2021 ANNUAL QUARTZ MINING LICENCE REPORT

Submitted to Yukon Government, Energy Mines and Resources

Yukon Quartz Mining Licence QML-0007

March 2022

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Carmacks Project, Yukon Territory

Submitted by:

Granite Creek Copper

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Executive Summary

Activities at the mine site during the period 17 April 2021 to 4 October 2021 consisted of:

- Diamond drilling 18 holes (12 pads, 11 pre-existing) for a total of 6,540.41m on the Boy 22 and Boy 83 claims.
- Reverse Circulation drilling 4 holes (3 pads, all pre-existing) for a total of 405.41m on the X 5, Boy 85 and W 7 claims.

The Annual Physical Inspection occurred on 26th August 2021 by Golder Associates Ltd. (attached).

No development activities were undertaken in 2021.

Closure and reclamation security in the amount of $80,300 has been posted with Yukon against the liability incurred as a result of exploration activities. Further consultation with YTG on progressive security payment adjustments is underway for progressive security adjustments to represent an updated summary of liabilities.

This report has been formatted to respond to the specific requirements in the QML even though there may be no corresponding project undertakings.

The current corporate structure that evidences the ownership of the mining leases underlying QML007 by Granite Creek Copper Ltd. is as follows: [1]838232 Yukon Inc., owner of the Quartz Mining leases, and surrounding Quartz Mining claims is a wholly owned subsidiary of Granite Creek Copper Ltd.

[1] The claims were transferred in early 2022 from Copper North Mining Corp to 838232 Yukon Inc.

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1.0 INTRODUCTION

This Annual Report has been prepared by TruePoint Exploration on behalf of Carmacks Mining Corp. and covers the period from January 1, 2021 to December 31, 2021 as required by Clauses 16.5 and 16.6 of Quartz Mining License (*herein* QML) QML-0007. As of January 19, 2012, the assignment of QML-007 was authorized from Carmacks Copper Limited to Carmacks Mining Corp., a now wholly-owned subsidiary of Granite Creek Copper (*herein* GCX).

This report provides a summary of activities at the Carmacks Property for the reporting year, including, but not limited to, physical stability inspection and exploration.

Few site activities occurred that would normally form a part of this report. The preliminary mine layout (proposed by Copper North) for the copper heap leach project is illustrated in ***Figure 1*** (following page). It should be noted that new ownership (GCX) intends to close this QML in the upcoming year and resume activities under a Class IV Mining Land Use Permit (filed with YESAB on March 5th 2022).

The previous ownership (Copper North) had been working to re-engineer the metallurgical process for the project to recover gold and silver in addition to copper since the QML-0007 was issued. The results of the re-engineering work to date are detailed in a Preliminary Economic Assessment (PEA) completed in October 2016 (JDS, 2016), a copy of which was provided with the 2016 Annual Report and represents the general plan for future development of the deposit, subject to regulatory approvals and financing. Nevertheless, QML-0007 applies to the project as planned at the time of issue and therefore dictates the context for this annual report.

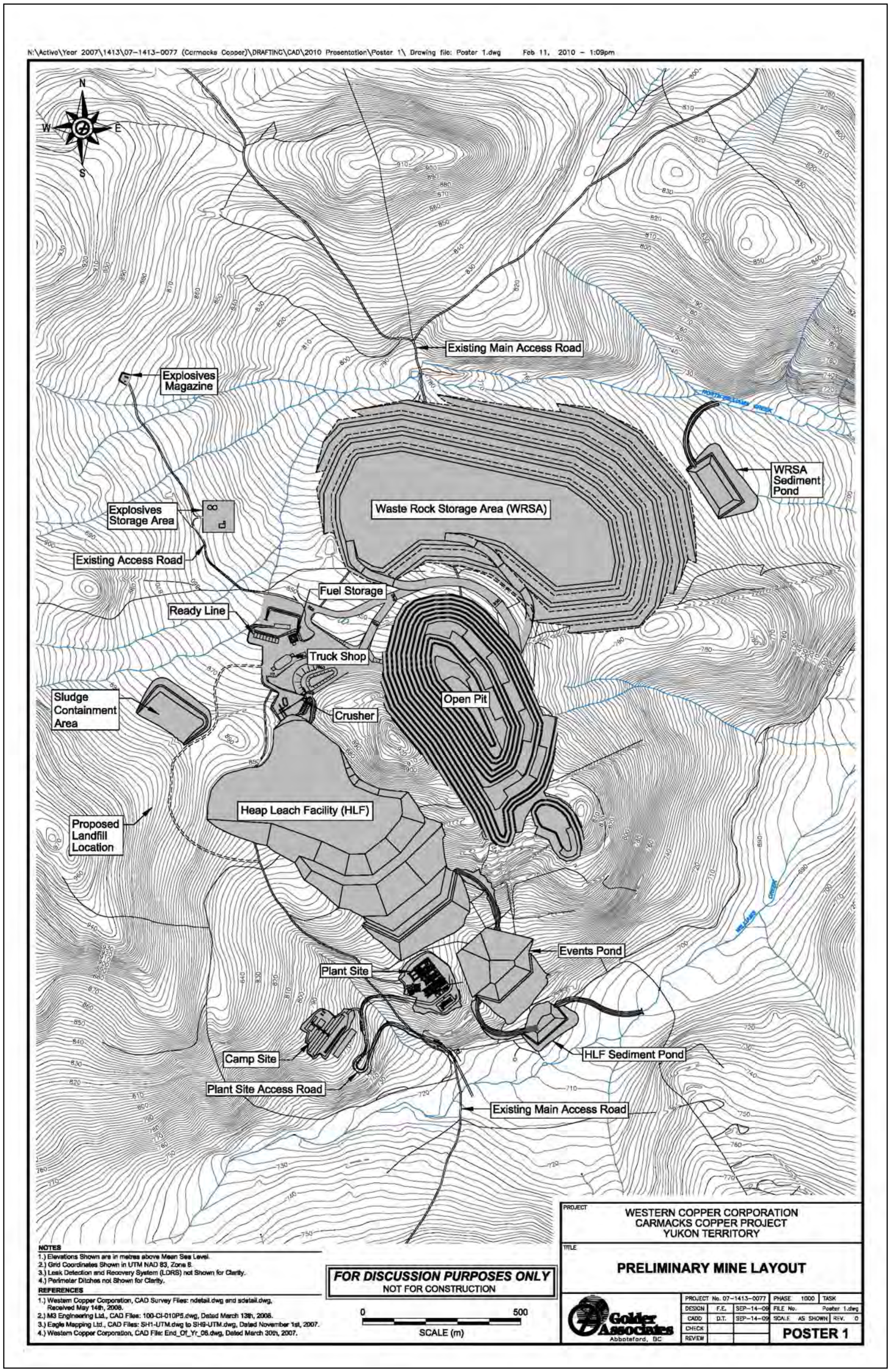


Figure 1. Preliminary Mine Layout (*not yet constructed*)

2.0 SITE ACTIVITIES

2.1 EXPLORATION

2021 Exploration included drilling twenty-two holes, including 18 diamond drillholes and 4 RC for a total meterage of 6,945.82m:

- Diamond drilling 18 holes (12 pads, 11 pre-existing) for a total of 6,540.41m on the Boy 22 and Boy 83 claims.
- Reverse Circulation drilling 4 holes (3 pads, all pre-existing) for a total of 405.41m on the X 5, Boy 85 and W 7 claims.

The above drilling activities occurred to ascertain the resource as well as re-examine metallurgy and quantify mineralization present as sulphide-ore. These activities inadvertently reactivated the QML which was under temporary closure; as surface disturbance occurred outside of the licensed ore body prior to clarification from YG which outlined allowable activities and where these activities could occur. Upon receipt, GCX moved all equipment onto the assessed and licensed orebody and submitted a Class 1 notification to overlap the QML in order to cover the exploration activities.

Total physical 2021 disturbance which occurred on the QML is tabulated below in ***Table 1.***

Table 2. 2021 Disturbance Summary

Claim	*Grant #*	*2021 Clearings*	*2021 Road Upgrades*	*2021 Road Construction*	*Note*
BOY 22	*Y51120*	885 m^2	--	--	885 m^2 of increased disturbance on 5 pre-existing disturbances.
BOY 24	*Y51122*	--	--	40 m	Short segment of new road to connect existing roads.
BOY 83	*Y51181*	*750 m^2*			*750 m^2 of increased disturbance on 1 pre-existing disturbance.*
BOY 85	*Y51183*		49 m		Small section of road upgrade
W 7	*YB26714*	--	175 m	--	Flattened two existing trenches (TR15-36, TR15-23) in a previosuly disturbed area to make road.
2021 TOTALS ON OREBODY =		***750 m^2***	***--***	***--***	
2021 TOTALS OFF ORE BODY=		**885 m^2**	**224 m**	**40 m**	

2.2 CONSTRUCTION AND DEVELOPMENT

2.2.1 Overview of Activities by Quarter

No construction or development activities occurred on the property in 2021.

2.2.2 As-built Drawings

No as-built drawings were produced in 2021.

2.3 MINING ACTIVITIES

2.3.1 Overview of Activities by Quarter

No mining activities took place in 2021.

2.3.2 Production Schedule – Ore and Waste Removal

Not applicable for this reporting period; no mining activities took place in 2021.

2.3.3 Average Head Grades

Not applicable for this reporting period; no mining activities took place in 2021.

2.3.4 Open Pit Stability

Not applicable for this reporting period; no mining activities took place in 2021.

2.3.5 Heap Leach Cells – Status of Leaching (including layout drawing)

Not applicable for this reporting period; no mining activities took place in 2021.

2.3.6 Copper Production

Not applicable for this reporting period; no mining activities took place in 2021.

2.3.7 Spills

No spills occurred during the reporting period. However, an equipment leak was observed; this was collected with sorbents and sand/gravel and shoveled into buckets. A total of 5 buckets (or <115L of earth/material) was then transported for disposal at an approved facility. The faulty equipment was then repaired.

2.3.8 On-going Reclamation

No reclamation was completed in 2021.

2.3.9 Actions Undertaken in Response to Annual Engineer's Inspection

No response was necessary to the Annual Engineer's inspection report.

2.3.10 Access Road

The access road to the site has not been constructed.

2.4 RESOURCES AND RESERVES

The current resource estimate for the property was recently updated and is as stated in ***Table 2*** (following page). This resource estimate dated March 16, 2022 supersedes the previous resource estimates in the October 2016 Preliminary Economic Assessment (PEA; JDS 2016) and the 2018 resource update. A revised PEA is in progress. No reserve is currently stated for the property.

Table 2. Carmacks Project Mineral Resource Statement (March 16, 2022)

CATEGORY	Cut -Off Cu (%)	Quantity (Mt)	Grade					Contained Metal				
			Cu Total (%)	Au (g/t)	Ag (g/t)	Mo (%)	CuEq Total (%)	Cu (Mlbs)	Au (koz)	Ag (koz)	Mo (klbs)	CuEq (Mlbs)
IN PIT OXIDE												
Measured	0.30	11.361	0.96	0.40	4.11	0.006	1.30	239.327	145	1,501	1,530	324.93
Indicated	0.30	4.330	0.91	0.28	3.37	0.007	1.16	86.846	39	469	621	110.99
Measured + Indicated	0.30	15.691	0.94	0.36	3.91	0.006	1.26	326.173	184	1,971	2,150	435.93
Inferred	0.30	0.216	0.52	0.09	2.44	0.006	0.63	2.473	1	17	31	3.01
IN PIT SULPHIDE												
Measured	0.30	5.705	0.68	0.16	2.54	0.016	0.88	86.046	28	467	2,002	110.53
Indicated	0.30	13.486	0.72	0.19	2.83	0.013	0.93	214.323	82	1,226	3,999	277.23
Measured + Indicated	0.30	19.191	0.71	0.18	2.74	0.014	0.92	300.369	110	1,693	6,001	387.76
Inferred	0.30	1.675	0.51	0.13	2.24	0.020	0.70	18.918	7	121	732	25.95
BELOW PIT SULPHIDE												
Measured	0.60	0.026	0.71	0.16	2.54	0.010	0.88	0.407	0	2	6	0.506
Indicated	0.60	1.341	0.82	0.19	2.88	0.012	1.03	24.329	8	124	364	30.418
Measured + Indicated	0.60	1.367	0.82	0.19	2.88	0.012	1.03	24.736	8	126	370	30.924
Inferred	0.60	0.967	0.77	0.17	2.48	0.012	0.96	16.456	5	77	249	20.436

2.5 CARE AND MAINTENANCE

No activities to report.

2.6 PROPOSED DEVELOPMENT AND PRODUCTION FOR UPCOMING YEAR

There are presently no development or production plans for the 2022 year. As aforementioned, the intention is to close the QML and continue work activities under a Class IV Mining Land Use Permit which was submitted on March 5th 2022.

3.0 MONITORING PROGRAMS AND STUDIES

The QML contains several requirements for studies and monitoring programs. The following sections outline work done with respect to these studies and programs.

3.1 ON-GOING METALLURGICAL STUDIES

3.1.1 Field Tests

No metallurgical field tests were in progress as of 2021.

3.1.2 Laboratory Tests

Sulfide and oxide flotation, comminution and ore sorting metallurgical laboratory tests were completed by Sedgman (refer to ***Appendix A***).

3.2 HEAP LEACH PAD LINER PERFORMANCE MONITORING

No liner has been placed and no performance monitoring is in progress.

3.3 WATER QUALITY SURVEILLANCE PROGRAM

Water quality surveillance was conducted by Tutchone Environmental in the region during the 2021 field season. Unfortunately, the current pandemic situation created numerous challenges and as a result this sampling was limited. All water quality sampling occurred off of the QML to cover the surrounding area.

The locations established to date for the monitoring of surface water quality are in ***Table 3*** and ***Figure 2***. Additional locations may be added as needed. Approximately 30 groundwater monitoring wells have been drilled on the QML and immediate vicinity since 1995. The most recent were six (6) installed by Golder Associates Ltd. in 2017 to enable pumping tests and monitoring of piezometric elevation. The water quality surveillance program details are summarized in ***Figure 2***, following page.

