



Certificate of Analysis

IAG / CGL 018 MRH-1 (Rhyolite)

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Description of the certified reference material

Bulk material was collected from the rhyolite occurrence in the Zuun tsagaandel area located in the Ikh khet soum, Dornogobi province, Mongolia. Sampling was performed by the Central Geological Laboratory (CGL), Ulaanbaatar, Mongolia in accordance with relevant sampling procedures in 2007.

The mineralogy of the sample has been determined as follows:

Minerals	g/100 g
Potassium feldspar	38
Quartz	30
Plagioclase	25
Biotite	6
Ilmenite, magnetite	Few grains
Sphene	trace
Apatite	trace

Sample preparation, homogeneity and stability testing studies were performed by the CGL laboratories between 2008 and 2014. After crushing and pulverization, the entire batch of selected bulk material passed a sieve with an opening of 75 µm using an ultrasonic sieving machine. The pulverized bulk material was homogenized using a high performance intensive mixer. After the primary homogeneity testing study, portions of 100 g of the reference material were bottled using a rotary splitter and labelled. After homogenization and bottling, a homogeneity testing study was performed under repeatability conditions. Twenty-three measurands were determined in duplicate on 10 randomly selected units. Homogeneity test results were evaluated using the F-test, and against ISO 13528 and the “harmonized protocol” and confirmed that material is sufficiently homogeneous.

Intended use

This certified reference material is designed for use by laboratories undertaking the determination of major and trace element mass fractions in silicate rocks and equivalent matrices for the calibration of a measurement system, the assessment of a measurement procedure, assigning values to other materials, and quality control. Note that the material may be used only for a single purpose in the same measurement process. For example, it must not be used for calibration and method validation at the same time.

Instructions for handling

When non-volatile analytes are to be determined, test portions of the test sample must be dried at 105 ± 5 °C for at least 2 hours. Avoid contamination and cross-contamination of the test material during handling. The material should not be reground before use. The mass loss on drying has been found to be in the range 0.05-0.32 g/100 g.

Minimum sample size

The minimum size of test portion is recommended to be 0.2 g, based on the results of a formal repeatability assessment procedure undertaken by the Central Geological Laboratories, Mongolia.

Storage information

Store in a sealed container in a cool dry environment.

Period of validity

Provided the storage and handling conditions are met, this reference material is not expected to deteriorate with time. As a consequence, the nominal period of validity of this certificate is selected as 20 years. On exposure to air, the material may absorb moisture, and instructions for handling to remove absorbed water before use of the material must be followed.

Certified values

This material was certified based on procedures that are summarised in the International Association of Geoanalysts' Certification Protocol (Kane et al., 2003, *Geostandards and Geoanalytical Research*, 27, 227-244). Twenty-five laboratories were invited to participate in this certification round on the basis of their successful performance in round 27 of the IAG GeoPT proficiency testing programme (2010). A nested design was adopted for data acquisition as proposed in the IAG certification protocol. Participating labs received 3 bottles of MRH-1 and one bottle of CGL 009 MGL-AND (the “traceability” sample which was used here for quality control purposes). Participating laboratories were requested to make two independent sample preparations (e.g., digestions) of each bottle and analyse the preparations on two different days. Labs were thus requested to submit 12 values (3x2x2 Bottles x Prep x Day) for each measurand for which they had the analytical capability. Values for LOI, Cs, Ta and U were certified on the basis of data from a single technique. Further details of the quality of data and data distributions may be found in the associated IAG/CGL 018 MRH-1 certification report.

Number of values, ‘n’

The number of laboratory means, n, that contributed to the estimation of the certified value after rejection of outliers is listed in the tables. Outliers were selected based on Youden plots, Mandel's k and detection limit criteria.

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Certified values and uncertainties

