

TEST REPORT

SGS South Africa (Pty) Ltd.
58 Melville Street
Booyens
Johannesburg

Yves Clement
Xtra Gold Resources Corp
yclement@xtragold.com
Ph: (416) 366-4227
Fax: (416) 366-4225
Cell: (778) 389-7401
Ghana Cell: +233 24 2072676

MINERALOGICAL REPORT No: MIN 0611/106

Work Requested By: Yves Clement
On Behalf Of: Xtra Gold Resources Corp
Proposal Number: 11/033 Rev. 1
Date issued: 10 October 2011
Investigator: L.N. Glossop

Gold Department Study on Sample G478923 (Sulphide Material) and Composite Sample (Oxide Material)

Kibi Gold Project, Ghana



L.N. Glossop
Mineralogist



L.L. Coetzee
Manager: Mineralogy

This document is issued by the Company under its General Conditions of Service accessible at http://www.sgs.com/terms_and_conditions.htm Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

WARNING: The sample(s) to which the findings recorded herein (the "Findings") relate was(were) drawn and/or provided by the Client or by a third party acting at the Client's direction. The Findings constitute no warranty of the sample's representativity of all goods and strictly relate to the sample(s). The Company accepts no liability with regard to the origin or source from which the sample(s) is/are said to be extracted. Any unauthorised alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

TABLE OF CONTENTS

1. INTRODUCTION	3
2. METHODOLOGY	4
2.1. Sample Preparation	4
2.2. Mineralogical Test work (Modified Gold Department Study)	4
3. DEFINITIONS	6
4. RESULTS:	7
4.1. Head Chemical Analyses	7
4.2. Heavy Liquid Separation (HLS)	8
4.3. Gravity Separation by Knelson	10
4.4. Grading Analyses	12
4.5. X-ray Diffraction (XRD)	15
4.6. Bulk Modal Analysis (BMA)	17
4.7. Gold Department	18
4.7.a. <i>Gold Grain Speciation</i>	18
4.7.b. <i>Gold Containing Particles</i>	19
4.7.c. <i>Gold Grain Dimensions</i>	22
4.7.d. <i>Gold Grain Exposure and Mineral Association</i>	22
4.7.e. <i>Gold Particle Types and Mineral Association</i>	23
4.7.f. <i>Direct Cyanidation and Diagnostic Leach Test</i>	24
5. DISCUSSION AND CONCLUSIONS	27

1. INTRODUCTION

Yves Clement, of Xtra Gold Resources Corp., requested SGS South Africa (Pty) Ltd, to conduct a Modified Gold Department Study aimed at characterizing the gold, in two samples, in order to recommend a process route to maximize gold recoveries.

Approximately 10kg of sample **G478923** sulphide material (drill core) and ~10kg of composite oxide (saprolite) material were utilised for the testwork. The composite oxide sample was created by SGS from trench samples that were crushed and combined.

The Mineralogical test work consisted of a “**Modified Gold Department Study**” which includes metallurgical and mineralogical tests. The objective of the study was to gain an understanding of the nature and mode of occurrence of the gold in each sample. The study included:

- Test work to determine the amenability of the ore to gravity recovery.
- Gold distribution across size fractions (grading analysis).
- Heavy Liquid Separation to determine the amount of free gold or gold in heavy particles such as sulphides.
- Exposure and mineral association analysis of the particulate gold grains in the gravity concentrate.
- Chemical composition of the ore and metallurgical test products.
- General mineralogical characterization of the ore.
- Identification and quantification of gold minerals, including native gold, gold-tellurides etc., in the gravity concentrate.
- Grain size distribution of the gold grains in the gravity concentrate.
- Test work to determine the gold recovery by direct cyanidation.
- Diagnostic leach analysis of the gravity tailings in order to determine the gold department in the gravity tails.

The mineralogical testwork was done in conjunction with gravity testwork by the Metallurgical Section of SGS South Africa.

The methodology below outlines how the different tests were conducted. This is followed by the results of the test work and a conclusion, in which the results are discussed and recommendations are made.

2. METHODOLOGY

2.1. Sample Preparation

Approximately 10kg of each sample was received for the gold deportment study. Each sample was crushed, blended and milled to ~50% passing 75µm. Two 4kg split aliquots were submitted for gravity concentration, two 500g split aliquots were used for grading analysis and Heavy Liquid Separation (HLS) and a 1kg split was further milled to ~80% passing 75µm. The ~80% passing 75µm milled sample was split for head assay, modal mineralogy and direct cyanidation.

2.2. Mineralogical Test work (Modified Gold Deportment Study)

The mineralogical testwork included X-Ray Diffraction, modal mineralogy of the head sample and gravity concentrate and trace mineral search analysis by QEMSCAN on the gravity concentrate.

- **Gravity Concentration:** 2 x ~4kg of the G478923 sample and Composite sample (milled to ~50%-75µm) were submitted for gravity separation by Knelson Gravity Separator. The gravity concentration was conducted by SGS Metallurgy. A 3" Knelson concentrator was used to recover the gravity concentrate. Each ~4kg sample was fed continuously as slurry.

The Knelson concentrator utilizes centrifugal forces to recover heavy minerals from the sample. The separator is designed to fluidize the captured gravity concentrate bed by the introduction of an upflow of water. This allows segregation within the bed with heavier materials dropping to the outside of the cone and lighter materials overflowing to the gravity tailings.

The sample to be treated through the Knelson concentrator was made up to a slurry of approximately 30% solids. This material was fed through the feed guard screen (1.7 mm) and feed funnel on the Knelson Concentrator. The Knelson concentrator was run at a speed which yielded a force of 60G. The fluidizing water pressure to the unit was 1.5psi.

The tailings samples were assayed and the gold and sulphur distributions were calculated.

- **Heavy Liquid Separation (HLS):** A ~500g split aliquot of sample was deslimed at 25µm. The +25µm fraction was subjected to HLS using TBE at an SG of 2.96. The slimes and floats were assayed and gold and sulphur distributions were calculated.
- **Grading Analysis:** Grading analysis was conducted on a ~500g split of the sample (~50% -75µm). Five individual size fractions were produced: +106µm, -106/+75µm, -75/+53µm, -53/+25µm and -25µm. The size-fractions were assayed and the gold, and sulphur distributions calculated.
- **Head Chemistry:** A split aliquot of ~200g of the sample was pulverized and submitted for: gold assay by Fire Assay – AAS finish, in triplicate; major and minor element analysis by XRF; arsenic by AAS; total sulphur and organic carbon by Leco.
- **X-Ray Diffraction:** A ~10g split aliquot of the sample was pulverized and the resultant powder analysed by means of X-Ray Diffraction (XRD) in order to identify the major minerals present in the sample. XRD data collection was done using a Panalytical X'Pert Pro Diffractometer (Co-radiation), and data interpretation was done using HighScore analytical software and the PDF2 database.

- **Modal Mineralogy:** Two 90° cut polished sections were prepared from each sample and these were analysed by QEMSCAN Bulk Mineralogical Analysis (BMA) in order to obtain the quantitative mineralogical composition of the sample. Furthermore, BMA analysis was also performed on two polished sections of the Gravity Concentrate, in order to obtain the mineralogical compositions of these fractions.
- **Trace Mineral Search:** QEMSCAN Trace Mineral Search (TMS) analyses were conducted on 10 polished sections of each gravity concentrate, in order to quantitatively determine the gold deportment in the gravity concentrate fractions.
- **Direct Cyanidation Leach Test:** A split aliquot of ~500g of the sample was milled to ~80%-75µm and submitted to SGS Metallurgy for a direct cyanide leach test.
- **Diagnostic Leach Test:** A split aliquot of the gravity tails underwent *diagnostic leach tests*. The procedure involved the sequential solubilising of the least-stable minerals via various pre-treatments, and extraction of the associated gold by cyanidation/CIL. The acid treatment is carried out in 5-litre mechanically-agitated vessels, and the cyanide leaching is carried out in 2-litre glass bottles. The liquid / solid ratio is 2:1 for all the samples. Excess caustic and cyanide is added to the samples. ANK 11 carbon is added as the adsorbent. The duration of the leaching is 24 hours.
 - To quantify the gold that can be extracted via direct cyanidation (i.e. free and exposed gold) a sub-sample is cyanided.
 - To quantify the gold that is preg-robbed, but which should be recoverable via CIL processing, a second sub-sample is cyanided in the presence of activated carbon.
 - To quantify the gold liberated by mild oxidative pre-treatment (occluded in carbonates, chlorite, magnetite, pyrrhotite etc.), the CIL residue is subjected to hot HCl followed by CIL dissolution of the acid-treated residue.
 - To quantify the gold occluded within sulphide minerals (excluding pyrrhotite), the residue from the previous step is subjected to a severe oxidative pre-treatment using hot HNO₃ followed by CIL dissolution of the acid-treated residue.
 - To quantify the gold associated with carbonaceous material such as kerogen, the subsequent residue sample is subjected to complete oxidation via roasting, followed by CIL dissolution of the calcine product.
 - The undissolved gold remaining in the final residue is assumed to be occluded within resistant silicate gangue.

3. DEFINITIONS

QEMSCAN technology is an automated electron beam mineralogical technique, based on a Scanning Electron Microscope (SEM) with four light-element energy dispersive X-ray spectrometers (EDS). The QEMSCAN is used in combination with X-ray Diffraction (XRD) and geochemical analyses to identify and quantify mineralogical characteristics of geological material.

Please note that the qualitative descriptions and quantitative measurements are based on observations made in two-dimensional section through polished blocks of the sample. Various descriptive terms are used in this report; these terms are defined as follows:

- **Area %:** Particles and grains are exposed at the surface of a polished section as two-dimensional cross-sections. Any quantification of mineral characteristics is based on measurements, in pixels, of the exposed areas.
- **Association:** Association refers to adjacency. Two minerals are "associated" if a pixel of one of the minerals occurs adjacent to a pixel of the other mineral. In this report association takes into account both vertically- and horizontally-adjacent pixels.
- **Association Mineral %:** The number of pixels of a mineral type adjacent to the mineral of interest expressed as a percentage of all the pixels associated with the mineral of interest.
- **Calculated Chemical Composition:** The major element chemical composition of the sample can be calculated taking the SG and theoretical chemical composition of each mineral into account. The calculated chemical composition is compared to the measured chemical composition and good agreement serves as validation of the mineralogical composition. Please note that the calculated and measured chemical compositions are never exactly similar due to uncertainties in the mineral chemistry.
- **Grain:** A mineral grain that consists of a single mineral type. Several grains can make up a particle. In the case of a liberated grain, the terms grain and particle are equivalent.
- **Mass %:** If a statistical number of mineral grains are measured, then the area % of each mineral can be converted into mass % taking the SG of each mineral into account.
- **Particle:** Several grains make up a particle. A particle usually refers to a fragment of a rock or ore, the size of which is dependent on crushing and milling conditions.

