

A Mineralogical Description of a Head Sample from the XXXX Project

Prepared for

## **XXXXX RESOURCES**

Project # JUN2012-04

Date: November 2, 2012

NOTE:

This report refers to the samples as received.

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## **SUMMARY REPORT**

One sample identified as "XX Head" was submitted to Process Mineralogical Consulting Ltd for mineralogical examination. The purpose of the examination was to determine the deportment and distribution of gold within the sample detailing grain size and association.

## METHODOLOGY

The sample was received, weighed and a representative portion riffled for gold assay using fire assay techniques. The sample was then screened on a 38µm screen to produce two fractions and a representative portion was riffled from each fraction for gold assay. The individual fractions were then pre-concentrated using a combination of heavy liquids and Superpan tabling. The heavy liquid separation was carried out on the individual size fractions using Lithium Metatungstate at a density split point of 2.90g/cc in a centrifuge to concentrate an optimal amount of the heavy minerals present in each sample. A representative portion of the 2.9g/cc float product was riffled and submitted for gold assay. The 2.90g/cc Sink fractions were submitted for further concentration using the Haultain Superpanner to prepare a high gold concentrate (Tip), a sulphide concentrate (Midd) and a heavy silicate concentrate (Tail) as illustrated in Diagram 1. The resulting Superpan products were submitted for polished section preparation where replicate polished sections were prepared from the Midd (2) and Tail (3) products and a single polished section prepared from the Tip product. Riffled portions of the Midd, Tail and Slimes products were also submitted for Au assays. The replicate polished sections were systematically scanned using bright phase recognition software equipped on a Tescan Vega 3 Scanning Electron Microscope equipped with an Energy Dispersive Spectrometer (SEM-EDS) to determine the elemental composition of the higher atomic weight elements (Au). The grains were measured based upon the pixel areas and the semi-quantitative elemental composition analyzed. The associations with other minerals were noted and the data assembled to present the grain size distribution, weight distribution and gold mineral association. Backscatter Electron Images (BEI) were taken of selected grains to demonstrate mineral texture and associations. Mineral abundance determinations were made of the individual size fractions of each sample using the Tescan Integrated Mineral Analyzer (TIMA). Additionally, Secondary Ion Mass Spectrometry (SIMS) work was carried out on the XX Float Concentrate sample (submitted under Project #SEP2-12-01) to determine the Au content in the pyrite family (pyrite, arsenopyrite and arsenian

pyrite). These values were utilized in this dataset to account for the sub-micron Au in these minerals in the XX head sample.



Diagram 1: Schematic of gravity concentration procedures

## **RESULTS**

The results of the mineralogical investigation are presented in the graphs and tables included in this section, and demonstrate the following:

- The sample is primarily composed of non-opaque gangue minerals, which include quartz (28%) and plagioclase (39%) with moderate amounts of other silicate minerals (biotite, orthoclase and clay minerals). Pyrite was observed in minor amounts (4%), trace amounts of arsenian-pyrite (0.5%) and arsenopyrite (0.5%).
- The primary gold bearing mineral present in the sample is native gold, with minor amounts of electrum. The semi-quantitative EDX analysis of the gold grains indicates the gold content ranges from 48 to 100% with an average gold content of 98%.
- Distribution of gold between the separation products indicates that ~80% of the gold was recovered into the heavy liquid sink products with 70% in the combined Tip and Midd for the XX Head sample.
- Gold-bearing minerals occur with a normal distribution between 0.5µm and 18µm with an average of 3 µm often occurring as inclusions in pyrite and arsenopyrite.

- Textural determinations made by Backscatter Electron Imaging (Appendix 1) indicate that gold-bearing minerals occur primarily as attachments to pyrite and non-opaque gangue, with a moderate amount locked in pyrite and 7 % as free gold-bearing grains.
- Overall, the visible gold distribution in Table 2 indicates ~7% is present as free grains, ~35% is associated with sulphide minerals, and ~13% is associated with non-opaque gangue minerals.
- Significant amounts of the gold in this sample remains as solid solution in arsenopyrite (31%), arsenian pyrite (~10%) and pyrite (4%) as shown in the SIMS report (Appendix 4)
- The distribution of ~35% as fine visible inclusions in sulphides averaging ~3µm in size added with the free gold grains observed, indicates flotation followed by CN Leach may recover ~40 % of the gold. The large quantities of gold as sub-microscopic (solid solution) gold in arsenopyrite and pyrite would suggest that ~45% of the gold would be recovered by pressure oxidation (POX). The remaining ~15% of the gold remains as locked/attached grains to non-opaque gangue.

The accompanying tables, graphs and appendices of backscatter electron images and raw data provide further detail to the distribution of gold-bearing minerals present in each sample.

Mineral	Abundance-	XXHead	
Fraction	`+38	`-38	Head
Fraction %	58.8	41.2	-
Arsenopyrite	0.43	0.62	0.51
Arsenian Pyrite	0.48	0.48	0.48
Pyrite	4.63	3.6	4.2
Other Sulphides	0.07	0.25	0.14
Pyroxene	2.16	2.5	2.3
Quartz	32.8	21.3	28.1
Orthoclase	2.45	6.6	4.1
Plagioclase	35.9	45.4	39.8
Talc	0.37	0.03	0.23
Amphibole	1.49	0.47	1.1
Biotite	5.07	5.3	5.2
Clay	4.01	0.73	2.7
Other Silicates	3.57	5.7	4.4
Oxide	2.10	5.5	3.5
Phosphate/Carbonate	3.78	1.6	2.9
Other	0.63	0.0	0.38

**Table 1:** Mineral abundance of XX Head sample determined by TIMA analysis

Assoc	iation Summary		Gold	<b>Distibution</b>	%
	Type of Association	Frequency	Head	+38	-38
1	Free	14	6.6	6.5	6.0
2	Locked in Pyrite	82	8.8	12.7	1.7
3	Exposed / Attached to Pyrite	33	17.8	20.2	12.1
4	Locked in Arsenopyrite	18	0.9	1.4	0.1
5	Exposed / Attached to Arsenopyrite	16	4.2	5.4	1.8
6	Locked in Non-opaque Gangue	15	1.1	0.2	2.3
7	Exposed / Attached to Non-opaque Gangue	7	12.1	18.7	0.4
8	Associated with Oxides	2	0.01	0.0	0.03
9	Associated with Tetrahedrite or Sphalerite	2	3.0	0.0	7.1
10	Solid Solution in Arsenopyrite	-	31.3	23.0	49.3
11	Solid Solution in Arsenian Pyrite	-	9.7	8.4	12.6
12	Solid Solution in Pyrite	-	3.6	3.4	4.0
13	In Sp Slimes	-	1.0	-	2.6
TOTA	лL	187	100	100	100

