

QOTHO CERTIFIED REFERENCE MATERIAL (QCRM)

QCRM-1-176

CHROME ORE

CERTIFICATE OF ANALYSIS

CERTIFIED VALUES			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
Al ₂ O ₃	%	14.39	±0.10
CaO	%	0.82	±0.06
Cr ₂ O ₃	%	38.96	±0.13
FeO	%	23.35	±0.12
MgO	%	11.42	±0.08
MnO	%	0.21	±0.01
P		0.005	±0.002
S	%	0.009	±0.002
SiO ₂	%	8.47	±0.14
ASSIGNED VALUES (FOR INFORMATION ONLY)			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
TiO ₂	%	0.71	±0.02
V ₂ O ₅	%	0.34	±0.02

1. Use:

QCRM-1-176 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 Chrome 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 Samancor Western Chrome, South Africa.

3. Mineral and Chemical Composition:

Chromite is found as orthocumulate lenses of chromitite in peridotite from the Earth's mantle. It also occurs in layered, ultramafic intrusive rocks. In addition, it is found in metamorphic rocks such as some serpentinites. Ore deposits of chromite formed as early magmatic differentiates. It is commonly associated with olivine, magnetite, serpentine, and corundum. The vast Bushveld igneous complex of South Africa is a large layered mafic to ultramafic igneous body with some layers consisting of 90% chromite making the rare rock type.

4. Date of Initial Issue:

18 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 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 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 , C, CaO, Cr_2O_3 , FeO, MgO, MnO, P, S, SiO_2 , TiO_2 and V_2O_5 .

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.	AHK Steelpoort	South Africa
5.	ALS Geochemistry	South Africa
6.	ALS Inspection Richards Bay	South Africa
7.	ALS SAIL - Limpopo	South Africa
8.	Chromtech	South Africa
9.	Cotecna Richards Bay	South Africa
10.	Dwarsrivier Chrome Mine	South Africa
11.	Glencore Boshhoek	South Africa
12.	Glencore Eastern Mines	South Africa
13.	Glencore Kroondal	South Africa
14.	Glencore Lydenburg Smelter	South Africa
15.	Glencore Rustenburg Smelter	South Africa
16.	Glencore UG2 Alloys	South Africa
17.	GNK Laboratories Zimlabs	Zimbabwe
18.	Intertek JHB	South Africa
19.	Intertek Steelpoort	South Africa
20.	Jubilee Metals Group	South Africa
21.	Mitra SK South Africa	South Africa
22.	Nkomati JV	South Africa
23.	PCL Rustenburg	South Africa
24.	PCL Steelpoort	South Africa
25.	Pilanesberg Platinum Mine	South Africa
26.	Quality Laboratory Services	South Africa
27.	Samancor Ferrometals	South Africa
28.	Samancor Tubatse Alloy Smelter	South Africa
29.	SGS Richards Bay	South Africa
30.	Suntech Geomet Labs	South Africa
31.	UIS Analytical Services	South Africa
32.	Zimasco Kwekwe	Zimbabwe

10. Assay Data:

Data used for Assigning Values and Certification.

Laboratory	Al ₂ O ₃	C	CaO	Cr ₂ O ₃	Cr:Fe Ratio	FeO	MgO	MnO	P	S	SiO ₂	TiO ₂	V ₂ O ₅
Unit	%	%	%	%		%	%	%	%	%	%	%	%
LAB001	14.04		0.755	38.935		23.415	11.33			0.01	8.65		
LAB002	14.038		0.906				10.93				8.496		
LAB003				39.228									
LAB004	14.454		0.839	39.141	1.476	23.338	11.494	0.225			8.353	0.712	0.322
LAB005	14.372		0.885	39.148	1.465	23.55	11.53	0.212	0.009	0.01	8.518	0.724	0.308
LAB006				39.105									
LAB007	14.317		0.716	39.164	1.47	23.435	11.494				8.563	0.697	
LAB008				38.91									
LAB009	14.785			38.715	1.49	23.19	11.375			0.013	8.715	0.715	
LAB010				38.93									
LAB011	14.58	0.061	0.816			23.593	11.444	0.216		0.007	8.303	0.707	0.356
LAB012	14.215	0.029	0.7	38.655	1.455	23.4	10.9	0.036		0.008	8.175	0.695	0.358
LAB013	14.445		0.89	38.46	1.495	22.865	11.425	0.21			8.58	0.685	
LAB014				38.455									
LAB015				38.92		23.395					3.617		
LAB016	14.56		0.84	38.965		23.59	11.315	0.215	0.005	0.021	8.35	0.68	0.347
LAB017											7.883	0.724	0.346
LAB018	14.43		0.319	38.736		23.172	11.605	0.212			9.541	0.681	
LAB019				38.82									
LAB020	14.295				1.47	23.25	11.325	0.21			8.055	0.705	0.34
LAB021				38.88									
LAB022	14.48		0.83	39.665		23.695		0.21			8.55		
LAB023				39.55									
LAB024	14.497		0.784	39.141		23.479	11.585				8.43		
LAB025				38.398									

Laboratory	Al ₂ O ₃	C	CaO	Cr ₂ O ₃	Cr:Fe Ratio	FeO	MgO	MnO	P	S	SiO ₂	TiO ₂	V ₂ O ₅
Unit	%	%	%	%		%	%	%	%	%	%	%	%
LAB026			1.05			23.245	11.49		0.004	0.01	8.52		
LAB027				38.975									
LAB028	14.375					23.35	11.31				8.361		
LAB029				38.885									
LAB030					1.445								
LAB031	14.4		0.775	39.16		23.498	11.48		0.005		8.46		
LAB032						22.845							
LAB033				38.2							8.99		
LAB034	14.585		0.86	39.155		23.57	11.595		0.005	0.005	8.295		
LAB035				39.175							8.425		
LAB036	14.432			39.028		23.25	11.435				8.624		
LAB037	14.4	0.026	0.82	38.91	1.47	23.295	11.385		0.004	0.008	8.445		
LAB038				38.85									
LAB039				38.775		22.55					8.905		
LAB040		0.035			1.489							0.746	0.365
LAB041	14.229		1.243	39.204	1.48	23.324	11.396	0.218	0.005		8.483	0.714	0.361
LAB042				39.295									
LAB043	14.052		0.808	39.072	1.461	23.547		0.189	0.004	0.011	8.948	0.722	0.298
LAB044	14.582		0.668	39.16	1.46	23.608	11.311	0.231	0.005	0.009	8.12	0.726	0.363
LAB045	14.31	0.01	0.785	38.62	1.492	22.793	11.37	0.215	< 0.010	< 0.010	8.2	0.675	
LAB046				38.71									
LAB047				39.87									
LAB048					1.45								

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. 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	%	22	2.074	0.048	± 0.10	± 0.10
CaO	%	19	2.093	0.029	± 0.06	± 0.06
Cr ₂ O ₃	%	37	2.026	0.064	± 0.13	± 0.13
FeO	%	25	2.060	0.056	± 0.11	± 0.12
MgO	%	21	2.080	0.035	± 0.07	± 0.08
MnO	%	12	2.179	0.003	± 0.01	± 0.01
P	%	9	2.262	0.001	± 0.002	± 0.002
S	%	11	2.201	0.001	± 0.002	± 0.002
SiO ₂	%	28	2.048	0.067	± 0.13	± 0.14
TiO ₂	%	15	2.131	0.007	± 0.01	± 0.02
V ₂ O ₅	%	10	2.228	0.008	± 0.02	± 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. 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 Certificate of Analysis.

Certifying & Technical Signatory	
Qotho Managing Director	18 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.

END