4. RESULTS:

4.1. Head Chemical Analyses

A split aliquot of approximately 200g of the sample was pulverized for chemical analyses. This included analysis for gold and silver in triplicate by fire assay with AAS finish. The major element chemical compositions were determined by borate fusion XRF. The base metal composition was determined by pyrosulphate fusion XRF. Total sulphur and carbon was determined by Leco. Arsenic was determined by AAS. The results of the chemical analyses are given in Table 1. The analytical methods, as well as the upper (ULD) and lower (LLD) detection limits are also given.

The gold grade is shown in Table 1. The average gold grade for the G478923 gold ore is **~3.47 g/t Au** and for the Composite gold ore it is **~7.28 g/t Au**. The silver grades for both samples are below detection limit.

The major element compositions (Table 1 and Table 2) indicate that the samples are very silicate-rich and therefore, the samples are expected to be quartz-rich. The samples also contain significant Al₂O₃ (12.8% and 21.5% for G478923 and Composite ores respectively) which suggests they contain aluminium rich minerals such as feldspar. The total sulphur grade of 2.2% for the G478923 gold ore is much higher than the total sulphur grade for the Composite gold ore, which was below the detection limit.

Table 1: Head chemical composition of the G478923 and Composite gold ore samples.

Element	SiO ₂	Al ₂ O ₃	CaO	MgO	Fe ₂ O ₃	K ₂ O	MnO
<i>Method</i>	XRF79V	XRF79V	XRF79V	XRF79V	XRF79V	XRF79V	XRF79V
<i>LLD</i>	0.05	0.05	0.01	0.05	0.01	0.01	0.01
<i>ULD</i>	100	100	100	100	100	100	100
<i>Unit</i>	%	%	%	%	%	%	%
G478923	54.1	12.8	4.74	1.2	11.5	0.79	0.18
Composite	45.3	21.5	0.04	0.13	16.6	1.11	0.08
Element	Na ₂ O	P ₂ O ₅	TiO ₂	Cr ₂ O ₃	V ₂ O ₅	LOI	Total
<i>Method</i>	XRF79V	XRF79V	XRF79V	XRF79V	XRF79V	XRF79V	XRF79V
<i>LLD</i>	0.05	0.01	0.01	0.01	0.01	-50	0.01
<i>ULD</i>	100	100	100	50	100	100	120
<i>Unit</i>	%	%	%	%	%	%	%
G478923	5.63	0.27	1	<0.01	<0.01	5.24	97.45
Composite	0.05	0.25	1.48	0.01	0.01	13.28	99.84
Element	As			Au (g/t)			
<i>Method</i>	AAS11C			FAA303			
<i>LLD</i>	0.01			0.02			
<i>ULD</i>	20			50000			
<i>Unit</i>	%			A	B	C	Avg.
G478923	0.13			3.03	3.91	I/S	3.47
Composite	0.10			9.44	5.77	6.64	7.28
Element	Total S	ORG-C		Ag (g/t)			
<i>Method</i>	CSA06V	CSA03V		FAA303			
<i>LLD</i>	0.01	0.05		0.01			
<i>ULD</i>	100	40		50000			
<i>Unit</i>	%	%		A	B	C	Avg.
G478923	2.21	2.23		<1	<1	<1	<1
Composite	<0.01	<0.05		<1	<1	<1	<1

Table 2: Base metal compositions as determined by borate fusion XRF.

Element	Co	Cr	Mn	Ni	Pb	Zn	Cu	Fe
Method	XRF77R	XRF77R	XRF77R	XRF77R	XRF77R	XRF77R	XRF77R	XRF77R
LLD	0.02	0.05	0.05	0.05	0.05	0.05	0.05	0.05
ULD	100	100	100	100	100	100	100	100
Unit	%	%	%	%	%	%	%	%
G478923	<0.02	<0.05	0.13	<0.05	<0.05	<0.05	<0.05	8.06
Composite	<0.02	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	10.3

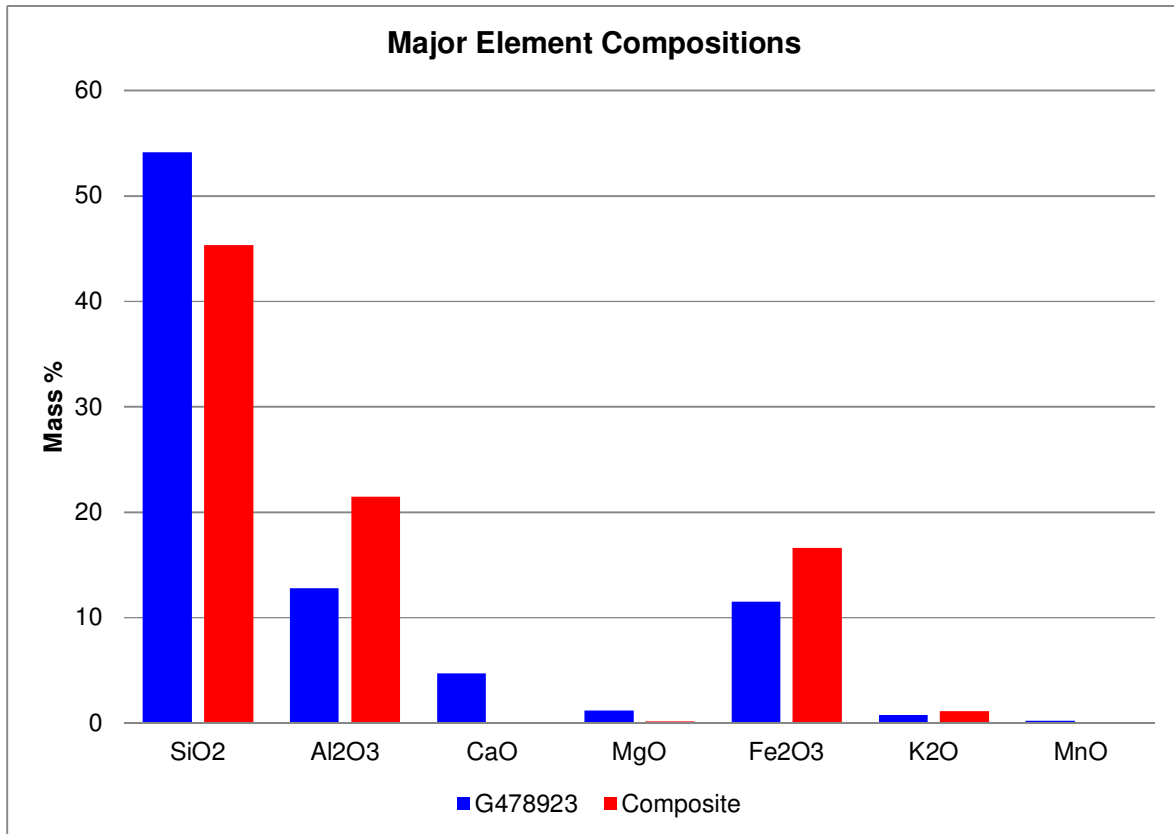


Figure 1: Major element compositions.

4.2. Heavy Liquid Separation (HLS)

The results of the Heavy Liquid Separation (HLS) analysis on the **G478923** sample are given in Table 3 and Figure 2, indicating the mass of each fraction, as well as the distribution of gold, and sulphur in the different fractions. Upgrading of the gold by HLS was very good, as the grade increases to ~29 g/t and ~78% of the gold is recovered for the G478923 sample. The Composite sample grade increased to ~21 g/t and ~57% of the gold is recovered.

Approximately ~26% of the mass reported to the slimes fraction, and the slimes fraction contained ~12% (1.69 g/t Au) of the gold and ~34% (1.84% S) of the sulphur. This indicates that ~12% of the gold grains are primarily associated with particles smaller than 25µm in size, or are liberated and smaller than 25µm in size. About ~64% of the mass reported to the floats fraction, which contained ~10% (0.57 g/t Au) of the gold and ~52% (1.14% S) of the sulphur. The gold in the floats is likely to be associated with lighter gangue phases such as quartz.

Approximately ~9.8% of the mass reported to the HLS sinks fraction, which contained ~78% (28.7 g/t Au) of the gold and ~14% (2.03% S) of the sulphur. The upgrading of

gold into the HLS sinks indicates that most of the gold grains are well liberated (or associated with heavier gangue such as sulphides and oxides) and occur in particles larger than 25µm.

Table 3: Results of the Heavy Liquid Separation of the G478923 gold ore sample.

Fraction	Mass		Gold		Total Sulphur	
	Mass (g)	Dist. (%)	Grade (g/t)	Dist. (%)	Grade (%)	Dist. (%)
Sinks	48.56	9.80	28.7	77.68	2.03	14.10
Floats	316.78	63.94	0.57	10.06	1.14	51.65
Slimes	130.12	26.26	1.69	12.26	1.84	34.25
Total	495.46	100.00	3.62	100.00	1.41	100.00

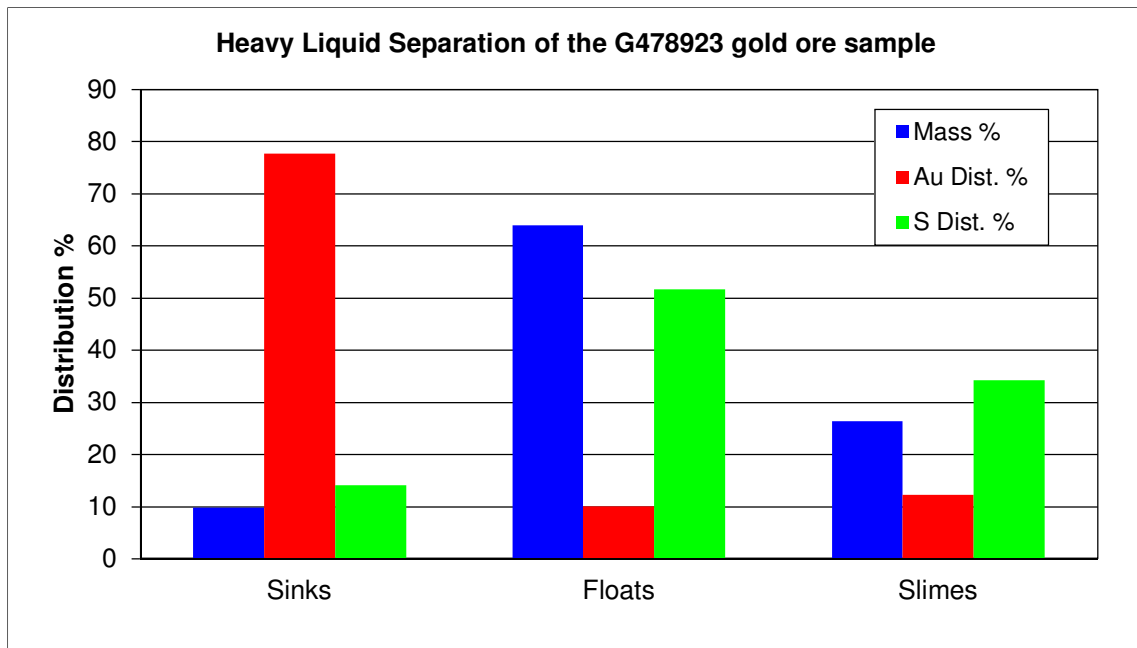


Figure 2: Result of the HLS analysis on the G478923 gold ore sample.