**Table 2:** Association Distribution of Gold including "Invisible" Gold in Pyrite Group

Table 3: So	lid Solution v	s. Visible	Gold De	termination
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Estimated "Invisible" Gold							
Fraction	Overall	`+38	`-38	Head			
Mass %	Au(ppm)	58.8	41.2	-			
Arsenopyrite	88.25	0.38	0.55	0.45			
Arsenian Pyrite	26.89	0.13	0.13	0.13			
Pyrite	1.23	0.06	0.04	0.05			
Invisible Au (calc)		0.57	0.72	0.63			
Discrete Gold		1.09	0.39	0.81			
Total Au (Assay)		1.66	1.11	1.44			

Product	Weight (g)	Weight %	Au Assay (g/t)	% Distribution
+38 Float	267.1	58.1	0.19	7.83
+38 SP Tail	9.3	2.0	5.44	7.80
+38 sp Mid	17.3	3.8	21.10	56.29
+38 SP Tip	1.0	0.2	17.22	2.66
-38 Float	141,4	30.8	0.50	10.90
-38 SP Tail	7.6	1.7	1.94	2.27
-38 sp Mid	2.4	0.5	11.70	4.3
-38 SP Tip	0.5	0.1	89.27	6.19
-38 Slime	12.8	2.8	0.88	1.74
Head (calc)	459,4	100.0	1.41	109.00
Head (assay)			1.44	

Table 4: Distribution of Gold Between Upgrade Products in XX Head



Figure 1: Gold-bearing Mineral Association Weighted by Au Distribution in XX Head



Figure 2: Visible Gold-bearing Mineral Association Frequency in XX Head



Figure 3: Visible Gold Grain Weighted Size Distribution in XX Head



Figure 4: Visible Gold Grain Size Distribution Frequency in XX Head

## **FINDINGS**

The occurrences of visible gold in the sample are primarily fine (<16 $\mu$ m) with significant amounts associated with sulphide minerals. The heavy liquid separation concentrated ~80% of the gold, suggesting gravity concentration may be an alternative for pre-concentration, although the fine nature of grains may limit this application. The mass distribution of gold in the separation products indicates that ~19% remains in the heavy liquid float products which is support through our observations with 15% of the visible gold occurring as locked or attached grains to non-opaque gangue minerals. The remaining 4% of the gold will be present as solid solution / sub-microscopic gold in the arsenopyrite / pyrite grains attached or locked to nonopaque gangue minerals. The textural occurrences of gold observed are primarily as fracture fillings in sulphide minerals and as finely disseminated grains interstitial to non-opaque gangue minerals. An increase in the grinding of the material may provide opportunity for leaching due to permeability along grain boundaries; although the very fine nature may limits this effect. Significant amounts of gold are present in solid solution in the pyritic minerals; the arsenopyrite has an observed maximum of 427 ppm gold with an average gold content of 88.25 ppm. The pyrite in the SIMS report has been divided for mineralogical purposes into arsenian pyrite and pyrite, where arsenian pyrite contains arsenic that is greater than 5000 ppm and pyrite contains less than 5000 ppm. The arsenian pyrite has a maximum gold content of 127 ppm with an average content of 26.9 ppm; the pyrite has an observed maximum content of 2.1 ppm with an average of 1.2 ppm gold. The combination of SIMS and TIMA indicates that the gold found in solid solution comprises 44% of the total gold in the sample. This combined with the visible gold associated with sulphide minerals indicates that  $\sim$ 79% is in someway associated with sulphide minerals. This and the fine nature of the gold and suggest flotation followed by pressure oxidation or smelting as the most effective method to obtain the highest recovery.

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# Appendix 1

# **Backscatter Electron Images of Gold Occurrences**



Figure 1: Three Native Gold Grains Exposed on Arsenopyrite



Figure 2: Pyrite binary with Native Gold



Figure 3: Native Gold Exposed on Pyrite



Figure 4: Native Gold attached to Pyrite grain



Figure 5: Native Gold rim on Pyrite grain with Native Gold attachment



Figure 6: Native Gold attached to Rutile with NOG inclusions



Figure 7: Native Gold binary with Arsenopyrite with small Galena inclusion





Figure 9: Interstitial Native Gold in Arsenopyrite fracture.



Figure 10: Native Gold binary with Pyrite



Figure 11: Native Gold attached to Pyrite



Figure 12: Native Gold locked in Pyrite



Figure 13: Native Gold Locked in Pyrite as attachment to Tetrahedrite



Figure 14: Native Gold Exposed on Pyrite



Figure 15: Native Gold locked in Pyrite/Non Opaque Gangue grain boundaries



Figure 16: Native Gold exposed on Arsenopyrite



Figure 17: Native Gold Locked in Pyrite exposed on Non Opaque Gangue



Figure 18: Electrum attached to Non Opaque Gangue with Pyrite Inclusions



Figure 19: Native Gold locked in fractured Non Opaque Gangue



Figure 20: Native Gold exposed as friable rim on Arsenopyrite



Figure 21: Native Gold locked in Non Opaque Gangue



Figure 22: Native Gold locked in Non Opaque Gangue with Pyrite inclusions



Figure 23: Native Gold locked in Non Opaque Gangue – Pyrite grain boundary



Figure 24: Native Gold locked in Non Opaque Gangue fracture with Pyrite inclusions