Measurand	Certified value	Uncertainty (expanded)	Unit	n	Measurand	Certified value	Uncertainty (expanded)	Unit	n
SiO ₂	76.39	0.19	g/100 g	17	Ho	1.62	0.04	mg/kg	13
TiO ₂	0.199	0.010	g/100 g	22	La	68.0	1.7	mg/kg	19
Al ₂ O ₃	11.86	0.06	g/100 g	20	Li	47	3	mg/kg	11
Fe ₂ O ₃ T	1.81	0.06	g/100 g	22	Lu	0.58	0.02	mg/kg	13
MnO	0.0713	0.0009	g/100 g	22	Nb	75	3	mg/kg	20
MgO	0.094	0.010	g/100 g	18	Nd	67.5	2.1	mg/kg	15
CaO	0.048	0.004	g/100 g	17	Pb	47	2	mg/kg	19
Na ₂ O	3.73	0.09	g/100 g	19	Pr	18.5	0.3	mg/kg	13
K ₂ O	5.17	0.03	g/100 g	20	Rb	274	4	mg/kg	18
P ₂ O ₅	0.010	0.002	g/100 g	13	Sc	2.3	0.5	mg/kg	10
					Sm	14.8	0.3	mg/kg	14
As	3.9	0.7	mg/kg	10	Sn	6.2	0.3	mg/kg	10
Ba	3.6	0.6	mg/kg	11	Sr	4.5	0.6	mg/kg	16
Be	7.1	0.4	mg/kg	10	Ta	4.2	0.3	mg/kg	10
Ce	127	2	mg/kg	16	Tb	1.70	0.04	mg/kg	14
Cr	41	2	mg/kg	18	Th	28.9	1.4	mg/kg	17
Cs	4.3	0.2	mg/kg	12	Tm	0.629	0.019	mg/kg	13
Dy	9.1	0.2	mg/kg	14	U	3.2	0.4	mg/kg	15
Er	4.4	0.1	mg/kg	12	V	3.4	1.0	mg/kg	10
Eu	0.471	0.021	mg/kg	13	Y	44.7	1.9	mg/kg	21
Ga	24.6	0.8	mg/kg	18	Yb	4.00	0.10	mg/kg	13
Gd	11.4	0.2	mg/kg	13	Zn	161	6	mg/kg	20
Hf	14.6	0.9	mg/kg	12	Zr	471	11	mg/kg	21

Certified value and uncertainty– see text

n: number of values (after outlier rejection) that contributed to the certified value.

Fe₂O₃T is the total iron expressed as Fe₂O₃

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Information values and uncertainties

Measurand	Information value	Uncertainty (expanded)	Unit	n
Bi	0.077	0.014	mg/kg	6
Cd	0.09	0.07	mg/kg	7
Co	0.23	0.11	mg/kg	7
Cu	1.3	0.5	mg/kg	8
H ₂ OM	0.18	0.04	g/100 g	8
In	0.093	0.012	mg/kg	5
Mo	1.04	0.05	mg/kg	8
LOI	0.35	0.04	g/100 g	19
Ni	1.1	0.4	mg/kg	7
Sb	0.16	0.02	mg/kg	6
Tl	1.14	0.07	mg/kg	8
W	1.8	0.3	mg/kg	6

Information values and uncertainty – see text.

n: number of values (after outlier rejection) that contributed to the certified value.

H₂OM is moisture (weight loss on drying at 105 °C for 2 hours).

LOI is the mass loss on ignition (generally 1050 °C for 2 hours)

Uncertainties

U is the expanded uncertainty, corresponding to 95% confidence limits and incorporates the relevant student t factor (t) to account for the finite number of contributing laboratory average measurements. The standard uncertainty (u) may be calculated from $u = U/t$ and includes a random component, and a material variability (heterogeneity) component, as described in Kane et al. (2003). The stability component has not been included, as it is vanishingly small compared to the other components. For elements where technique bias was detected (Fe_2O_3 , TiO_2 , Na_2O) an additional contribution was added to the quoted uncertainty.

Information values

Information values are designed to provide guidance on the mass fractions of other selected elements and should not be used to validate analytical measurements. A minimum of 5 laboratory average determinations were used to calculate information values.

Metrological traceability

Traceability was demonstrated for this reference material by requesting participating laboratories to co-analyse the certified reference material MGL-AND (andesite). This material was certified by the Central Geological Laboratory, Mongolia (B. Batjargal and Z. Ganbold, 2009, Certificate of Analysis CGL 009 MGL-AND, Central Geological Laboratory, Ulaanbaatar, Mongolia, 6pp). An assessment of the results for CGL 009 MGL-AND was undertaken to confirm the absence of systematic bias, establishing a chain of comparisons between the present IAG/CGL 018 MRH-1 certification and a previous geochemical certification project.

Certification characterisation report

Further details of the procedures used, the results, their statistical analysis and data assessment, on which the property values listed in this certificate are based, can be found in the IAG/CGL 018 MRH-1 characterisation report.

Safety information

Silicate powders can cause harm especially if ingested or in contact with the skin. User organisations must undertake a health and safety risk assessment and ensure that the appropriate procedures are followed in the handling and use of this material. Further details may be found on the relevant material safety data sheet.

Legal notice – terms and conditions

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Revisions

This certificate is version 1.00. Any revisions to this Certificate of Analysis will be made available on the IAGeo Ltd web site (www.iageo.com).

Acknowledgements

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Approvals

This Certificate of Analysis was approved on behalf of the International Association of Geoanalysts and the central Geological Laboratory, Mongolia, as follows:

Name *Phil Potts* **Position** *Chair - IAG Certification and Reference Material Committee* **Date** **16th November 2015**

Name *Thomas Meisel* **Position** *President of the International Association of Geoanalysts.* **Date** **18th November 2015**

Name *Tegshbayar Norov* **Position** *Director of the Central Geological Laboratory, Ulaanbaatar, Mongolia* **Date** **17th November 2015**