The Heavy Liquid Separation on the **Composite** sample is given in Table 4. Approximately ~54% of the mass reported to the slimes fraction, and the slimes fraction contained ~19% (1.76 g/t Au) of the gold. This indicates that ~19% of the gold grains are primarily associated with particles smaller than 25µm in size, or are liberated and smaller than 25µm in size. About ~33% of the mass reported to the floats fraction, which contained ~24% (3.57 g/t Au) of the gold. The gold in the floats is likely to be associated with lighter gangue phases such as quartz.

Approximately ~13% of the mass reported to the HLS sinks fraction, which contained ~56% (20.8 g/t Au) of the gold. The upgrading of gold into the HLS sinks indicates that some of the gold grains are well liberated (or associated with heavier gangue such as sulphides and oxides) and occur in particles larger than 25µm.

Figure 3 illustrates the results of the heavy liquid separation and shows that gold is upgraded in the sinks fraction and downgraded in the floats fraction, relative to the mass of each fraction.

Table 4: Results of the Heavy Liquid separation of the Composite gold ore sample.

Fraction	Mass		Gold		Total Sulphur*	
	Mass (g)	Dist. (%)	Grade (g/t)	Dist. (%)	Grade (%)	Dist. (%)
Sinks	64.63	13.28	20.8	56.48	0.005	13.28
Floats	161.82	33.25	3.57	24.27	0.005	33.25
Slimes	260.29	53.48	1.76	19.25	0.005	53.48
Total	486.74	100.00	4.89	100.00	0.01	100.00

*The sulphur grades were below the detection limit of 0.01%.

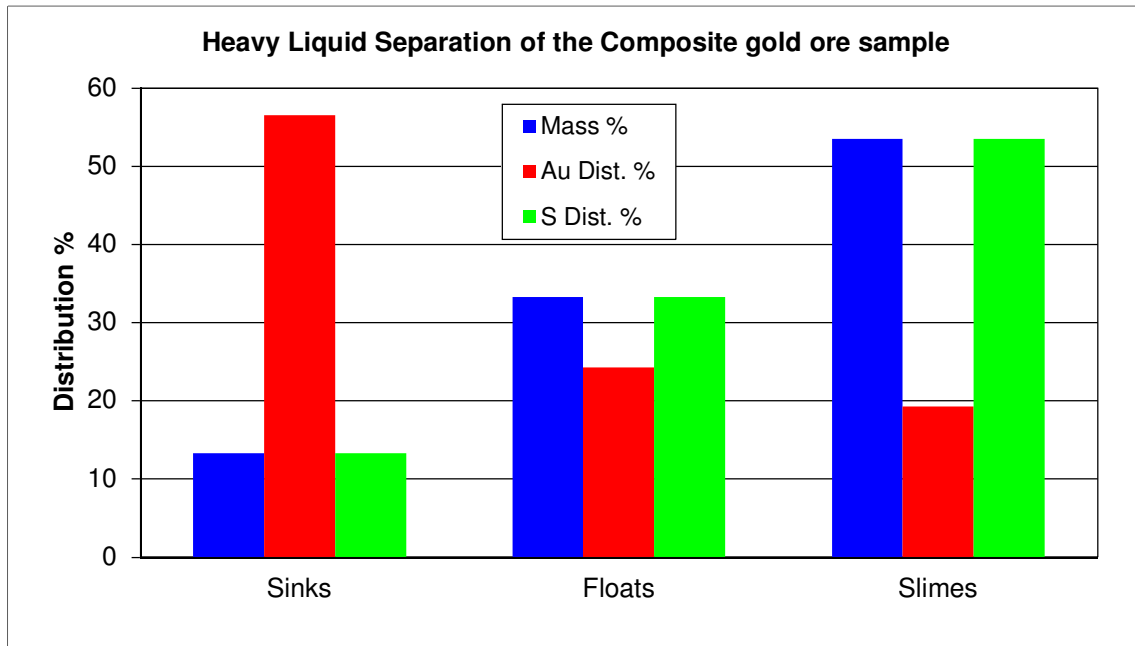


Figure 3: Result of the HLS analysis on the Composite gold ore sample.

4.3. Gravity Separation by Knelson

The results of gravity concentration test work are shown in Table 5, for the G478923 gold ore sample and Table 6 for the Composite gold ore sample. As indicated the G478923 sample is highly amenable to gravity upgrading of the gold as ~67% (92.53g/t Au) of the gold and ~3% of the mass reported to the gravity concentrate. Please note the gold has been upgraded from 3.47g/t Au from the head grade, to 92.53g/t Au in the gravity concentrate. Although this is a significant increase in grade, some gold still remains in the tailings which have been downgraded from 3.47g/t Au to 1.16g/t Au. The tailings still contain some of the gold (~33%). The results of the gravity test work are presented graphically in Figure 5, which shows that most material reported to the tailings which show a downgrading of gold. Gold is upgraded in the gravity concentrate.

Table 5 : Results of the gravity separation test work conducted on the G478923 gold ore sample.

Fraction	Mass		Gold		Total Sulphur	
	Mass (g)	Dist. %	g/t	Dist. (%)	%	Dist. (%)
Tailings	7742.90	97.47	1.16	32.58	2.03	88.73
Conc.	200.83	2.53	92.53	67.42	9.94	11.27
Head	7943.7	100.00	3.47	100.00	2.23	100.00

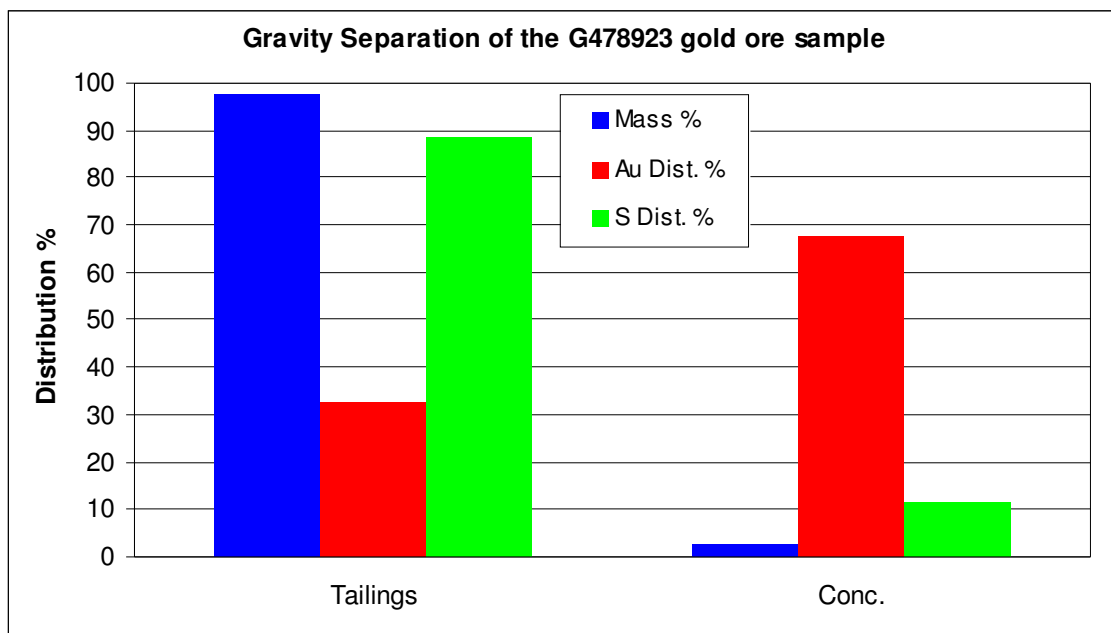


Figure 4: Gravity separation test result of the G478923 gold ore sample.

The Composite gold ore sample is to some extent amenable to gravity upgrading of the gold as only ~56% (134.83 g/t Au) of the gold and ~3% of the mass reported to the gravity concentrate. Please note the gold has been upgraded from 7.28g/t Au from the head grade, to 134.83g/t Au in the gravity concentrate. Although this is a significant increase in grade, much gold still remains in the tailings which have been downgraded from 7.28g/t Au to 3.32g/t Au. The tailings still contain much of the gold (~44%). The results of the gravity test work are presented graphically in Figure 5, which shows that most material reported to the tailings which show a downgrading of gold.

Table 6: Results of the gravity separation test work conducted on the Composite gold ore sample.