Figure 25: Electrum locked in Sphalerite



Figure 26: Electrum locked in Pyrite



Figure 27: Native Gold Locked in Pyrite with Non Opaque Gangue attached



Figure 28: Native Gold locked in Arsenian Pyrite fracture



Figure 29: Native Gold locked in Pyrite



Figure 30: Native Gold Locked in Brecciated Pyrite



Figure 31: Native Gold Exposed on Arsenopyrite



Figure 32: Native Gold locked in Pyrite- Non Opaque Gangue grain Boundary



Figure 33: Native Gold locked in Pyrite in Non Opaque Gangue



Figure 34: Native Gold locked in Arsenopyrite in Non Opaque Gangue

Appendix 2

# **Raw Data for All Visible Gold Occurrences**

Table 1.1: Raw Data for All Occurrences in XX Heat	ad
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Geld Grain	Ano*	Equivalent	Equ. Spherical	48 (141,76)	AE(91.50	Minorph	Association	Comments
	ingener	Diamator*	Tolenor" (ruble				Type	
and the second second	mitrose)	(Microsol)	seconeed				1000	
-38 Ploat	12.1	1.9	82	54	48	Electrum		Electrum Locked in Sphalerite
-38 Plant	4.5	2.8	12	D	106	<b>Notice Geld</b>		Attached to Py
-34 Finat	2.1	1.2:	1	0	100	Notive Gold		Au attached to Dtz
-28 Float	2.3	1.7	1.	Ð	108	Platine facilit		Au locked in Py
-18 Midd	62.1	9.3	413	12	28	Native Dold	- 6	Attached to Assessmenting
-38 Mindd	5.0	25		1	90	Native Gold	3	exposed on Arsenogurite
-18 Million	2.6	1.5	1	1	99	Nation Gold	1	exposed on Ananopurity
18 Minh	4.3	0.8	4	1	100	Notice Cold		Locked in Americanity in
-38 Midd	43	0.5		1	99	Native Gold		Exposed on Purity
-38 Midd	48.5	7.8	254	1	99	Native Gold	1	Binary with during
18 4444	44	34	2	1	99	Natur Cold	-	Ensured on Parily
All Adupt	2.6	14			99	Bather Cold		American in motion
-24 \$5.04	11.4	3.7	15	1	100	Peating Could		Attached to perfor
IR Model	4.7	0.8			90	Red has Doubl		Environd on Parilie
All Adult		04			99	Bather Cold		Farmand on Porite
38 46.04	0.5	1.6				Patrice Gold		inspected on Artistecturity
10.45.44	4.7	1.0	10		100	Watten Date	-	Attached to Relie
10 10 10		- 11				Pasting Cold		Attached to have a
-38 90.00	20.1	21			99	Harding Cold		Added to Americany the
22.24.00	1.0	2.4				Paper South	-	Locked in Anteriopyrise
10.10.00	- 20					Past for Const		Captored on LAuse
-38 Mildd	1.7	1.5	1	1	99	NOCIME GOM		Locket in Anienopyrita
-38 Midd	1.1	10			99.	Nation Gold		Locked in Pyrtor
-38 Midd	0.5	0.8	4.		99	Platter Lold		Exposed on pyrite
-38 Midd	41	- 1.1			99	Pasting Gold	1	Free
-38 Midd	4.5	0.8	9	1	199	Notive Gold		Locked in Arsenopyrite
-18 Midd	0.4	0.7	- 0-	- 1	99	Pastine Locid		Exposed on Buble
-34 Midd	18.2	4.5	10		90.	Notive Gold	- 1 - C	Exposed on Pyrite
<38 Midd .	1.0	1.1	1.	- 1	99	Plative Gold		Exposed on Pyrite
-SEMIDE	3.8	2.2		- 1	99.	Native Gold	- A	Attached to Pyrite
-38 Midd	18.8	4.9	91	1	99	Notive Gold		Binary with pyrise
-38 Midd	8.0	1.0	1	1	99	Nathe Gold	1000	Locked in Pyrite
-38 Midd	2.1	1.4.	2	- 1	90	Notice Gold	- C.B	Locked in Pyrite
-38 Milled	5.0	1.1	£ .	- 1	99	Notive Gold	1	Locked in Pyrite
-38 Midd	42.6	7.4		1	99	Notive Gold		Attached to Pyrite
38 Midd	43	3.4	2	1	- 99	Native Gold		Exposed on Pyrite
-38 Midd	-7.3	2.0	15		99	<b>Native Gold</b>		Locked in Pyrite
18 Midd 1	2.3	1.5	2	- 1	99	Notice Gold		Exposed on tetrahedrite
-38 Midd	30.4	6.2	127	1	99	Notive Gold	- 6	binary with Amenopyrite
-38 Midd	61.0	10.2	549	1	99	Notive Gold	1.1	Free
-38 Midd	0.4	0.3	0	1	99	Notice Gold	1	Locked in Pyrine
-38 Adului	13	1.1	1	1	99	Native Cold		Locked in Amenoprity
-38 Midd	0.1	0.3	4	1	99	Pastus Cold		Locked in Amenowine
-28 Midd	0.1	4.0		1	99	Notice Gold		Exposed on Pyrite
-tel Midd	0.8	1.6	1	1	00	Nation Cold		Essent on Polity
TH Model	34.0	55			90	Bartiss Cold	1	looked in tetrahadrite purity
28 \$5.51	2.6	1.6			90	Watine Gold		exposed on Anapopulate
All Minded	5.0	1.6			90	Number Could	-	inspected on Americantile
TH ARISH	- 24	- 10				Red or Cold		and the second s
- par series	0.5	0.0	17		99	Reptue Cold		Cocked in Action of the
-18 Mildd	3.4	1.5	10	-	99	Plather Looid		Pres
- Ste Minded	-2.8	1.0				Platter Good		Locked in Arsenayine
-36 Midd	_1.1	12	1		99.	Pastier Gold		Locked in Amenoynte
-18 Mil01	1.1	13	. 18.	1	99	Plative Gold		Locked in Arsenoying
-38 Midd	8.1	8.2	19	1	99	Platine Gold		Exposed on Pyrile
-38 Midd	13	1.2		1	- 99	Notive Gold	1	Attached to dolomite
-38 Midd	2.7	0.9		- 1	99	Native Gold	1.1	exposed on dolomite (GB)
-38 Talls	3.3	3.0	4	10	90	Notice Gold		Free
-34 Tails	1.5	3.4	1 . · · ·	.0	100	Notive Gold		Exposed on Anamopyrite
-38 Tails.	5.9	1.6	2	Ó	500	Native Gold	3.1	Locked in Py
-38 Talls	5.0	25	8	ø	300	Native Gold	- 6	Locked in Qtr
-34 Taris	-2.2	3.8		- 0	100	Native Gold		Exposed on Py
-34 Tails -	1.1	1.3	1	0	1000	Notice Gold	. 1	Exposed on Arsenopyrite
-Bill Tailly	4.3	2.3		Ð	500	Native Gold		Locked in MOG
-36 Tals	.8.0	3.2	12	. 0	500	Planting Gold	- 6	Locked in NOG
-38 Taris	0.5	1.4	1	P	1000	Native Gold		Locked in MOG

