

QOTHO CERTIFIED REFERENCE MATERIAL (QCRM)

QCRM-5-082

COPPER CONCENTRATE

CERTIFICATE OF ANALYSIS

CERTIFIED VALUES			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
Cu	%	24.91	±0.35
Fe	%	11.79	±0.87
ASSIGNED VALUES (FOR INFORMATION ONLY)			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
Al	%	1.03	±0.30
As	%	1.33	±0.34
Ca	%	3.01	±0.37
Co	%	0.60	±0.06
Cu (Soluble)	%	10.9	±1.9
Mg	%	1.43	±0.32
Mn	%	0.20	±0.03
Ni	%	0.09	±0.02
Pb	%	0.21	±0.03
S	%	11.4	±2.0
Si	%	4.46	±0.28
Zn	%	6.14	±0.49

1. Use:

QCRM-5-082 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 analyzing similar materials.

2. Origin of Material:

This standard was sponsored by ALS Inspection in Johannesburg and is a mixture of copper concentrates originating from the Kalahari Copperbelt in Botswana.

3. Mineral and Chemical Composition:

The concentrate originates from ore from the Kalahari Copper Belt which is a sediment-hosted, stratiform Cu-Ag deposit hosted in Meso- and Neoproterozoic rocks. The Belt extends from northern Botswana into Namibia along the NW edge of the Kalahari Craton, and consists of folded and greenschist metamorphosed Ghanzi (Botswana) and Tsumis (Namibia) Group metasedimentary rocks. The Cu-Ag-As-Zn deposits occur in chemically reduced shales and siltstones that overlay oxidized sandstones.

4. Date of Initial Issue:

6 January 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:

- 2, 3 and 4-acid digestion with Electro Gravimetric finish
- Aqua Regia digestion with ICP-OES finish
- 3 and 4 - Acid digestion with AAS finish
- 4-Acid digestion with Potentiometric Titration
- Sulphur by combustion analysis.

8. Analysis required:

An instruction letter was sent to all participants within the PT Scheme. The analysis required was noted in the instruction letter and reporting template, including but not limited to Ag, Al, As, Ca, Co, Cu, Cu (Soluble), Fe, H₂O, Mg, Mn, Ni, Pb, S, Si and Zn.

9. Participating Laboratories:

NO	LABORATORY	COUNTRY
1.	AHK Kitwe	Zambia
2.	AHK Lumwana	Zambia
3.	ALS Geochemistry Kempton Park	South Africa
4.	Dundee Precious Metals	Namibia
5.	Dundee Precious Metals - Process	Namibia
6.	Kamoto Copper Company	DRC
7.	Lubambe Copper Mine	Zambia
8.	Mutanda Mining	DRC
9.	OCC Kolwezi	DRC
10.	OCC Likasi	DRC
11.	OCC Tenke	DRC
12.	Palabora Mining Company	South Africa
13.	Robinson International	DRC
14.	Societe de Surveillance Mine Lab	DRC
15.	Zambia Revenue Authority	Zambia

10. Assay Data:

Data used for Assigning Values and Certification.

Laboratory	Ag	Al	As	Au	Ca	Co	Cu	Cu (Soluble)	Fe	Mg	Mn	Ni	Pb	S	Si	U	Zn
Unit	g/t	%	ppm	g/t	%	%	%	%	%	%	%	%	%	%	%	ppm	%
LAB001		0.996			2.935		25.304		12.398	1.589				11.926	4.526		
LAB002						0.565			11.99		0.186	0.083					6.043
LAB003						0.567	24.155		10.365								
LAB004	32.484	1.119	14689				24.9		12.426	1.622	0.24		0.208	13.235	4.614		5.281
LAB005		0.593			2.736	0.667	25.519	11.57	11.619	1.153	0.208	0.166	0.138		4.306		6.42
LAB006	34	1	12435		3.07		24.775		12.425	1.255			0.215	10.855	4.265		6.15
LAB007							24.405										
LAB008						0.6					0.16						
LAB009					2.82	0.635	24.4	9.36		1.295	0.19			8.725			
LAB010			13430				25.565	11.9					0.235	11.68	4.605		
LAB011						0.537			11.57		0.209	0.116					
LAB012							24.528										
LAB013	30.6	1.025	13425	1.205	3.05	0.615	25.05	11.35	10.945	1.46	0.21	0.085	0.2	11.025		7.5	6.115
LAB014							25.025										
LAB015							24.822	10.505									
LAB016	32.365	1.252	12345		3.463	0.613	24.925		12.902	1.623	0.22	0.09	0.2	12.221			7.238
LAB017						0.573			11.239		0.203	0.087					5.95
LAB018							25.045										
LAB019							25.151										

11. Method of Certification:

QM is a SANAS Accredited Proficiency Testing Scheme Provider, No. PTS0012

This material was distributed as test items, in the Qotho Copper PT Round 4 of 2020. The participating laboratories were each given 1 randomly selected sample from the batch, to analyze and report on in duplicate. Some laboratories reported results via more than one analytical method. 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. Equivalence tests were performed on all analytes to determine whether the data from the accredited and non-accredited laboratories, can be treated as equal (at a level of significance of $\alpha = 0.05$). Where equivalent, all the data was used. Where not, only the data from the accredited laboratories were considered. Certification of analytes were then done, provided that a minimum of 10 datapoints remained available.

Where analytes cannot be certified, estimate concentrations were assigned, using all the data in the dataset.

12. Measurement of Uncertainty:

Measurement uncertainty, u_{CRM} , 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. $UCRM = k u_{CRM}$, 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: $x_{CRM} \pm UCRM$.

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	ν (degrees of freedom)	k (coverage factor)	u (standard error)	95% measurement uncertainty	Expanded Uncertainty
Al	%	5	2.571	0.114	± 0.23	± 0.30
As	ppm	4	2.776	0.123	± 0.25	± 0.34
Ca	%	5	2.571	0.142	± 0.28	± 0.37
Co	%	8	2.306	0.025	± 0.05	± 0.06
Cu	%	14	2.145	0.162	± 0.32	± 0.35
Cu (Soluble)	%	4	2.776	0.682	± 1.4	± 1.9
Fe	%	9	2.262	0.382	± 0.76	± 0.87
Mg	%	6	2.447	0.128	± 0.26	± 0.32
Mn	%	8	2.306	0.01	± 0.02	± 0.03
Ni	%	5	2.571	0.005	± 0.01	± 0.02
Pb	%	5	2.571	0.012	± 0.02	± 0.03
S	%	6	2.447	0.82	± 1.6	± 2.0
Si	%	4	2.776	0.099	± 0.20	± 0.28
Zn	%	6	2.447	0.2	± 0.40	± 0.49

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. Most laboratories reported on the QA/QC CRM's used during the analysis of this QRM and reported the values obtained during the sample run. This provides additional evidence of measurement traceability.

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/Analytical Report.

Certifying & Technical Signatory	
Qotho Managing Director	6 January 2021

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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