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QOTHO CERTIFIED REFERENCE MATERIAL (QCRM)

QCRM-6-027

GOLD - LOW GRADE

CERTIFICATE OF ANALYSIS

CERTIFIED VALUES			
ANALYTES	**UNITS**	**CONCENTRATIONS**	**EXPANDED UNCERTAINTY**
Al_2O_3	%	5.41	±0.80
Au	g/t	0.19	±0.02
Cu	%	0.008	±0.002
MgO	%	0.41	±0.08
S	%	0.65	±0.09
ASSIGNED VALUES (FOR INFORMATION ONLY)			
ANALYTES	**UNITS**	**CONCENTRATIONS**	**EXPANDED UNCERTAINTY**
Ag	g/t	1.05	±0.67
As	ppm	97	±19
CaO	%	0.60	±0.05
Fe_2O_3	%	2.31	±0.13
MnO	%	0.063	±0.004
SiO_2	%	86.8	±2.8
TiO_2	%	0.23	±0.02

1. **Use:**
QCRM-6-027 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 Low Grade Gold and as a calibration standard for the calibration of equipment used for analysing similar materials.

2. **Origin of Material:**
This standard was sponsored by Harmony Gold.

3. **Mineral and Chemical Composition:**
This material originates from the Welkom gold fields. The Welkom gold deposits are found in the sedimentary rock sequences of the Central Rand Group, which represent unconformity bounded genetic packages. The origin of gold in the Witwatersrand basin can be classified into the modified placer theory. The various placers contain vein quartz, chert, quartzite, quartz-porphyry, and 26% yellow shale. The gold is extracted from the ore, via conventional cyanide leach processes.

4. **Date of Initial Issue:**
18 October 2023.

5. **Packaging & Handling instructions:**
The material is packaged in 500g sealed plastic tub. 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 500-gram sealed plastic tub. 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:**
   - Sodium peroxide fusion with ICP-OES finish
   - Multi-acid digestion with AAS or ICP-OES finish
   - Aqua Regia digestion with AAS or ICP-OES finish
   - Fused beads with XRF finish
   - Pressed powder with XRF finish
   - Sulphur by combustion analysis.
   - Copper by multi-acid digestion and Potentiometric finish
   - Silica by multi-acid digestion and gravimetric finish
   - Gold and Silver by Lead collection fire assay and AAS or ICP-OES finish

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_2O_3, As, Au, CaO, Cr_2O_3, Cu, Fe_2O_3, LOI, MgO, MnO, P, S, SiO_2, and TiO_2.

9. Participating Laboratories:

NO	LABORATORY	COUNTRY
1.	AHK Kitwe	Zambia
2.	AHK Lumwana	Zambia
3.	Alex Stewart International	United Kingdom
4.	ALS Geochemistry Kempton Park	South Africa
5.	ALS Inspection UK	United Kingdom
6.	ALS Kansanshi	Zambia
7.	Bisha Mining Company	Eritrea
8.	BMC Analysis	United Kingdom
9.	Bureau Veritas Minerals Perth	Australia
10.	Dundee Precious Metals	Namibia
11.	Harmony Freegold	South Africa
12.	Harmony Gold Kalgold	South Africa
13.	Intertek Tschudi	Namibia
14.	Kamoto Copper Company	Democratic Republic of Congo
15.	Mintek	South Africa
16.	Misenge Environmental & Technical	Zambia
17.	Mineração Caraíba S.A.	Brazil
18.	Mitra Sk India	India
19.	Mitra Sk South Africa	South Africa
20.	Mopani Nkana	Zambia
21.	Mutanda Mining	Democratic Republic of Congo
22.	Palabora Mining Company	South Africa
23.	QLS Northern Cape	South Africa
24.	Robinson International	Democratic Republic of Congo
25.	Rio Tinto Kennecott	United States of America
26.	SGS Randfontein	South Africa
27.	SGS Vaal River Lab	South Africa
28.	Suntech Geomet Labs	South Africa
29.	UIS Analytical Services	South Africa
30.	Zambia Revenue Authority	Zambia

10. Assay Data:

Data used for Assigning Values and Certification.

