
							x						**3**		1.5	4.0	5	**PyrRC3**	45.0	1.43	0.090	5.8	16.70	0.9	38.00	1.6	4.69	1.4	9.46	1.8	11.50	1.5	8.61	6.0	8.55	5.7	0.72	0.0
							130									4.0		**PyrRT3**	1879.0	59.56	0.015	39.2	8.26	18.2	48.16	84.8	6.81	82.3	10.27	83.8	16.34	86.5	0.99	28.9	1.15	32.3	0.62	1.3
PyrRT3		**(Pyrite Rougher-4)**										**4.0**		1750		4.0																					
							x									**4.0**																					
		3					x			**50**						4.0																					
		1					x				**20**					4.0																					
							x						**3**		1.5	4.0	6	**PyrRC4**	58.9	1.87	0.065	5.5	16.70	1.2	37.80	2.1	4.69	1.8	9.33	2.4	11.50	1.9	9.57	8.8	8.95	7.9	0.69	0.0
							110									4.0		PyrRT4	1820.1	57.69	0.013	33.8	7.99	17.1	48.50	82.8	6.88	80.5	10.30	81.4	16.50	84.6	0.71	20.1	0.90	24.5	0.62	1.3
								Combined Pyrite Rougher Concentrate										**PyrRC1...4**	239.8	**7.60**	0.161	55.3	18.55	5.2	36.04	8.1	4.47	6.9	8.98	9.4	10.93	7.4	11.44	42.7	11.09	39.7	0.70	0.2
																		Calc. Feed	3155.0	100.00	**0.022**	100.0	**26.98**	100.0	**33.81**	100.0	**4.93**	100.0	**7.30**	100.0	**11.26**	100.0	**2.04**	100.0	**2.12**	100.0	**28.09**	100.0
														Sept. 26th at 10.40AM				Feed Assays	'CuEJ3'		**0.018**		**30.30**		**31.90**		**5.16**		**6.92**		**9.96**		**2.19**		**2.19**		**32.91**	
Totals		**17**					**875**			**200**	**80**						**24**																					

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK Mintec

Sample:	**Hannukainen, VE2, CuRghTails**	**Primary Grinding :**	**Mill:** Pilot RM & BM
Project:	Rautajärvi (50401-10296)		**Charge:**
Date:	**27.9.2017**		**Water:**
Author:	P. Seppälä / A. Kirpala		
Test No.:	**Test 10**	**Ore Type :**	**VE2 Feed (Pilot)**
		Screen check :	

