International Association of Geoanalysts'

Certified Reference Material Programme

IAG CRM-3

Certificate of Analysis: Central Geological Laboratory Alkaline Granite MGL- OShBO

Description of the Sample:
A sample with a total mass of 400 kg of the candidate CRM was collected from "Tsagaan Horoot" of Buren somon in the Central Province of Mongolia following standard procedures and under the guidance of field geologists. It was originally prepared, packaged and certified in the year 2000 by the Central Geological Laboratory (CGL), Ulaanbaatar, Mongolia. The material consists of a homogeneous powder of which 93.3% passed a 63 µm sieve, while 0.44% was larger than 100 µm. The mineralogy of the material (in % m/m) has been determined to be:

- 32.2 albite
- 32.1 potassium feldspar
- 31.5 quartz
- 3.7 muscovite, lepidolite
- 0.35 topaz, apatite
- minor zircon, sphene, magnetite, ilmenite and pyrite

This material has been produced in units of 100 g packaged in a polyethylene bottle for delivery to users.

Tables 1 and 2 state the determined composition of ML-OShBO and the associated expanded uncertainties. A full description of how these values and their uncertainties have been established can be found in Kane et al. (2003). Table 3 provides additional information that is essential for user laboratories to evaluate their own results for the CRM in the manner outlined in ISO Guide 33 (ISO 2000).

Intended uses of this CRM:
This CRM is intended for use in calibration and quality control by laboratories when analyzing samples that are matrix-matched to ML-OShBO.

Table 1. Certified Values and their Uncertainties; Mass fraction or concentration

Oxide/Element	CV	± U	N
	in % m/m		
SiO_2	71.72	0.29	48
Al_2O_3	16.12	0.12	40
Fe_2O_3(TOT)	0.500	0.029	23
FeO	0.299	0.004	11
MnO	0.149	0.017	40
CaO	0.388	0.011	31
Na_2O	5.34	0.26	34
K_2O	3.58	0.04	32
P_2O_5	0.0293	0.0017	11
H_2O^-	0.074	0.020	15
F	1.13	0.16	10
LOI	1.10	0.04	23
	in mg/kg		
Ce	27.4	1.6	12
Cu	7.1	1.1	16
La	8.4	0.7	12
Li	1730	40	15
Lu	0.326	0.021	10
Nb	64	4	19
Nd	15.5	0.5	10
Ni	10.7	1.6	17
Pb	63	6	18
Rb	2360	110	29
Sc	9.2	1.4	11
Sm	6.0	0.4	10
Sr	12.3	1.1	17
Ta	46.7	2.4	12
Th	13.3	0.8	10
Yb	2.38	0.13	10
Zn	92	6	25
Zr	40.1	2.8	16

Table 2. Information Values and their Uncertainties; Mass fraction or concentration

Oxide/Element	IV	± U	N
	in % m/m		
TiO_2	0.029	0.002	5
	in mg/kg		
Ba	12.3	1.0	8
Be	60	7	5
Cr	160	50	12
Cs	87	16	22
Dy	4.33	0.26	9
Er	1.78	0.11	9
Eu	0.027	0.009	5
Ga	56.7	1.8	9
Gd	4.11	0.19	9
Hf	7.89	0.28	8
Ho	0.67	0.05	8
Pr	4.40	0.26	8
Tb	0.83	0.05	9
Tm	0.322	0.026	8
U	3.84	0.25	9
Y	23.4	1.7	9

Notes Tables 1 and 2: U is the expanded uncertainty corresponding to a level of confidence of 95 %. It has been developed according to the Guide for the Expression of Uncertainty in Measurement (Ellison et al. 2000) with a coverage factor k > 2 that varies as a function of N. N is the number of results from independent laboratories and/or techniques used to determine the certified or information value. The between-laboratory standard deviation cannot be obtained simply by dividing U by k. See Table 3.

Table 3. Pooled within-laboratory and between-laboratory standard deviations needed for evaluation of laboratory results for ML-OShBO; Mass fraction or concentration

Oxide/Element	sd(within)	sd(between)
	in % m/m	
SiO_2	0.27	0.57
Al_2O_3	0.07	0.36
Fe_2O_3(TOT)	0.030	0.032
FeO	0.064	0.006
MnO	0.005	0.014
CaO	0.015	0.019
Na_2O	0.04	0.19
K_2O	0.11	0.11