Fraction	Mass		Gold		Total Sulphur	
	Mass (g)	Dist. %	g/t	Dist. (%)	%	Dist. (%)
Tailings	7665.30	96.99	3.32	44.21	<0.01	3.01
Conc.	238.18	3.01	134.83	55.79	<0.01	96.99
Head	7903.5	100.00	7.28	100.00	<0.01	100.00

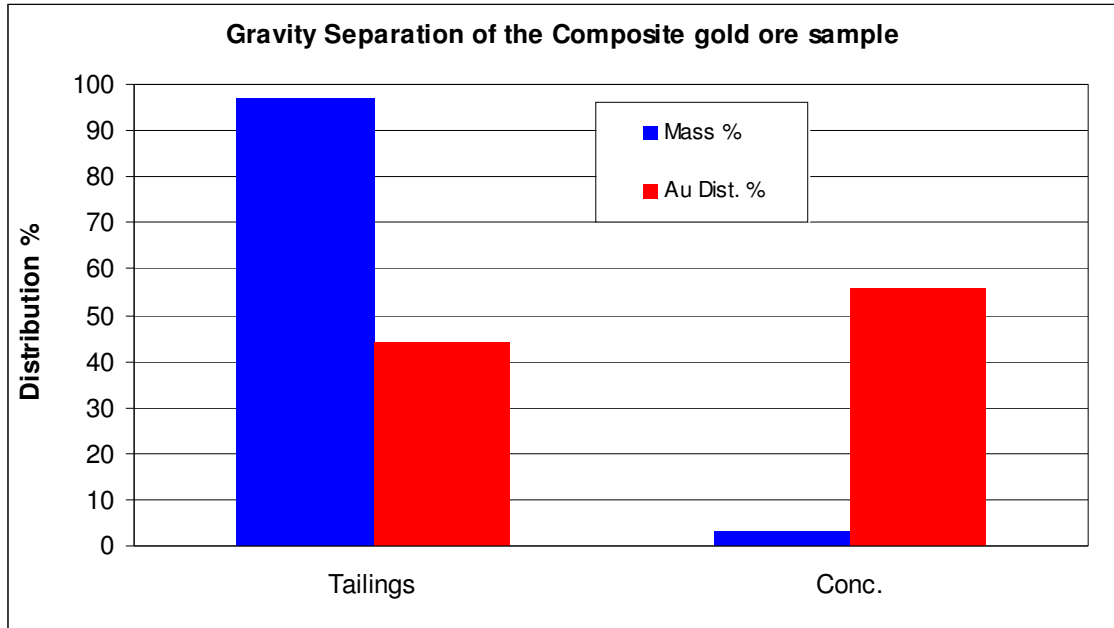


Figure 5: Gravity separation test result of the Composite gold ore sample.

Please note that the gravity test in this section was done at a grind size of ~ 50%-75 μ m.

4.4. Grading Analyses

The results of the grading analyses done on the G478923 gold ore are given in Table 7. The results indicate that most of the gold, ~69% (11.40 g/t Au) is found in particles larger than +106 μ m, which represent ~40% of the sample by mass. The finer size fractions have a constant gold distribution of ~7.1-8.5%. The -25 μ m particles contains the second highest mass distribution of ~30%, with the highest amount of sulphur at ~27% (1.84% S).

The fact that the highest gold grade occurs in the largest size fraction suggests that most of the gold occurs as large liberated gold grains or gold contained in large particles (>106 μ m).

From Figure 6 it can be seen that most of the gold reports to the +106 μ m fraction, where the gold is upgraded. Gold is downgraded in all the other size fractions, but the greatest downgrading occurs in the -25 μ m. This indicates a low amount of small liberated gold grains.

Table 7: Results of the grading analyses from the G478923 gold ore sample.

Fraction	Mass		Mass - Cumulative		Gold		Total Sulphur	
	Mass (g)	Dist. (%)	% retain	% pass	Grade (g/t)	Dist. (%)	Grade (%)	Dist. (%)
+106µm	196.98	39.89	39.89	60.11	11.40	68.73	1.22	23.90
+75µm	41.08	8.32	48.21	51.79	5.62	7.07	2.95	12.05
+53µm	41.90	8.49	56.70	43.30	6.60	8.46	3.15	13.12
+25µm	67.06	13.58	70.28	29.72	3.97	8.15	3.61	24.07
-25µm	146.76	29.72	100.00	0.00	1.69	7.59	1.84	26.85
Total	493.78	100.00			6.62	100.00	2.04	100.00

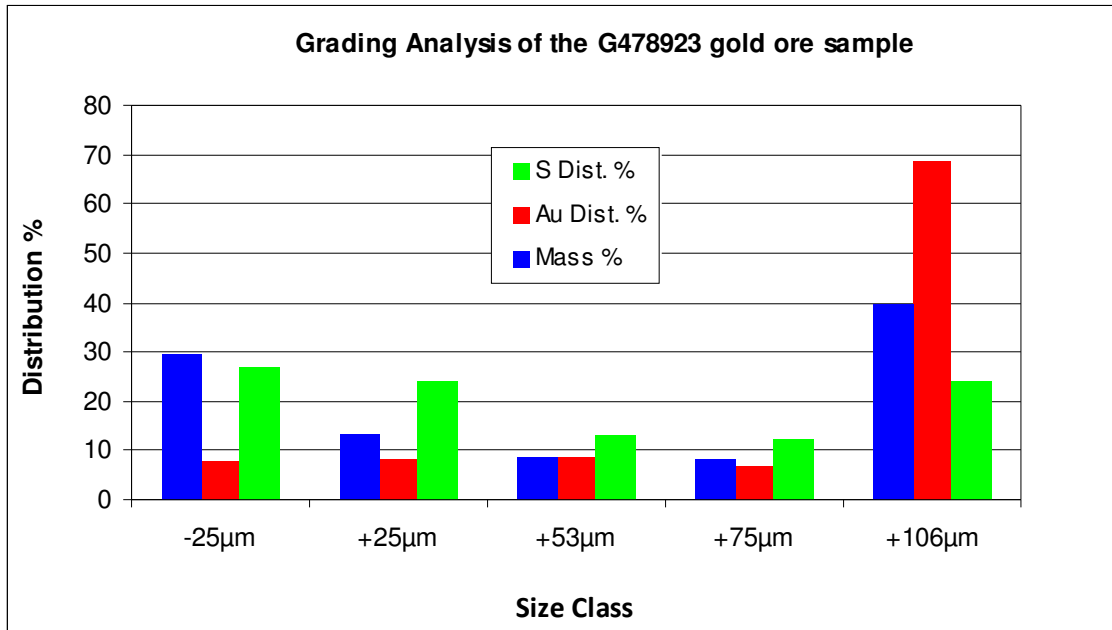


Figure 6: Results of the grading analyses performed on the G478923 gold ore sample.

The results of the grading analyses done on the Composite gold ore are given in Table 8. The results indicate that most of the gold, ~70% (15.8 g/t Au) is found in particles larger than +106µm, which represent ~26% of the sample by mass. The -25µm size fraction contains the second highest gold distribution ~16% (1.73 g/t Au), which has a mass of ~54%.

The remaining size fractions of +75µm to +25µm have relatively low mass and gold distributions.

The fact that the highest gold grade occurs in the largest size fraction suggests that most of the gold occurs as large liberated gold grains or gold contained in large particles (>106µm).

From Figure 6 it can be seen that most of the gold reports to the +106µm fraction, where the gold is highly upgraded. The gold is most downgraded in the -25µm size fraction but all the other size fractions have a slight downgrading as well.

Table 8: Results of the grading analyses from the Composite gold ore sample.

Fraction	Mass		Mass - Cumulative		Gold		Total Sulphur	
	Mass (g)	Dist. (%)	% retain	% pass	Grade (g/t)	Dist. (%)	Grade (%)	Dist. (%)
+106µm	133.17	26.15	26.15	73.85	15.8	69.29	0.02	29.16
+75µm	19.22	3.77	29.93	70.07	5.37	3.40	0.01	2.10
+53µm	25.22	4.95	34.88	65.12	5.86	4.87	0.02	5.52
+25µm	57.15	11.22	46.10	53.90	3.62	6.81	0.005	3.13
-25µm	274.44	53.90	100.00	0.00	1.73	15.63	0.02	60.09
Total	509.20	100.00			5.96	100.00	0.02	100.00

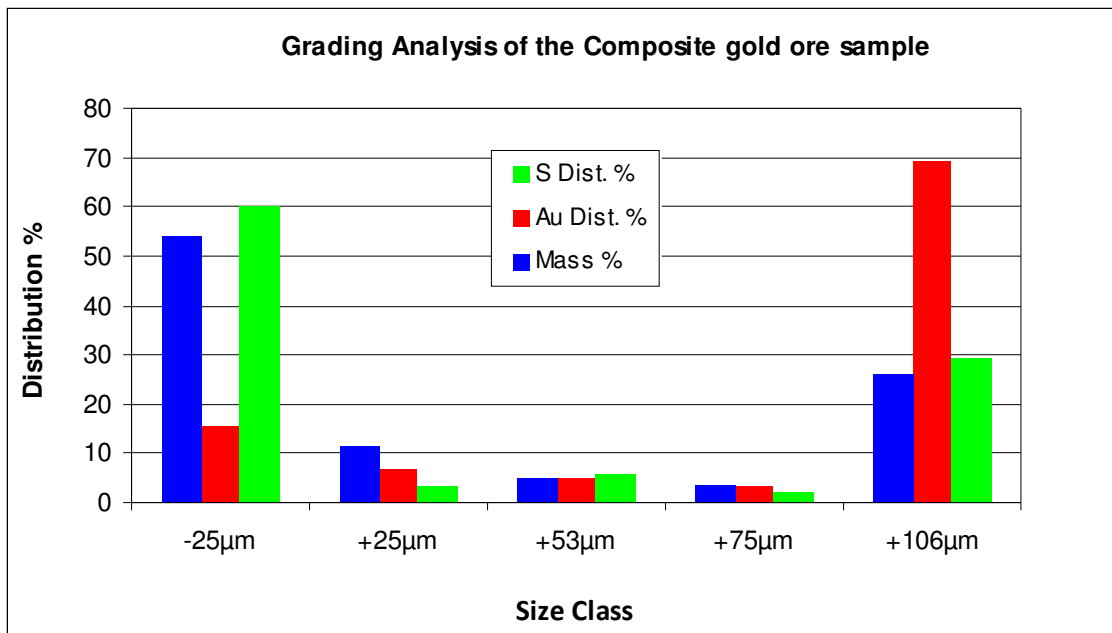


Figure 7: Results of the grading analyses performed on the Composite gold ore sample.