Remarks: **No Wet LIMS**
Direct 4-Stage Pyrite Rougher Flotation for the CuRghTails Feed
CuRT Sample slurry taken from the pilot test work Sept. 27th 2017
All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	Reagents (g / ton of Fresh Test Feed) Ca(OH)$_2$	H_2SO_4	SIBX	Dow 250	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu Rec%	Fe (XRF) %	Fe Rec%	SiO_2 (XRF) %	SiO_2 Rec%	MgO (XRF) %	MgO Rec%	Al_2O_3 (XRF) %	Al_2O_3 Rec%	CaO (XRF) %	CaO Rec%	S (Eltra) %	S Rec%	S (XRF) %	S Rec%	Satmagan %	Satmagan Rec%
Solution strengths :				50 %	5.0 %	100 %																											
CuRghTails slurry from the pilot test work																																	
CuRT		**(Pyrite Rougher-1)**		**Starting pH**			**4.0**		1750		**5.5**																						
				x							**5.0**																						
		3		x	**90**						5.0																						
		2		x		**30**					5.0																						
				x				**3**		1.5	5.0	3	PyrRC1																				
		3		x	**90**						5.0																						
		2		x		**30**					5.0																						
				x				**3**		1.5	5.0	3	PyrRC2																				
													PyrRC1+2	30.88	3.70	0.469	55.4	39.60	5.3	17.20	1.9	2.27	1.6	4.46	2.2	5.01	1.8	24.90	38.5	23.30	35.1		
				535							5.0		**PyrRT2**	804.4	96.30	0.014	44.6	27.40	94.7	33.52	98.1	5.24	98.4	7.63	97.8	10.24	98.2	1.52	61.5	1.66	64.9		
PyrRT2		**(Pyrite Rougher-2)**					**4.0**		1750																								
		2			**90**																												
		2				**60**																											
								3		1.5	5.1	3.5	**PyrRC3**	7.95	0.95	0.220	6.7	43.70	1.5	14.40	0.4	1.84	0.3	3.88	0.5	3.99	0.4	23.96	9.5	22.50	8.7		
													PyrRT3	796.4	95.35	0.012	37.9	27.23	93.2	33.71	97.7	5.28	98.0	7.67	97.3	10.31	97.8	1.30	51.9	1.45	56.2		
PyrRT3		**(Pyrite Rougher-3)**					**4.0**		1750																								
		2			**180**																												
		2				**60**																											
								3		1.5	5.1	3.5	**PyrRC4**	7.52	0.90	0.152	4.4	43.40	1.4	14.60	0.4	1.91	0.3	3.91	0.5	4.10	0.4	25.50	9.6	22.70	8.3		
													PyrRT4	788.9	94.45	0.011	33.5	27.08	91.8	33.89	97.3	5.31	97.7	7.70	96.8	10.36	97.4	1.07	42.3	1.25	47.9		
PyrRT4		**(Pyrite Rougher-4)**					**4.0**		1750		5.1																						
			x								**6.5**																						
		2			**60**																												
		2				**30**																											
								3		1.5	6.5	4	**PyrRC5**	6.58	0.79	0.143	3.6	36.60	1.0	21.20	0.5	2.74	0.4	5.50	0.6	6.18	0.5	18.80	6.2	18.50	5.9		
													PyrRT5	782.32	93.66	0.010	29.9	27.00	90.8	34.00	96.7	5.33	97.3	7.72	96.3	10.40	96.9	0.92	36.1	1.10	42.0		
									Combined Pyrite Rougher Concentrate				**PyrRC1…5**	52.93	**6.34**	0.346	70.1	40.38	9.2	16.91	3.3	2.21	2.7	4.42	3.7	4.87	3.1	24.09	63.9	22.50	58.0		
													Calc. Feed	835.25	100.00	**0.031**	100.0	**27.85**	100.0	**32.92**	100.0	**5.13**	100.0	**7.51**	100.0	**10.05**	100.0	**2.39**	100.0	**2.46**	100.0		
									Sept. 26th at 8.00PM				Feed Assays	'CuEJ'		**0.046**		**28.60**		**32.30**		**5.10**		**7.11**		**10.00**		**2.39**		**2.56**			
									Sept. 27th at 1.00PM				Feed Assays	'CuEJ'		**0.027**		**30.00**		**32.10**		**5.11**		**7.06**		**10.00**		**2.39**		**2.57**			
Totals		**22**		**535**	**510**	**210**						**17**																					

V A A H D O T U S K O E P Ö Y T Ä K I R J A

GTK	**Näyte:**	Hannukainen VE2 Feed type	**Jauhatus:**	**Mylly:**	**Kuulia:**	**Syöte:** 1.5 kg
	Projekti:	Rautajärvi (50401-10296)		**Vesi:**	**Tankoja:**	
	Tekopvm:	28.9.2017	**Huom.:**	Test 11		
	Tekijä:	P.Seppälä		**CuEJ pilotista 28.9.2017, jonka Eltra S on 2.38**		
	Koenumero:	11				

