

QOTHO CERTIFIED REFERENCE MATERIAL (QCRM)

QCRM-1-180

FERROCHROME

CERTIFICATE OF ANALYSIS

CERTIFIED VALUES			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
Al	%	0.06	±0.02
Co	%	0.062	±0.002
Cr	%	49.66	±0.11
Fe	%	39.15	±0.28
Mn	%	0.258	±0.004
Ni	%	0.198	±0.004
P	%	0.019	±0.002
S	%	0.063	±0.002
Si	%	2.53	±0.06
Ti	%	0.30	±0.01
V	%	0.35	±0.01
ASSIGNED VALUES (FOR INFORMATION ONLY)			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
C	%	6.93	±0.05
Mg	%	0.05	±0.02

1. Use:

QCRM-1-180 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 Ferrochrome and as a calibration standard for the calibration of equipment used for analyzing similar materials.

2. Origin of Material:

This material was sponsored by Samancor FMT based in Emalahleni, South Africa. The Ferrochrome was produced from chrome concentrates, originating from the Bushveld Complex in South Africa.

3. Mineral and Chemical Composition:

The material is not naturally occurring, but it is a product of Pyrometallurgical processing of the chromite ore or foundry sand to yield a ferrochrome alloy. From the molten alloy state, this sample is cast and crushed into a lump size product of <2mm in size. The alloy has main phases of (Cr,Fe)₇C₃, (Cr,Fe)₂₃C₆, traces (Fe,Cr)₃C carbides, Cr containing α-Fe, Cr-Si and traces of S, P, along with minor (<0,5%) amounts of Mn, V, Ti - all species are present in alloy form.

4. Date of Initial Issue:

12 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:

- Sodium peroxide fusion with ICP-OES finish
- Sodium peroxide fusion with Auto/Manual Potentiometric Titration
- Fused beads with XRF finish
- 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 Al, C, Co, Cr, Fe, Mg, Mn, Ni, P, S, Si, Ti, V.

9. Participating Laboratories:

NO	LABORATORY	COUNTRY
1.	Afarak Elektrowerk Weisweiler GmbH	Germany
2.	AHK North West	South Africa
3.	AHK Richards Bay	South Africa
4.	ALS Inspection Richards Bay	South Africa
5.	ARM Machadodorp	South Africa
6.	Columbus Analytical Lab	South Africa
7.	Glencore Boshhoek	South Africa
8.	Glencore Lion	South Africa
9.	Glencore Lydenburg Smelter	South Africa
10.	Glencore Rustenburg Smelter	South Africa
11.	Glencore Wonderkop Smelter	South Africa
12.	Mitra SK South Africa	South Africa
13.	PCL Rustenburg	South Africa
14.	PCL Steelpoort	South Africa
15.	Samancor Ferrometals	South Africa
16.	Samancor TCS Laboratory	South Africa
17.	Samancor Tubatse Alloy Smelter	South Africa
18.	Samancor Tubatse Chrome	South Africa
19.	SGS Netherlands BV	Netherlands
20.	SGS Richards Bay	South Africa
21.	UIS Analytical Services	South Africa
22.	Zimasco Kwekwe	Zimbabwe

10. Assay Data:

Data used for Assigning Values and Certification.

Laboratory	Al	C	Co	Cr	Fe	Mg	Mn	Ni	P	S	Si	Ti	V
Unit	%	%	%	%	%	%	%	%	%	%	%	%	%
LAB001		6.845	0.063	49.719	38.745		0.265	0.2	0.021	0.063	2.668	0.328	0.355
LAB002				49.657									
LAB003	0.081	6.85	0.06		39.565		0.244	0.2	0.019	0.064	2.415	0.3	0.35
LAB004				49.785									
LAB005	0.024	7.145	0.062		38.828		0.263	0.191	0.022	0.063	2.56	0.321	0.348
LAB006				50.082									
LAB007		7.05			39.49			0.198	0.019	0.064	2.46	0.294	0.342
LAB008				49.65									
LAB009	0.057	6.905	0.059	49.39	39.339		0.245	0.205	0.021	0.059	2.61	0.29	0.365
LAB010				49.495									
LAB011	0.041	6.57		49.145	39.005	< 0.005	0.013	0.197		0.067	2.425	0.29	0.366
LAB012		6.87	0.062	49.645	39.065		0.256	0.195	0.022	0.061	2.58	0.302	0.348
LAB013				49.59									
LAB014		6.866	0.063	49.86	39.236	0.043	0.268	0.198	0.019	0.065	2.541	0.31	0.357
LAB015				49.899									
LAB016		6.925		49.695	38.922	0.146	0.254	0.198		0.068	2.547	0.304	0.346
LAB017				49.8									
LAB018	0.067				39.41	0.05	0.267				2.605	0.31	0.357
LAB019				49.6									
LAB020	0.071	7.1	0.061		39.335		0.255	0.195	0.018	0.067	2.45	0.3	0.37
LAB021				49.6									
LAB022	0.063	6.885	0.063		39.35		0.26	0.195	0.015	0.068	2.45	0.31	0.36
LAB023				49.5									
LAB024	0.051	7.11	0.061	50.253	39.877		0.257	0.199	0.015	0.061	2.678	0.336	0.3
LAB025	0.05	6.935		49.625	38.71	0.058	0.261	0.205	0.02	0.064	2.32	0.281	0.39
LAB026				49.56									
LAB027	0.084	6.875		49.6	39.645				0.021	0.054	2.455		
LAB028		6.915				0.053							

QOTHO MINERALS (PTY) LTD

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Laboratory	Al	C	Co	Cr	Fe	Mg	Mn	Ni	P	S	Si	Ti	V
Unit	%	%	%	%	%	%	%	%	%	%	%	%	%
LAB029	0.069	7.04	0.065	49.73	39.55		0.255	0.195	0.018	0.064	2.48	0.305	0.37
LAB030				49.685									
LAB031	0.001		0.066		38.648		0.256	0.202	0.022		2.657	0.311	0.349
LAB032				49.875									
LAB033	0.044	6.93					0.258		0.018	0.064	2.52		
LAB034				49.45									
LAB035	0.069	6.903		49.435	38.825	0.055	0.256	0.208	0.015	0.065		0.291	0.331
LAB036	0.07	6.858	0.061	49.802	39.085	0.059	0.255	0.2	0.015	0.061	2.569	0.303	0.361
LAB037	0.04	6.431	0.063	48.795	38.465	0.03	0.26	0.19	0.02	0.061	2.475	0.293	0.29

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 Chrome PT Round 6 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. $U_{CRM} = k u_{CRM}$, 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	%	15	2.131	0.007	± 0.01	± 0.02
C	%	19	2.093	0.025	± 0.05	± 0.05
Co	%	12	2.179	0.001	± 0.002	± 0.002
Cr	%	27	2.052	0.05	± 0.10	± 0.11
Fe	%	19	2.093	0.131	± 0.26	± 0.28
Mg	%	8	2.306	0.007	± 0.01	± 0.02
Mn	%	18	2.101	0.002	± 0.004	± 0.004
Ni	%	17	2.110	0.002	± 0.004	± 0.004
P	%	17	2.110	0.001	± 0.002	± 0.002
S	%	18	2.101	0.001	± 0.002	± 0.002
Si	%	19	2.093	0.029	± 0.06	± 0.06
Ti	%	18	2.101	0.004	± 0.01	± 0.01
V	%	18	2.101	0.005	± 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	
Qotho Managing Director	12 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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