## Table 1.2: Raw Data for All Occurrences in XX Head <continued>

<b>Cold Crain</b>	Area*	Equivalent	Equ. Sphortical	ALC: 41,753	And CHILL THE	Minural	Accordinglists	Comments
100000000	Implant	Busedor?	Volume* tradie:	100000	10000	0.00000000	True	
	mirrowski	Endersemi	microsoft				1000	
-38 54	42.8	9.2	411	¥	- 10.0	Native Gold		Broan with Parity
38 20	0.1	0.5			199	Murris di Catal		Experied on Advancements
10.00	44					Harris Course		Contrast in a second deal
38.70	37.5	8.6	108	+	99	Native Gold	-	Free
38.7p	2.3	13	1.2	-1	- 99	Native Gold		Benary with Pyrite
-34 Ter	2.8	1.6	2.5	1	- 00	Native Gold		Exposed on Pyrite
-38 Tar	8.0	8.2.	12	0	900	Native Gold		free
-34 Tes	6.9	5.0	1.4	0	150	Native Gold	1	free
14 14	14.5		42		100	Marrian Could		Free
1.24 5.00	16.7					Harrison Courts	-	I called in the star
• (## Propert	0.0	- 4.9	- 10	- 10	- 19	NUCLAR COLD	4 .	Locked in Pyrtie
+(88 F1041	35.2	8.5	00		- 97	Native Gold	1	Exposed on Py
+38 Float	11.6	3.8	30		97	Native Gold		Locked in Py
+38 Float	17.1	47	50	0	300	Native Gold	. 6	Locked in Rolfanite
+38 Florati	6.6	2.6	20	0	3.00	Native Dolld		Locked in monohadhia alche-
+18 Final	2.8	1.8	1	0	100	Marriage Circlel	1	Locked in Purity
A DE COMP	10.0				100	Marine Calif		and and in the state
1 36 Friday	112	- 11	0	~		marrow Gront		Locaro e ryere
+36 Ploat	47.3	. 7.8	243	0	100	Native Gold	1	Locked in Pyrine
+38 Float	18	1.9			100	Native Gold		Locked in Pyrite
+38 Float	6.2	2.8	10	0	300	Native Gold		Locked in monohydrocalicity
+38 Float	11.0	1.7.	27	- 10	300	Native Gold	- 4	Locked in Appy
+ 38 Floort	4.4	2.4	2	6	200	Native Gold	1	Locked in Fully
+ THE EXcent	22.2	2.5			1.50	Martines Fronts		A subject in Parity.
1.28 1.204	38.7			<u>v</u>		manner canna		Latter of Pyrot
<ul> <li>28 Prout</li> </ul>	2.8	1.9		- D	300	Number Cards		Locked in Pyres
+38 Phoat	18.2	4.1	36	0	300	Native Gold		Locked in Pyrile
+38 Float	945.4	\$4.5	1604	.0	300	Native Gold		Locked in Pyrite
+38 Float	48.8	0.4	434	8	100	Native Gold		Locked in Pyrite
+ 36 Figure -	326.7	11.6	811	0	100	Marriage Goold		Locked in Pyrite
a life filment	12.5		80		1.00	Number Could		I softend in Purity.
1.20 1.000	14.1					Martine Could		and and in the
+38 FIGURE	9.8	. 1.8	11	0	330	NUCLE DOG	4	Locked in Py
+38 Phoat	2.8	1.8		0	300	Native Gold	. 4	Locked in AraenianPy ron of Py
+38 Ploati	7.7	8.1	18	-0	300	Native Gold	- 1	Locked In Py
+38 Float	26.5	6.8	50	0	300	Native Gold	4	Locked in Pg
+38 Final	14.5	46	44	0	100	Native Cold		Locked in Py
+34 First		4.4	18	ð.	100	Marriage Could		Locked in Palemonated in Joble Cashe
- 24 12	- 10-				- 10-	And and an other last	and the second second	and the second second second second
- 76 Filler					- 52	married Label		Capital In webs
+38 Float	0.0	1.7	10	0	3.00	Native Gold		GB controlled on Py and Chlorite.
+38 Float		1.9		0	300	Native Gold		G8 controlled on Py and Chlorite
+38 Float	8.4	8.5	32	Ú.	300	Native Gold	1	Locked in Py
+38 Poult	39.4	8.5	- 65	0	100	Native Gold	· .	Locked in Py
• TR Float	1911	10.5	4.52	-0	3.96	Nation Cold		Locked m fam.
A TR Front	4.1	1.1	18	0	3.92	Marilee Cold	-	Local M. R.
THE PROPERTY						No. of Address		Location of Ty
+38 Piper	2.4	1.5		- P	100	Native Gold	4	Locked in Py
+38 Float	13.7	4.1	56	-0	100	Number Gold		Locked in Py
+36 Float	16.2	6.7	157	0	100	Native Gold		Locked in Py
+38 Float	16.0	4.5	48	0	300	Native Gold	1	Locked in Py
+34 Float	2.4	1.9		<sup>ib</sup>	100	Number Gold	1	Locked in Py
A 38 Down			18	0	0/00	Murrises Could		Fill constrained inclusion in MWG Sh-
+ JS Proven	10	5.4			100	Harvey General		the controlled including in Reading
+38 Ploat	7,7.	- 54	. 10	.0	300	NUTIVE DOUB		Locked in Py
+38 Ploat	11,7	6.0	34	0	300	Native Gela		Locked in Py
+38 Float	2.8	1.8		¢.	300	Native Gold	4	GB sonknoffed inclusion in K-span/Py
+38 Float	2.8	1.9		0	300	Native Geld		Locked in NOG
+38 Prest	1.3	. 8.0	14	ð.	200	Matter Gold		Locked in Py
+ bh Floren	14.4		10.1		- 10	Married Could		Locked in the
124 200	10.4	2.0	100		100	Name of Cold		and the second sec
+ 38 Hour	5.5	1.9	- 10		200	NUMBER OF STREET		Locked in Py
+38 Float	0.8	2.9		0	300	Native Gold		Locked in NOG
+ BB Float	4.4	2.8		0	300	Native Gold		Exposed on NOG
+ IR Final	12.2	8.5	1016	-0	200	Native Gold	- 1	Locked in Py
+38 Float	4.6	2.4		0	300	Native Cold	4	GB controlled inclusion in PuPADG
+ RE Floor	73	1.6	14	P	3.90	Nation Cold		CR controlled inclusion in Pullich
1.34 5	1.6	1.5		-	5.40	Marine Profil		Locked to By
- SS FROM					1.40	Name of Cold	-	to the second se
+36 Ploat	4.5	8.8 -		0	200	Narver Gold		Locked in Py
+38 Float	4.4	2.4	- P	0	909	Native Gold		Locked in NOG
+38 Float	42.9	- 9.2	199	0	300	Native Gold	1	Locked in Py
+38 Float	5.4	2.9	19	0	200	Native Gold	7	Fracture control in Py
- 18 54-04	42.4		414		84	Matthew Funds		Exposed on Py
1.20.57.00	10.0				- 100	ALCONT GROUP	-	Product of the American state
+18 Millio	6.8	- 28		6	194	PERCEPT LINUS		CAPORED on Antenopyrite

