

QOTHO CERTIFIED REFERENCE MATERIAL (QCRM)

QCRM-1-267

CHROME CONCENTRATE

CERTIFICATE OF ANALYSIS

CERTIFIED VALUES			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
Al ₂ O ₃	%	14.59	±0.13
Cr ₂ O ₃	%	46.55	±0.10
FeO	%	26.05	±0.16
MgO	%	9.69	±0.11
MnO	%	0.23	±0.01
SiO ₂	%	0.73	±0.04
TiO ₂	%	0.62	±0.01
V ₂ O ₅	%	0.38	±0.02
ASSIGNED VALUES (FOR INFORMATION ONLY)			
ANALYTES	UNITS	CONCENTRATIONS	EXPANDED UNCERTAINTY
C	%	0.04	±0.02
CaO	%	0.15	±0.05
P	%	0.004	±0.002
S	%	0.004	±0.002

1. Use:

QCRM-1-267 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 Concentrate and as a calibration standard for the calibration of equipment used for analysing similar materials.

2. Origin of Material:

This standard was sponsored by and prepared for Dwarsrivier Chrome Mine, South Africa.

3. Mineral and Chemical Composition:

Chromite is found as ortho-cumulate lenses of chromitite in peridotite from the Earth's mantle. Ore deposits of chromite formed as early magmatic differentiates. The ore originates from the Dwarsrivier Chrome Mine, which falls within the so called Tweefontein section of the Rustenburg Layered Suite of the Eastern Limb of the Bushveld Complex. This ore was mined from the so-called Steelpoort Chromitite Seam.

4. Date of Initial Issue:

09 September 2024.

5. Packaging & Handling instructions:

The material was packaged as 100g unit sizes, placed in geo-envelopes, within a vacuum sealed aluminium 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:

- Pressed Pellet with XRF Finish
- Sodium Peroxide Fusion with ICP-OES Finish
- Fusion beads with XRF Finish
- Milled Powder with XRF Finish
- Chrome by Sodium Peroxide Fusion Potentiometric Titration
- Chrome by Aqua Regia Digestion with Potentiometric Titration
- Carbon & Sulphur by thermal combustion and infrared detection

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 , Cr:Fe Ratio, 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.	CCIC Africa Lab	South Africa
6.	Chromtech	South Africa
7.	Cotecna Richards Bay	South Africa
8.	Dwarsrivier Chrome Mine	South Africa
9.	Eastplats Mine	South Africa
10.	Glencore Boshhoek	South Africa
11.	Glencore Eastern Mines	South Africa
12.	Glencore Kroondal	South Africa
13.	Glencore Lion	South Africa
14.	Glencore Rustenburg Smelter	South Africa
15.	Glencore UG2 Alloys	South Africa
16.	Glencore Wonderkop Smelter	South Africa
17.	IMEC Laboratory Services	South Africa
18.	Intertek Durban	South Africa
19.	Intertek JHB	South Africa
20.	Intertek Steelpoort	South Africa
21.	Jubilee Metals Group	South Africa
22.	Mintek	South Africa
23.	Northam Booyesendal Fire Assay Lab	South Africa
24.	PCL Rustenburg	South Africa
25.	PCL Steelpoort	South Africa
26.	Quality Laboratory Services (Rustenburg)	South Africa
27.	Samancor Dikwena	South Africa
28.	Samancor ECM	South Africa
29.	Samancor WCM	South Africa
30.	SGS Randfontein	South Africa
31.	SGS Richards Bay	South Africa
32.	Tharisa Minerals	South Africa
33.	UIS Analytical Services	South Africa