4.5. X-ray Diffraction (XRD)

XRD analysis revealed that G478923 gold ore sample is composed of the following minerals:

Mineral

- Quartz (SiO_2)
- Clinocllore ($(Mg, Fe^{2+})_5Al(AlSi_3O_{10})(OH)_8$)
- Muscovite ($KAl_2(AlSi_3O_{10})(F, OH)_2$)
- Amphibole ($(Mg, Fe)_7Si_8O_{22}(OH)_2$)
- Albite ($NaAlSi_3O_8$)
- Talc ($Mg_3SiO_2(H_2O)$)
- Pyrite (FeS_2)
- Dolomite ($CaMg(CO_3)_2$)

The results agree with the sample chemistry given in Table 1, which show a high silica oxide content (~50%) explaining the quartz in the sample. The presence of aluminium oxide (~12%) is explained by the presence of albite and muscovite, plagioclase and mica minerals respectively. Clinocllore is a common chlorite mineral. Pyrite, talc and dolomite occur in low amounts. The X-ray diffractogram of the sample is given in Figure 8 below, indicating peaks for the respective minerals.

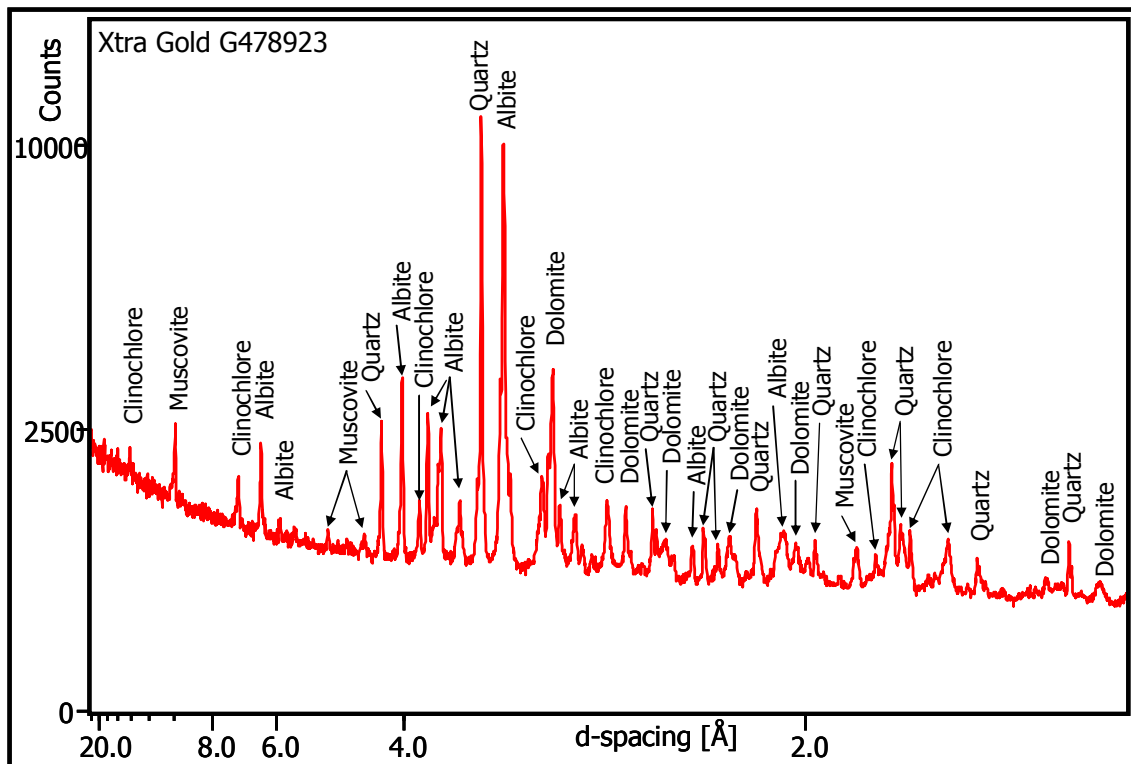


Figure 8: X-ray diffractogram of the G478923 sample.

XRD analysis revealed that Composite gold ore sample is composed of the following minerals:

Mineral

- Quartz (SiO_2)
- Clinocllore ($(Mg, Fe^{2+})_5Al(AlSi_3O_{10})(OH)_8$)
- Muscovite ($KAl_2(AlSi_3O_{10})(F, OH)_2$)
- K-feldspar ($KAlSi_3O_8$)
- Albite ($NaAlSi_3O_8$)
- Pyroxene ($(Fe, Mg)SiO_3$)
- Pyrite (FeS_2)

The results agree with the sample chemistry given in Table 1, which show a high silica oxide content (~67%) explaining the quartz in the sample. The presence of aluminium oxide (~14%) is explained by the presence of albite and muscovite, plagioclase and mica minerals respectively. Clinocllore is a common chlorite mineral. Pyrite and pyroxene occur in low amounts. The X-ray diffractogram of the sample is given in Figure 9 below, indicating peaks for the respective minerals.

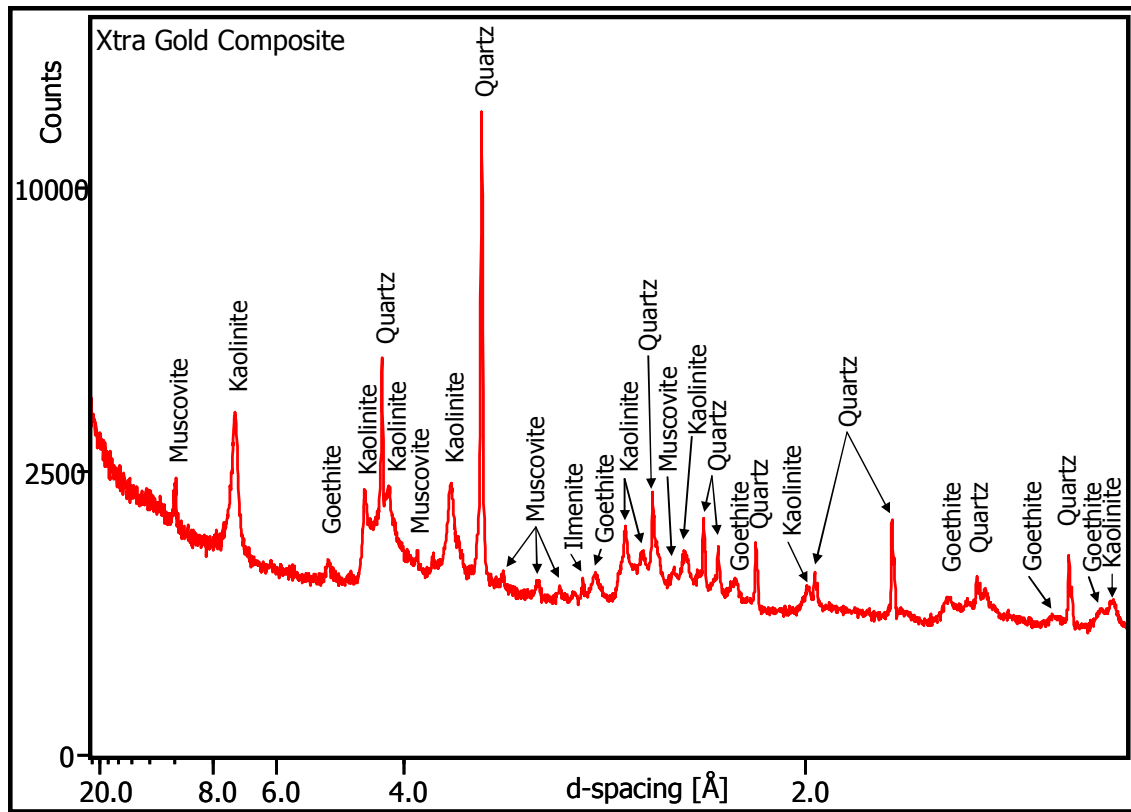


Figure 9: X-ray diffractogram of the Composite gold ore sample.

4.6. Bulk Modal Analysis (BMA)

The mineralogical compositions of the head samples and gravity concentrate fractions, as determined by QEMSCAN Bulk Modal Analysis (BMA), are given in Table 9 below and are presented graphically in Figure 10. The BMA was conducted on 2 polished blocks of the head sample and 2 of the gravity concentrate fraction of the sample. The QEMSCAN modal analysis confirms the XRD mineral identification.

Table 9: Mineralogical composition of the G478923 and Composite gold ore samples.

Mineral	Approximate Formula	G478923		Composite	
		Head	Grav. Conc.	Head	Grav. Conc.
Pyrite/ pyrrhotite	FeS ₂	7.02	35.15	0.02	0.01
Chalcopyrite	CuFeS ₂	0.03	0.03	0.00	0.00
Arsenopyrite	FeAsS	0.24	8.45	0.00	0.00
Galena	PbS	0.00	0.00	0.00	0.00
Sphalerite	ZnS	0.03	0.02	0.00	0.00
Other sulphides		0.01	0.00	0.00	0.00
Total Sulphides		7.31	43.66	0.02	0.01
Quartz	SiO ₂	15.74	8.42	15.35	26.20
Kaolinite	Al ₄ Si ₄ O ₁₀ (OH) ₈	11.56	2.18	43.57	7.97
Plagioclase	(Ca,Na)AlSi ₃ O ₈	32.33	19.05	0.78	1.43
Mica	KAl ₃ Si ₃ O ₁₀ (OH) ₂	9.92	6.10	18.53	8.36
Amphibole	Fe ₂ Mg ₅ Si ₈ O ₂₂ (OH) ₂	2.25	0.54	0.01	0.01
Chlorite	(Mg,Fe) ₃ (Si,Al) ₄ O ₁₀ (OH) ₂ (Mg,Fe) ₃ (OH) ₆	2.77	1.02	4.58	1.39
Sphene	CaTiSiO ₅	0.02	0.03	0.00	0.00
Zircon	ZrSiO ₄	0.09	0.04	0.06	0.03
Total Silicates		74.68	37.38	82.87	45.38
Fe-oxide/ hydroxide	Fe ₂ O ₃ - FeOOH	4.20	4.00	14.94	46.84
Ilmenite	FeTiO ₃	1.49	4.86	1.22	5.41
Rutile	TiO ₂	0.20	0.67	0.72	2.07
Chromite	FeCr ₂ O ₄	0.03	0.01	0.00	0.00
Total Oxides		5.93	9.53	16.88	54.33
Apatite	Ca ₅ (PO ₄) ₃ (F,Cl,OH)	0.67	0.43	0.02	0.00
Carbonates	CaCO ₃ to Ca(Mg,Fe)(CO ₃) ₂	11.27	8.88	0.03	0.01
Monazite	(Ce,La)PO ₄	0.01	0.04	0.08	0.11
Total Phospho-Carbonates-Sulphates		11.96	9.35	0.13	0.12
Other		0.12	0.08	0.09	0.16
Total		100	100	100	100

