

## QOTHO CERTIFIED REFERENCE MATERIAL (QCRM)

### QCRM-5-088

#### COPPER CONCENTRATE

#### CERTIFICATE OF ANALYSIS

CERTIFIED VALUES			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
Ag	g/t	43.4	±3.1
Al	%	1.56	±0.11
Ca	%	0.06	±0.04
Co	%	0.028	±0.004
Cu	%	50.15	±0.50
Cu (Soluble)	%	6.13	±0.79
Fe	%	5.14	±0.18
Mg	%	0.11	±0.01
Mn	%	0.012	±0.002
S	%	17.45	±0.76
Zn	%	0.008	±0.002
ASSIGNED VALUES (FOR INFORMATION ONLY)			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
Au	g/t	0.20	±0.08
Ni	%	0.005	±0.002
Pb	%	0.007	±0.002
Si	%	6.96	±0.67

**1. Use:**

QCRM-5-088 is a certified reference material which is suitable for use as random control samples in routine analytical laboratory quality control, when inserted within a batch of samples and measured in parallel to the unknown. The QCRM can also be used as a control sample in the analysis of samples of a similar type, verification of analytical methods for copper concentrate and as a calibration standard for the calibration of equipment used for analysing similar materials.

**2. Origin of Material:**

This concentrate was sponsored by the Kinsenda Copper Mine, situated south-east of Lubumbashi, in the Democratic Republic of Congo.

**3. Mineral and Chemical Composition:**

The Kinsenda deposit is located on the southern edge of the Luina basement dome. It is a copper-only sulphide orebody, predominantly composed of chalcocite, bornite and chalcopyrite mineralization, hosted in a thick sequence of coarse to fine-grained sandstones, siltstones and shales of the Mindola Clastics Formation, the lowermost unit of the Lower Roan Subgroup, and occurs in the footwall of the Copperbelt Orebody Member. As such it is a "footwall deposit", similar to those at Chibuluma, further to the south in Zambia. It is one of the northern-most deposits of the Zambian Copperbelt. This predominantly sulphide concentrate, is the product of a floatation process.

**4. Date of Initial Issue:**

25 August 2021

**5. Packaging & Handling instructions:**

The material is packaged as 100g geo envelopes, within a vacuum sealed aluminum foil bag. Open the seal of the foil with care and shake or otherwise agitate prior to use. Normal safety precautions for handling fine particulate matter are recommended, such as the use of safety glasses, breathing protection, gloves and a laboratory coat. Once opened, material must be stored in a cool, dry environment. Results on page 1 is presented on dry basis. Analysis should therefore be done on dry basis, after drying to constant mass, at 105 degrees Celsius.

**6. Method of Preparation:**

The material was sieved through a 75-micron screen and the oversize was re-milled to ensure 100% passing through the screen. It was then blended, systematically divided and packaged into 100-gram zip-lock bags. Randomly selected samples, from the bags, were tested in-house via XRF, to confirm homogeneity. Once confirmed and certification completed, the items were placed in geo-envelopes and vacuum sealed in aluminium foil bags.

**7. Methods of Analysis used:**

- Multi-acid digestion with Electro-Gravimetric finish
- Soluble copper by mild sulfuric acid leach and ICP-OES or AAS finish
- Multiple acid digestion with ICP-OES or AAS finish
- Gold and silver by Fire Assay and ICP-OES finish
- Sodium peroxide fusion with ICP-OES or AAS finish
- Sodium peroxide fusion with Potentiometric Titration
- Pressed powder with XRF finish
- Sulphur by combustion analysis.

**8. Analysis required:**

An instruction letter was sent to all participants. The analysis required was noted in the instruction letter and reporting template, including but not limited to Ag, Al, As, Au, Ca, Co, Cu, Cu (Soluble), Fe, H<sub>2</sub>O, Mg, Mn, Ni, Pb, S, Si & Zn.

**9. Participating Laboratories:**

No	LABORATORY	COUNTRY
1.	AHK DRC South	DRC
2.	AHK Kitwe	Zambia
3.	AHK Lumwana	Zambia
4.	ALS Geochemistry Kempton Park	South Africa
5.	ALS Zambia	Zambia
6.	Dundee Precious Metals	Namibia
7.	Dundee Precious Metals - Process Control Laboratory	Namibia
8.	Intertek Tschudi	Namibia
9.	Kamoto Copper Company	DRC
10.	Lubambe Copper Mine	Zambia
11.	Mopani Mufulira Mine	Zambia
12.	MSALabs Tanzania	Tanzania
13.	Mutanda Mining	DRC
14.	OCC Kolwezi	DRC
15.	OCC Likasi	DRC
16.	OCC Lubumbashi	DRC
17.	OCC Tenke	DRC
18.	Palabora Mining Company	South Africa
19.	Rio Tinto Kennecott	USA
20.	Robinson International	DRC
21.	Sable Zinc	Zambia
22.	Societe de Surveillance Mine Lab	DRC
23.	Zambia Revenue Authority	Zambia