Syöte	Jauh. min	Valm. min	Reagenssit (g/t) / (ml,g) H_2SO_4 50 %	Cu_2SO_4 5 %	SIBX 5 %	Dow250 100 %		Kenno l	Kuorijan viive s	Ilma l/min	Rpm	pH	Vaah. min	Tuote	Tuotteen paino g	%	Pitoisuudet ja saannit S (Eltra) %	Rec%				
CuRT												7.5					2.38					
		3	1037	50								5.0										
		2			100			4	1.5		1750											
		1				50																
										3			4	**PyrRC1**	27.1	2.0	37.3	31.386				
														PyrRT1	1338.46	98.0	1.65	68.614				
		3	123	50								5.0										
		2			50			4	1.5		1750											
		1				50																
										3			4	**PyrRC2**	17.1	1.3	29.8	15.822				
														PyrRT2	1321.36	96.8	1.29	52.792				
		3	70	50								5.0										
		2			50			4	1.5		1750											
		1				50																
										3			3	**PyrRC3**	9.52	0.7	21.8	6.4439				
														PyrRT3	1311.84	96.1	1.14	46.348				
		3	40	50								5.0										
		2			25			4	1.5		1750											
		1				50																
										3			3	**PyrRC4**	11.44	0.8	13.4	4.7598				
														PyrRT4	1300.4	95.2	1.03	41.588				
														Lask. syöte	1365.56	100.0	2.36	100				
Yhteensä			1270	200	225	200							14									

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK Mintec

Sample:	Hannukainen, VE2 Feed Type	Primary Grinding :	Mill: Lab BM
Project:	Rautajärvi (50401-10296)		Charge: 8 kg steel balls; 1.5 kg ore
Date:	17.10.2017		Water: 0.9 liters
Author:	M. Kuusisto / P. Seppälä		
Test No.:	Test 12	Ore Type : VE2 Feed (Lab)	Screen check : BM product 65.1% -75 µm