Table 3. Continued

Oxide/Element	sd(within)	sd(between)
	in % m/m	
P_2O_5	0.0034	0.0017
H_2O^-	0.028	0.036
F	nd	0.07
LOI	0.05	0.07
	in mg/kg	
Ce	1.6	1.5
Cu	1.0	1.2
La	0.4	0.9
Li	50	90
Lu	0.014	0.018
Nb	4	7
Nd	0.5	0.6
Ni	1.7	3.0
Pb	4	5
Rb	100	130
Sc	0.4	0.9
Sm	0.2	0.4
Sr	0.7	2.0
Ta	2.7	3.0
Th	0.7	1.7
Yb	0.09	0.12
Zn	5	8
Zr	2.4	3.4

not certified, for information purposes only

Oxide/Element	sd(within)	sd(between)
	in % m/m	
TiO_2	0.001	0.001
	in mg/kg	
Ba	0.8	0.8
Be	3	6
Cr	5	38
Cs	2	15
Dy	0.14	0.26
Er	0.07	0.11
Eu	0.042	0.073
Ga	3.1	3.2
Gd	0.15	0.23
Hf	0.21	0.32
Ho	0.03	0.05
Pr	1.44	0.23
Tb	0.03	0.05
Tm	0.015	0.025
U	0.19	0.32
Y	1.7	2.0

Note: nd = not determined.

Safety Precautions:
The usual laboratory safety precautions apply.

Instructions for Storage and Use:
The CRM should be stored at room temperature and tightly sealed to protect it from absorption of atmospheric moisture and laboratory chemicals.

The recommended minimum sample test portion mass is 100 mg. If an analytical technique requires a smaller test portion mass, it is recommended that more than 100 mg be weighted out and further pulverized in an agate mortar before weighing out the needed mass. No material that has been removed from the sample bottle should be returned to it, as that might cause contamination of all remaining sample.

Certified values are for total concentrations of oxides and elements, reported on a dry weight basis. Prior to analysis the test portion should be dried at 105 ^{o}C for 2 hours before weighing. Alternatively, moisture content may be determined on a second test portion, the results from which can be used to correct to a dry weight basis data acquired on material weighed on an "as received" basis. Also, analysts should not expect to achieve the certified values if they use any partial decomposition technique for their sample preparation. Before taking a sub-sample a rehomogenisation by manual shaking of the closed bottle is strongly recommended.

Sample Preparation and Certification:
The original preparation, homogeneity and stability testing were performed by the Central Geological Laboratory, Ulaanbaatar, Mongolia (Erdenetsetseg and Davaasuren 1999). Four hundred kg of material were collected. The raw material was first crushed using jaw and roll crushers and then further processed in a disc mill to produce powder, of which 97.8% was <74 µm. A total of 288.5 kg of sample resulted. Homogenization had to be done in two batches because the total volume exceeded the blender capacity. Before bottling, homogeneity testing was done on each batch and on the three elements most likely to exhibit heterogeneity, namely, Li, Rb and Cs; all were found to be distributed homogeneously between batches and individual units of sample. In 2007-2008 this material was certified by the International Association of Geoanalysts on behalf of the CGL using the IAG's protocol on the certification of reference materials (Kane et al. 2003). Some of the original certification analyses were retained as having been provided by "expert" laboratories (Kane et al. 2007). Methods of analysis used for the 2007-2008 certification are listed in Table 4.

Table 4. Methods of Analysis Used in this Certification
Certified Oxides/Elements

SiO_2	GRAV, ICP-AES, PHOT, XRF
Al_2O_3	AAS, ICP-AES, PHOT, VOL, XRF
Fe_2O_3	AAS, ICP-AES, PHOT, VOL, XRF
FeO	VOL
MnO	AAS, ICP-AES, ICP-MS, XRF
CaO	AAS, ICP-AES, ICPMS, VOL, XRF
Na_2O	AAS, FI PHOT, ICP-AES, XRF
K_2O	AAS, FI PHOT, XRF
P_2O_5	ICP-AES, PHOT
H_2O^-	GRAV
LOI	GRAV
Ce	dc arc OES, ICP-AES, ICP-MS, NAA, XRF
Cu	AAS, dc arc OES, ICP-AES, ICP-MS, XRF
La	dc arc OES, ICP-AES, ICP-MS, NAA
Li	FI PHOT, ICP-MS
Lu	ICP-AES, ICP-MS, NAA

