

## QOTHO CERTIFIED REFERENCE MATERIAL (QCRM)

### QCRM-4-072

IRON ORE - EXPLORATION GRADE

### CERTIFICATE OF ANALYSIS

CERTIFIED VALUES			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
Al <sub>2</sub> O <sub>3</sub>	%	2.82	±0.03
CaO	%	0.15	±0.01
Fe	%	57.50	±0.25
K <sub>2</sub> O	%	0.41	±0.02
Mn	%	0.03	±0.01
P	%	0.063	±0.002
S	%	0.03	±0.01
SiO <sub>2</sub>	%	13.02	±0.11
TiO <sub>2</sub>	%	0.18	±0.01
ASSIGNED VALUES (FOR INFORMATION ONLY)			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
Cr <sub>2</sub> O <sub>3</sub>	%	0.02	±0.01
LOI	%	0.90	±0.07
MgO	%	0.04	±0.01
Na <sub>2</sub> O	%	0.03	±0.02

**1. Use:**

QCRM-4-072 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 Iron Ore and as a calibration standard for the calibration of equipment used for analyzing similar materials.

**2. Origin of Material:**

This standard was sponsored by Kumba Iron Ore, Sishen mine, which is located 30km North West of the Town of Kathu in the Northern Cape Province of South Africa. The iron ore deposit at Sishen Mine is one of many genetically related high-grade hematite deposits situated in the Sishen - Postmasburg area.

**3. Mineral and Chemical Composition:**

This Hematite iron ore deposit is classified as the Superior-Type Banded Iron Formation of the Transvaal Supergroup. It consists of ferruginous conglomerates of the Gamagara Formation which unconformably overlies supergene-enriched iron formation of the Asbestos Hill Subgroup. The Iron (Fe) containing assemblages of this material are made up of 92% Hematite and 2% Goethite with minor to trace amounts of limonite.

**4. Date of Initial Issue:**

9 February 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 106-micron screen (as per the directive of ISO 3082: 2017) 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, 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:**

- Lithium tetraborate fusion with XRF finish
- Multi acid digestion with potentiometric titration
- Borax fusion with XRF finish
- Pressed pellet with XRF 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  $Al_2O_3$ , CaO,  $Cr_2O_3$ , Fe,  $K_2O$ , LOI, MgO, Mn,  $Na_2O$ , P, S, SG,  $SiO_2$  and  $TiO_2$ .

**9. Participating Laboratories:**

No	LABORATORY	COUNTRY
1.	AHK Richards Bay	South Africa
2.	ALS Geochemistry Kempton Park	South Africa
3.	Anglo American - CMD Lab	Brazil
4.	Assmang Beeshoek	South Africa
5.	Assmang King Laboratory	South Africa
6.	Assmang Parsons Laboratory	South Africa
7.	Bureau Veritas Minerals Perth	Australia
8.	Dorowa Minerals	Zimbabwe
9.	Intertek Genalysis Australia	Australia
10.	Intertek JHB	South Africa
11.	Kolomela Laboratory	South Africa
12.	Metex Sishen	South Africa
13.	Mitra Sk South Africa	South Africa
14.	SGS Randfontein	South Africa
15.	Sishen Iron Ore	South Africa

**10. Data:**

Data used for Assigning Values and Certification.

Laboratory	Al <sub>2</sub> O <sub>3</sub>	CaO	Cr <sub>2</sub> O <sub>3</sub>	Fe	K <sub>2</sub> O	LOI	MgO	Mn	Na <sub>2</sub> O	P	S	SG	SiO <sub>2</sub>	TiO <sub>2</sub>
Unit	%	%	%	%	%	%	%	%	%	%	%	g/cm <sup>3</sup>	%	%
LAB001	3.301				0.481			0.128					11.662	
LAB002	2.817	0.145	0.022	57.529	0.42	0.905	0.047	0.025	0.037	0.064	0.029		12.982	0.173
LAB003	2.605	0.115	0.017	56.91	0.4		0.04		0.33					
LAB004	2.885	0.14		57.54	0.4	0.875	0.035	0.02	0.015	0.062	0.026		13.035	0.18
LAB005	2.821	0.145		57.52	0.41					0.06	0.028		13.107	
LAB006		0.136		56.172	0.435		0.005	0.022	0.005	0.066	0.015			0.17
LAB007	2.83	0.15	0.011	57.51	0.405	0.86	0.035	0.03	0.03	0.061	0.022		13.02	0.18
LAB008	2.805	0.145	0.009	57.515	0.407	0.85	0.04	0.03	0.014	0.063	0.022	4.59	12.965	0.176
LAB009	2.804	0.145		57.582	0.416		0.034	0.026		0.063	0.022		12.945	0.175
LAB010	2.821	0.154		57.115	0.427	0.895	0.036	0.033	0.036	0.069	0.04		13.829	0.179
LAB011				57.185										
LAB012	2.745		0.02	58.765	0.4		0.03		0.04	0.07	0.03			0.18
LAB013				57.62										
LAB014							0.098		0.109					
LAB015		0.166		57.745			0.042		0.044	0.052	0.005			0.197
LAB016				57.695										
LAB017	2.89	0.151		57.345		0.933	0.053	0.026		0.064			13.115	0.176
LAB018	2.835	0.15	0.013	57.97	0.42	0.99	0.04	0.028	0.034	0.06	0.03	4.395	12.975	0.18

#### 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 Iron PT Round 2 of 2020. The participating laboratories were each given 1 randomly selected sample from the batch, to analyze and report on in duplicate. 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.  $U_{CRM} = k u_{CRM}$ , 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:  $x_{CRM} \pm U_{CRM}$ .

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
Al <sub>2</sub> O <sub>3</sub>	%	11	2.201	0.014	± 0.03	± 0.03
CaO	%	11	2.201	0.004	± 0.01	± 0.01
Cr <sub>2</sub> O <sub>3</sub>	%	5	2.571	0.004	± 0.01	± 0.01
Fe	%	15	2.131	0.115	± 0.23	± 0.25
K <sub>2</sub> O	%	11	2.201	0.006	± 0.01	± 0.02
LOI	%	6	2.447	0.029	± 0.06	± 0.07
MgO	%	12	2.179	0.003	± 0.01	± 0.01
Mn	%	9	2.262	0.002	± 0.01	± 0.01
Na <sub>2</sub> O	%	10	2.228	0.008	± 0.02	± 0.02
P	%	11	2.201	0.001	± 0.002	± 0.002
S	%	10	2.228	0.004	± 0.01	± 0.01
SiO <sub>2</sub>	%	9	2.262	0.048	± 0.10	± 0.11
TiO <sub>2</sub>	%	10	2.228	0.002	± 0.01	± 0.01

**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	
<b>Qotho Managing Director</b>	<b>9 February 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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