Remarks: Ore feed 1.5 kg, **Crushed to - 1.4 mm [P(80) = 602 µm] for Primary grinding to P(80) = 90 µm**
Cu Rougher-Scavenger Flotation, followed by **three-stage Silicate Removal Flotation (Ca Reduction)**
Pyrite Rgh-Sca Flotation for the Silicate Tailing, followed by wet three-stage LIMS for the Pyrite Sca Flotation Tailing
Reverse Pyrrhotite Flotation for the LIMS Cleaned Magnetic Conc "WLC" in two stages, plus Dewatering LIMS
All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	PAX	Lilaflot 14		$Ca(OH)_2$	H_2SO_4		DF 507	SIPX	Dow 250	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu (XRF) Rec%	Fe (XRF) %	Fe (XRF) Rec%	SiO_2 (XRF) %	SiO_2 (XRF) Rec%	MgO (XRF) %	MgO (XRF) Rec%	Al_2O_3 (XRF) %	Al_2O_3 (XRF) Rec%	CaO (XRF) %	CaO (XRF) Rec%	S (Eltra) %	S (Eltra) Rec%	S (XRF) %	S (XRF) Rec%	Satmagan %	Satmagan Rec%
		Reagents (g / ton of Fresh Test Feed)																	Grades and Recoveries (XRF MP-10, Eltra S, and Satmagan)																		
Solution strengths :			1.0 %	1.0 %		100 %	50 %		1.0 %	5.0 %	100 %																										
Fresh Ore 1.5 kg																																					
- 1.4 mm	35																																				
							Natural pH					4.0		1600		7.1																					
		(Cu Rougher Flotation)				725										9.0																					
		3	50																																		
		2									20					8.5																					
													3		1.5	8.2	6	CuRC																			
																7.9		CuRT																			
CuRT												4.0		1600																							
		(Cu Scavenger Flotation)				105										9.0																					
		3	30																																		
		1									20																										
													3		1.5	8.7	6	CuSC																			
		Copper Rgh & Sca Flot'n products combined																CuRCSC	68.2	4.58	1.93	91.3	38.00	4.4	13.40	2.6	1.88	2.1	3.60	3.4	3.98	2.2	30.50	49.5	31.60	49.2	5.87	0.6
																8.5		CuST	1421.8	95.42	0.009	8.7	39.59	95.6	24.39	97.4	4.16	97.9	4.86	96.6	8.56	97.8	1.49	50.5	1.57	50.8	48.27	99.4
CuST		(Silicate Removal Flotations)										4.0		1600		8.2																					
		5		50																																	
													3		1.5	8.1	5	SiliRC1	12.6	0.85	0.119	1.0	32.30	0.7	22.60	0.8	3.15	0.7	5.70	1.0	6.93	0.7	22.80	6.8	21.30	6.1	7.25	0.1
																8.1		SiliRT1																			
SiliRT1		5		100																																	
													3		1.5	8.1	5	SiliRC2	19.1	1.28	0.069	0.9	26.40	0.9	32.00	1.7	4.53	1.4	8.35	2.2	9.86	1.5	7.81	3.5	8.16	3.6	14.16	0.4
																8.0		SiliRT2																			
SiliRT2		3		100																																	
													3		1.5	8.0	5	SiliRC3	27.0	1.81	0.049	0.9	26.20	1.2	33.20	2.5	4.67	2.1	9.03	3.4	10.20	2.2	3.70	2.4	3.89	2.4	20.00	0.8
		(Silicate products calculated as combined)																SiliRC1-3	58.7	3.94	0.071	2.9	27.58	2.7	30.53	5.0	4.30	4.2	8.09	6.6	9.39	4.4	9.14	12.8	9.02	12.1	15.36	1.3
																8.0		SiliRT3	1363.1	91.48	0.006	5.9	40.11	92.9	24.13	92.4	4.15	93.7	4.72	89.9	8.53	93.4	1.16	37.7	1.24	38.7	49.69	98.1
SiliRT3		(Pyrite Rougher Flotation)										4.0		1600		7.8																					