**10. Assay Data:**  
Data used for Assigning Values and Certification.

LABORATORY	Ag	Al	As	Au	Ca	Co	Cu	Cu (Soluble)
UNIT	g/t	%	ppm	g/t	%	%	%	%
LAB001	44.485		13.5	4	0.036	0.026	48.7	
LAB002			< 54.000	0.21				
LAB003							47.78	
LAB004							48.545	
LAB005		1.51					50.412	
LAB006							49.7	6.43
LAB007							48.975	
LAB008							49.585	
LAB009	41.723	1.499	8.896			0.027		6.205
LAB010							50.005	
LAB011	47	2.345	< 100.000	0.135	0.09		49.95	
LAB012							49.41	
LAB013					0.357	0.02	45.37	
LAB014				0.245				
LAB015					0.249	0.029	49.946	6.34
LAB016			< 100.000					6.73
LAB017							51.64	
LAB018							48.745	
LAB019							49.985	7.515
LAB020		1.682			0.026		49.555	5.565
LAB021	42.8	1.62	5.5	0.21	0.04	0.03	52.05	
LAB022							52.055	
LAB023								7.02
LAB024							50.788	
LAB025		1.771	< 10.000		0.068		49.754	
LAB026	45.74	1.565	22.467			0.027	49.675	5.95
LAB027						0.026		
LAB028							49.816	
LAB029	39.5					0.021	50.73	8.055
LAB030	47.343	1.47	6.195			0.03	50.55	5.22
LAB031		1.535				0.027	50.425	4.33
LAB032	40.65	1.65	7	0.225	0.04	0.03	51.25	5.98
LAB033							50.995	
LAB034	44.5	1.6	108		0.06		50.515	
LAB035							50.715	
LAB036			50.5				53.215	0.695
LAB037					0.106	0.039	50.04	5.47
LAB038								4.852

LABORATORY	Ag	Al	As	Au	Ca	Co	Cu	Cu (Soluble)
UNIT	g/t	%	ppm	g/t	%	%	%	%
LAB039							51.672	
LAB040							51.375	
LAB041						0.024	49.295	
LAB042		1.28					50.397	
LAB043	40.26	1.454	< 10.000	0.167	0.035	0.027	48.44	
LAB044			< 20.000				48	
LAB045							52.985	
LAB046					0.056	0.043	50.554	6.478
LAB047						0.033	50.135	
LAB048							50.149	

LABORATORY	Fe	Mg	Mn	Ni	Pb	S	Si	Zn
UNIT	%	%	%	%	%	%	%	%
LAB001	5.274	0.1	0.012	0.005	0.006		7.43	0.007
LAB002				< 0.005	< 0.010			0.004
LAB003								
LAB004							5.35	
LAB005	5.44					16.88	7.345	
LAB006								
LAB007								
LAB008	5.999		0.013	0.024				
LAB009	5.198	0.103	0.011		0.003	18.035	7.005	
LAB010								
LAB011		0.15			0.01	15.09	7.08	0.01
LAB012								
LAB013			0.008					
LAB014								
LAB015	4.462		0.013					
LAB016	5.14				< 0.010	14.96	7.555	< 0.010
LAB017								
LAB018	5.133		0.014	0.029				
LAB019								
LAB020		0.094		0.034		18.133	8.32	0.056
LAB021	5.42	0.11	0.01	< 0.010	< 0.010	17.725		
LAB022								
LAB023								
LAB024								
LAB025	5.405	0.095	0.011		< 0.001			< 0.010
LAB026	4.655	0.105	0.011	0.006	0.005			0.009

LABORATORY	Fe	Mg	Mn	Ni	Pb	S	Si	Zn
UNIT	%	%	%	%	%	%	%	%
LAB027								
LAB028								
LAB029	4.784		0.011		< 0.010			0.007
LAB030		0.12			0.01	17.482		0.01
LAB031	5.34	0.137			0.027	19.314	7.153	0.008
LAB032	4.865	0.11	0.012	< 0.010	< 0.010	17.325		0.03
LAB033								
LAB034	5.345				0.02	18.585	3.315	0.02
LAB035								
LAB036					< 0.010	17.69	7.585	0.01
LAB037		0.101	0.027					
LAB038								
LAB039								
LAB040	4.875							
LAB041	5.11		0.011	0.006				0.007
LAB042	5.207					17.017	6.844	
LAB043	5.229	0.11	0.012	0.005	0.006	17.2	6.065	0.007
LAB044				0.004	0.018		6.31	
LAB045								
LAB046	5.081	0.09	0.014	0.095	0.02		6.739	0.031
LAB047	5.017							
LAB048								

#### 11. Method of Certification:

**Qotho Minerals is a SANAS Accredited Proficiency Testing Scheme Provider, No. PTS0012**

This material was distributed as test items, in the Qotho Copper PT Rounds 6 of 2020 and 4 of 2021. In each round the participating laboratories were each given 1 randomly selected sample from the batch, to analyse and report on in duplicate. Some laboratories reported results via more than one analytical method and not all laboratories participated in both rounds. Obvious blunders were resolved with the laboratories (if any), after which the data was processed using Robust Statistics, through PROLab Plus

Not all the participating laboratories were accredited to analyse this material. Historical performance in Qotho PT Schemes, as well as an evaluation of the CRM QA/QC data generated by the laboratories, during the analysis of this QRM, were considered, to evaluate the competence of laboratories.