## Table 1.3: Raw Data for All Occurrences in XX Head <continued>

<b>Gold Grain</b>	Aries"	Equivalent.	Equ. Spherical	Ap (W1.75)	Ac (101,75)	Minural	Annulation	Comments
	(square	Dismeter"	Volume* texhie				Type	
	microsoft	Ondervata)	microsol.	-			100	
+38 Midd	-4.4	2.4	7	5	- 95	Native Gold		Exposed on Amenopyrite
+38 Midd	8.6	2.8	11	1	907	Native Gold		Locked in Py
=38 Midd	16-0	-45	48	0.	100	Native Gold	- 4	Locked in Arsenopyrite
+38 Modd	19.3	5.0	64	0	300	Native Gold	3	Locked in Py
+38 Midd	11.0	3.7	19	0	300	Notive Gold	2	Locked in Py
+18 Mold	106.9	15.7	1345	ů.	200	Native Gold		Exposed on Py
- 10 Midd	14.0	4.1	41	0	100	Native Gold	1.1	Locked in Py
vill Mahl	2.8	1.9	1	0	130	Native Gold		Looked in Pr
+ 10 Midd	25.9	5.7	995	0	200	Native Gold		Exposed on Py
-18 Madel	11.0	17	23	0	100	Nation Gold		Locked in Pr
+ bit bitubit	14.0	1.6	100		2.00	Nution field		I relief in the
- 10 billet	14.5	4.4	47		100	Retire Cold		Energy of the
-38 Mildo	24.7	2.2	8.7		200	Retive Gold		Exposed on Py
-10.10.40	17	2.1		<u>u</u>	100	Platine Gold		Last contracted inclusion in Pg/Mag
+38 MIG0	2.8	1.9	.1	0.	. 100	Pastine Gold		Locked in Py
=38.Mbdd	114	3.8	30	0	330	Nuther Gold	4	Locked in Arsenopyrite
+38 Midd	5.5	2.6	10	0	100	Native Gold	1	Locked in Py
+38 Midd	- 2.4	-5.5	- 22	0	300	Native Gold		Locked in Py
+38 Midd	3.5	2.6	- 50	0	300	Native Gold	. I	Exposed on Py
=38 Midd	381.4	15.2	1840	0	100	Native Gold		Exposed on Qtz
+38 Muld.	8.8	2.8	13	0	130	Native Gold	.4	Locked in Arsehopynte
+38 Midd	79.2	30.0	531	0	300	Native Gold		Exposed on Amenopyrite
+38 Midd	4.4	24	7	0	330	Native Gold	1	Locked in Py
+38 Midd	4.4	2.8	2	0	300	Native Gold		Locked in Py
+38 Midd	711	4.7	53	0	350	Native Gold	1	Locked in Pp
+38 Midd	2.7	3.1	36	0	300	Native Gold	- x -	Locked in Py
+38 Midd	2.6	1.9	3	0	100	Native Gold	. 2	Locked in Py
+18 Midd	17.6	4.7	58	Ó.	300	Native Gold		Locked in Py
+38 blodd	.55	2.6	540	0	300	Native Gold		Locked in Amenogarity
+10 Mahl	2.8	1.9	1	0	150	Nather Gold		Locked in Pa
+ 10 blocks	11.1		10	0	100	Nation Gold	1	Locked in Py
- 18 Market	13.2	43	14	0	100	Ridher Gold	4	Locked in Assessmelle
and fail	114	47		35	100	Electro att		Constant of the second party of the
-10.7-1	17.4	7.8	44	14	74	Electropic and		Presented on Presently
- 20 100	-			18	14	Ciectingers		Coposed on Coposite
-10 7-0	442.0	14.4	49	36	74	Centrum.		line .
×38 198	40.9.3		909	12	13	EXECTION		rree
100 100	3.7	1.0		- 13	- 13	Electrum		free
+38 147	128.4	12.8	1/1	- 18		Rative Gold		Free.
+38 Tall	340.5	20.8	495	17	- 83	Native Gold		Free
+38.10	0.3	0.6		0	300	Native Gold		exposed on pyrite
+38 Tip	5.5	.2.6		0	100	Native Gold		Locked in pyrife
+38 10	3.0	8.1	2	0	300	Native Gold	3	Locked in pyrite
+34 Tg		0.8		0	300	Native Gold	t	Locked in pyrite
+38 Tip	. 5.1	2.5		0	300	Native Gold	3	Locked in pyrite
+38 Tig	16.8	4.6	54	0	330	Native Gold		Locked in pyrite
+38 Tip	2.2	1.7		0	330	Native Gold		Locked in pyrite
+38 Tip	30.9	6.1	1,29	ů.	300	Native Gold		exposed on pyrite
+38 Tp	29.5	6.1	130	0.	300	Native Gold	1.1	Locked in Pyrite
+18.5p	2.8	1.8	4	ġ,	. 330	Native Gold		Locked in Pyrite
=38 Tip	5.5	2.5	9	0	300	Native Gold	3	exposed on pyrite
+38.70	6.5	0.6	1	0	330	Native Gold	2	Locked in Pyrite
+38 To	25	1.8	1	0	300	Native Gold	4 -	Locked in Arsenoparite
+38.7m	4.5	2.4	7	8	330	Native Gold	1	Attached to pertu
+10 10	2.5	11		0	200	Pasting Gold	1	Locked in Parity
sig Top	0.5	04		0	100	Nation Gold		attached to Tetrahedrite Locked in write
+18 50	2.4	1.0			200	Notice divisit		exposed on Americanity
+18.7-	3.0	14	2	0	100	Westing Cold	-	Linked in purity
10 10	2.0	14			340	Butine Cold		Locked in partic
114 1		1.0			2,00	Harrison Calord		A sector of the particle
-38 10	1.4	1.1		0	200	Parties Gold		Locate in period
100.00		4.8	-	9	\$30	Harner Gold	-	Contract on Database
<18 Tip	-14	-1.1		0	. 200	Native Gold		Locked in pyritis