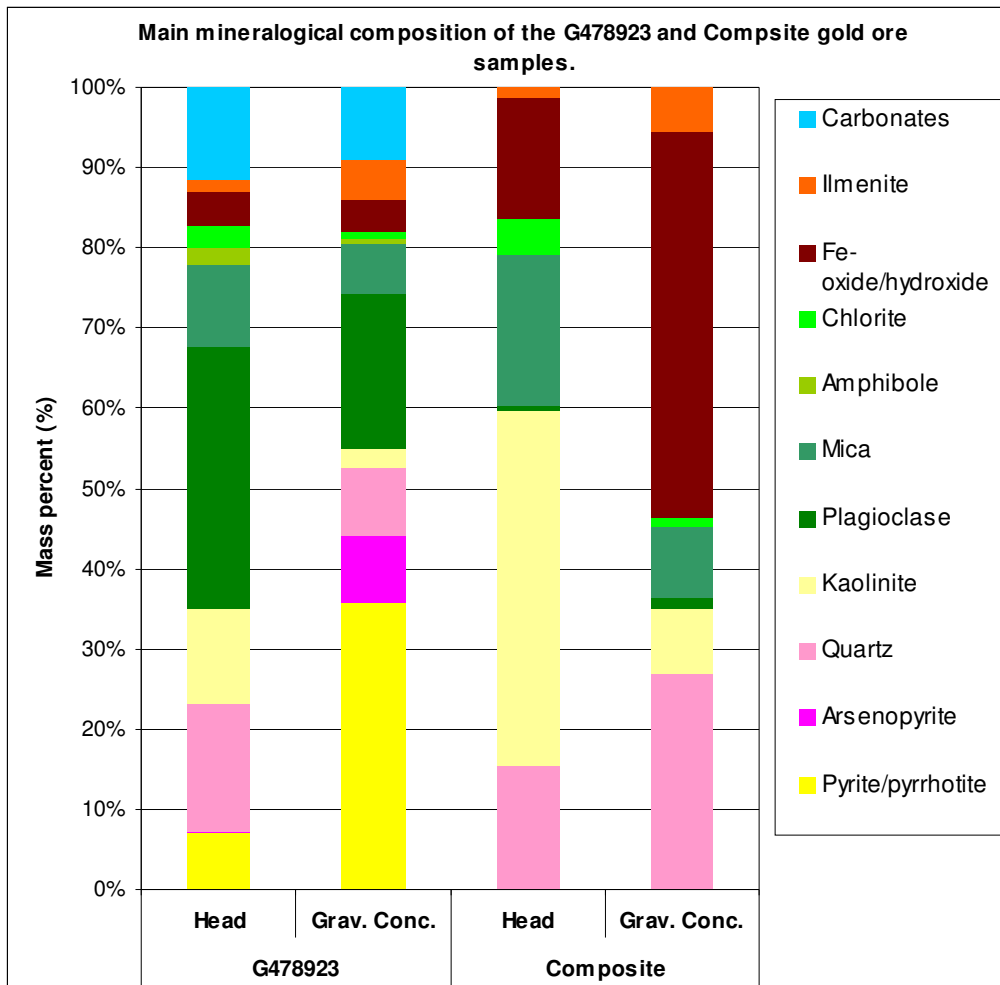


Figure 10: Bulk mineral composition of the G478923 and Composite gold ore samples.

4.7. Gold Department

The aim of the Trace Mineral Search (TMS) analysis is to first locate, then measure and finally describe the mineral associations of all the gold grains located in the analysis plane of the polished sections. The QEMSCAN was set up to find and map particles containing areas of high backscattered electron (BSE) intensity (including gold grains). Gold department analysis includes Au-phase speciation, liberation characteristics, mineral exposure, association characteristics and gold grain-size distribution.

For the TMS 10 polished sections of the gravity concentrate fraction were analysed by means of QEMSCAN in order to describe all the gold-bearing particles present in the analysis plane of these sections.

4.7.a. Gold Grain Speciation

Scanning Electron Microscope Energy Dispersive Spectrometry (SEM-EDS) analyses indicated that the gold occurs as *native gold* (Ag<25%) containing variable amounts of silver and minor *electrum* (Ag>25%).

4.7.b. Gold Containing Particles

The particle images were analysed using iDiscover 5.2 software. The following two-dimensional parameters were measured for each gold grain:

- **Area:** Size of particles μm^2 .
- **Total gold:** Size of the gold μm^2 occurring in the particles.
- **Equivalent circular diameter (ECD):** Diameter of a circle with the same area as that of the particles/ grains

Scanning Electron Microscope – Backscattered Electron (SEM-BSE) images, and QEMSCAN particle maps, depicting selected gold containing particles are given in Figure 11, Figure 12 and Figure 13. Some gold grains are associated with sulphides. Silicate and oxide-rich particles containing gold were found. The gold grain dimensions are given in section 4.7.c.

A total of 83 gold containing particles were found in the G478923 gravity concentrate. In the 83 gold containing particles 143 gold grains were found. In the Composite gravity concentrate there were 32 gold containing particles found. The Composite gold containing particles contained 125 gold grains.

The gold-containing particle sizes of the G478923 gravity concentrate, in Table 10, shows that the minimum, maximum and average particle size (ECD in μm) was 2.71 μm , 561.91 μm and 133.27 μm , respectively. The Composite gravity concentrate had gold containing particles with a minimum size of 1.36 μm , a maximum size of 779.65 μm and an average size of 299.07 μm ECD.

Table 10: Gold particle data of the G478923 and Composite gold ore samples.

No of gold containing particles Particle	Particle Area (pix)	Particle Area (μm^2)	Particle Size ECD (μm)	Total Gold Size (μm^2)	Vol % Gold	No of gold grains	
G478923 gold ore sample							
83	Avg	36557	26393.80	133.27	204.62	28.13	143
	Max	343234	247986.57	561.91	2633.51	100.00	
	Min	8	5.78	2.71	0.37	0.00	
Composite gold ore sample							
32	Avg	211385	146038.93	299.07	259.14	35.29	125
	Max	660766	477403.44	779.65	3632.73	100.00	
	Min	2	1.45	1.36	0.72	2.63	

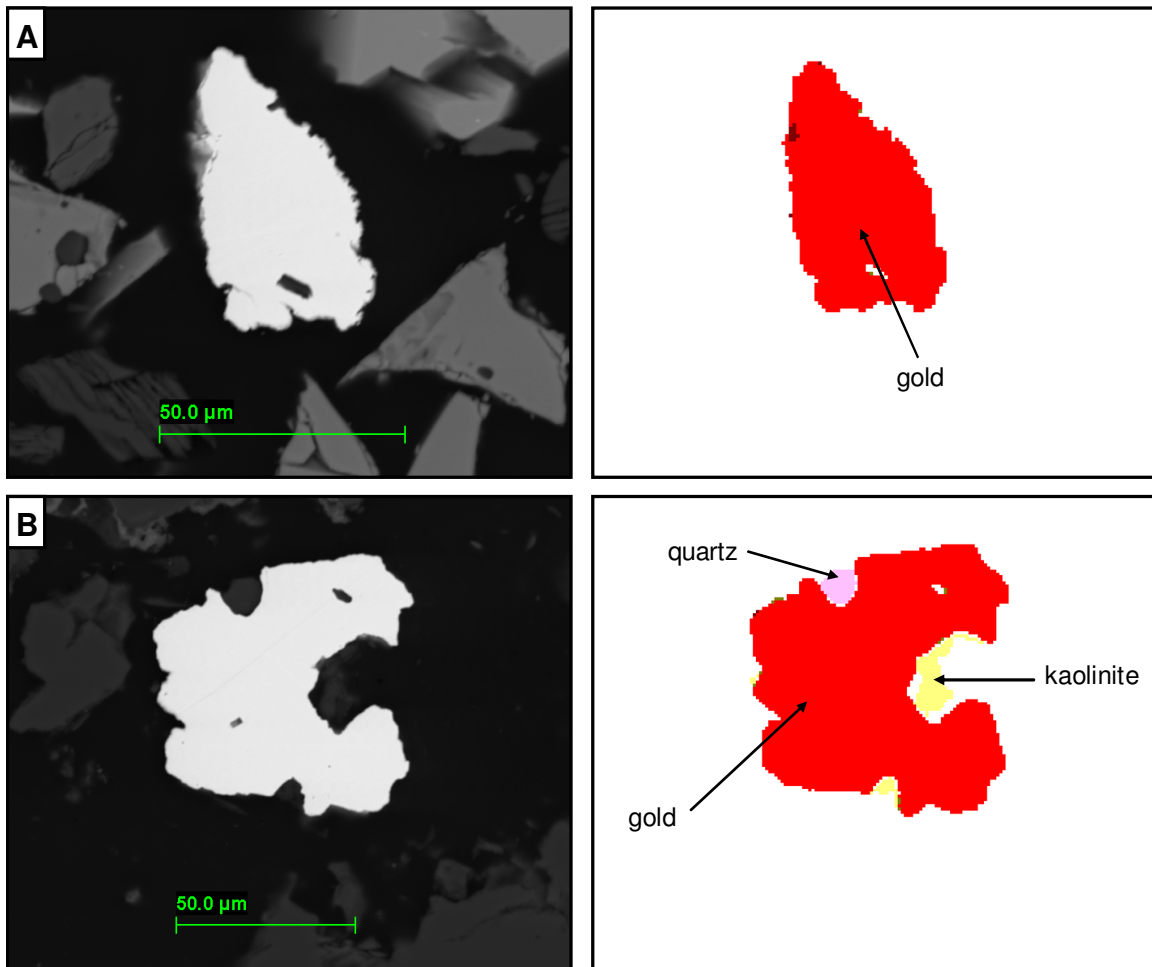


Figure 11: On the right hand side is a QEMSCAN particle map of the gold containing particle and on the left is the Scanning Electron Microscope image. A) This is a large, librated gold grain from the G478923 sample. B) A large librated gold grain in contact with silicate minerals from the Composite sample.