Table 3. **Surface** Water Quality Surveillance Program Site Descriptions and Locations

Station	Description	Northing	Easting
W2	Williams Creek Upstream of North Williams Creek Confluence	6914145	413499
W3	Lower North Williams Creek Upstream of Confluence with Williams Creek	6914379	413640
W4	Williams Creek Downstream of Confluence with North Williams Creek	6914653	413888
W5	South East Tributary to Williams Creek	6912947	412978
W6	Williams Creek Downstream of South East Tributary	6913373	413042
W7	Upper North Williams Creek Tributary Upstream of Road Crossing	6914810	411778
W9	Williams Creek Upstream of Access Road Crossing	6912511	411907
W10	Williams Creek Upstream of Yukon River	6919033	416606
W11	Nancy Lee Creek (Tributary of Williams Creek)	6918096	415803
W12	Williams Creek Downstream of Confluence with Nancy Lee Creek	6918000	416102
W13	Williams Creek Upstream of Confluence with Nancy Lee Creek	6917984	415912
Y1	Yukon River Upstream of Williams Creek	6918974	416752
Y2	Yukon River Downstream of Williams Creek	6919308	416249

Notes: Coordinates are UTM Zone 8 NAD83

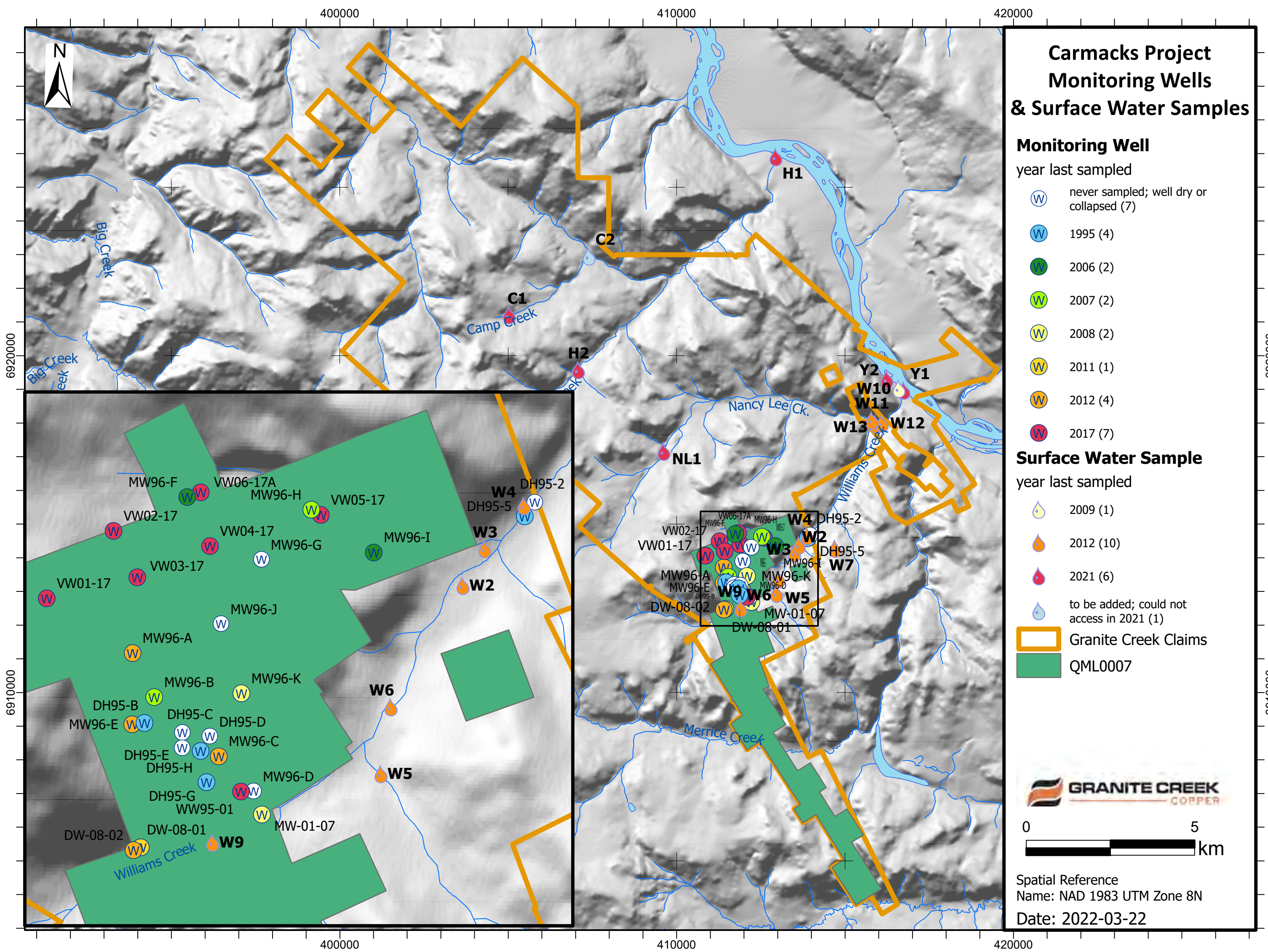


Figure 2. Water Quality Monitoring Station Locations

3.3.1 Surface Water Quality

Surface water quality monitoring was conducted by Tutchone Environmental in 2021, but was limited due to pandemic-related constraints and did not occur within the QML area but on surrounding claims. Continued surface water quality monitoring will occur during the 2022 season.

3.3.2 Groundwater Quality

As forementioned, water quality monitoring was limited in 2021, as a result no groundwater quality monitoring was completed on the QML during the 2021 season.

3.4 HYDROGEOLOGY STUDIES

Six (6) groundwater wells were installed by Golder Associates Ltd. in 2017 in the area of the planned dry stack tailings management area (described in JDS, 2016) to enable pumping tests and monitoring of piezometric elevation to preface mine-development. Data was collected from the piezometers in 2017 but no report was completed on the study. Granite Creek is working towards closure of the QML and a Class IV Mining Land-Use Application was filed on March 5th 2022.

3.5 WATER TREATMENT AND MANAGEMENT

No water treatment studies, or water management studies were required or conducted in 2021.

3.6 CLIMATE DATA AND SNOW SURVEY MONITORING PROGRAM

Granite Creek Copper did not conduct any meteorological monitoring on site in 2021.

3.7 GEOCHEMICAL STUDIES AND ACID-BASE ACCOUNTING

Tailings residue from locked cycle metallurgical tests conducted in 2015 have been submitted for geochemical analysis and humidity cell testing. The lab work has been completed and the geochemical test report is attached in ***Appendix A***.

3.8 PHYSICAL MONITORING PROGRAM

Physical monitoring of structures and facilities in 2021 was limited to the Annual Engineer's Inspection.

3.9 ENGINEER'S ANNUAL PHYSICAL INSPECTION REPORTS

Granite Creek Copper engaged Golder Associates Ltd. to perform the Annual Physical Inspection of the site required under Sections 16.1 and 16.2 of the QML. This inspection occurred on the 26 of August 2021.

The 2021 Annual Physical report focused on inspection of existing site conditions and of the limited infrastructure on site, since no development has yet taken place on site. No areas were identified as requiring immediate attention. Items requiring repair were limited to the geomembrane liner of the fuel storage berm, which had been damaged by a bear. This item will be addressed prior to a need for fuel storage on site. Recommendations in the 2019 Annual Physical Inspection report was limited to identifying areas of minor maintenance to be addressed, as required, in relation to road maintenance to prevent erosion and washouts and ongoing minor maintenance of silt fences and sediment traps. Also, the beaver dam located downstream of the Merrice Creek Bridge was indicated for removal in order to prevent erosion of the bank supporting the bridge. This beaver dam has since been removed and the water levels in Merrice Creek were observed to be lower in comparison to 2019.

3.10 RECLAMATION AND REVEGETATION STUDIES

In 2007, a test patch of seeding was completed on an approximately 500 m x 12 m area located adjacent to the west side the access road and south of the Williams Creek crossing and the helicopter pad area. The seeding, and resulting vegetation, was intended to help stabilize sediments in this area and has been observed in the past six years to be performing well and is now well established. In addition, local native species of grasses and woody plants have begun to naturally establish in the area and no sediment movement has been observed indicating that the re-vegetation has been effective to minimize erosion.

3.11 SUBMISSION AND APPROVAL OF PLANS

No development plans were submitted during 2021. Application for a Class IV Mining Land Use permit was submitted into YESAB on March 5th 2022 and is intended to be utilized upon receival for future activities in the near future.

4.0 OUTSTANDING FINANCIAL LIABILITY

4.1 HEAP LEACH

There has been no update to the assessment of the liability associated with the Heap Leach Facility, which was presented in the May 2009 revision of the Preliminary Detailed Closure and Reclamation Plan.

4.2 WASTE ROCK STORAGE

There has also been no update to the assessment of the liability associated with the Waste Rock Storage Facility, which was presented in the May 2009 revision of the Preliminary Detailed Closure and Reclamation Plan.

4.3 OVERALL LIABILITY

The estimated maximum overall liability associated with the development and operation of the mine remains as set out in the May 2009 revision of the Preliminary Detailed Closure and Reclamation Plan is detailed in ***Table 4***.

***Table 4*.** Estimated closure liability for the planned heap leach project

Facility or Area Description	Cost
Open Pit	$ 23,000
Heap Leach Facility	$ 17,295,000
HLF Events and Sediment Ponds	$ 296,000
Waste Rock Storage Area	$ 740,000
Plant and Ancillary Facilities	$ 467,000
Camp	$ 103,000
Truck Shop Service Complex	$ 70,000
Miscellaneous Facilities	$ 95,000
Access and Haul Roads	$ 248,000
Site Management	$ 1,103,000
Total	**$ 20,440,000**

To date, security in the amount of $80,300 has been posted with Yukon Government. This represents the accrued liability due to exploration activities on the site. Further discussions are underway for progressive security adjustments to represent an updated summary of liabilities.

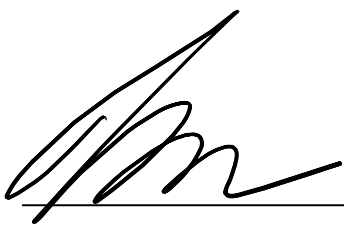
In June of 2021 GCX completed a Security Assessment review with YG.

4.4 ENGINEERING CONTINGENCIES

In accordance with Section 11.0 of the QML, Copper North Mining Corp. prepared a Contingency Plan based on a workshop held in October 2009. The plan was submitted to the Chief of Mining Land Use in January 2010. The main purpose of the Contingency Plan was to identify possible alternative approaches to decommissioning the Heap Leach Facility, however, other facilities were also examined. The plan identified several possible failure modes and contingency measures for each of the facilities and recommended further work that should be undertaken. The report was issued in draft format pending comments from government. No comment from government has been received to date. No further work has been undertaken to develop any of the contingency plans identified.

GRANITE CREEK COPPER

(On behalf of CARMACKS MINING CORP.)



Tim Johnson

CEO & Director Granite Creek Copper

Director Carmacks Mining Corp

Appendix A. 2021 Metallurgical Testing

SEDGMAN

Memorandum

To: Tim Johnson
From: David Way
CC: Jason Pope, Sam Cho, Mark Wilkin, John Caldbick
Date: 01 October 2021
Our Ref: A970-D01-0202-ME-0010
Subject: **Carmacks Oxide Metallurgical Testwork**

Executive Summary

The Carmacks oxide sample selected for flotation testwork provided a maximum copper rougher recovery of approximately 41%, at 2.8% Cu concentrate grade. Running parallel to this flotation testwork program was a process mineralogy assessment to determine the mineral composition, and mineral liberation and association for the sample at the defined primary grind size of P_{80} 150 μm.

Particle Mineral Analysis (PMA) indicated that the majority, approximately 61%, of the copper content is locked in credhneite, iron oxide and chlorite minerals and is not floatable due to the minerals being hydrophilic and no known processes exist to selectively increase the hydrophobicity of these minerals. The remaining 39%, where majority are copper oxide minerals (malachite/azurite/cuprite) can be recovered via flotation with sulphurdisation and/or special oxide collectors, which presents a very low cap on achievable metallurgical performance of ores represented by this sample. This PMA finding is backed up by batch rougher flotation testwork.

The liberation of the copper bearing minerals in the oxide sample is extremely poor, wherein an uneconomic primary grind to sub-20 μm P_{80} is required to overcome this issue.

An acid leach test of the oxide sample was undertaken to determine whether the high extraction rates previously reported (PEA 2015) are achievable. Acid (copper) and cyanide (gold) leaching results were found to be comparable to the PEA 2015 work, even though the primary grind sizes are significantly different. This is an important result as it suggests that the PEA 2015 samples likely contain a similar composition of minerals to the oxide sample and there is no separate sub-domain of Carmacks oxide. Therefore, all oxides at Carmacks Copper are likely to be similar.

This rules out process pathways via oxide flotation, and even glycine and ammonia leaching, which have not been demonstrated to leach the most abundant copper containing minerals identified in the oxide sample. It is recommended that any samples available from the 2015 PEA program be identified and submitted for mineral composition analysis to confirm that the oxide zone is similar across the Carmacks Copper resource before selecting further variability samples.

Oxide Sample ID and Composition

The oxide sample selected for flotation testwork is from Zone 1 hole WC-021A and continuous intersection from 14 m to 28 m. A total mass of 51 kg was provided. The oxide content of the sample was estimated to be 90%.

The chemical composition for the two sulfide samples and the oxide sample sent to Bureau Veritas Commodities, Metallurgy – Mineralogy Division, (BV) for process mineralogy and flotation testwork assessment is provided in Table 1. The oxide sample contains 1.01% Cu and low levels of sulphur (0.03% S). It is important to run flotation and mineralogy programs in parallel because the process mineralogy can provide important details about the composition of the sample and estimates for primary grind and regrind size targets, that should be feed into the flotation testwork program for guidance on flowsheet development.