Appendix 3

# Visible Gold Distribution Data by Product

# XX Head

#### **Association Summary +38 Float**

+38 Float	Type of Association	Frequency	%Weight
1	Free	0	0
2	Locked in Pyrite	39	94
3	Exposed / Attached to Pyrite	1	3
4	Locked in Arsenopyrite	2	1
5	Exposed / Attached to Arsenopyrite	1	0
6	Locked in Non-opaque Gangue	11	3
7	Exposed / Attached to Non-opaque Gangue	1	0
8	Associated with Oxides	0	0
9	Associated with Tetrahedrite or Sphalerite	0	0
Total		55	100

#### Association Summary +38 Tail

+38 Tail	Type of Association	Frequency	%Weight
1	Free	6	96
2	Locked in Pyrite	0	0
3	Exposed / Attached to Pyrite	0	0
4	Locked in Arsenopyrite	0	0
5	Exposed / Attached to Arsenopyrite	0	0
6	Locked in Non-opaque Gangue	0	0
7	Exposed / Attached to Non-opaque Gangue	1	4
8	Associated with Oxides	0	0
9	Associated with Tetrahedrite or Sphalerite	0	0
Total		7	100

#### Association Summary +38 Midd

+38 Midd Type of Associat	ion	Frequency	%Weight
1 Free		0	0
2 Locked in Pyrite		18	10
3 Exposed / Attache	d to Pyrite	5	39
4 Locked in Arsenop	byrite	5	3
5 Exposed / Attache	d to Arsenopyrite	3	11
6 Locked in Non-opa	aque Gangue	0	0
7 Exposed / Attache	d to Non-opaque Gangue	2	37
8 Associated with O	xides	0	0
9 Associated with T	etrahedrite or Sphalerite	0	0
Total		33	100

#### Association Summary +38 Tip

+38 Tip	Type of Association	Frequency	%Weight
1	Free	0	0
2	Locked in Pyrite	16	59
3	Exposed / Attached to Pyrite	4	40
4	Locked in Arsenopyrite	1	1
5	Exposed / Attached to Arsenopyrite	1	1
6	Locked in Non-opaque Gangue	0	0
7	Exposed / Attached to Non-opaque Gangue	0	0
8	Associated with Oxides	0	0
9	Associated with Tetrahedrite or Sphalerite	0	0
Total		22	100

#### **Association Summary -38 Float**

	Type of Association	Frequency	%Weight
1	Free	0	0
2	Locked in Pyrite	1	8
3	Exposed / Attached to Pyrite	1	40
4	Locked in Arsenopyrite	0	0
5	Exposed / Attached to Arsenopyrite	0	0
6	6 Locked in Non-opaque Gangue		0
7	Exposed / Attached to Non-opaque Gangue	1	3
8	Associated with Oxides	0	0
9	Associated with Tetrahedrite or Sphalerite	1	49
Total		4	100

#### Association Summary -38 Tail

Type of Association	Frequency	%Weight
1 Free	1	8
2 Locked in Pyrite	1	4
3 Exposed / Attached to Pyrite	1	7
4 Locked in Arsenopyrite	0	0
5 Exposed / Attached to Arsenopyrite	2	5
6 Locked in Non-opaque Gangue	4	75
7 Exposed / Attached to Non-opaque Gangue	0	0
8 Associated with Oxides	0	0
9 Associated with Tetrahedrite or Sphalerite	0	0
Total	9	100

#### Association Summary -38 Midd

	Type of Association	Frequency	%Weight
1	Free	3	28
2	Locked in Pyrite	7	6
3	Exposed / Attached to Pyrite	18	35
4	Locked in Arsenopyrite	9	1
5	Exposed / Attached to Arsenopyrite	9	29
6	Locked in Non-opaque Gangue	0	0
7	Exposed / Attached to Non-opaque Gangue	2	0
8	Associated with Oxides	2	1
9	Associated with Tetrahedrite or Sphalerite	1	0
Total		51	100

#### Association Summary - 38 Tip

Type of Association	Frequency	%Weight
1 Free	4	51
2 Locked in Pyrite	0	0
3 Exposed / Attached to Pyrite	3	49
4 Locked in Arsenopyrite	1	0
5 Exposed / Attached to Arsenopyrite	0	0
6 Locked in Non-opaque Gangue	0	0
7 Exposed / Attached to Non-opaque Gangue	0	0
8 Associated with Oxides	0	0
9 Associated with Tetrahedrite or Sphalerite	0	0
Total	8	100

