

QOTHO CERTIFIED REFERENCE MATERIAL (QCRM)

QCRM-4-082

IRON ORE - EXPLORATION GRADE

CERTIFICATE OF ANALYSIS

CERTIFIED VALUES			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
Al ₂ O ₃	%	1.37	±0.03
CaO	%	0.019	±0.006
Fe	%	58.53	±0.22
K ₂ O	%	0.23	±0.01
MgO	%	0.023	±0.011
Mn	%	0.027	±0.004
P	%	0.026	±0.002
S	%	0.010	±0.002
SiO ₂	%	13.60	±0.15
TiO ₂	%	0.065	±0.004
ASSIGNED VALUES (FOR INFORMATION ONLY)			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
Cr ₂ O ₃	%	0.03	±0.01
LOI	%	0.59	±0.07
Na ₂ O	%	0.021	±0.016
V ₂ O ₅	%	0.007	±0.002

1. Use:

QCRM-4-082 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 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 Assmang Khumani Mine.

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 overlie 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 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 Potentiometric Titration
- Sodium peroxide fusion with Potentiometric Titration
- Fused beads with XRF finish
- Pressed pellet 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 Al_2O_3 , CaO, Cr_2O_3 , Fe, K_2O , LOI, MgO, Mn, Na_2O P, S, SiO_2 , TiO_2 , V_2O_5 and SG.

9. Participating Laboratories:

NO	LABORATORY	COUNTRY
1.	AHK Richards Bay	South Africa
2.	ALS Geochemistry Kempton Park	South Africa
3.	Anglo Technical Solutions	South Africa
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.	Qingdao CIQ Iron Ore Laboratory	China
15.	SABS PTA	South Africa
16.	Sishen Iron Ore Fusion	South Africa
17.	Suntech Geomet Labs	South Africa

10. Assay Data:

Data used for Assigning Values and Certification.

Laboratory	Al ₂ O ₃	CaO	Cr ₂ O ₃	Fe	K ₂ O	LOI	MgO	Mn	Na ₂ O	P	S	SG	SiO ₂	TiO ₂	V ₂ O ₅
Unit	%	%	%	%	%	%	%	%	%	%	%	g/cm ³	%	%	%
LAB001				58.119											
LAB002				58.225											
LAB003				58.88											
LAB004		0.01	0.026	58.695	0.235		0.05		0.19	0.026				0.08	0.013
LAB005	1.247	< 0.010		58.721	0.218	0.69	< 0.010	0.027		0.023		4.575	13.689	0.064	
LAB006	1.37	0.02	0.037	58.28	0.22	0.54	0.03	0.02		0.027	0.01		13.555	0.06	0.005
LAB007	1.376	0.01		58.728	0.23		0.006	0.026		0.027	0.011		13.582	0.067	0.022
LAB008		0.017		58.446	0.224		0.005	0.034	0.005	0.02	0.005		15.826	0.066	
LAB009	1.368	0.014		58.764		0.562	0.023	0.027		0.025	0.009		13.682	0.062	
LAB010	1.375	0.025	0.029	58.52	0.23	0.565	0.03	0.03	0.01	0.025	0.009		13.66	0.07	0.005
LAB011	1.4	0.02	0.029	58.67	0.229	0.525	0.03	0.02	0.02	0.026	0.01	4.69	13.65	0.065	0.006
LAB012	1.372	0.028		58.738	0.23		0.032	0.024		0.026	0.009		13.529	0.069	
LAB013	1.361	0.018	0.017	58.427	0.236	0.597	0.037	0.07	0.024	0.025	0.015		13.204	0.066	0.005
LAB014				58.394											
LAB015		0.03	0.04	59.7			0.01		0.04	0.029	0.015			0.065	0.01
LAB016				58.15											
LAB017				58.39											
LAB018	1.62	0.141		58.36			0.04	0.036		0.063	0.024		13.54	0.051	
LAB019				58.17	0.211				0.029						
LAB020	1.39	0.02		58.475		0.69	0.02	0.029		0.026			13.82	0.06	
LAB021	1.33	0.02	0.028	58.955	0.229	0.635	0.01	0.028	0.023	0.029	< 0.010		13.45	0.06	0.006
LAB022	1.456	0.022		59.025	0.229	0.526	< 0.027	0.027	< 0.032	0.025	0.01	4.595	13.683	0.066	0.007
LAB023				57.855											

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 6 of 2020. Each of 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. $U_{CRM} = k u_{CRM}$, 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	ν (degrees of freedom)	k (coverage factor)	u (standard error)	95% measurement uncertainty	Expanded Uncertainty
Al ₂ O ₃	%	11	2.201	0.012	± 0.02	± 0.03
CaO	%	14	2.145	0.003	± 0.006	± 0.006
Cr ₂ O ₃	%	6	2.447	0.003	± 0.01	± 0.01
Fe	%	22	2.074	0.106	± 0.21	± 0.22
K ₂ O	%	11	2.201	0.003	± 0.01	± 0.01
LOI	%	8	2.306	0.031	± 0.06	± 0.07
MgO	%	14	2.145	0.005	± 0.010	± 0.011
Mn	%	12	2.179	0.002	± 0.004	± 0.004
Na ₂ O	%	8	2.306	0.007	± 0.014	± 0.016
P	%	14	2.145	0.001	± 0.002	± 0.002
S	%	11	2.201	0.001	± 0.002	± 0.002
SiO ₂	%	12	2.179	0.069	± 0.14	± 0.15
TiO ₂	%	14	2.145	0.002	± 0.004	± 0.004
V ₂ O ₅	%	8	2.306	0.001	± 0.002	± 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. 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	9 February 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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