Table 1: Chemical composition for the two sulfide samples and the oxide sample as determined by BV

CHEMICAL COMPOSITION OF THE THREE COMPOSITES

Element	Symbol	Chemical Compositions (percent or grams/tonne)		
		Var 2 Sulphide Composite	Var 4 Sulphide Composite	Oxide Composite
Copper	Cu	0.46	0.76	1.01
Iron	Fe	2.39	4.75	3.56
Molybdenum	Mo	0.01	0.04	0.01
Sulphur	S	0.78	1.19	0.03
Carbon	C	0.05	0.06	0.24
Gold	Au	0.18	0.17	0.18

Notes: 1) Gold was measured in grams/tonne. All other elements were measured in percent.

The mineral compositions for the two sulfide samples and the oxide sample are provided in Table 2.

As expected, the copper sulfide content of the oxide sample is very low at 0.10%. The oxide sample also contains the copper bearing minerals Malachite/Azurite at 0.59% and Credhneite at 0.15%. Other minerals found to contain copper in the oxide sample are iron oxides (2.49%), Chlorite (10.6%) and biotite (5.21%).

Table 2: Mineral compositions for the two sulfide samples and the oxide sample as determined by BV

MINERAL COMPOSITION OF THE THREE COMPOSITES

Mineral	Mineral Compositions (Mass percent)		
	Var 2 Sulphide Composite	Var 4 Sulphide Composite	Oxide Composite
Chalcopyrite	1.23	2.14	0.10
Molybdenite	0.04	0.12	<0.01
Pyrite	0.64	0.44	0.02
Other Sulphides	0.02	0.02	0.01
Sulphide Total	**1.93**	**2.71**	**0.13**
Malachite/Azurite	<0.01	0.00	0.59
Credhneite (CuMnO2)	0.00	0.00	0.15
Iron Oxides	0.37	0.33	2.49
Quartz	21.6	10.5	6.60
Plagioclase Feldspar	32.0	42.1	59.9
K-Feldspars	30.7	9.85	4.11
Biotite/Phlogopite	4.65	16.9	5.21
Amphibole (Actinolite)	0.49	4.13	6.10
Chlorite	4.61	4.34	10.6
Muscovite	0.90	1.53	0.75
Epidote	0.88	4.24	0.26
Calcite	0.30	0.38	1.06
Sphene/Titanite	0.92	1.15	0.92
Apatite	0.41	0.70	0.68
Ca-sulphate (Gypsum)	0.01	0.88	<0.01
Others	0.20	0.18	0.44
Total	100.0	100.0	100.0

Notes: 1) Chalcopyrite includes Bornite, Chalcocite/Covellite, Enargite/Tennantite and Tetrahedrite. Other sulphides include Sphaleirte and Galena.
2) Sphene/Titanite includes trace amounts of Rutile/Anatase and Ilmenite.
3) Others include Kaolinite (Clay), Zircon, Fluorite, Barite, Corumdum, Cassiterite and Al-Phosphate

Copper deportment by copper bearing minerals for the two sulfide samples and the oxide sample is presented in Figure 1.

61% of the copper content in the oxide composite sample is from non-sulfide gangue minerals, including:

- credhneite (6.5%);
- iron oxides (mostly goethite and limonite) (25.7%);
- chlorite (28.6%); and
- minor Cu-biotite.

The presence of these minerals is most important because they are not expected to be recovered via the flotation process.

It is possible that the remaining 39% of the copper minerals can be recovered via flotation, which presents a very low cap on achievable metallurgical performance of ores represented by this sample. These minerals include:

- malachite/azurite (30.3%);
- cuprite (4.6%);
- chalcocite/covellite (1.3%);
- bornite (0.1%); and
- chalcopyrite (2.5%).

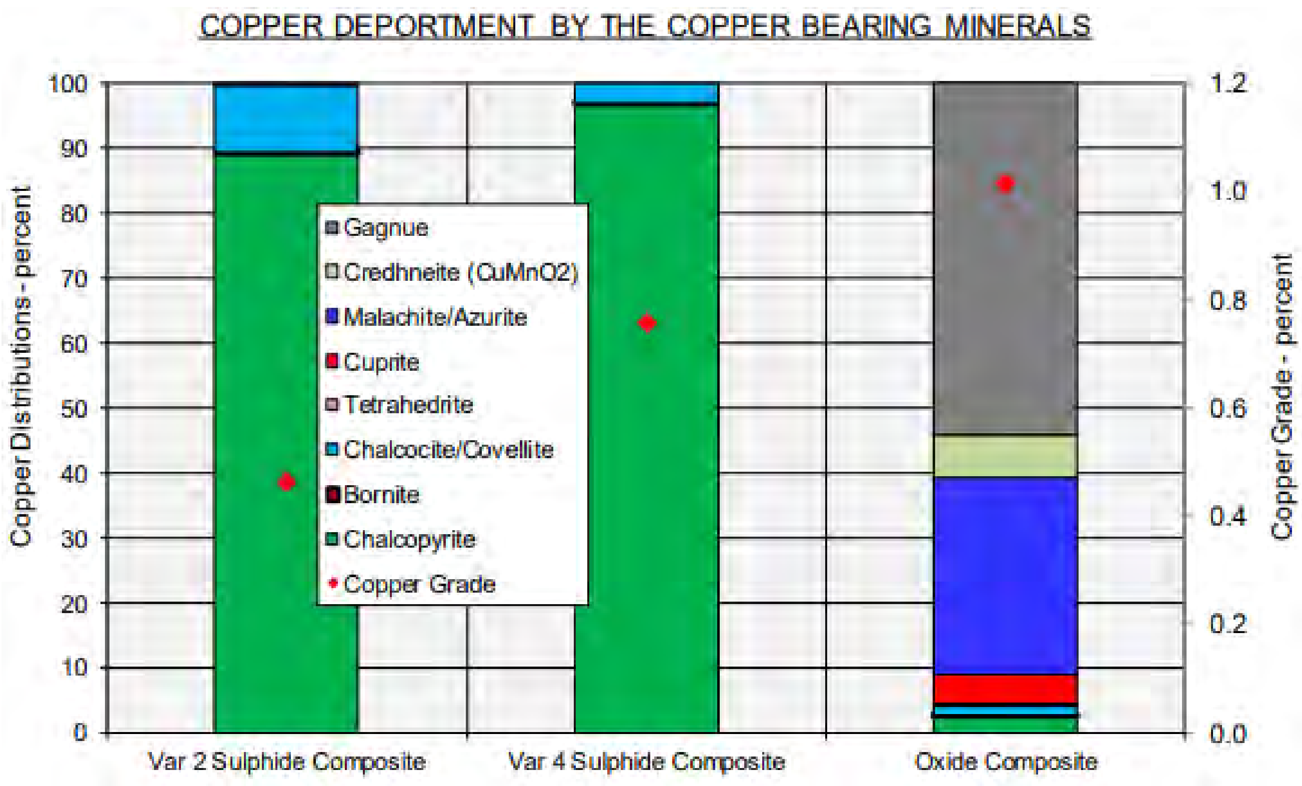


Figure 1: Copper deportment by copper bearing minerals for the two sulfide samples and the oxide sample

Oxide Sample Process Mineralogy

The two-dimensional liberation of the dominant copper bearing minerals malachite/azurite (including cuprite) in the oxide composite (at P_{80} of 154 µm) is 40% (see Figure 2). In addition, the copper sulfides (including chalcopyrite, bornite, chalcocite/covellite and enargite/tennantite) have a very low level of liberation (28%) as illustrated in Figure 3. Most two-product copper concentrators (one concentrate + one tailing) operate with 50 – 60% copper mineral liberation in flotation feed according to an operational benchmark database. This poor level of liberation at the primary grind size of 154 μm P_{80} means that a finer primary grind is required to achieve sufficient liberation of copper sulfide minerals for efficient flotation recovery.

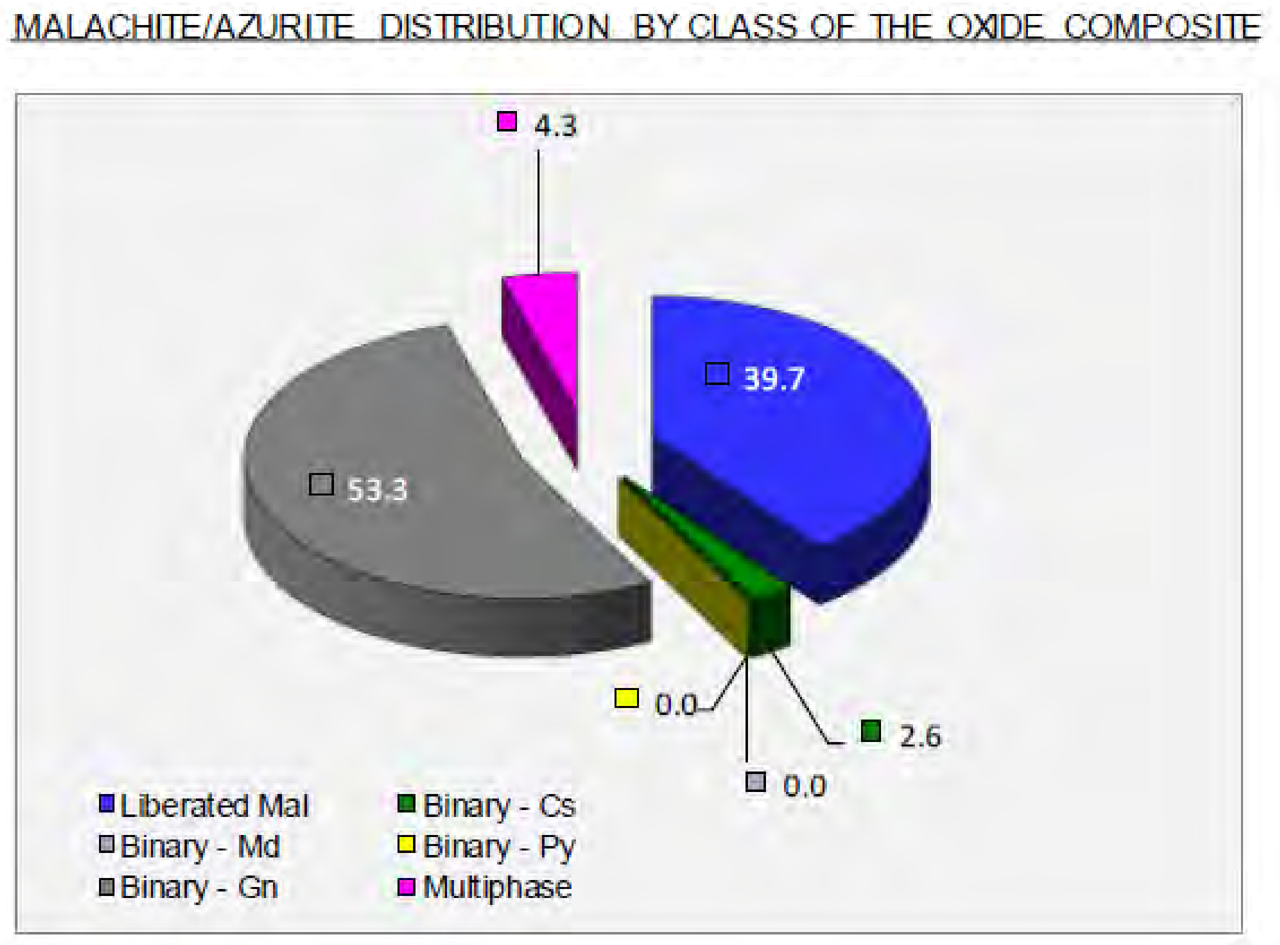


Figure 2: Malachite/Azurite liberation of the oxide sample

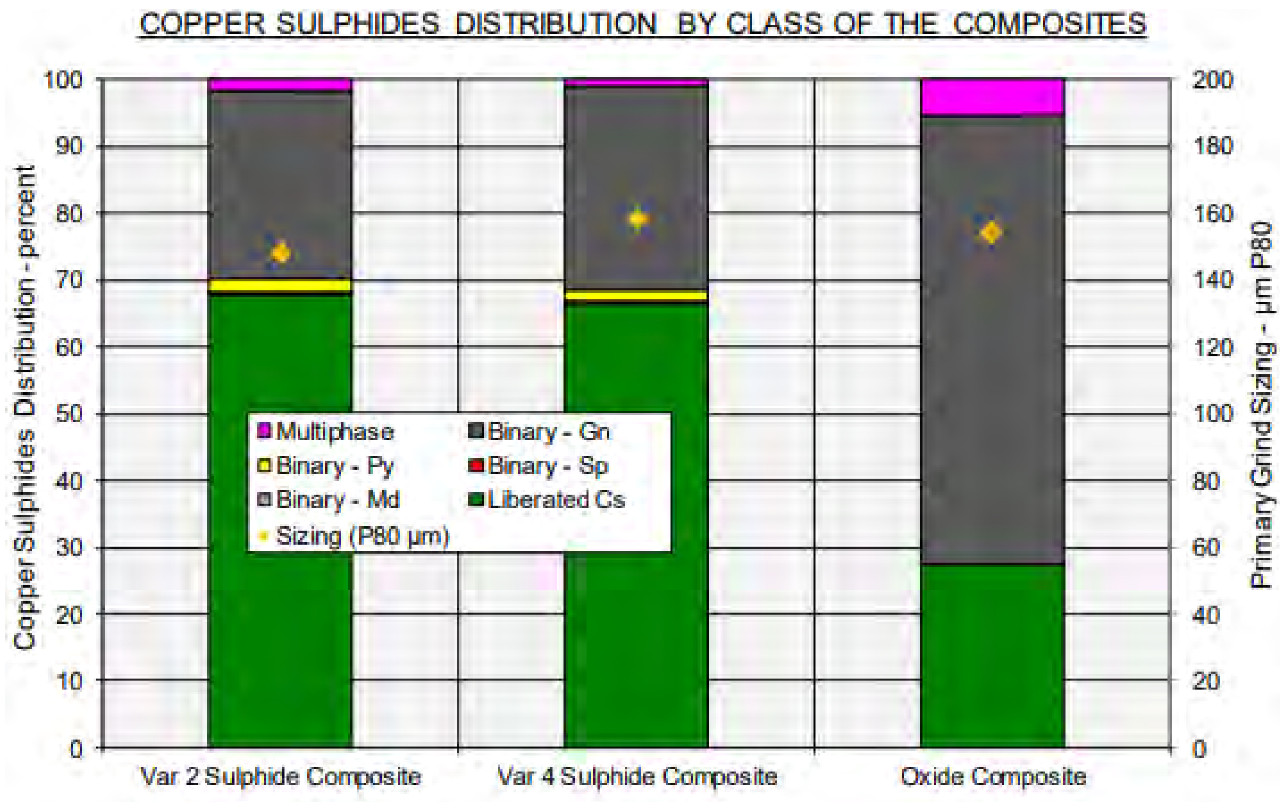


Figure 3: Copper sulfide mineral liberation for the two sulfide samples and the oxide sample

Figure 4 and Figure 5 present the liberation profile by size fractions of the copper bearing minerals Malachite/Azurite and Cu Sulfides in the oxide sample, and interpretation of this data suggest that a primary grind to sub-20 μm P_{80} is required to achieve the copper mineral liberation target of typical two-product copper concentrators. Clearly, it is not economically feasible to primary grind the entire ore to sub-20 μm P_{80}.