Where analytes cannot be certified, due to inability to demonstrate laboratory competence for at least 10 datasets, as is the case for this report, estimate concentrations were assigned, using all the data in the dataset.

#### 12. Measurement of Uncertainty:

Measurement uncertainty, uCRM, was calculated according to ISO 13528:2015 (equation 6), and it includes the effects of uncertainty due to inhomogeneity, transport, potential instability, and laboratory uncertainty. Because of all the uncertainties under consideration, QM further applies an expanded uncertainty, for certification purposes. UCRM = kuCRM, where k is a coverage factor, which is determined from the Student's t-distribution, based on the degrees of freedom, per analyte.

This presents a certified value, as follows:  $x_{CRM} \pm U_{CRM}$ .

Measurement uncertainty for Assigned values, are calculated in the same manner.

For laboratories prefer to use the 95% measurement uncertainty, rather than the expanded uncertainty, all available information relating to measurement uncertainty of the certified/assigned values, are given below:

Analyte	Unit of measure	$\nu$ (degrees of freedom)	k (coverage factor)	$u$ (standard error)	95% measurement uncertainty	Expanded Uncertainty
Ag	g/t	9	2.262	1.376	$\pm 2.8$	$\pm 3.1$
Al	%	12	2.179	0.051	$\pm 0.10$	$\pm 0.11$
Au	g/t	6	2.447	0.032	$\pm 0.06$	$\pm 0.08$
Ca	%	11	2.201	0.015	$\pm 0.03$	$\pm 0.04$
Co	%	15	2.131	0.002	$\pm 0.004$	$\pm 0.004$
Cu	%	40	2.021	0.247	$\pm 0.49$	$\pm 0.50$
Cu (Soluble)	%	15	2.131	0.37	$\pm 0.74$	$\pm 0.79$
Fe	%	19	2.093	0.083	$\pm 0.17$	$\pm 0.18$
Mg	%	12	2.179	0.005	$\pm 0.01$	$\pm 0.01$
Mn	%	14	2.145	0.001	$\pm 0.002$	$\pm 0.002$
Ni	%	11	2.201	0.001	$\pm 0.002$	$\pm 0.002$
Pb	%	16	2.120	0.001	$\pm 0.002$	$\pm 0.002$
S	%	12	2.179	0.348	$\pm 0.70$	$\pm 0.76$
Si	%	13	2.160	0.309	$\pm 0.62$	$\pm 0.67$
Zn	%	15	2.131	0.001	$\pm 0.002$	$\pm 0.002$

**13. Metrological Traceability:**

The values quoted herein are based on the consensus values derived from statistical analysis of the data from an inter laboratory measurement program. Traceability to SI units is via the accredited laboratories, as ISO 17025 requires laboratories to use CRM's traceable to the SI units, during the calibration of their equipment. Not all laboratories are accredited.

Fortunately, most laboratories reported on the QA/QC CRMs used during the analysis of this QRM and reported the values obtained during the sample run. Evaluation of their QA/QC performance serves as further evidence of metrological traceability.

Equivalence tests were performed on all analytes to determine whether the metrologically traceable data and those for which traceability evidence was not available, could be treated as equal (at a level of significance of  $\alpha = 0.05$ ). Where equivalent, all the data was used. Where not, only the metrologically traceable data was considered. As mentioned in Section 11, certification of analytes could only be done, if a minimum of 10 qualifying datasets, were available.

**14. Minimum sample size:**

The recommended minimum sample size for the use of this material is as per the participants method validation criteria.

**15. Period of validity:**

The certified values are valid for this product, while still sealed in its original packaging, for a minimum period of 5 years from date of Initial Certification. Stability monitoring of inventory will be done at regular intervals. Any concerns regarding potential instability of the material, will immediately be communicated to all consumers.

**16. Legal:**

This certificate and the reference material described in it have been prepared with due care and attention. The requirements of ISO Guide 31, ISO 17043 and ISO 17034 were followed in the preparation of this reference material and certificate of analysis.

Qotho Minerals, however, accepts no liability for any decisions or actions taken following the use of the reference material. The company has a complaints procedure, which will be made available upon request, should there be any dissatisfaction with either the product or the COA.

Certifying & Technical Signatory	
<b>Qotho Managing Director</b>	<b>25 August 2021</b>

*This Certificate of Analysis (CoA) has been electronically signed using an Advanced Electronic Signature (AES) in terms of the Electronic Communications and Transactions Act No. 15, 2002 (ECT Act). Any amendments to the CoA can be detected by reference to the Signature Panel displayed in the electronic pdf version of the CoA.*

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