LABORATORY	Ag	Al_2O_3	As	Au	CaO	Cr_2O_3	Cu	Fe_2O_3	LOI (950°C)	MgO	MnO	P	S	SiO_2	TiO_2
UNIT	g/t	%	ppm	g/t	%	%	%	%	%	%	%	%	%	%	%
LAB001	0.85				0.585	0.07	0.004		2.175		0.065	0.01	0.675	87.45	0.23
LAB002				0.21											
LAB003	0.534	4.762	91.5		0.562	0.035	0.005	2.175		0.333	0.06	0.009	0.702	89.77	0.13
LAB004				0.185											
LAB005				0.26											
LAB006	2		85	0.17	0.581	0.06	0.009	2.425	2.165	0.36	0.061	0.007		85.78	0.236
LAB007				0.197											
LAB008				0.204											
LAB009	0.955						0.005								
LAB010	1.395	5.988	104.611		0.619	0.054	0.007		1.925		0.058	0.085		78.954	0.237
LAB011				0.2											
LAB012	0.65		90		0.57	0.058	0.008		1.925	0.375	0.06	0.01	0.661	86.85	0.243
LAB013				0.155											
LAB014				0.215											
LAB015		5.645		0.205	0.539	0.088		2.14		0.33				76.7	0.226
LAB016	0.182		107.5		0.6	0.027	0.004				0.065	0.009		89.315	0.137
LAB017				0.158											
LAB018				0.172											
LAB019				0.125											
LAB020				0.112											
LAB021	0.368	5.536	75.818		1.896		0.028	2.309		0.381	0.775		0.676		
LAB022		5.811					0.021	2.29		0.435			0.499		

LABORATORY	Ag	Al_2O_3	As	Au	CaO	Cr_2O_3	Cu	Fe_2O_3	LOI (950°C)	MgO	MnO	P	S	SiO_2	TiO_2
UNIT	g/t	%	ppm	g/t	%	%	%	%	%	%	%	%	%	%	%
LAB023			102		0.637								0.61		
LAB024							0.04								
LAB025	1		90		0.574		0.01				0.065			88.931	
LAB026							0.005								
LAB027	2.5														
LAB028	1.333	3.963	149.167		0.61		0.004	2.097		0.266	0.035				
LAB029					0.822		0.013			0.445	0.075		0.72		
LAB030					0.405		0.011				0.071				
LAB031					0.679		0.012								
LAB032		3.911			0.565			2.366		0.341				90.332	
LAB033							0.024								
LAB034		5.61					0.01	2.27		0.389	0.063				
LAB035							0.007	2.434		0.574	0.056				
LAB036		4.109			0.233			1.444					0.744	55.226	
LAB037							0.007								
LAB038							0.006								
LAB039		6.739			1.645			2.805		0.61	0.061			66.268	
LAB040							0.005								
LAB041							0.006								
LAB042		6.443			0.872			2.302		0.388	0.063		0.565	87.337	
LAB043		6.4			0.596			2.326		0.651	0.063		0.614	88.126	
LAB044							0.18								
LAB045				0.17											

LABORATORY	Ag	Al_2O_3	As	Au	CaO	Cr_2O_3	Cu	Fe_2O_3	LOI (950°C)	MgO	MnO	P	S	SiO_2	TiO_2
UNIT	g/t	%	ppm	g/t	%	%	%	%	%	%	%	%	%	%	%
LAB046				0.198											
LAB047				0.19											
LAB048				0.18											
LAB049				0.193											
LAB050				0.241											

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 Gold PT Round 6 of 2021, Round 4 of 2022, Round 2 of 2023 and Copper PT Round 3 of 2022. 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. 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. 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 competence could not be confirmed, the affected data was deselected from the dataset. Certification of analytes was then done, provided that a minimum of 10 qualifying datapoints remained available.

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

12. Measurement of Uncertainty:

Standard uncertainty, uCRM, was calculated according to ISO 13528:2022 (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. The measurement uncertainty of the certified value is therefore calculated as follows: 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: xCRM ± UCRM.

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

Laboratories which 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	*s* (Standard Deviation of Dataset)	*v* (Degrees of Freedom)	*k* (Coverage Factor)	*u* (Standard Uncertainty)	95% Measurement Uncertainty	Expanded Uncertainty
Ag	g/t	0.824	10	2.228	0.3	± 0.60	± 0.67
Al_2O_3	%	1.008	11	2.201	0.362	± 0.72	± 0.80
As	ppm	20.014	8	2.306	8.094	± 16	± 19
Au	g/t	0.033	19	2.093	0.009	± 0.02	± 0.02
CaO	%	0.091	18	2.101	0.024	± 0.05	± 0.05
Cu	%	0.004	23	2.069	0.001	± 0.002	± 0.002
Fe_2O_3	%	0.183	12	2.179	0.06	± 0.12	± 0.13
MgO	%	0.092	13	2.160	0.034	± 0.07	± 0.08
MnO	%	0.006	15	2.131	0.002	± 0.004	± 0.004
S	%	0.092	9	2.262	0.039	± 0.08	± 0.09
SiO_2	%	4.282	12	2.179	1.285	± 2.6	± 2.8
TiO_2	%	0.016	6	2.447	0.007	± 0.01	± 0.02

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 were 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 equivalent, only the metrologically traceable data was considered.

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 were 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 Signatories	
Dr Hannelie de Beer (Pr. Sci. Nat.)	***Takudzwa Tsapayi (Pr. Sci. Nat.)***
18 October 2023	

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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