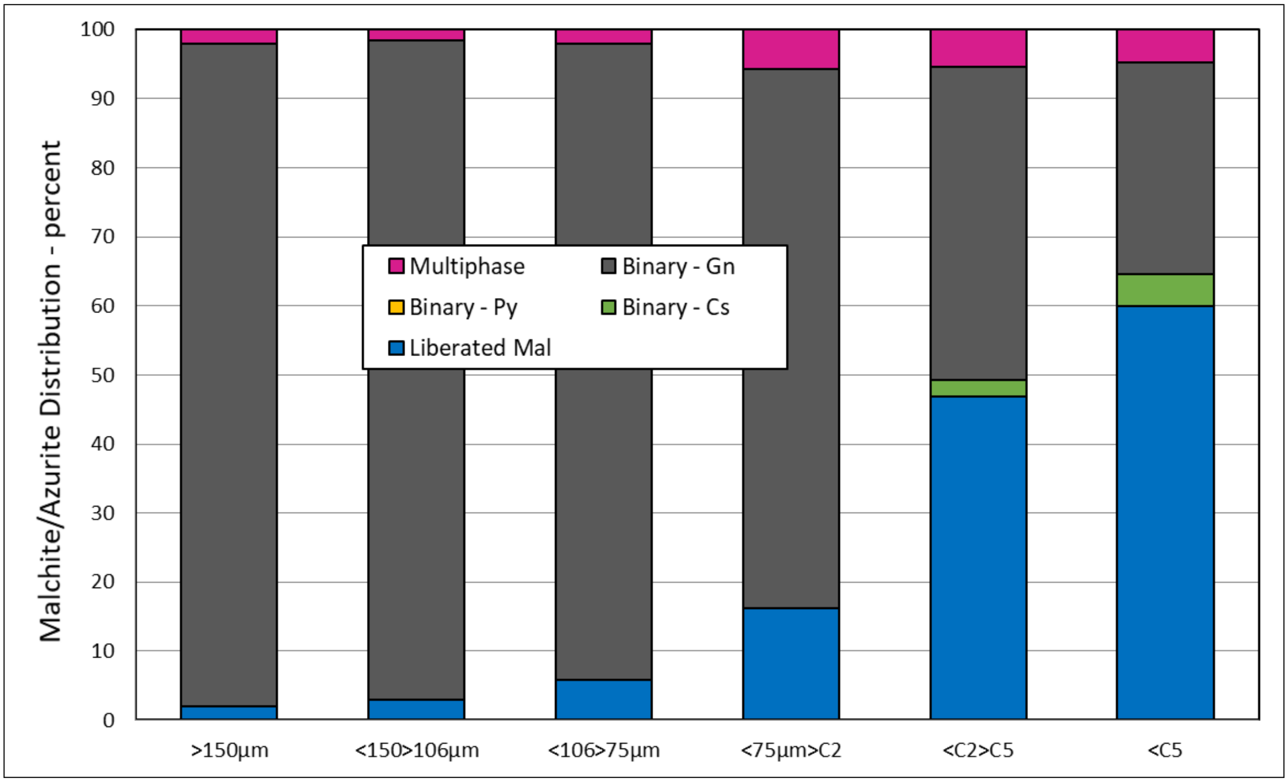


Figure 4: Malachite/Azurite mineral liberation by size of the oxide sample

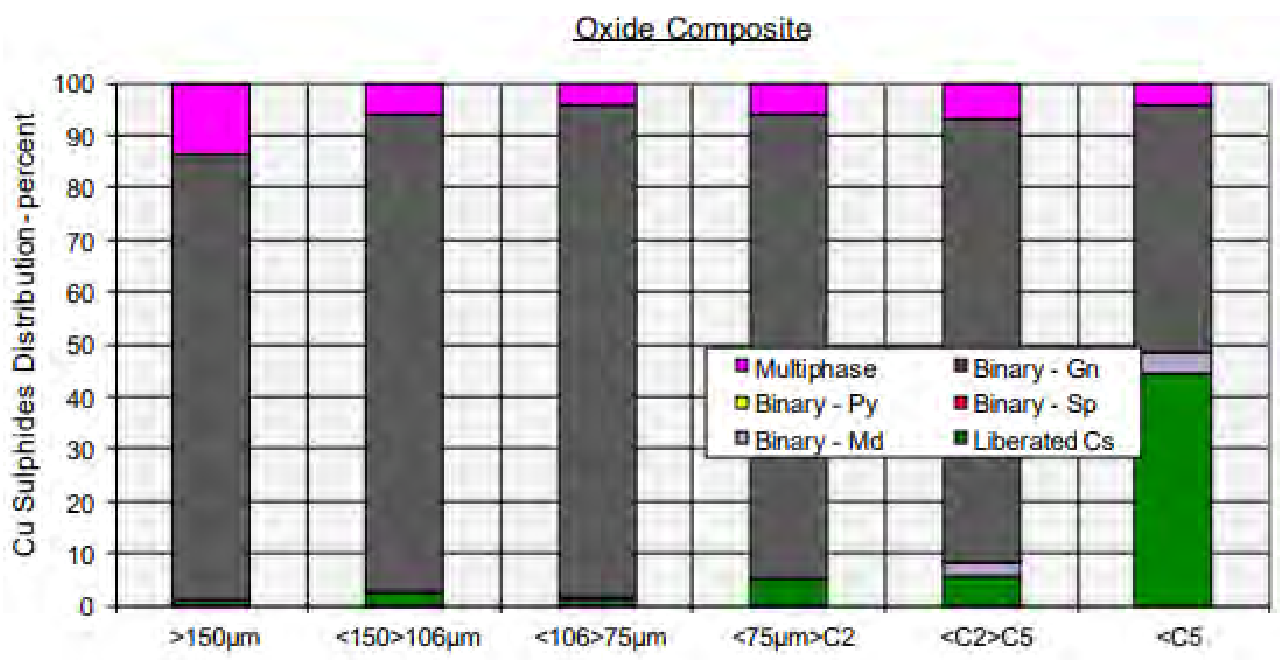


Figure 5: Copper sulfide mineral liberation by size of the oxide sample

Oxide Sample Flotation Performance

BV completed three open circuit batch rougher flotation tests for the oxide sample (see Figure 6). Notable characteristics of these plots are:

1. The limit for the oxide sample copper rougher recovery to 35% – 40% as predicted by the mineralogy data; and

2. The first rougher concentrate grade and shape of the grade-recovery curves indicate a process struggling to achieve high concentrate grade targets because of poor copper mineral liberation or copper minerals competing with gangue minerals for recovery or both. Interpretation of the liberation data certainly supports the earlier case that there is poor copper mineral liberation.

The rougher mass recoveries after 25-minute laboratory flotation times are:

1. 1150g/t AM28 = 15%

2. 550g/t AM28 + 50g/t PAX = 10%

3. 300g/t NaSH + 50g/t PAX = 5%

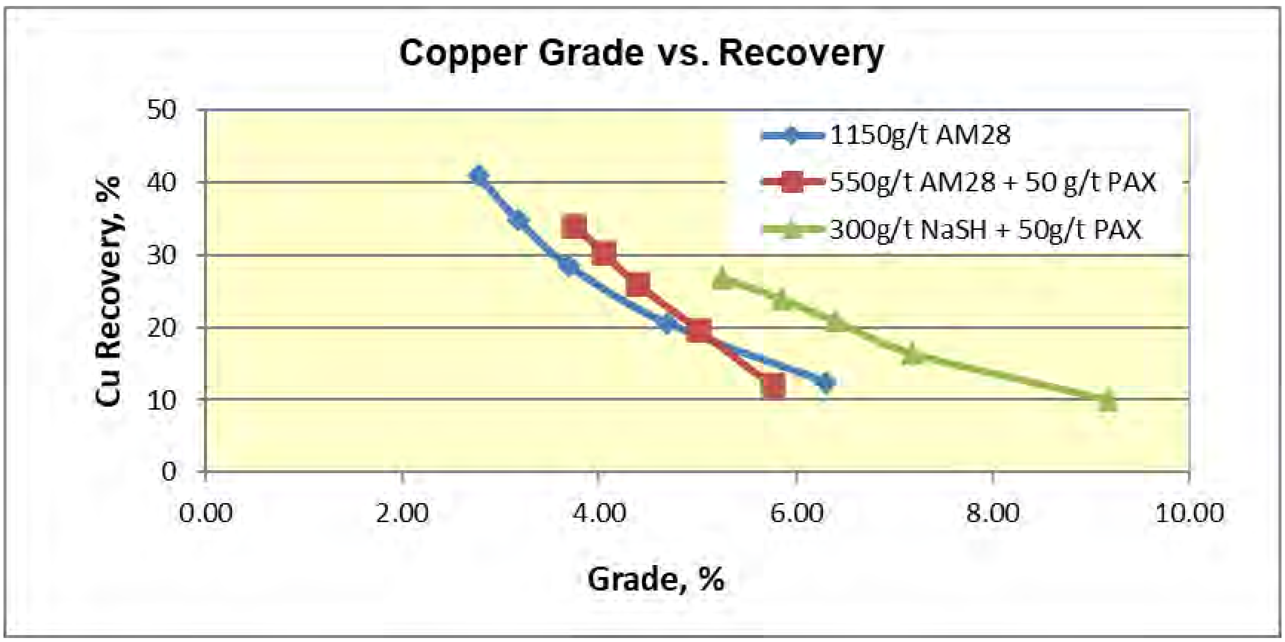


Figure 6: Copper recovery versus grade for batch rougher flotation tests for the oxide sample

Even with slow flotation kinetics and low rougher mass recovery the best rougher stage grade achieved is 9.1% copper grade at 10% recovery. Similarly, gold recovery appears limited via flotation to less than 50% Au in total as shown in Figure 7.

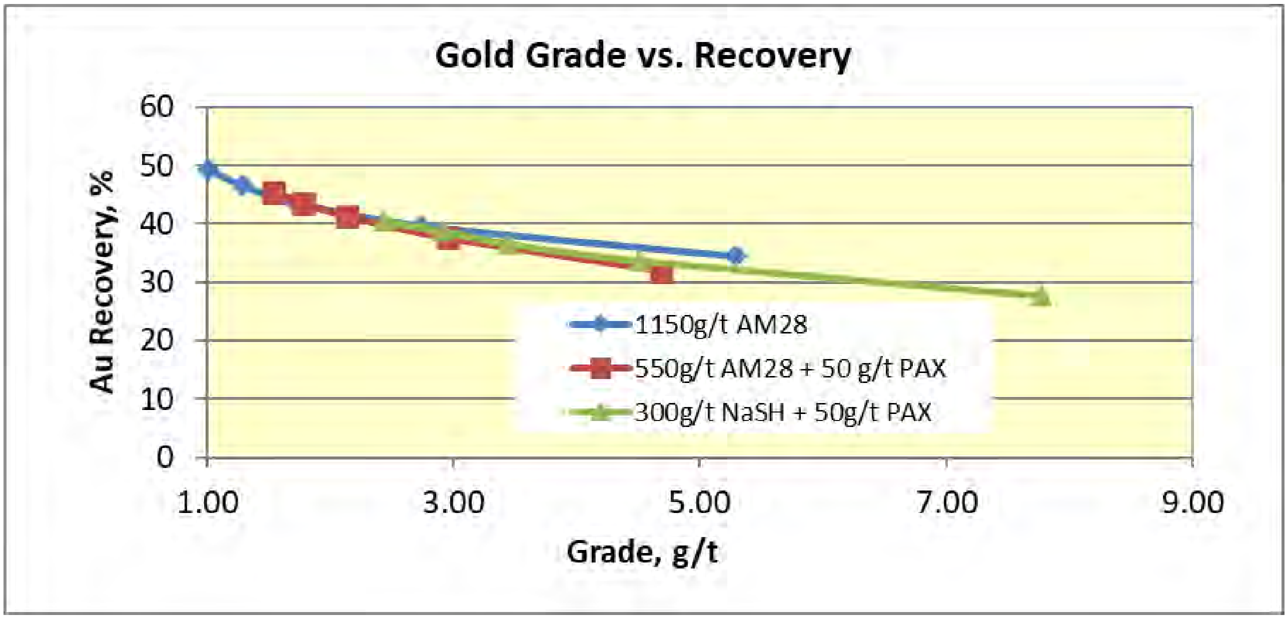


Figure 7: Gold recovery versus grade for batch rougher flotation tests for the oxide sample

BV plotted the limiting grade-recovery curves illustrated in Figure 8 for the two sulfide samples and one oxide sample. Limiting grade-recovery curves are very important that they present the maximum theoretical performance that can be expected if all copper minerals reported to concentrate at a target primary grind size. The limiting curves are never achieved but approached. They are best applied as a guide to determine whether metallurgical performance in plant operation or testwork development programs is achieving efficient mineral separation in respect to the liberation profile of the fragmented minerals in the feed.