							x									5.0																					
		3					x			100																											
		2					x				20																										
							x						3		1.5	5.0	6	PyrRC																			
							745									5.0		PyrRT																			
PyrRT		(Pyrite Scavenger Flotation)										4.0		1600		5.0																					
							x									4.0																					
		3					x			200																											
		1					x				20																										
							x						3		1.5	4.0	6	PyrSC																			
							625																														
		Pyrite Rgh & Sca Flot'n products combined																PyrRCSC	71.8	4.82	0.056	2.8	38.40	4.7	21.90	4.4	3.31	3.9	5.74	5.8	6.41	3.7	12.20	20.8	12.20	20.0	26.08	2.7
																4.0		PyrST	1291.3	86.66	0.003	3.1	40.21	88.2	24.25	88.0	4.20	89.8	4.66	84.2	8.65	89.7	0.55	16.9	0.64	18.7	51.00	95.4
PyrST		(LIMS Roughing + two Cleanings)											Wet LIMS 1 to 3					WLC	713.9	47.91	0.001	0.7	66.06	80.1	5.05	10.1	1.04	12.3	1.10	11.0	1.49	8.5	0.81	13.8	0.82	13.4	91.64	94.8
		Pump speed "170", Flow restrictor Ø 4 mm, "Selectivity" setting																WLT	577.4	38.75	0.006	2.4	8.24	8.1	48.00	77.9	8.10	77.5	9.06	73.2	17.50	81.2	0.226	3.1	0.402	5.3	0.76	0.6
WLC		(Reverse Rougher Flotation of Pyrrhotite)										2.5		1600		6.7																					
							x									5.0																					
		3					x		50	100																											
		1					x				20																										
							x						3		1.5	5.0	5	PoRC																			
							155									5.0		PoRT																			
PoRT		(Reverse Scavenger Flotation of Pyrrhotite)										2.5		1600		5.0																					
							x									4.0																					
		3					x		50	100																											
		1					x				20																										
							x						3		1.5	4.0	5	PoSC																			
		Pyrrhotite Rgh & Sca Flot'n products combined																PoRCSC	42.3	2.84	0.020	0.6	61.80	4.4	4.63	0.6	0.95	0.7	1.04	0.6	1.35	0.5	12.10	12.2	11.90	11.5	62.63	3.8
							175									4.0		PoST	671.6	45.07	0.000	0.1	66.33	75.6	5.07	9.6	1.05	11.6	1.11	10.4	1.50	8.1	0.100	1.6	0.126	1.9	93.47	90.9
PoST		(Final LIMS cleaning for the Reverse Flotation cell product;											Wet LIMS 4					WLCT	5.6	0.37	0.010	0.0	10.20	0.1	47.40	0.7	8.98	0.8	7.76	0.6	17.70	0.8	0.180	0.0	0.313	0.0	4.93	0.0
		i.e. "Product dewatering LIMS treatment")																																			
													Magnetite Concentrate					WLCC	666.0	44.70	0.000	0.0	66.80	75.6	4.72	8.8	0.98	10.8	1.05	9.8	1.36	7.3	0.099	1.6	0.124	1.9	94.21	90.9
		Combined Sulphur Bulk Product (= Pyrite & Pyrrhotite Concentrates)																SBulkConc	114.1	7.66	0.043	3.4	47.08	9.1	15.49	5.0	2.43	4.6	4.00	6.4	4.53	4.2	12.16	33.0	12.09	31.5	39.64	6.6
						Note :	All product Fe assays are Satmagan corrected											Calc. Feed	1490.0	100.00	0.097	100.0	39.52	100.0	23.89	100.0	4.05	100.0	4.80	100.0	8.35	100.0	2.82	100.0	2.94	100.0	46.33	100.0
																		Feed Assays	(1500)		0.091		38.70		24.90		4.62		5.15		7.86		3.12		3.14		44.33	
Totals	35	39	80	250		830	1700		100	500	120						49																					