Nb	dc arc OES, ICP-MS, XRF
Nd	ICP-AES, ICP-MS, NAA
Ni	AAS, dc arc OES, ICP-AES, ICP-MS, NAA, XRF
Pb	AAS, ICP-AES, ICP-MS, XRF
Rb	AAS, FI PHOT, ICP-MS, NAA, XRF
Sc	dc arc OES, ICP-AES, ICP-MS, NAA, XRF
Sm	ICP-AES, ICP-MS, NAA
Sr	AAS, ICP-AES, ICP-MS, XRF
Ta	ICP-MS, XRF
Th	ICP-MS, NAA, XRF
Yb	ICP-AES, ICP-MS, NAA
Zn	AAS, dc arc OES, ICP-AES, ICP-MS, XRF
Zr	ICP-AES, ICP-MS, NAA, XRF

Uncertified (Information only) Elements

TiO_2	PHOT
Ba	ICP-AES, ICP-MS
Be	AAS, ICP-AES, ICP-MS
Cr	AAS, dc arc OES, ICP-MS, PHOT, XRF
Cs	FI PHOT, ICP-MS, NAA, XRF
Dy	ICP-MS
Er	ICP-MS
Eu	ICP-MS
Ga	ICP-MS, XRF
Gd	ICP-MS
Hf	ICP-MS, NAA
Ho	ICP-MS
Pr	ICP-MS
Tb	ICP-MS, NAA
Tm	ICP-MS
U	ICP-MS, NAA
Y	ICP-AES, ICP-MS, XRF

Validity of the Certificate:
This material is considered to be very stable. Therefore, this certificate of analysis shall remain valid through 2018, unless users are otherwise notified.

Availability of Material:
This CRM can be obtained by contacting Dr. Batjargal at the Central Geological Laboratory, Ulaanbaatar, Mongolia.

Participating Laboratories:
Data for the 2007-2008 certification were contributed by laboratories pre-qualified to provide certification data through their participation in the IAG's GeoPT program (Potts et al. 2004). The original 1999 certification analyses that fulfilled IAG quality criteria were also used in the re-certification. Those laboratories which provided data for the current Certificate of Analysis are listed in Table 5.

Table 5. Institutions which Provided Data for the Current Certificate of Analysis

IAG laboratories:
School of Science, University of Greenwich at Medway, Chatham Maritime, Kent, UK
Institute de Geosciencias, Universidade Estadual de Campines, Brazil
Savannah River National Laboratory, Aiken, SC, USA

Laboratorio do INETI, S. Mamede de Infesta, Portugal
Institute of Nuclear Physics, Tirana, Albania
Instituto de Geociêcias da USP, Cidade Universitaria, São Paulo, Brazil
GTK Geolaboratory, Geological Survey of Finland, Rovaniemi, Finland
HuK Umweltlabor GmbH, Wenden, Germany
GeoForschungsZentrum, Potsdam, Germany
Central Geoanalytical Laboratories, Ulaanbaatar, Mongolia
Mineral Resources Laboratory, US Geological Survey, Denver, CO, USA
Geoanalytical Laboratory, School of Earth and Environmental Sciences, Washington State University, Pullman, WA, USA
ALS Chemex, North Vancouver, BC, Canada
Central Laboratory, Czech Geological Survey, Prague, Czech Republic
Geosciences Laboratories, Ontario Geological Survey, Sudbury, ON, Canada

Original certification laboratories whose data was retained for the recertification:
Three laboratories within the Central Geological Laboratory, Mongolia
Federal Institute for Geosciences and Natural Resources, Hannover, Germany
Three laboratories of the Institute for Geochemistry, Irkutsk, Russia
Chemical and Technology Center for New Materials, National University of Mongolia
Physics and Technology Institute of the Academy of Science, Mongolia
Central Chemical Laboratory of “Erdenet” Mongolian-Russian joint venture

Legal Notice:
The results reported here are based on the International Association of Geoanalysts’ published certification protocol (Kane et al. 2003).The values reported here reflect the data submitted by the organizations which participated in this certification programme. Although great care has been taken throughout the certification process, it should be noted that neither the IAG, its subsidiaries, its contractors nor any person acting on their behalf
(a) make any warranty or representation, express or implied that the use of any information, material, apparatus, method or process disclosed in this document does not infringe any privately owned intellectual property rights; or
(b) assume any liability with respect to, or for damages resulting from, the use of any information, material, apparatus, method or process disclosed in this document.

Issuing Organisation:
This certificate of analysis has been issued by the International Association of Geoanalysts. The contact address for this organisation can be found at the web address: http://geoanalyst.org

Accepted as an IAG Certified Reference Material:

Jean Kane, Certification Project Leader

Jean S. Kane

Thomas Meisel, Certification Committee Chair

Thomas [illegible]

Michael Wiedenbeck, IAG President

M. Wiedenbeck

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