The limiting grade-recovery plot for the Carmacks oxide sample at P_{80} of 154 µm identifies the maximum copper recovery at just under 40% (the "cap on recovery" via flotation), if all the copper sulfides and malachite/azurite where recovered. It also highlights that if all copper sulfides and malachite/azurite were recovered to the copper concentrate then the best copper concentrate grade achievable is 26.5% copper. Any increase in copper recovery beyond 40% will coincide with a significant decrease in copper concentrate grade achievable (see Figure 8).

The oxide flotation testwork on this sample was halted due to the poor rougher flotation recovery of the oxide sample and details about the mineral composition which support the flotation results that the majority of copper minerals present should not recover via the flotation process.

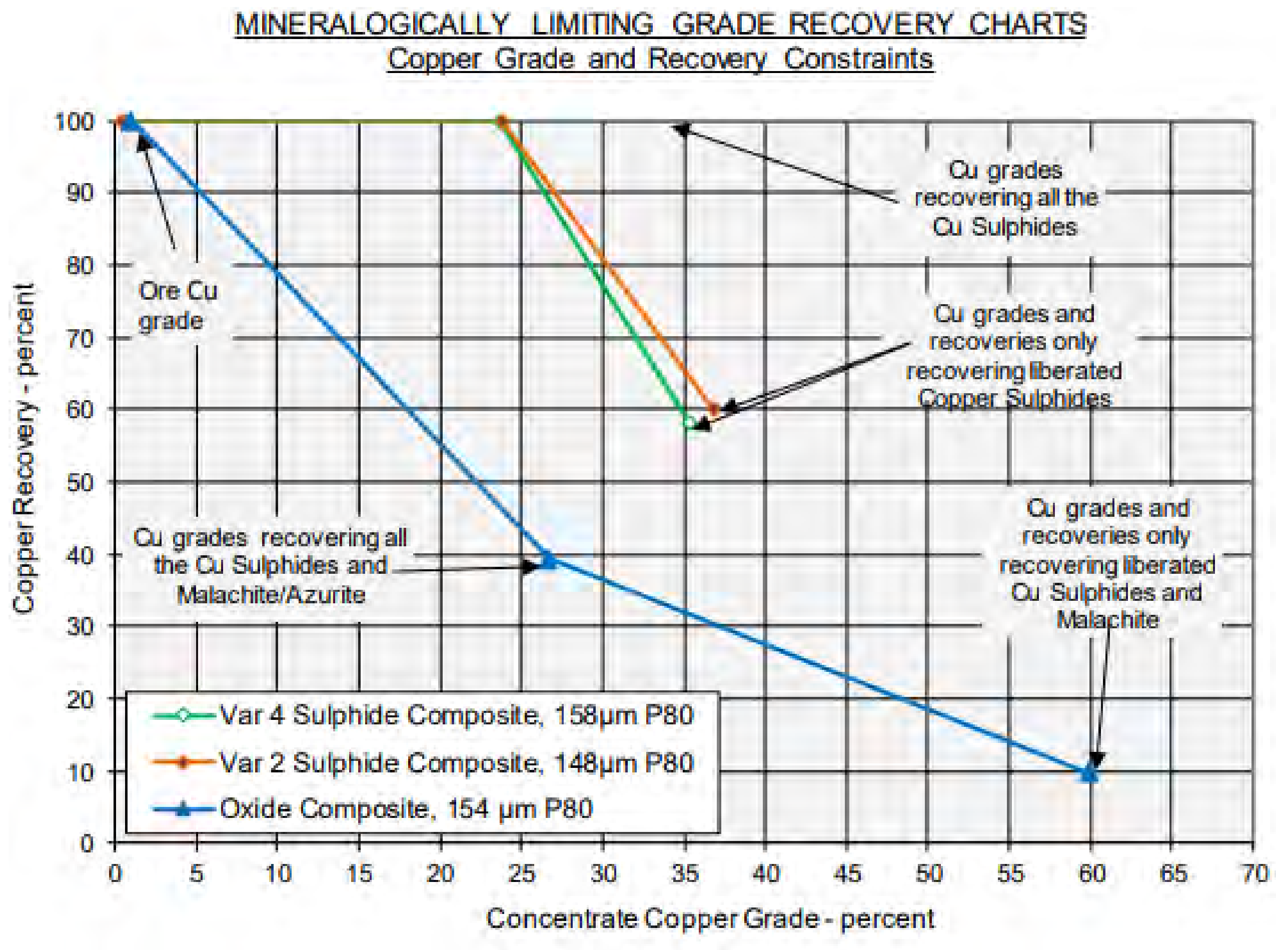


Figure 8: Limiting copper grade – recovery plots for the two sulfide samples and the oxide sample. Based on mineralogical assessments at approximately 150 μm P_{80} primary grind per sample.

Oxide Sample Leach Performance

BV completed an acid leach test for copper and cyanide leach for gold using the same oxide sample. The leach conditions were kept consistent with the 2015 PEA test work program, except for the primary grind size is 252 μm P_{80} (as-received oxide sample). The 2015 PEA test work was undertaken at a primary grind size of approximately 660 μm P_{80}.

Note: No detailed mineral composition analysis can be found for the PEA 2015 test work.

Leach extraction comparisons are provided below and in Figure 9:

1. Copper extraction after 6 hours of acid leaching = 83%
    - 2015 PEA results after 6 hours of acid leaching ranged from 76.5% to 88.8%
2. Gold extraction after 12 hours of cyanide leaching = 77%
    - 2015 PEA results after 12 hours of cyanide leaching typically ranged from 71% to 83%, apart from a few outliners of lower gold extraction

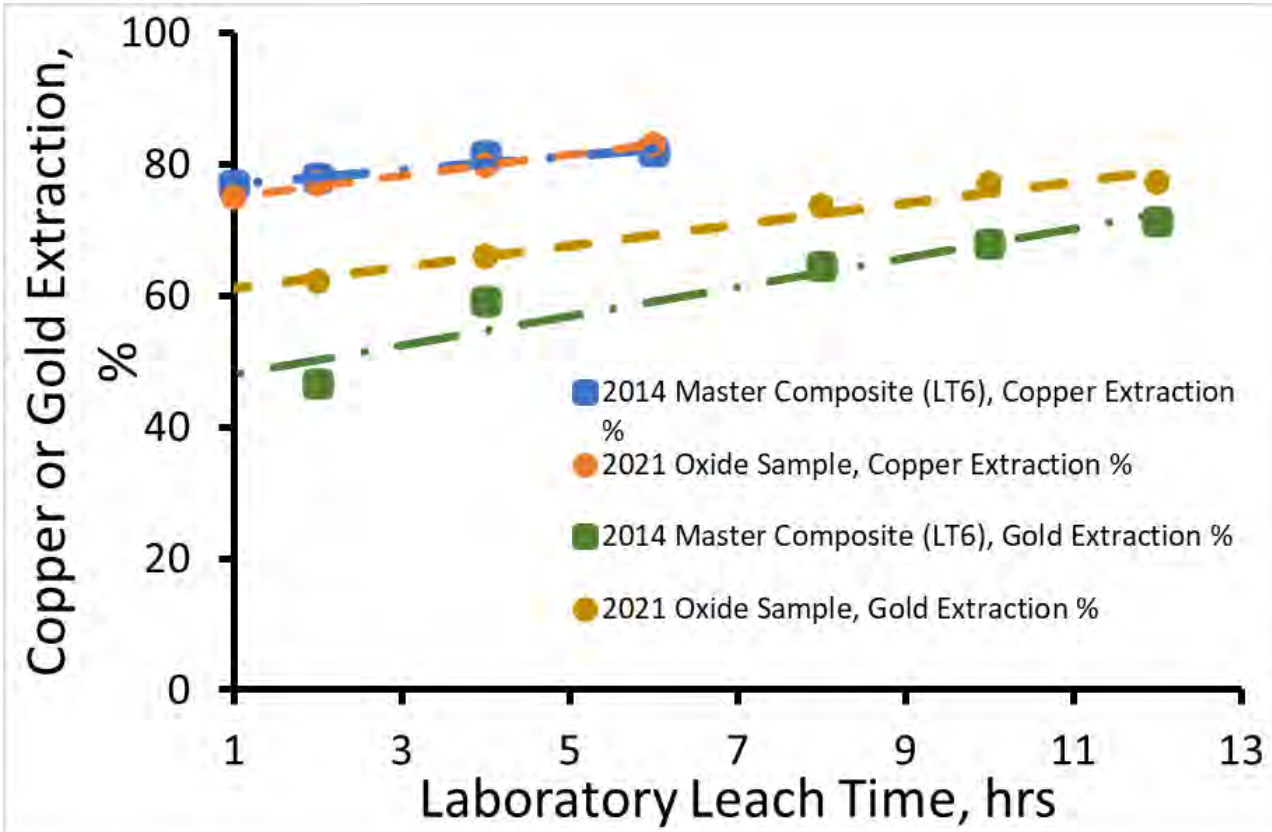


Figure 9: Comparison of leach extraction performance of 2014 Master Composite (LT6) and 2021 Oxide sample.

Copper leaching was undertaken by acid leaching whereas, gold leaching was performed using cyanide leaching.

It is obvious from the results plotted in Figure 9 that the oxide sample leaches similarly to the 2014 Master composite under similar leach conditions. Therefore, the mineral composition of these two samples is likely to be similar.

It is recommended that any samples available from the 2015 PEA program be submitted for mineral composition analysis to confirm that the oxide zone at Carmacks Copper is similar across the resource and no significant variations in mineral compositions exist. The intention of this work is to link knowledge gained across the current and previous testwork programs. This result simplifies the development program forward for this project because options such as oxide flotation can be confidently ruled out and options such as glycine and ammonia leaching haven't yet been reported to extract copper from credhneite, goethite, limonite and chlorite which accounts for 61% of the copper content in the oxide sample.

Conclusion and Recommendation

The Carmack oxide sample presented for testwork in 2021, contains 61% of the copper in mineral forms not expected to recover by flotation. This limits the copper concentrate recovery to 30% - 39% for this sample and laboratory flotation testwork confirmed the mineralogy assessment.

These concerns were substantial enough to recommend halting the flotation testwork program for this oxide sample. Sedgman then recommended that an acid leach test of the sample be undertaken to determine whether the high extraction rates previously reported (PEA 2015) are achievable. Acid (copper) and cyanide (gold) leaching results were found to be comparable to the PEA 2015 work, even though the primary grind sizes are substantially different. This is an important result as it suggests that the PEA 2015 samples likely contain a similar composition of minerals to the oxide sample and there is no separate sub-domain of Carmacks oxide. No detailed mineral composition analysis can be found for the PEA 2015 testwork.

This rules out process pathways via oxide flotation, and even glycine and ammonia leaching which have not been demonstrated to leach many of the copper containing minerals identified in the oxide sample. It is recommended that any samples available from the 2015 PEA program be identified and submitted for mineral composition analysis to confirm that the oxide zone is similar across the Carmacks Copper resource, as well as perform further variability testwork and mineral composition assessments.

SEDGMAN

Memorandum

To:	Tim Johnson
From:	Sam Cho
CC:	Jason Pope, David Way, Mark Wilkin, John Caldbick
Date:	01 October 2021
Our Ref:	A970-D01-0202-ME-0011
Subject:	**Carmacks Sulfide Metallurgical Testwork**

Executive Summary

Rougher flotation kinetic tests and open cleaner flotation tests were conducted on the Var 2 and Var 4 variability samples at Bureau Veritas Commodities, Metallurgy – Mineralogy Division, (BV). The Carmacks primary sulfide samples selected for flotation test work provided high flotation copper recoveries at P_{80} 150 μm primary grind and P_{80} 25 μm regrind sizes. Preliminary copper flotation recovery model is generated based on two open circuit cleaner flotation test results at fixed 25% copper concentrate grade as shown in Figure 1. This preliminary recovery estimation should only apply to copper feed grade of 0.46% to 1.0%.