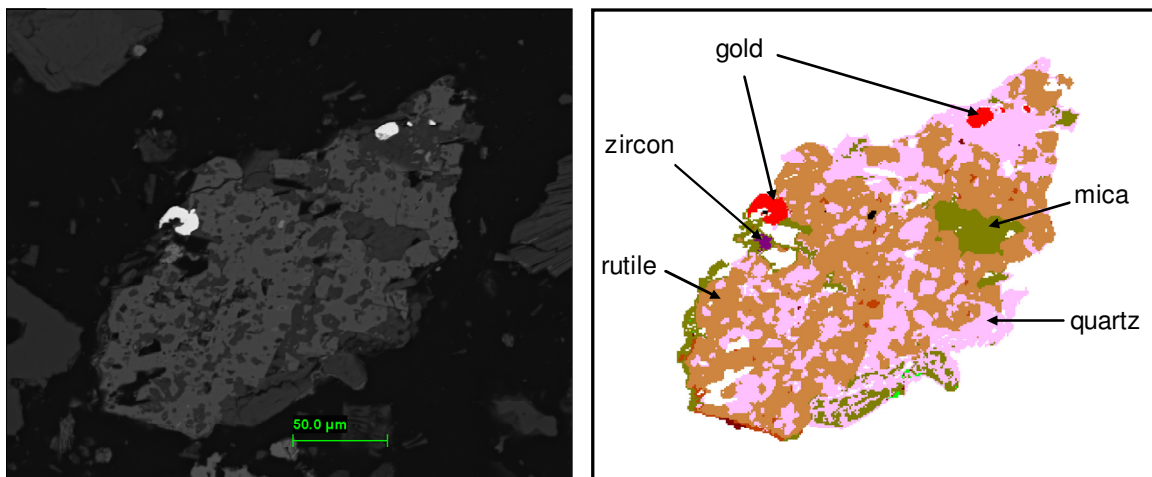


Figure 12: Shown is a large gold containing particle where two, medium sized, gold grains are locked within quartz and rutile, from the Composite sample.

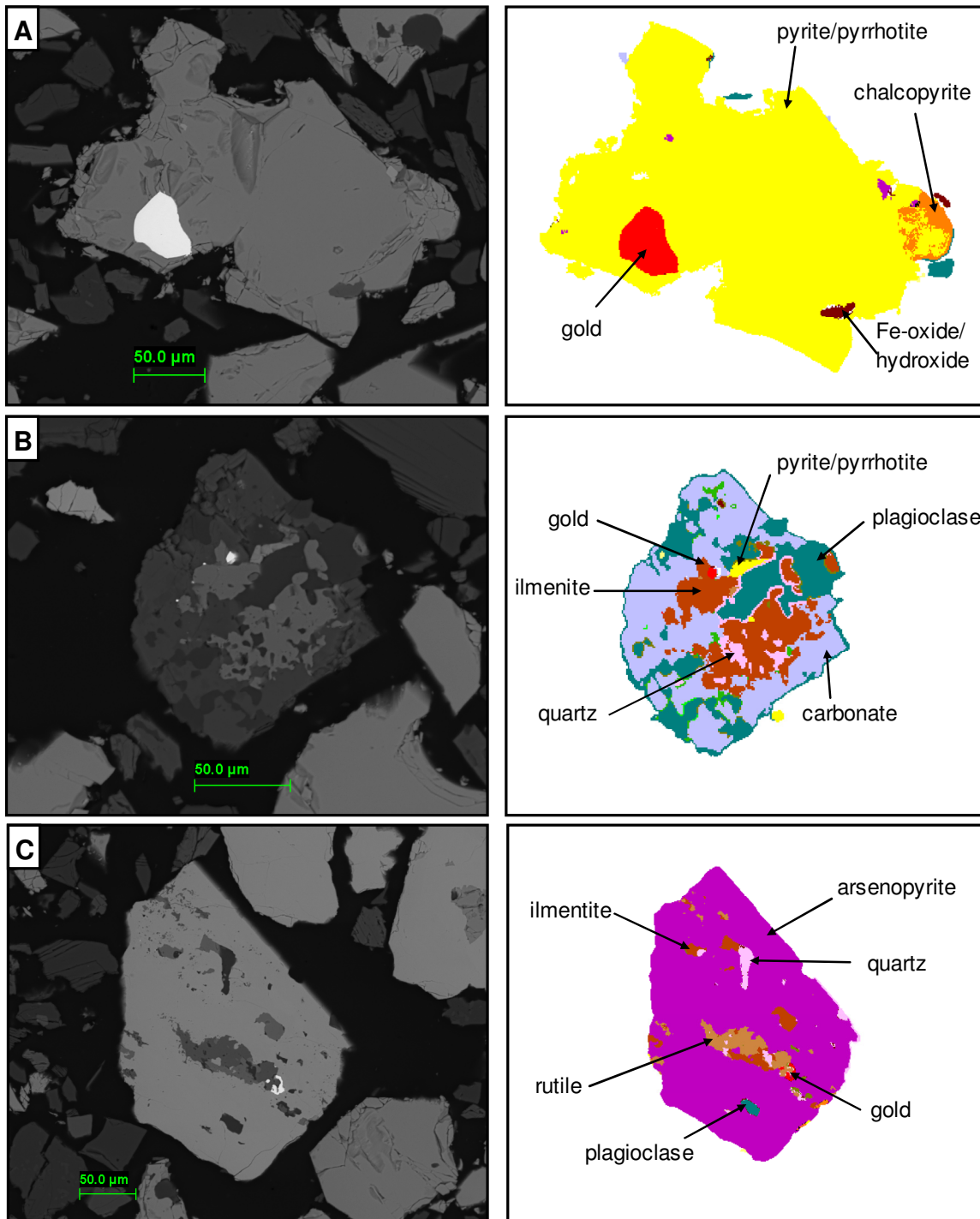


Figure 13: Shown are gold containing particles from the G478923 sample. A) A medium sized gold grain locked in pyrite/pyrrhotite. B) A small gold grain is locked on the boundary of ilmenite and a carbonate mineral. C) A small gold grain is locked on the boundary of rutile and arsenopyrite.

4.7.c. Gold Grain Dimensions

Gold grain dimensions were calculated from the results of the trace mineral search. The results are in line with the grading analysis done in section 4.4. The grain dimensions also give an indication of the necessary grind size needed to expose the gold.

The grain size distribution of the gold grains is given in Table 11. The majority of the gold by mass is greater than 25µm ECD. The G478923 and Composite samples has >60% of its gold by mass in the coarser size fractions.

Table 11: Gold grain size distribution of the G478923 and Composite gold ore samples.

Gold ore sample Size Class ECD (µm)	G478923			Composite		
	Mass % Gold	Area (pix)	N	Mass % Gold	Area (pix)	N
< 1	0.14	33	33	0.34	39	39
≥ 1 < 5	1.89	461	60	4.73	544	58
≥ 5 < 10	5.03	1226	23	8.36	961	16
≥ 10 < 15	4.08	996	7	4.63	532	4
≥ 15 < 20	9.06	2210	7	11.89	1367	4
≥ 20 < 25	6.51	1587	3	5.48	630	1
≥ 25 < 30	13.33	3251	3	0.00	0	0
≥ 30 < 35	10.48	2559	2	20.83	2395	2
≥ 35 < 40	12.58	3067	2	0.00	0	0
≥ 40 < 50	8.36	2039	1	0.00	0	0
≥ 50 < 60	28.54	6961	2	0.00	0	0
≥ 60 < 80	0.00	0	0	43.74	5028	1
≥ 80	0.00	0	0	0.00	0	0
Total	100	24390	143	100	11496	125

Please note that touching grains were combined (measured as one grain).

The grading analysis done in Section 4.4 indicate that most of the gold, ~69% is found in particles larger than +106 µm and the finer size fractions have a constant gold distribution of ~7.1-8.5% for the G478923 gold ore sample. Most of the gold grains, by quantity, found were smaller than 25µm. This suggests that there are large liberated gold grains and abundant small gold grains, some of which are locked in larger particles (>106µm).

The Composite gold ore sample indicated that most of the gold (~70%), by mass reported to the +106µm fraction and ~16% reported to the -25µm fraction. Indicating that there are a few large liberated gold grains and small locked gold grains in large particles.

4.7.d. Gold Grain Exposure and Mineral Association

The gold grain exposure and association characteristics are given in Table 12. The exposure of gold is directly related to the ability of gold to be leached during cyanidation. The direct cyanidation given in Section 4.7.f should correlate with Table 12.

The gold containing particles were classified into following classes;

- **Exposed (≥80%):** More than 80% surrounded by background.
- **Exposed (≥10%<80%):** Between 80 and 10% surrounded by background.
- **Exposed (<10%):** Less than 10% surrounded by background.

- **Locked in mineral (100%):** Surrounded by sulphides, silicates, oxides or carbonates/phosphates/sulphates.
- **Locked on the boundary:** locked between two minerals with no exposure.
- **Locked on polymineral boundary:** If the gold grain is locked on multiply grain boundaries with no exposure and does not fall into the above categories.

The exposure of gold in the G478923 sample is relatively high with ~90% of it having some exposure and ~8% locked on sulphide-oxide boundaries. The Composite sample has ~96% of its gold with some exposure and only ~2% locked in oxide minerals.

Table 12: Gold grain exposure and mineral association of the G478923 and Composite gold ore samples.

Gold ore sample	G478923			Composite		
	Mass % Gold	Area (pix)	N	Mass % Gold	Area (pix)	N
Exposed (≥80%)	62.53	15249	23	58.84	6764	10
Exposed (≥10%<80%)	27.13	6618	35	37.49	4310	58
Exposed (<10%)	0.43	105	4	0.63	72	2
Locked in sulphide (100%)	1.43	348	39	0.00	0	0
Locked in silicate (100%)	0.00	0	0	0.08	9	6
Locked in oxide (100%)	0.11	28	10	2.28	262	35
Locked in carb/phos/sulphates (100%)	0.00	0	0	0.00	0	0
Locked on sulphide-silicate boundary	0.00	0	0	0.00	0	0
Locked on sulphide-oxide boundary	7.93	1935	20	0.00	0	0
Locked on sulphide-carb/phos/sulphates boundary	0.00	0	0	0.00	0	0
Locked on silicate-oxide boundary	0.01	2	2	0.67	77	13
Locked on silicate-carb/phos/sulphates boundary	0.00	0	0	0.00	0	0
Locked on poly-mineral boundary	0.43	105	10	0.02	2	1
Total	100	24390	143	100	11496	125

4.7.e. Gold Particle Types and Mineral Association

The liberation and association characteristics of the G478923 and Composite gold ore samples are given in Table 13.