FLOTATION AND LOW-INTENSITY MAGNETIC SEPARATION TEST REPORT

GTK Mintec

Sample:	**Hannukainen, VE3 Feed Type**	**Primary Grinding :**	**Mill:** Mergan BM
Project:	Rautajärvi (50401-10296)		**Charge:** 22.5 kg steel balls; 5 kg ore
Date:	**22.-25.9.2017**		**Water:** 5.0 liters
Author:	M. Kuusisto / P. Seppälä		
Test No.:	**Test 0** **Ore Type :** **VE3 Feed (Lab)**	**Screen check :**	**BM product 53.4% -75 µm**

Remarks: Ore feed 5 kg, **Crushed to - 1.4 mm [P(80) = xxx µm] for Primary grinding to P(80) = 124 µm**
Cu Rougher-Scavenger Flotation; CuRCSC Regrinding; 3-stage Cleaner Flotation for Copper Concentrate
Pyrite Rgh-Sca Flotation for the Cu Sca Tailing, followed by wet two-stage LIMS for the Pyrite Sca Flotation Tailing
Reverse Pyrrhotite Flotation for the LIMS Cleaned Magnetic Conc "WLC" in two stages, plus Dewatering LIMS
All reagent consumptions calculated against the fresh test feed

Feed	Grind min	Cond min	PAX	CMC FF-BDA	SEX	$Ca(OH)_2$	H_2SO_4	AP 3418A	DF 507	SIBX	Dow 250	Cell liter	Air L/min	Rotor rpm	Scraper delay sec	pH	Flot min	Product	Weight g	Weight %	Cu (XRF) %	Cu (XRF) Rec%	Fe (XRF) %	Fe (XRF) Rec%	SiO_2 (XRF) %	SiO_2 (XRF) Rec%	MgO (XRF) %	MgO (XRF) Rec%	Al_2O_3 (XRF) %	Al_2O_3 (XRF) Rec%	CaO (XRF) %	CaO (XRF) Rec%	S (Eltra) %	S (Eltra) Rec%	S (XRF) %	S (XRF) Rec%	Satmagan %	Satmagan Rec%
			Reagents (g / ton of Fresh Test Feed)																Grades and Recoveries (XRF MP-10, Eltra S, and Satmagan)																			
Solution strengths :			5.0 %	1.0 %	5.0 %	100 %	50 %	1.0 %	5.0 %	5.0 %	100 %																											
Fresh Ore 5 kg																																						
- 1.4 mm	30																																					
		(Cu Rougher Flotation)					Natural pH					15.0		2500		8.5																						
		3	25					10	10																													
		2									20																											
													8		1.5	8.5	5	CuRC																				
																8.6		CuRT																				
CuRT		(Cu Scavenger Flotation)										15.0		2500		8.6																						
		3	15					5	5																													
		2									20																											
													8		1.5	8.6	5	CuSC																				
		Cu Rgh & Sca Flot'n products combined for regrinding and cleaning																CuRCSC	241.7	4.87	1.15	84.8	29.68	8.8	22.44	2.7	2.98	2.6	6.53	3.2	9.03	2.8	23.60	84.7	21.78	80.9	4.91	2.6
																8.6		CuST	4719.6	95.13	0.011	15.2	15.79	91.2	40.70	97.3	5.65	97.4	10.03	96.8	16.16	97.2	0.219	15.3	0.263	19.1	9.47	97.4
CuRCSC	30					200													(Lab BM regrinding for Cu cleaner flotation; 1 gram slaked lime added into the mill)																			
		(Cu 1st Cleaning)					Natural pH					2.5		1500		11.0																						
						80										11.6																						
		5		20																																		
		3			20																																	
		2									10					11.4																						
													3		1.5	11.3	7	CuCC1	57.8	1.17	4.52	79.9	34.07	2.4	12.72	0.4	1.79	0.4	3.65	0.4	5.30	0.4	34.42	29.5	31.57	28.1	1.78	0.2
																11.2		CuCT1	183.9	3.71	0.088	4.9	28.30	6.4	25.50	2.4	3.36	2.3	7.44	2.8	10.20	2.4	20.20	55.1	18.70	52.9	5.89	2.4
		(Cu 2nd Cleaning)										1.5		1100		10.9																						
						90										11.8																						
													2		manual	11.7	9	CuCC2	32.1	0.65	7.84	76.9	36.69	1.4	6.33	0.1	0.94	0.1	1.84	0.1	2.77	0.1	40.54	19.3	36.84	18.2	0.71	0.0
																11.6		CuCT2	25.7	0.52	0.377	3.0	30.80	1.0	20.70	0.3	2.85	0.3	5.92	0.3	8.46	0.3	26.80	10.2	25.00	9.9	3.12	0.2
		(Cu 3rd Cleaning)										1.5		1100		11.4																						
						140										12.0																						
							Copper Concentrate						1.5		manual	12.0	5	CuCC3	17.6	0.35	13.20	71.0	34.70	0.7	3.75	0.0	0.54	0.0	1.09	0.0	1.44	0.0	40.90	10.7	35.80	9.7	0.36	0.0