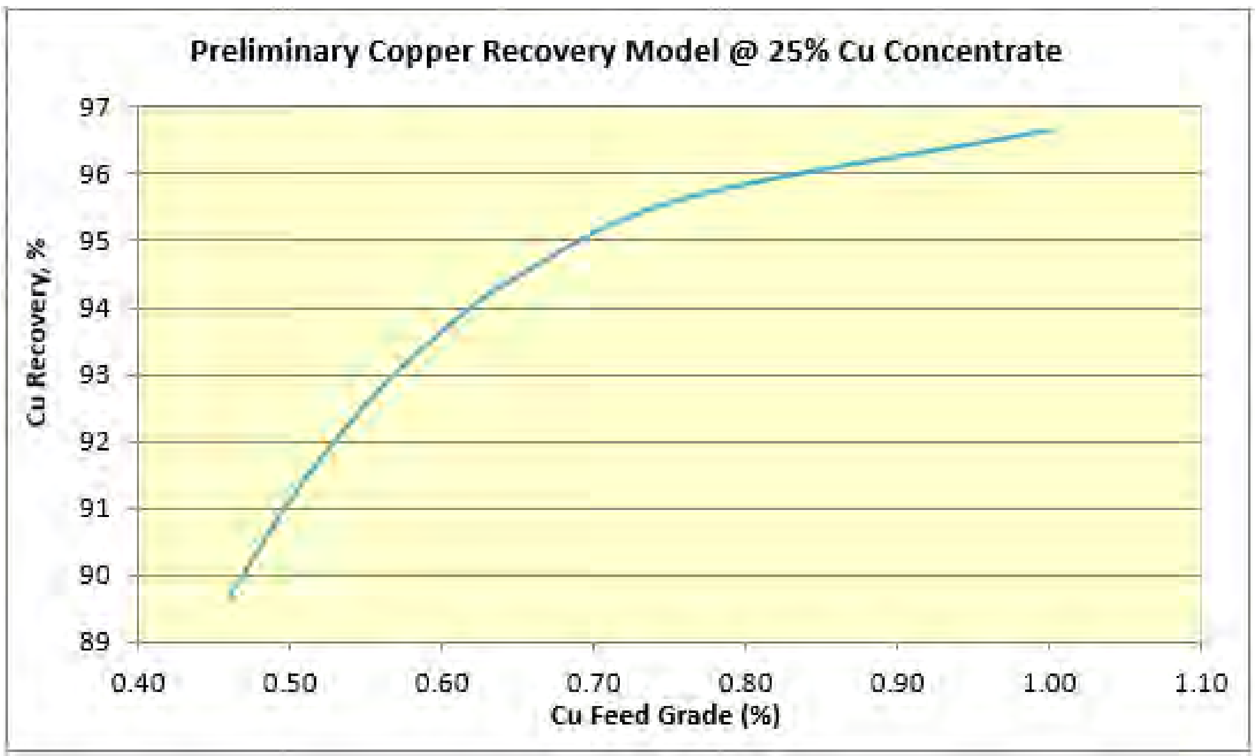


Figure 1: Preliminary Copper recovery estimate @25% Cu concentrate grade

Running parallel to this flotation test work program was a process mineralogy assessment to determine the mineral composition and mineral liberation and association for the sample at the defined primary grind size of P_{80} 150 μm. Particle Mineral Analysis (PMA) indicated that most of the sulphide mineral consists of chalcopyrite and minor covellite/chalcocite, with minor pyrite. Copper sulfide minerals are well liberated for rougher recovery via flotation at P_{80} of 150 μm. Gold is associated with mainly copper sulfide minerals and some pyrite. The majority of gold particles are <10 µm and are categorized as refractory and flotation of gold with copper concentrate would be the most economical way to recover this gold.

Sulfide Sample ID and Composition

The primary sulfide variability samples (Var 2 and 4) selected for flotation test work are from Zone 2000S hole CRM21-003 and continuous intersection from 152 m to 168 m and 188m to 202m. A total mass of 43 kg and 42 kg was provided for Var 2 and Var 4, respectively.

The chemical composition for the two sulfide samples and the oxide sample sent to BV for process mineralogy and flotation test work assessment is provided in Table 1 as shown in memo A970-D01-02020-ME-0010. The sulfide samples contain 0.46 and 0.76% Cu and 0.18 and 0.17 g/t Au.

Table 1: Chemical composition for the two sulfide samples and the oxide sample as determined by BV

CHEMICAL COMPOSITION OF THE THREE COMPOSITES

Element	Symbol	Chemical Compositions (percent or grams/tonne)		
		Var 2 Sulphide Composite	Var 4 Sulphide Composite	Oxide Composite
Copper	Cu	0.46	0.76	1.01
Iron	Fe	2.39	4.75	3.56
Molybdenum	Mo	0.01	0.04	0.01
Sulphur	S	0.78	1.19	0.03
Carbon	C	0.05	0.06	0.24
Gold	Au	0.18	0.17	0.18

Notes: 1) Gold was measured in grams/tonne. All other elements were measured in percent.

The mineral compositions for the two sulfide samples and the oxide sample are provided in Table 2.

Chalcopyrite is main copper sulfide mineral with relatively low pyrite content. Both Var 2 and 4 sulfide samples are expected to float easily with no or very little difficulties.

Table 2: Mineral compositions for the two sulfide samples and the oxide sample as determined by BV

MINERAL COMPOSITION OF THE THREE COMPOSITES

Mineral	Mineral Compositions (Mass percent)		
	Var 2 Sulphide Composite	Var 4 Sulphide Composite	Oxide Composite
Chalcopyrite	1.23	2.14	0.10
Molybdenite	0.04	0.12	<0.01
Pyrite	0.64	0.44	0.02
Other Sulphides	0.02	0.02	0.01
Sulphide Total	**1.93**	**2.71**	**0.13**
Malachite/Azurite	<0.01	0.00	0.59
Credhneite (CuMnO2)	0.00	0.00	0.15
Iron Oxides	0.37	0.33	2.49
Quartz	21.6	10.5	6.60
Plagioclase Feldspar	32.0	42.1	59.9
K-Feldspars	30.7	9.85	4.11
Biotite/Phlogopite	4.65	16.9	5.21
Amphibole (Actinolite)	0.49	4.13	6.10
Chlorite	4.61	4.34	10.6
Muscovite	0.90	1.53	0.75
Epidote	0.88	4.24	0.26
Calcite	0.30	0.38	1.06
Sphene/Titanite	0.92	1.15	0.92
Apatite	0.41	0.70	0.68
Ca-sulphate (Gypsum)	0.01	0.88	<0.01
Others	0.20	0.18	0.44
Total	100.0	100.0	100.0

Notes: 1) Chalcopyrite includes Bornite, Chalcocite/Covellite, Enargite/Tennantite and Tetrahedrite.
Other sulphides include Sphaleirte and Galena.
2) Sphene/Titanite includes trace amounts of Rutile/Anatase and Ilmenite.
3) Others include Kaolinite (Clay), Zircon, Fluorite, Barite, Corumdum, Cassiterite and Al-Phosphate

Copper deportment by copper bearing minerals for the two sulfide samples and the oxide sample is presented in Figure 2.

Over 90% of the sulfide copper content is made up with chalcopyrite and the rest as covellite/chalcocite. When liberated, chalcopyrite is expected to exhibit fast flotation kinetic and recover it in relatively short period of time.

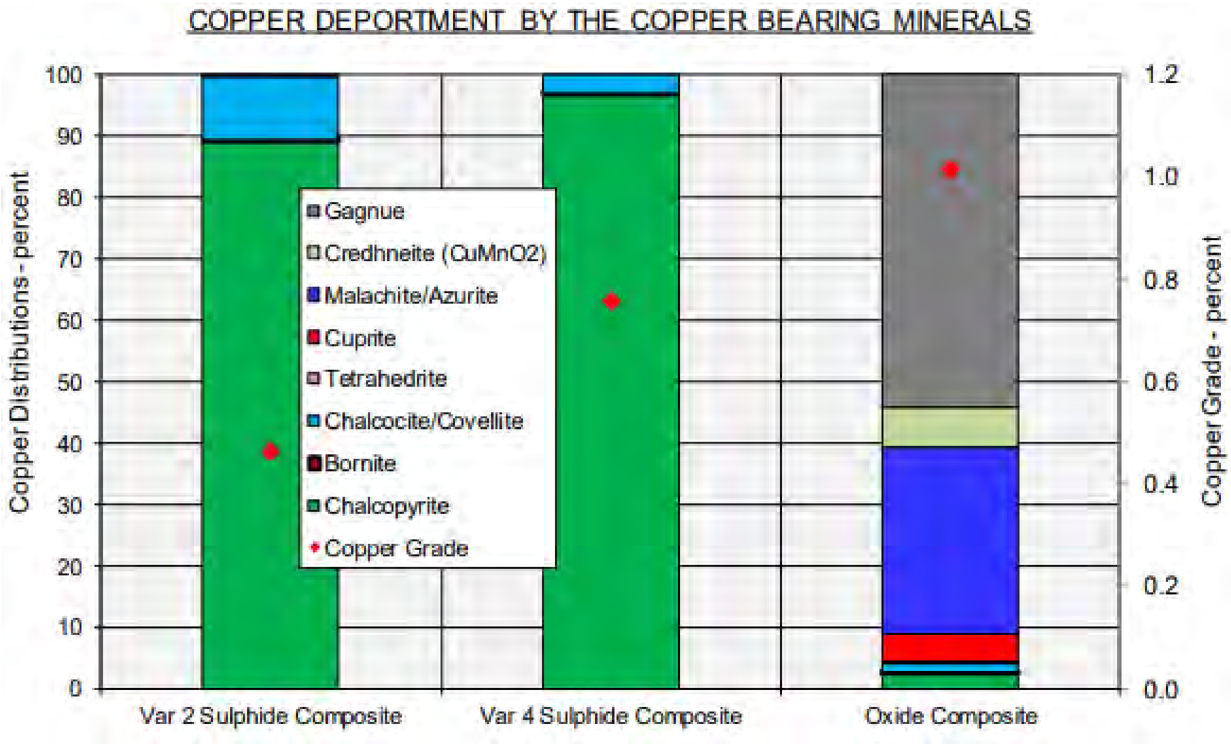


Figure 2: Copper deportment by copper bearing minerals for the two sulfide samples and the oxide sample

Sulfide Sample Process Mineralogy

The copper sulfide minerals have high level of liberation (~67%) as illustrated in Figure 3. Most two-product copper concentrators (one concentrate + one tailing) operate with 50 – 60% copper mineral liberation in flotation feed according to an operational benchmark database. The non-sulphide gangue liberation is equally important and for Var 2 and Var 4 the two-dimensional liberation was measured to be 97.4% and 96.5%, respectively. This level of liberation at the primary grind size of 154 μm P_{80} means that coarser primary grind sizes should be explored in test work because the samples are expected to maintain sufficient liberation of copper sulfide and non-sulphide gangue minerals for effective rougher flotation separation.

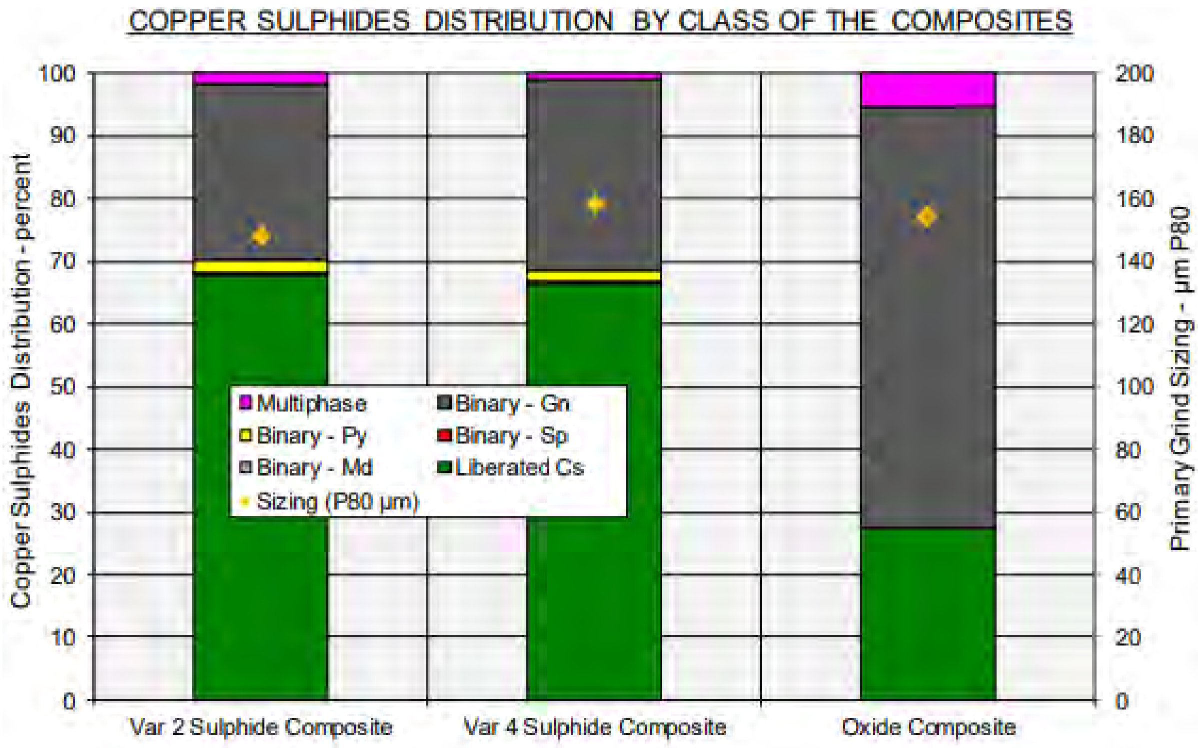


Figure 3: Copper mineral liberation for the two sulfide samples and the oxide sample

BV plotted the limiting grade-recovery curves illustrated in Figure 4 for the two sulfide samples and one oxide sample. Limiting grade-recovery curves present the maximum theoretical grade and recovery performance if all copper minerals reported to concentrate without any gangue entrapment. They are best applied as a guide to determine whether metallurgical performance in plant operation or test work development programs is achieving efficient mineral separation in respect to the liberation profile of the fragmented minerals in the feed.

The limiting grade-recovery plot for the Carmacks sulfide sample identifies that a suitable copper grade of 6% - 12% can be achieved to rougher concentrate at high recovery (see Figure 4).