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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			0.116			26.02		0.23					0.395
LAB002	9.905		0.305	46.27	1.56	26.1		0.24	0.007		0.85	0.68	0.42
LAB003				46.315									
LAB004					1.57	25.97						0.61	0.4
LAB005						26.09					0.77		
LAB006				46.22									
LAB007	14.49		0.144	46.71		25.815	9.885		0.004		0.92		
LAB008	14.35	0.04	< 0.350	47.7		26	9.695	0.25		< 0.010	0.45	0.62	
LAB009						24.495							
LAB010	14.785		0.17	46.715		26.205	9.86		0.005		0.745		
LAB011	14.575		0.215			26.435	9.71		0.004	0.004	0.715		
LAB012				46.67									
LAB013	14.576		0.203	46.413	1.615	25.301	9.611		0.005	0.005	0.76	0.581	
LAB014				46.135									
LAB015	14.491		0.274	46.592	1.565	26.233	9.735	0.23	0.005	0.005	0.673	0.603	
LAB016	14.738			46.447	1.425	25.943	9.465	0.232			0.609	0.627	0.353
LAB017				46.411									
LAB018													0.342
LAB019	14.535	0.029	0.075	46.255	1.589	25.635	9.63			0.005	0.79		
LAB020				46.115									
LAB021	14.613		0.104	46.616	1.575	26.058	9.825	0.224	< 0.006		0.675	0.61	0.39
LAB022	14.569		0.075	46.48		25.758	9.779				0.682	0.617	
LAB023	14.465		0.162	46.585	1.585	25.86	9.346		0.005	0.016	0.78		
LAB024				46.365									



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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	%	%	%	%		%	%	%	%	%	%	%	%
LAB025				46.63							0.951		
LAB026	14.535		0.07	46.795	1.555	26.495	9.62				0.67		
LAB027				47									
LAB028	15.938	0.032	0.064	46.478	1.596	25.642	9.523	0.223	0.002	0.004	0.74		0.353
LAB029				46.409									
LAB030	14.285	0.036	0.125	46.48		25.822	9.64	0.232	0.003	0.003	0.649	0.622	0.371
LAB031				46.645		26.22					0.75		
LAB032				46.675									
LAB033				46.285									
LAB034				47.1									
LAB035				47.025									
LAB036	14.615		0.17	46.785		25.945	9.848				0.755		
LAB037	14.45	0.041	0.108	46.7	1.585	25.95	9.62	0.234		0.004	0.765	0.605	0.388
LAB038	14.865		0.25	46.575		26.525	9.83		0.004	0.004	0.69		
LAB039											0.712		
LAB040	14.9		0.2	46.4		26.35	9.75		0.004	0.005	0.8		
LAB041	14.53			46.53		26.025	9.475				0.86	0.615	0.365
LAB042				46.6									
LAB043	14.71			46.655		26.175					0.75	0.605	0.375
LAB044				46.66									
LAB045	14.849			46.37	1.55	26.364	10.628				0.728	0.623	0.361
LAB046	14.13	< 0.005	0.009	47.77		26.98			0.003	0.003	0.59	0.63	
LAB047				46.68							0.59		
LAB048	14.72		0.135	46.745		25.9	9.8	0.235			0.75	0.625	0.365
LAB049				46.7									

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 2 of 2024. 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, u_{CRM} , 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: $U_{CRM} = k u_{CRM}$, 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.

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)	ν (Degrees of Freedom)	k (Coverage Factor)	u (Standard Uncertainty)	95% Measurement Uncertainty	Expanded Uncertainty
Al ₂ O ₃	%	0.247	23	2.069	0.06	± 0.12	± 0.13
C	%	0.008	4	2.776	0.005	± 0.01	± 0.02
CaO	%	0.088	19	2.093	0.025	± 0.05	± 0.05
Cr ₂ O ₃	%	0.245	41	2.020	0.047	± 0.09	± 0.10
FeO	%	0.39	28	2.048	0.076	± 0.15	± 0.16
MgO	%	0.176	20	2.086	0.051	± 0.10	± 0.11
MnO	%	0.01	9	2.262	0.003	± 0.01	± 0.01
P	%	0.002	11	2.201	0.001	± 0.002	± 0.002
S	%	0.001	10	2.228	0.001	± 0.002	± 0.002
SiO ₂	%	0.092	28	2.048	0.02	± 0.04	± 0.04
TiO ₂	%	0.018	14	2.145	0.005	± 0.01	± 0.01
V ₂ O ₅	%	0.026	12	2.179	0.009	± 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/IEC 17025:2017 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 33405:2024, ISO/IEC 17043:2023 and ISO 17034:2016 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	
<i>Dr Hannelie de Beer (Pr. Sci. Nat.)</i>	<i>Takudzwa Tsapayi (Pr. Sci. Nat.)</i>
09 September 2024	

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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