The gold containing particles were classified into the following classes:

- **Lib Gold:** More than 80 area % of the particle is gold.
- **High Middling Gold:** Between 50 area % and 80 area % of the particle is gold.
- **Low Middling Gold:** Between 30 area % and 50 area % of the particle is gold.
- **Lib Py:** More than 80 area % of the particle is pyrite.
- **Lib Aspy:** More than 80 area % of the particle is arsenopyrite.
- **Lib Other Sulp:** More than 80 area % of the particle is sulphide.
- **Sulp Midd: Hi Py:** Middling sulphides (>50 and ≤80 area %) and pyrite >25 area %.
- **Sulp Midd: Other:** Middlings sulphides (>30 and ≤80 volume %) particle is a sulphide.
- **Hi Silicate:** More than 70 area % of particle is a silicate.
- **Midd Silicate:** Middling silicates (>50 and ≤70 area %) of the particle is a silicate.
- **Hi Oxide:** More than 70 area % of particle is an oxide.

- **Midd Oxide:** Middling oxides (>50 and ≤70 area %) of the particle is an oxide.
- **Hi Carbonate:** More than 70 area % of particle is a carbonate.
- **Poly-mineral:** More than 0 area % of particle is gold and does not fall under the above categories.

In Table 13 the G478923 sample has ~63% of its gold well liberated and ~25% of its gold locked within liberated pyrite. The Composite sample has ~61% of its gold liberated and ~15% partially liberated. The Composite has ~10% and ~14% locked in silicates and oxides, respectively.

Table 13: Mass distribution of particulate gold per gold containing particle class.

Mass %	G478923	Composite
	Grav. Conc.	Grav. Conc.
Lib Gold	63.23	60.86
Hi Midd Gold	2.56	15.32
Low Midd Gold	0.24	0.01
Lib Py	25.08	0.00
Lib Aspy	2.03	0.00
Lib other sulphides	0.11	0.00
Sulp Midd: Hi Py	0.01	0.00
Sulp Midd: other	0.01	0.00
Hi silicate	2.55	1.28
Midd silicate	1.98	8.99
Hi oxide	0.89	5.51
Midd oxide	0.06	8.03
Hi carbonate	0.00	0.00
Poly-mineral particles	1.26	0.00

4.7.f. Direct Cyanidation and Diagnostic Leach Test

A direct cyanidation (on the head samples) and diagnostic leach test (on the gravity tailings samples) were performed on each sample. The leach conditions for the direct cyanidation test are given in Table 14 and the results are given in Table 15. Approximately 96.88% of the gold in the G478923 gold ore sample was recovered by direct cyanidation. The cyanide leach test was an excess leach test. Approximately 98.2% of the gold in the Composite gold ore sample was recoverable by direct cyanidation.

Table 14: Direct Cyanidation conditions for leach test on the G478923 and Composite gold ore samples.

Sample ID	units	ROM		
% Solids	(%)	50		
Pre-conditioning period	Hrs	1.0		
Liquid: Solid ratio		1:1		
Grind	(%)	80%- 75µm		
Dissolution period	Hrs	48.0		
Carbon addition:	g/l	20.0		
CaO addition	kg/t	0.33		
Cyanide addition	kg/t	5.00		
G478923	Au g/t	6.21	5.77	6.64
Composite	Au g/t	3.47	3.03	3.91

Table 15: Results of direct cyanidation test on the G478923 and Composite gold ore samples.

Reagent addition		Pregnant solution				Head		Residue
NaCN	CaO	NaCN	CaO	Int pH	Au	Assay	Calc.	Au
(kg/t)	(kg/t)	(%)	(%)		(PPM)	Au (g/t)	Au (g/t)	(g/t)
G478923 gold ore sample								
5.00	0.33	0.479	0.003	11.0	<0.1	3.47	3.33	0.10
Composite gold ore sample								
5.00	0.33	0.464	0.003	11.0	<0.1	6.21	5.94	0.11
Carbon	Reagent consumption		Dissolution (Assay)		Dissolution (Calc)		Account	
Au	NaCN	CaO	Sol + Carbon	Solid	Sol + Carbon	Solid	Au	
(g/t)	(kg/t)	(kg/t)	Au (%)	Au (%)	Au (%)	Au (%)	(%)	
G478923 gold ore sample								
107	0.21	0.30	92.92	54.25	96.88	96.88	95.92	
Composite gold ore sample								
195	0.36	0.30	94.04	98.28	98.20	98.20	95.76	

The G478923 gravity tailings had a gold grade of 1.279g/t. Of the total contained gold, 96.11% was amenable to direct cyanidation. Under direct cyanidation conditions, 0.61% of the gold was preg-robbed by components occurring within the sample. Some 96.72% of the contained gold is expected to be recoverable via carbon-in-leach processing.

Of the remaining gold, 0.54% (0.007g/t Au) was found to be occluded in siliceous gangue components. Some 0.09% (0.001g/t Au) of the gold was associated with carbonaceous constituents. The HCl digestion revealed that 1.87% (0.024g/t Au) of the contained gold was associated with HCl digestible minerals. The HNO₃ digestion phase showed that 0.78% (0.010g/t Au) of gold was associated with HNO₃ digestible minerals.

The Composite gravity tailings had a gold grade of 3.700g/t. Of the total contained gold, 96.93% was amenable to direct cyanidation. Under direct cyanidation conditions, 2.24% of the gold was preg-robbed by components occurring within the sample. Some 99.17% of the contained gold is expected to be recoverable via carbon-in-leach processing.

Of the remaining gold, some 0.16% (0.006g/t Au) was found to be occluded in siliceous gangue components. Some 0.06% (0.002g/t Au) of the gold was associated with carbonaceous constituents. The HCl digestion revealed that 0.11% (0.004g/t Au) of the contained gold was associated with HCl digestible minerals. The HNO₃ digestion phase showed that 0.50% (0.019g/t Au) of gold was associated with HNO₃ digestible minerals.

Table 16: Results of sequential diagnostic leach on the G478923 and Composite gravity tailings.

Gold association	G478923		Composite	
	Au g/t	%	Au g/t	%
Available to direct cyanidation	1.229	96.11	3.586	96.93
Preg-robbed – CIL	0.008	0.61	0.083	2.24
HCl digestible minerals	0.024	1.87	0.004	0.11
HNO ₃ digestible minerals	0.010	0.78	0.019	0.50
Carbonaceous matter	0.001	0.09	0.002	0.06
Quartz (balance)	0.007	0.54	0.006	0.16
Total	1.279	100.00	3.700	100.00

Table 17: Mass results of the sequential diagnostic leach on the G478923 and Composite gravity tailings.

Stage	G478923				Composite			
	Mass in	Mass out	Mass Loss (stage)		Mass in	Mass out	Mass Loss (stage)	
	grams	grams	grams	%	grams	grams	grams	%
HCL Leach	1068.13	945.75	122.38	11.46	1068.13	945.75	122.38	11.46
HNO₃ Leach	826.32	810.89	15.43	1.87	826.32	810.89	15.43	1.87
Roast	672.39	654.92	17.47	2.60	672.39	654.92	17.47	2.60

5. DISCUSSION AND CONCLUSIONS

The gold in the G478923 gold ore sample (3.49g/t Au) is highly amenable to cyanidation leaching with ~97% recoverable by means of direct cyanidation. This ore is also amenable to gravity upgrading, with ~67% of the gold recovered at a mass pull of ~3%. In the gravity concentrate (95.5g/t Au) a total of 143 particulate gold grains were observed in the gravity concentrate of this sample.

The grading analysis on the G478923 gold ore sample indicated a very high upgrading of gold in the +106 μ m size fraction (~69%). This indicates that the gold is either large gold grains or locked in large gold bearing particles. From the liberation and mineral association characteristics determined by QEMSCAN, on the gravity concentrate, the gold was found to be ~63% liberated and ~25% was associated with pyrite. This indicates that the gold is either large, liberated gold grains or locked in large gold-bearing pyrite particles.

The direct cyanidation and diagnostic leach indicates that the sample is highly amenable to cyanide leaching, with ~97% of the gold recovered from the head sample at a grind of 80%-75 μ m by direct cyanidation and ~96% for the gravity tailings at a grind of ~50%-75 μ m. This is corroborated by the exposure and mineral association characteristics as determined by QEMSCAN analysis of the gravity concentrate. Approximately 90% of the particulate gold grains are \geq 10% exposed and should be leachable.

The gold in the Composite gold ore sample (7.28g/t Au) is also highly amenable to cyanidation, with ~97% of the gold recoverable by means of direct cyanidation. This ore is also amenable to gravity upgrading, to some degree, with only ~56% of the gold recovered at a mass pull of ~3%. In the gravity concentrate (134.83 g/t Au) a total of 125 particulate gold grains were observed by QEMSCAN.

The grading analysis on the Composite gold ore sample indicated a very high upgrading of gold in the +106 μ m size fraction (~74%). This indicates that the gold is either large gold grains or locked in large gold bearing particles. From the liberation and mineral association characteristics determined by QEMSCAN analysis of the gravity tailings, it was found that the gold grains were moderately liberated (~76%) and that ~10% was occurring in silicates and ~14% in oxides. This indicates that the gold is either large, liberated gold grains or locked in large gold-bearing silicate/oxide particles.

The direct cyanidation and diagnostic leach tests indicated that the sample is highly amenable to cyanide leaching, with ~98% of the gold recovered from the head sample at a grind of 80%-75 μ m and ~99% of the gold in the gravity tailings at a grind of 50%-75 μ m. This is corroborated by the exposure and mineral association characteristics of particulate gold in the gravity concentrate, as determined by QEMSCAN analysis. Approximately ~96% of the gold grains are \geq 10% exposed and should be leachable.

The most simplistic processing option would be to mill the ore to ~80% -75 μ m followed by Carbon-in-leach (CIL) cyanidation. Another option, which may result in somewhat lower operational cost is to mill the ore relatively coarsely (say 80% -106 μ m) followed by gravity concentration and intensive cyanidation of the gravity concentrate. The gravity tailings could then be milled finer to ~80% -75 μ m, followed by CIL. Taking out the coarse gold and some of the sulphides by gravity, will allow shorter retention times in the leach tanks and possibly even lower cyanide consumption.

A final important note is that the sporadic and relatively coarse gold grains may result in a nugget effect (large assay variability). This could be overcome by assaying large samples (>4kg) by gravity combined by Fire assay (gravity concentrate assayed in totality and tailings in triplicate).