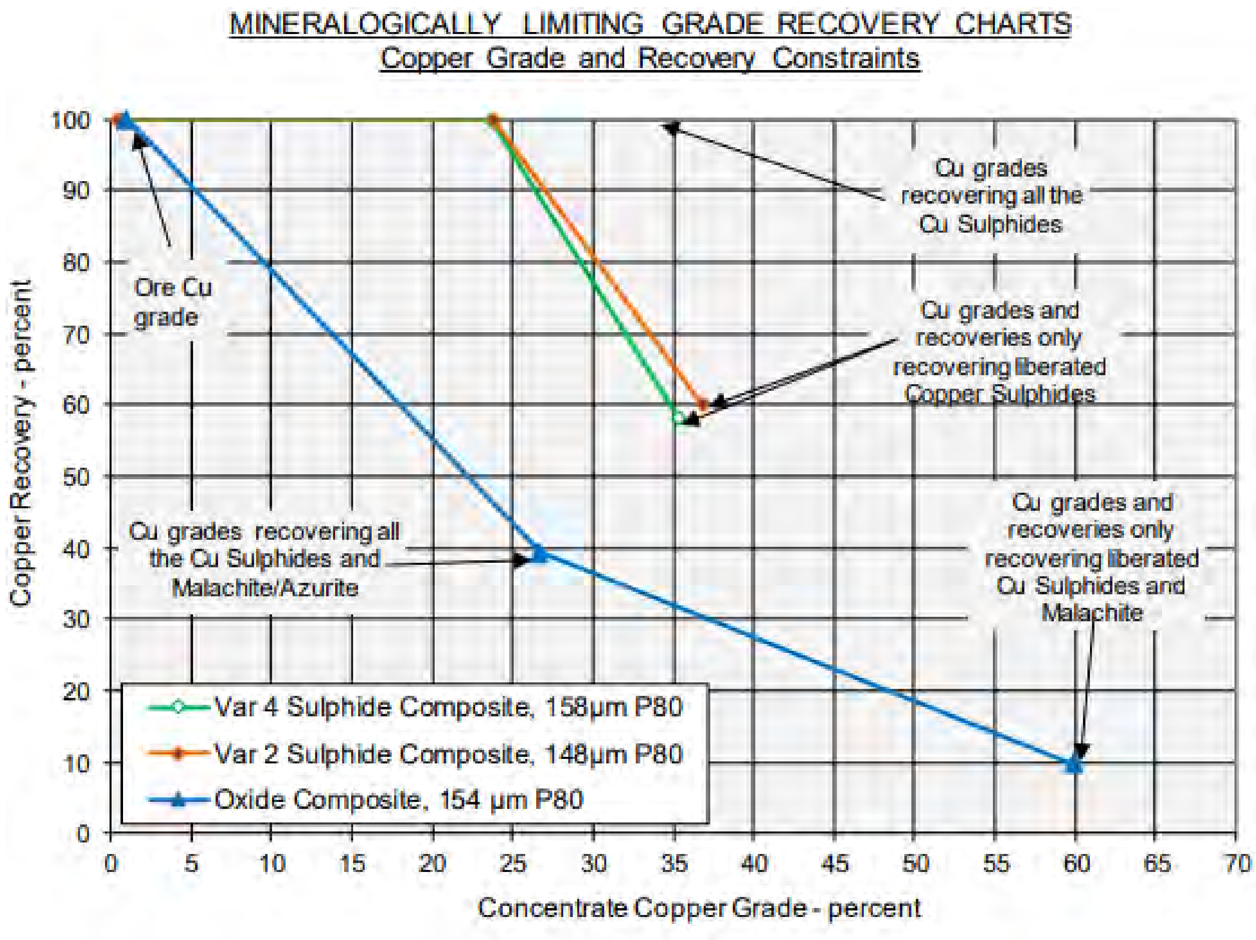


Figure 4: Limiting copper grade-recovery plots

Sulfide Sample Flotation Performance

BV completed three open circuit batch rougher flotation tests for both sulfide samples. Different combination and dosages of PAX and 3418A collectors are used to float all sulfide minerals. Modifiers, such as lime to regulate pH, were not needed to depress iron sulfides (pyrite) because the composition of these gangue sulphides is low. Rougher concentrate was collected and assayed in 5-minute intervals for total of 25 minutes flotation. Notable characteristics of the rougher flotation are:

1. Var 4 (0.76% Cu) showed faster flotation kinetic than the lower grade Var 2 (0.46% Cu) sample. Both samples resulted in typical porphyry copper rougher flotation performance of ~ 10 concentration ratio (feed weight/concentrate weight) and enrichment ratio (concentrate grade/feed grade) of ~0.1. Var 4 reached 98% Cu rougher flotation recovery with 11% mass pull and 7.9% Cu grade in 15 minutes and Var 2 reached ~98% Cu rougher recovery with 9.0% mass pull and 5.6% Cu grade in 25 minutes (see Figure 5 and 6). Rougher flotation was very simple with no copper mineral separation difficulties.

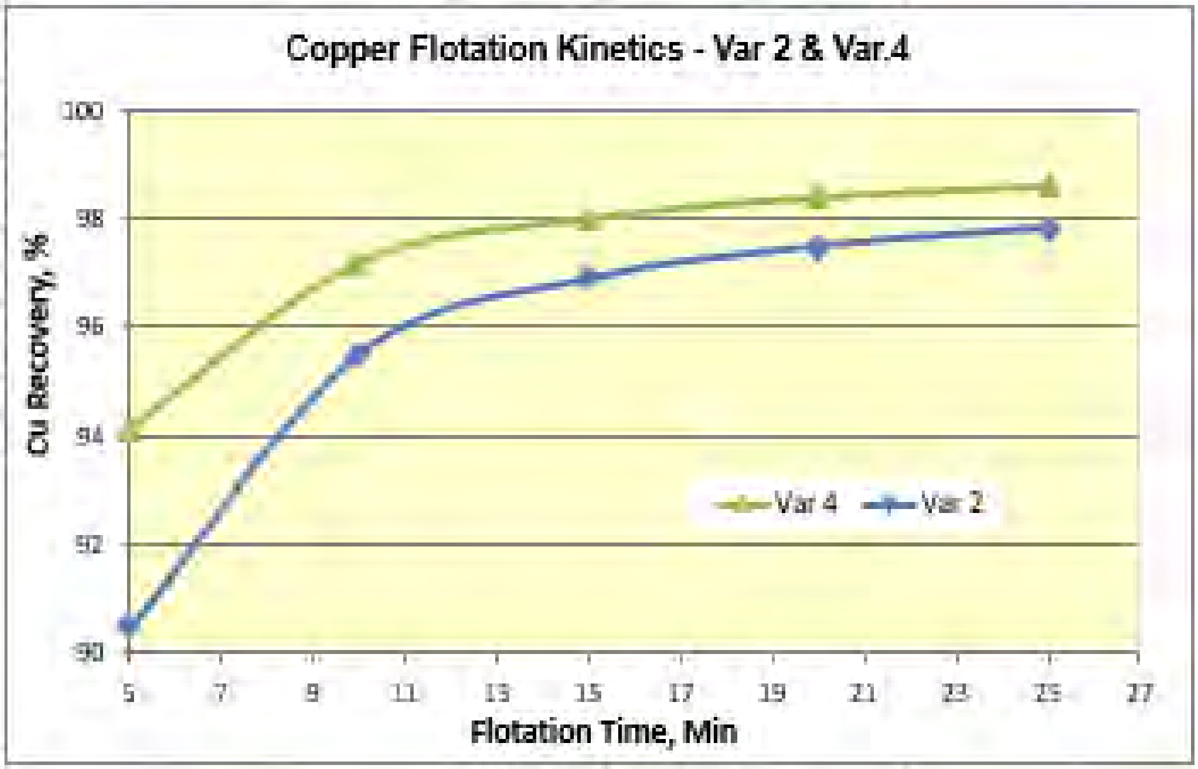


Figure 5: Rougher Copper Flotation Kinetics

2. As illustrated above in Figure 5, rougher flotation kinetics for both Var 2 and 4 are relatively slow (25 minutes) compared to our benchmark kinetics for porphyry copper ores with chalcopyrite as the main copper mineral. Most porphyry copper ores with chalcopyrite as the main copper mineral and low pyrite/clay content would exhibit fast flotation kinetics and likely complete rougher flotation in 5 to 10 minutes. Flotation kinetics is usually determined by particle size, liberation, and hydrophobicity. More testing is required to optimize the flotation performance in the next stage of study.

3. Overall selectivity of Var 4 sample was far superior to that of Var 2 sample (see Figure 6). More kinetic flotation test work with a shorter time frame (less than current 5 minutes) analysis should be conducted in the future works to fully understand the kinetic spectrum.

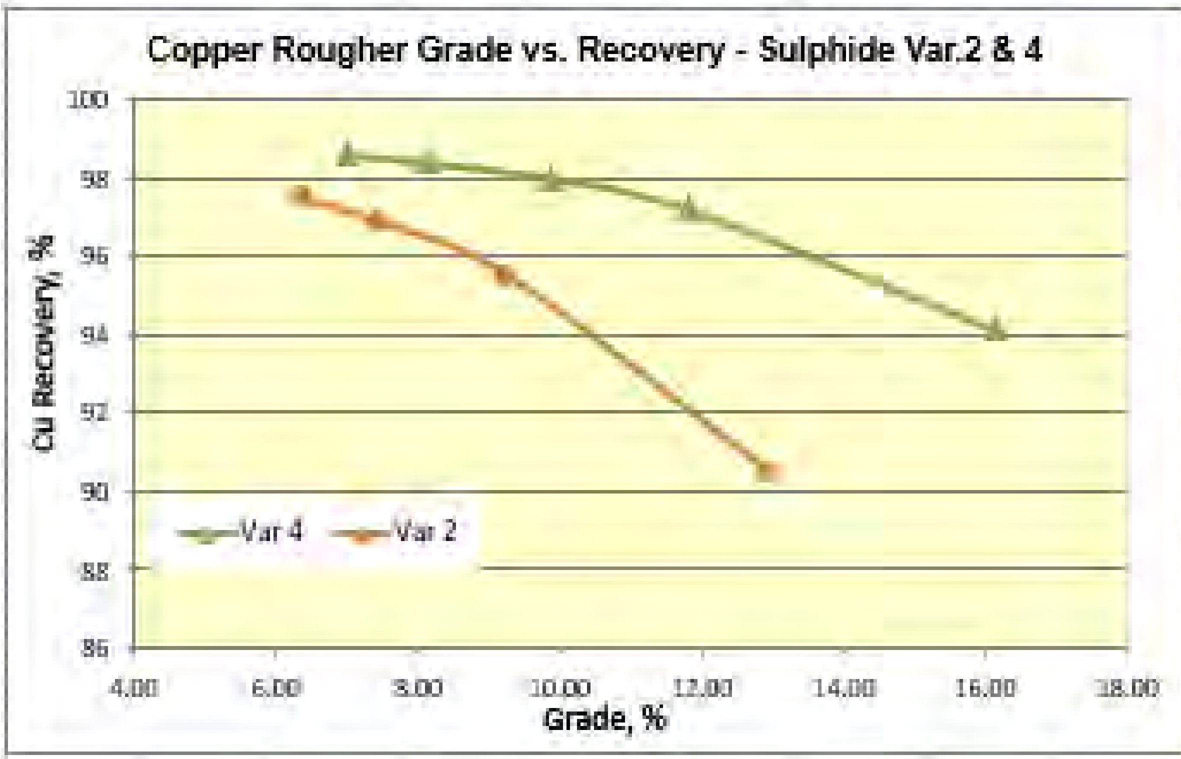


Figure 6: Copper recovery vs grade for batch rougher flotation tests

4. Gold recovery is closely related to Cu recovery (see Figure 7). As the copper recovery increases, the gold recovery increases but at a slower rate, indicating that some gold is associated with gangue minerals and/or liberated gold particles that are slower floating. Much of the gold associated with gangue is likely in pyrite. Rougher flotation was performed to float all sulfide minerals including pyrite. The BV gold deportation (QEM Scan PMA) analysis confirms the gold detected is associated with copper minerals and pyrite. However, gold content in non-sulfide gangue is not conclusive from the gold deportation analysis.

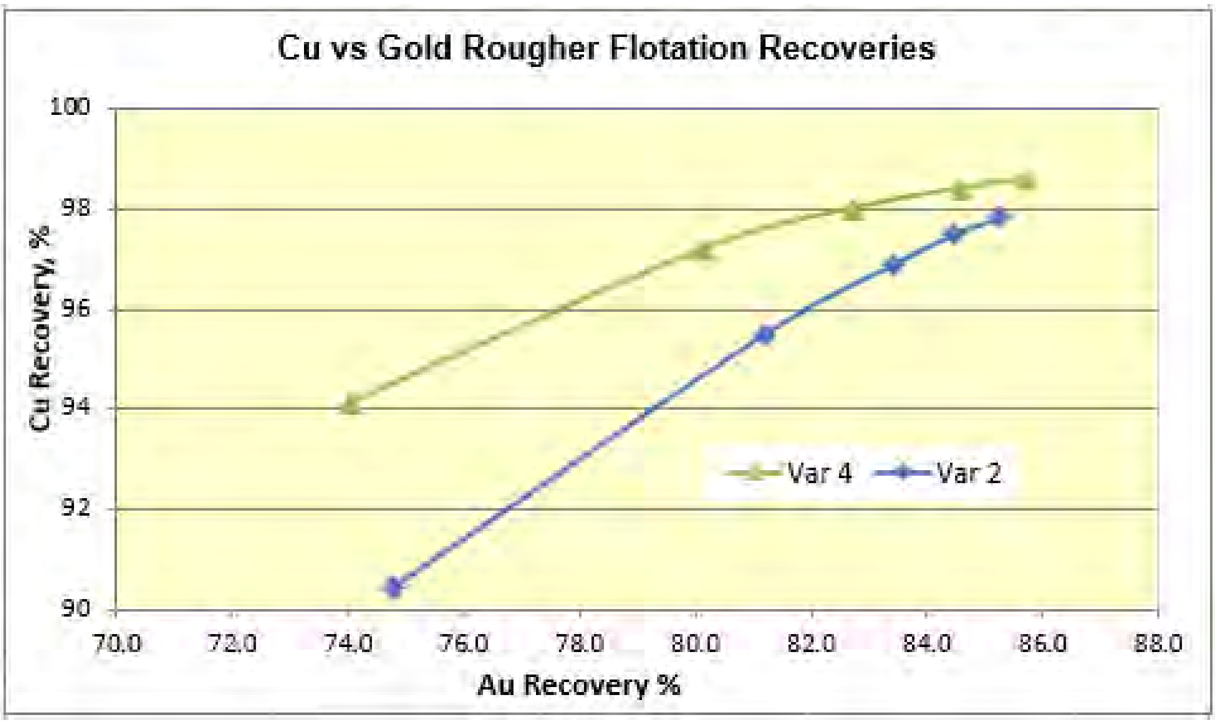


Figure 7: Cu recovery vs Au recovery for Batch Rougher Flotation tests

Sulfide Cleaner Flotation Performance

BV completed three open circuit cleaner flotation tests for both sulfide samples. PAX was used as the only collector and MIBC as the frother with lime to adjust the pH in the cleaners only. pH of the cleaner flotation slurry was increased as the cleaner stages advanced. BV applied pH of 9.5 and a flotation time of 9 minutes for the first cleaner and 3 minutes for the cleaner scavenger, 10.5 pH and 5 minutes for the second cleaner, and 11.5 pH and 3 minutes for the third cleaner. Three different regrind sizes (no regrind, P_{80} of 36 µm, and P_{80} of 23 µm) were studied and the 23 µm test provided the best copper selectivity (best grade and recovery). Cleaner test results at P_{80} of 23 µm will only be analysed in the following discussion.