	Type of Association	Frequency	%Au Distribution
1	Free	6	10
2	Locked in Pyrite	73	19
2	Exposed / Attached to Pyrite	10	31
4	Locked in Arsenopyrite	8	2
4	Exposed / Attached to Arsenopyrite	5	8
(	Locked in Non-opaque Gangue	11	0
7	Exposed / Attached to Non-opaque Gangue	4	29
8	Associated with Oxides	0	0
<u> </u>	Associated with Tetrahedrite or Sphalerite	0	0
Total		117	100

#### **Association Summary +38 Fraction**

### Association Summary -38 Fraction

	Type of Association	Frequency	%Au Distribution
1	Free	8	19
2	Locked in Pyrite	9	5
3	Exposed / Attached to Pyrite	23	38
4	Locked in Arsenopyrite	10	0
5	Exposed / Attached to Arsenopyrite	11	6
6	Locked in Non-opaque Gangue	4	7
7	Exposed / Attached to Non-opaque Gangue	3	1
8	Associated with Oxides	2	0
9	Associated with Tetrahedrite or Sphalerite	2	22
Total		72	98

Appendix 4 SIMS Report

#### SSW Reference: 45612.pro Final report



### **BY ELECTRONIC MAIL**

October 29, 2012

Mr. Geoffrey Lane Chief Mineralogist Process Mineralogical Consulting Ltd. 10630 240<sup>th</sup> Street Maple Ridge, B.C. V2W3B2

Dear Geoff,

Attached is the final report on the analysis of your sample that was received in our laboratory on October 1, 2012. The following sample was received: powder sample from one con composite

You requested that we analyze the sample in an attempt to determine the gold content and distribution in selected minerals. Normal turnaround was requested for this work.

## METHODOLOGY

The Dynamic SIMS technique is a benchmark technique for analysis of sub-microscopic (invisible) gold in minerals. The sub-microscopic gold detected and quantified by the Dynamic SIMS instrument is refractory gold, i.e. it is locked within the crystalline structure of the mineral phase (most often in sulphide minerals) and it can not be directly released by the cyanide leach process. This type of gold may be present as finely disseminated colloidal size gold particles (<0.5µm) or as a solid solution within the sulphide mineral matrix. During the D-SIMS analysis an ion beam removes consecutive layers of material from the surface of the polished mineral grains and generates depth profiles of the distribution of the chosen elements of interest. Examples of D-SIMS depth profiles (Figures 4-7) show the distribution of the basic matrix elements (S, Fe and As) as well as the trace elements, Au and As (for pyrite). The spikes in the gold signal intensity in the depth profiles represent colloidal gold (Figures 4a and 5a) and the vellow colored areas represent the approximate size of this colloidal type, sub-microscopic gold. The typical size is in the range of 100-**200nm.** D-SIMS depth profiles for solid solution sub-microscopic gold show a steady (flat) Au signal similar to the matrix elements but with different levels of intensity depending on the concentration of sub-microscopic gold present in the mineral phase (Figures 5b, 6.7).

The marked mineral particles of interest were analyzed using the Cameca IMS 3F SIMS instrument and concentration depth profiles for Au, As, S and Fe were produced. The quantification of the gold and arsenic was established using internal mineral specific standards. The experimental conditions are described in Appendix A.

### **SUMMARY**

The objectives of this study were to quantify the sub-microscopic gold content in the following minerals: pyrite and arsenopyrite.

The description of the sample analyzed by D-SIMS is provided in Table 1. In total, 93 analyses are provided. Examples of the mineral phases analyzed are presented in Figure 1.

A comparison between the determined Au content among the various analyzed mineral phases and morphological varieties in the sample is presented in Figure 2. In addition to the quantification of sub-microscopic gold in these minerals, the arsenic content in pyrite was measured. The correlations between sub-microscopic gold and arsenic content in different morphological types of pyrite was established, Figure 3.

### **Major findings:**

## A. Identified gold carriers:

## 1. Arsenopyrite: major gold carrier

i) The following different morphological types of arsenopyrite in the sample were identified: coarse, porous and microcrystalline arsenopyrite, Figure 1.

ii) The estimated average gold concentrations in the various morphological types of arsenopyrite in the sample are as follows, Table 2:

■ Coarse:	90.94 ppm
■ Porous:	87.92 ppm
Microcrystalline:	84.25 ppm

iii) Statistically, 100% of the SIMS concentration depth profiles in arsenopyrite showed presence of solid solution sub-microscopic gold, Figures 6 and 7.

## 2. Pyrite: major gold carrier

i) The following different morphological types of pyrite in the sample were identified: coarse, porous and microcrystalline pyrite, Figure 1.

ii) The estimated average gold concentrations in the various morphological types of pyrite in the sample are as follows, Table 3:

■ Coarse:	2.33 ppm
■ Porous:	24.79 ppm
Microcrystalline:	41.17 ppm

iii) Statistically, 62% of the SIMS concentration depth profiles in pyrite showed presence of colloidal size sub-microscopic gold (Figure 4a), the rest being solid solution sub-microscopic gold, Figure 5b.

iv) There is a positive correlation between the measured sub-microscopic gold concentration in pyrite and the arsenic content, Figure 3.

If you have any questions, or require further assistance, please contact us.

Sincerely,

Brian R. Hart Brian R. Hart Stamen Dimov Stamen Dimov

Research Scientists, for Surface Science Western

Att./Data

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Appendix A D-SIMS experimental conditions

## I. Quantification of sub-microscopic gold

The measured gold concentrations are given in Tables 2-3. Concentrations measured in each grain and their average values per mineral type with the corresponding 95% confidence intervals are included in the tables.