																12.0		CuCT3	14.5	0.29	1.34	5.9	39.10	0.7	9.46	0.1	1.43	0.1	2.74	0.1	4.38	0.1	40.10	8.6	38.10	8.5	1.14	0.0
CuST		(Pyrite Rougher Flotation)										15.0		2500		8.6																						
							x									5.3																						
		3					x			150								Notes :																				
		3					x				40								Froth bed was very thin ==> Frother dosage doubled																			
							x						8		1.5	5.3	5	PyrRC	Solids was stuck onto the cell bottom corners with the aeration on !																			
							3145									5.3		PyrRT	Utmost buffer capacity in the solids against the sulphuric acid pH control !																			
PyrRT		(Pyrite Scavenger Flotation)										15.0		2500		5.3																						
							x									4.3																						
		3					x			75																												
		1					x				20																											
							x						8		1.5	4.3	5	PyrSC																				
							2395																															
		Pyr Rgh & Sca Flot'n products combined																PyrRCSC	123.5	2.49	0.154	5.8	20.30	3.1	37.10	2.3	5.02	2.3	10.20	2.6	13.70	2.2	3.65	6.7	3.97	7.5	9.99	2.7
																4.3		PyrST	4596.1	92.64	0.007	9.4	15.66	88.1	40.80	94.9	5.67	95.1	10.02	94.2	16.23	95.1	0.127	8.6	0.163	11.5	9.45	94.7
PyrST		(LIMS Roughing + one Cleaning)											Wet LIMS 1 & 2					WLC	494.7	9.97	0.004	0.6	62.79	38.0	7.60	1.9	1.41	2.5	1.92	1.9	2.37	1.5	0.33	2.4	0.30	2.3	86.26	93.0
		Pump speed "175", Flow restrictor Ø 4 mm, "Selectivity" setting																WLT	4101.4	82.67	0.007	8.8	9.98	50.1	44.80	93.0	6.18	92.6	11.00	92.3	17.90	93.6	0.102	6.2	0.147	9.3	0.19	1.7
WLC		(Reverse Rougher Flotation of Pyrrhotite)										2.5		1600		7.1																						
							x									5.0																						
		3					x		75	150																												
		2					x				40								Very poor foaming ==> Frother dosage doubled																			
							x						3		1.5	5.0	5	PoRC	12.6	0.25	0.047	0.2	58.40	0.9	7.75	0.0	1.20	0.1	2.24	0.1	2.38	0.0	10.20	1.9	9.42	1.8	60.16	1.6
							250									5.0		PoRT	482.1	9.72	0.003	0.4	62.90	37.1	7.60	1.9	1.41	2.5	1.91	1.9	2.37	1.5	0.075	0.5	0.062	0.5	86.94	91.4
PoRT		(Reverse Scavenger Flotation of Pyrrhotite)										2.5		1600		5.0																						
							x									4.0																						
		3					x		50	100																												
		2					x				20								Froth bed a bit better than above																			
							x						3		1.5	4.0	8	PoSC	15.2	0.31	0.022	0.1	60.60	1.1	8.75	0.1	1.38	0.1	2.63	0.1	2.53	0.0	0.98	0.2	0.95	0.2	75.77	2.5
							105									4.0		PoST	466.9	9.41	0.002	0.3	62.98	36.0	7.56	1.8	1.41	2.4	1.88	1.8	2.36	1.4	0.045	0.3	0.033	0.2	87.31	88.9
PoST		(Final LIMS cleaning for the Reverse Flotation cell product;											Wet LIMS 3					WLCT	11.1	0.22	0.010	0.0	12.60	0.2	44.40	0.2	7.29	0.3	9.05	0.2	17.60	0.2	0.191	0.0	0.249	0.0	3.07	0.1
		i.e. "Product dewatering LIMS treatment")																																				
													Magnetite Concentrate					WLCC	455.9	9.19	0.002	0.3	64.20	35.8	6.67	1.5	1.27	2.1	1.71	1.6	1.99	1.2	0.042	0.3	0.028	0.2	89.35	88.8
		Combined Sulphur Bulk Product (= Pyrite & Pyrrhotite Concentrates)																SBulkConc	151.3	3.05	0.132	6.1	27.51	5.1	31.81	2.4	4.34	2.4	8.78	2.7	11.64	2.2	3.93	8.8	4.12	9.6	20.76	6.8
						Note :	All product Fe assays are Satmagan corrected											Calc. Feed	4961.2	100.00	0.066	100.0	16.46	100.0	39.81	100.0	5.52	100.0	9.86	100.0	15.81	100.0	1.36	100.0	1.31	100.0	9.25	100.0
																		Feed Assays	(5000)		0.069		16.50		40.85		5.82		10.10		16.25		1.35		1.38		8.89	
Totals	60	40	40	20	20	510	5895	15	140	475	170						54																					