Notable characteristics of the cleaner flotation tests include:

1. Overall copper selectivity of Var 4 sample was superior to that of Var 2 sample (see Figure 8). 25% copper concentrate grade is likely to be achieved with one (1) stage cleaning with ~96% overall recovery when Var 4 (0.76% Cu & low pyrite) or greater feed grade is introduced to the plant. Current cleaner flotation condition; using PAX as the only collector and MIBC as the frother with incremental pH adjustment over three (3) stage cleaning at P80 of 23 µm regrind; did not achieve 25% copper concentrate grade with satisfactory recovery for Var 2 (0.46% Cu & low pyrite) (see Figure 8). Further variability samples need to be selected to determine whether the liberation characteristics of Var 2 is typical or not for the sulphide deposit. If Var 2 is determined to have typical liberation characteristics, then regrinding to 15mm P80 should be completed.

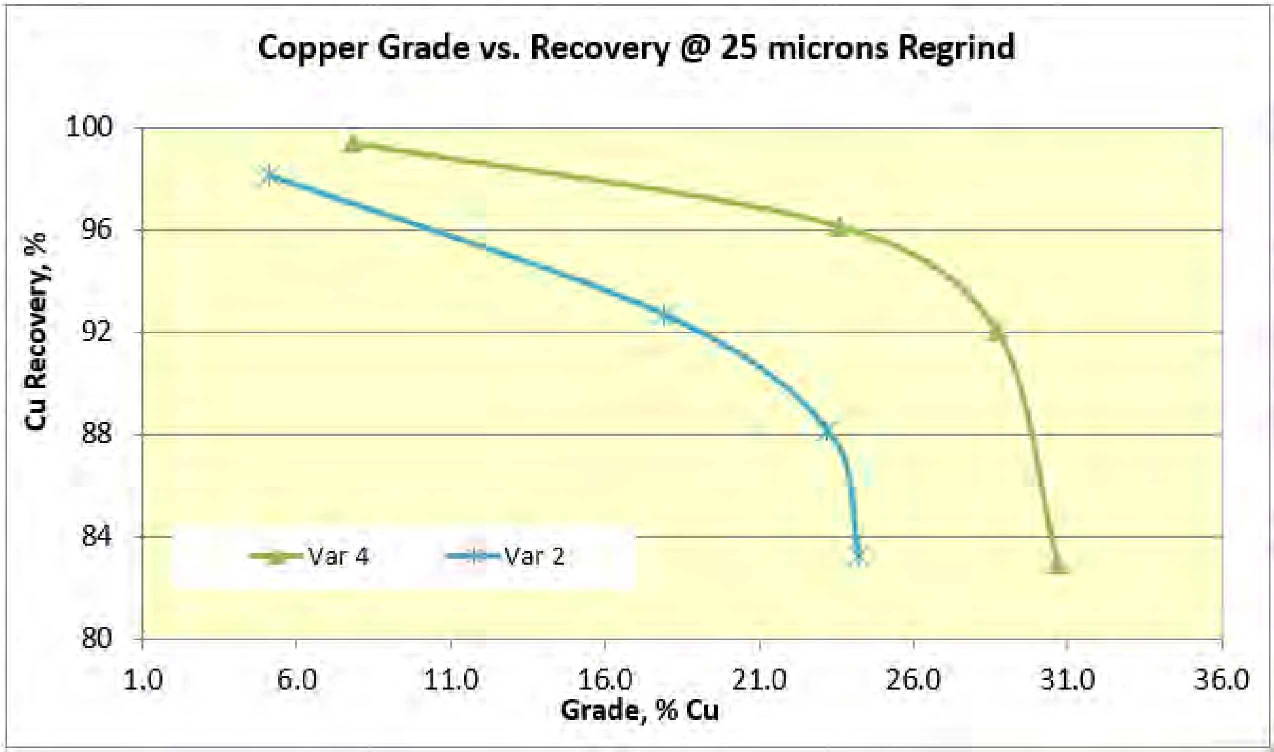


Figure 8: Cu grade vs recovery at P80 of 23 microns regrind

2. Gold recovery is closely related to Cu recovery (see Figure 9) as noted above. For Var 2 sample, gold recovery changes proportional to copper recovery in cleaner circuit flotation testing, indicating that most of the gold in this sample is associated with copper minerals (mainly chalcopyrite). Var 4 sample however shows a drastic change of gold recovery as the copper recovery varies at different stages of cleaner flotation, indicating some gold is associated with gangue minerals (mostly pyrite in this case) that is depressed by increasing pH (see Figure 9).

3. Pyrite associated gold in Var 4 is hard to recover once depressed in the cleaner circuit. Further flotation test work will focus on decreasing the pH in cleaning to reduce costs and increase gold recovery to copper concentrate. Gold deportation QEMScan PMA analysis confirms that most of the gold is refractory (<10 µm size gold) in sulfide minerals. It is therefore very important to reject the minimum amount of pyrite by adjusting the flotation conditions to minimize gold loss.

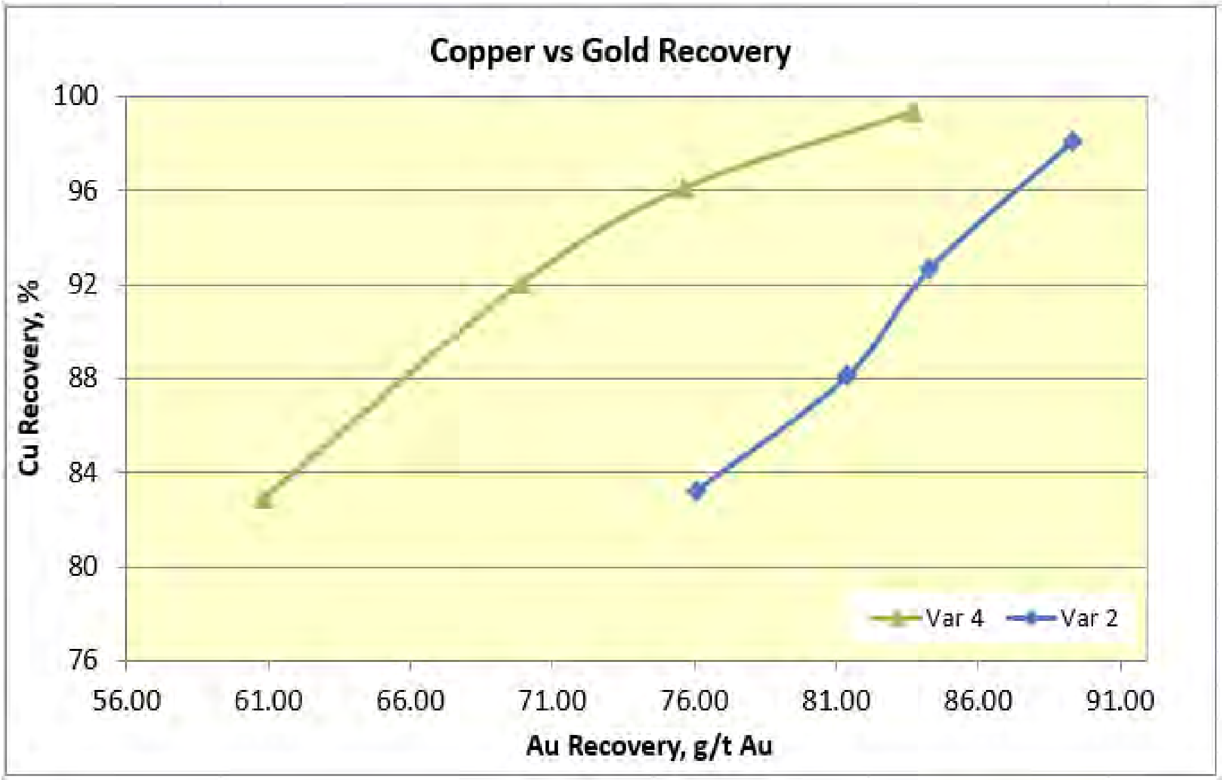


Figure 9: Cu vs Au recovery for open circuit batch rougher-cleaner flotation test

Recovery Estimation

Two open circuit rougher-cleaner flotation test results were used to generate the preliminary copper recovery estimation at 25% copper concentrate grade (see Figure 10). Open circuit cleaner flotation tests resulted in 24% Cu grade (maximum slightly above this value) and 85% Cu recovery for Var 2 and 25% Cu grade and 95.5% Cu recovery for Var 4 (see Figure 8). Sedgman experience was applied to scale up the open circuit flotation results to actual likely process plant recovery values of 88% for Var 2 and 96% for Var 4. Based on these two estimated recovery numbers, copper recovery vs copper feed grade plot was further extrapolated using first order equation as shown below (Figure 10). This preliminary recovery estimation should only apply to Cu feed grade of 0.46% to 1.0%.

Preliminary Copper Recovery = 97*(1-exp(-5.6 x Cu feed grade))

Gold recovery modelling is difficult with two samples containing almost equal contents of gold 0.16g/t (Var 2) and 0.18g/t (Var 4) and therefore a flat gold recovery at 76% gold recovery is recommended as a preliminary estimate until the project advances with more testing to support an improved model.

As the project advances, more batch and locked cycle tests (LCT) are required on a larger pool of representative samples to increase the confidence level of the recovery estimation.

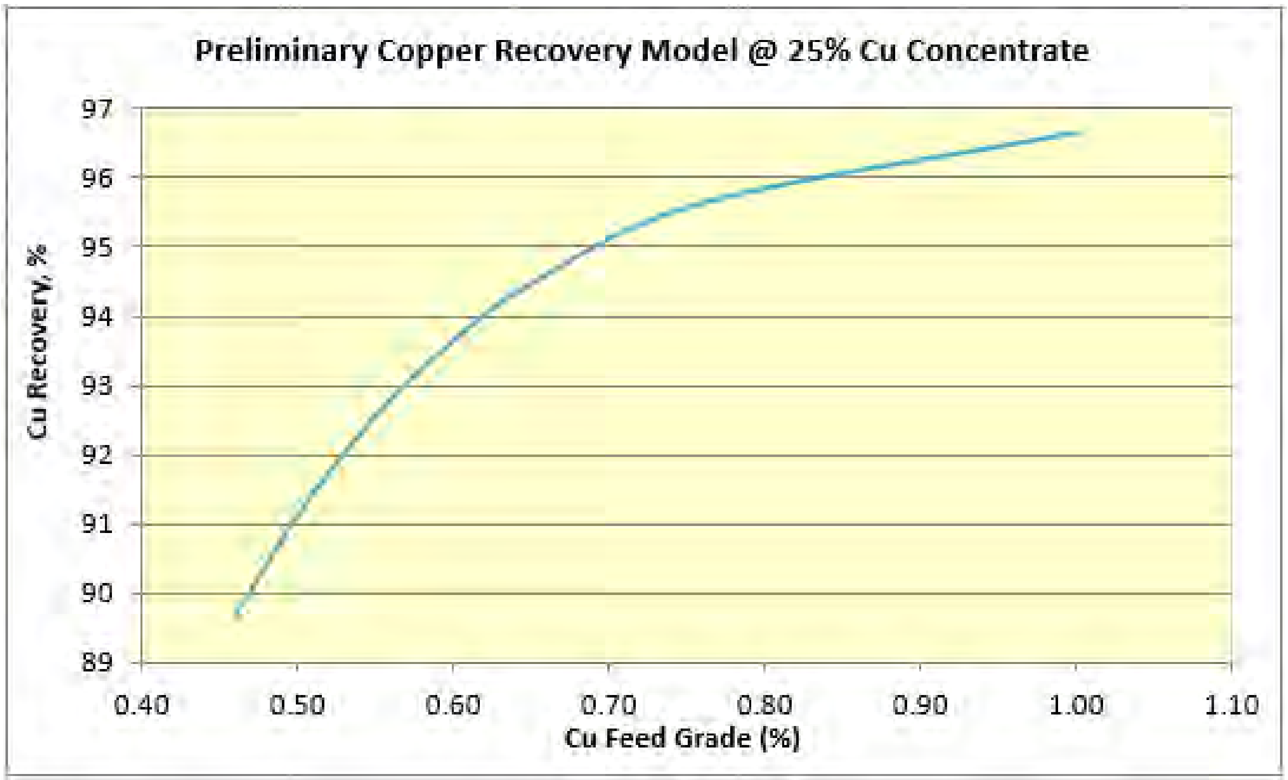


Figure 10: Preliminary Cu recovery estimate @25% Cu Concentrate Grade

Conclusion and Recommendation

The Carmack sulfide samples tested in 2021 contain chalcopyrite and minor covellite/chalcocite as the copper containing minerals, with low levels of pyrite. A series of flotation kinetic and open cleaner circuit tests demonstrated these two samples were easy to concentrate using PAX and MIBC in the flotation process at P_{80} of 150 μm for rougher flotation and 23 μm regrind size for the cleaner flotation stages. However, rougher flotation time was unusually long compared to typical porphyry copper ore and further optimization test work needs to be conducted as the project advances. Two initial flotation test results indicated that the main Carmacks ore (represented by Var 4 sample, 0.76% Cu) can be recovered at >95% into a 25% copper concentrate grade.

As the project moves forward, further metallurgical test work and variability samples are required to evaluate process equipment design parameters as well as validate copper and gold recoveries.