## Table 1. Description of the sample

Sample ID	Mineral type	# of analyses
SEP2012-01 CONS COMP +38μm MSI403	Pyrite	45
PS mount M1: SP Tip	Arsenopyrite	48
Total	<u>.</u>	93

PS mount M1						
Arsenopyrite						
Coar	rse	Porc	Porous		Microcrystalline	
Grain	Au	Grain	rain Au Grain		Au	
I.D.	ррт	I.D.	ppm	I.D.	ppm	
m1apc02	48.02	m1app01	468.98	m1apm58	39.64	
m1apc07	67.37	m1app01a	134.87	m1apm60	6.74	
m1apc08	78.01	m1app03	61.92	m1apm61	35.80	
m1apc09	125.93	m1app04	7.40	m1apm62	39.73	
m1apc10	18.30	m1app05	60.17	m1apm63	194.65	
m1apc12	36.63	m1app06	162.81	m1apm64	188.95	
m1apc16	17.77	m1app11	8.41			
m1apc20	426.57	m1app15	180.94			
m1apc22	54.88	m1app17	120.54			
m1apc25	184.54	m1app18	92.48			
m1apc27	4.25	m1app19	6.89			
m1apc28	14.88	m1app21	27.59			
m1apc29	62.23	m1app24	13.73			
m1apc30	34.50	m1app26	126.78			
m1apc33	394.97	m1app32	13.70			
m1apc42	26.11	m1app43	16.40			
m1apc44	4.60	m1app45	22.37			
m1apc51	9.16	m1app47	8.93			
m1apc52	36.34	m1app48	156.41			
m1apc53	23.56	m1app49	67.14			
m1apc59	20.84					
m1apc69a	311.24					
Average	90.94		87.92		84.25	
$\pm\lambda$	53.38		48.18		<b>68.78</b>	

## Table 2: Measured concentrations of sub-microscopic gold in arsenopyrite

 $\pm\lambda$ : 95 % confidence interval

 $\lambda = 2 \sigma / \sqrt{n}$ ;  $\sigma$  is the standard deviation; n is the number of analyses

PS mount M1 Pyrite									
Grain	Au	As	Grain	Au	As		Au	As	
I.D.	ppm	ppm	I.D.	ppm	ppm	Grain I.D.	ррт	ррт	
m1pyc100	3.48	15513	m1pyp48a	53.38	18370	m1pym119	17.37	17636	
m1pyc102	2.32	8199	m1pyp65	58.55	20903	m1pym120	10.52	116071	
m1pyc103	1.58	4966	m1pyp66	0.29	2397	m1pym121	3.77	12724	
m1pyc104	0.72	4254	m1pyp67	0.31	312	m1pym124	46.77	21248	
m1pyc118	10.33	11902	m1pyp68	2.24	12151	m1pym125	127.44	22896	
m1pyc122	1.11	2441	m1pyp69	3.06	9083				
m1pyc123	1.16	8346	m1pyp70	2.07	4055				
m1pyc76	3.10	7640	m1pyp71	0.52	3658				
m1pyc83	2.77	14485	m1pyp72	47.57	16286				
m1pyc85	1.79	993	m1pyp73	98.04	25199				
m1pyc87	1.24	3098	m1pyp74	18.33	14737				
m1pyc89	1.01	1312	m1pyp75	1.20	5260				
m1pyc91	1.01	520	m1pyp80	6.15	10086				
m1pyc92	1.38	3298	m1pyp81	52.51	17883				
m1pyc93	3.05	2071	m1pyp82	20.14	10969				
m1pyc94	2.01	901	m1pyp84	23.01	16115				
m1pyc95	0.33	3624	m1pyp86	27.40	17532				
m1pyc97	5.52	10688	m1pyp88	0.81	4528				
m1pyc98	1.48	5328	m1pyp90	1.80	353				
m1pyc99	1.13	2280	m1pyp96	78.49	26086				
Average	2.33	5593		24.79	11798		41.17	38115	
±λ	1.00	2052		13.32	3571		45.56	39134	

## Table 3: Measured concentrations of sub-microscopic gold and arsenic in pyrite

 $\pm\lambda$ : 95 % confidence interval

 $\lambda = 2 \sigma/\sqrt{n}$ ;  $\sigma$  is the standard deviation; n is the number of analyses

 Table 4: Determined by optical microscopy abundance of morphological types in pyrite

 and arsenopyrite

	Arsenopyrite					
	Coarse	Porous	Microcrystalline			
Abundanca %	28	58	14			
Abunuance, 70	Pyrite					
	Coarse	Porous	Microcrystalline			
	21	66	13			



Figure 1. Examples of minerals/morphological types analyzed by D-SIMS



Figure 2. Comparison by mineral phase/morphological type of the measured mean values of sub-microscopic gold concentration.



Figure 3. Scatter plot of gold and arsenic concentration in different morphological types of pyrite. Note: Au and As concentrations are plotted logarithmically.



Figure 4. Concentration depth profiles of sub-microscopic gold in pyrite.

A) colloidal size sub-microscopic gold in a porous pyrite grain: Au= 1.20ppm

B) solid solution type sub-microscopic gold in a porous pyrite grain: Au= 98.04 ppm <u>Note:</u> The spikes in the gold signal intensity in the depth profiles represent colloidal gold and the yellow colored areas represent the approximate size of the colloidal type sub-microscopic gold on the depth scale



Figure 5. Concentration depth profiles of sub-microscopic gold in pyrite.

A) colloidal size sub-microscopic gold in a coarse pyrite grain: Au= 0.72ppm

B) solid solution/colloidal type sub-microscopic gold in a microcrystalline pyrite grain: Au= 46.77 ppm



Figure 6. Concentration depth profiles of sub-microscopic gold in arsenopyrite.

A) solid solution type sub-microscopic gold in a coarse arsenopyrite grain: Au= 426.57ppm
 B) solid solution type sub-microscopic gold in a microcrystalline arsenopyrite grain: Au= 194.65 ppm



Figure 7. Concentration depth profiles of sub-microscopic gold in arsenopyrite.

A) solid solution type sub-microscopic gold in a porous arsenopyrite grain: Au= 468.98ppm

B) solid solution type sub-microscopic gold in a porous arsenopyrite grain: Au= 120.54 ppm

## **APPENDIX A**

## ANALYTICAL TECHNIQUE AND CONDITIONS

**Technique:** Secondary Ions Mass Spectrometry (SIMS)

**Instrument:** Cameca IMS-3f

## **Operating conditions for quantitative analysis:**

- Primary ions:  $Cs^+$
- Secondary ions: Au<sup>-</sup>, S<sup>-</sup>, Fe<sup>-</sup>, As<sup>-</sup>
- Primary ion energy: 10kV
- Primary current: 15nA
- Primary beam spot size: 15µm
- -180V offset to suppress molecular interferences in depth profile mode