International Association of Geoanalysts'
Certified Reference Material Programme
IAG CRM-2

Certificate of Analysis:
Central Geological Laboratory Serpentinite MGL- GAS

Description of the Sample:
This material was collected from the Naran Massif in the Khantaishir area of Mongolia. It was originally prepared, packaged and certified in December, 1998 by the Central Geological Laboratory (CGL), Ulaanbaatar, Mongolia. The material consists of a homogeneous powder of which 98.5% passed a 74 µm sieve. The mineralogy of the sample (in % m/m) has been determined to be as follows:

95.1 serpentine
2.4 magnetite
1.20 calcite
0.40 plagioclase
0.30 magnesite
0.30 chromite
0.25 goethite
0.15 sericite-muscovite
minor pyrite, pyrrhotite, olivine, chalcopyrite and amphibole

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-GAS and the associated expanded uncertainties. A full description of how these certified 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-GAS.

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

Oxide/Element	CV	± U	N
	in % m/m		
SiO_2	38.54	0.23	43
Fe_2O_3(TOT)	8.00	0.22	44
MnO	0.082	0.009	36
MgO	38.22	0.34	42
LOI	13.33	0.14	26
	in mg/kg		
Co	106	3	27
Cr	2780	30	26
Ni	2300	120	26
Sr	7.3	0.4	12
U	0.80	0.04	12
V	33.4	2.0	10
Zn	39	3	12

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

Oxide/Element	IV	± U	N
	in % m/m		
TiO_2	0.022	0.007	32
Al_2O_3	0.475	0.020	24
FeO	0.27	0.20	9
CaO	0.681	0.011	31
Na_2O	0.038	0.021	9
K_2O	0.018	0.009	24
P_2O_5	0.023	0.005	23
CO_2	0.84	0.03	10
H_2O^-	0.58	0.24	12

Table 2. Continued

Oxide/Element	IV	± U	N
	in mg/kg		
As	117	6	7
Ba	8.4	0.6	7
Sm	0.037	0.004	8

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 individual 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-GAS; Mass fraction or concentration

Oxide/Element	sd(within)	sd(between)
	in % m/m	
SiO_2	0.19	0.40
Fe_2O_3(TOT)	0.07	0.20
MnO	0.002	0.007
MgO	0.26	0.52
LOI	0.07	0.23

Table 3. Continued

Oxide/Element	sd(within)	sd(between)
	in mg/kg	
Co	3	6
Cr	40	70
Ni	28	80
Sr	0.7	0.4
U	0.02	0.03
V	3	2
Zn	2	3

not certified, for information purposes only

	in % m/m	
TiO_2	0.003	0.019
Al_2O_3	0.015	0.030
FeO	0.08	0.03
CaO	0.009	0.026
Na_2O	0.006	0.011
K_2O	0.002	0.016
P_2O_5	0.003	0.011
CO_2	0.02	0.24
H_2O^-	0.06	0.17
	in mg/kg	
As	5	4
Ba	2.6	0.5
Sm	0.005	0.004

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 Gantsetseg 1998). Two hundred fifty 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 200 kg of powder, of which 98.5% was <74 µm. Before bottling, homogeneity testing was done on the four elements most likely to exhibit heterogeneity, namely, Ni, Co, CaO and Cr_2O_3; all were found to be distributed homogeneously between 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	AAS, GRAV, ICP-AES, ICP-MS, PHOT, XRF
Fe_2O_3 (TOT)	AAS, ICP-AES, ICP-MS, NAA, PHOT, VOL, XRF
MnO	AAS, ICP-AES, ICP-MS, NAA, VOL, XRF
MgO	AAS, GRAV, ICP-AES, ICP-MS, VOL, XRF
LOI	GRAV
Co	AAS, ICP-AES, ICP-MS, NAA, XRF
Cr	AAS, ICP-AES, ICP-MS, NAA, PHOT, XRF
Ni	AAS, ICP-AES, ICP-MS, NAA, XRF
Sr	ICP-AES, ICP-MS, XRF
U	ICP-MS, NAA
V	AAS, ICP-AES, ICP-MS, XRF
Zn	AAS, ICP-AES, ICP-MS, NAA, XRF

Uncertified (Information) Oxides/Elements

TiO_2	ICP-AES, ICP-MS, XRF
Al_2O_3	ICP-AES, ICP-MS, VOL, XRF
FeO	VOL
CaO	AAS, ICP-AES, ICP-MS, VOL, XRF
Na_2O	AAS, XRF
K_2O	AAS, ICP-AES, XRF
P_2O_5	ICP-AES, XRF
CO_2	VOL
H_2O^-	GRAV
As	AAS, ICP-MS, NAA, XRF
Ba	ICP-AES, ICP-MS, NAA, XRF
Sm	NAA, ICP-MS

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. 2003). The original 1998 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
CERAM Testing and Environmental, Penkhull, Stoke-on-Trent, UK
Institute de Geosciencias, Universidade Estadual de Campinas, Brazil
Savannah River National Laboratory, Aiken, SC, USA
National Research Center for Geoanalysis, Beijing, PR China
Laboratorio do INETI, S. Mamede de Infesta, Portugal
VSEGEI All Russia Geological Research Institute Central Laboratory, St. Petersburg, Russia
Southern and Eastern African Mineral Centre, Dar es Salaam, Tanzania
Instituto de Geociêcias da USP, Cidade Universitaria, São Paulo, Brazil
GTK Geolaboratory, Geological Survey of Finland, Rovaniemi, Finland
HuK Umweltlabor GmbH, Wenden, Germany
Geoanalytical Laboratories, State Geological Institute of Dionyz Stur, Slovakia
GeoForschungsZentrum - Potsdam, 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
Laboratoire Pierre Süe, Gif-sur-Yvette, France
Departamento de Geoquimica, Instituto de Geologia, UNAM, Mexico
Central Laboratory, Czech Geological Survey, Prague, Czech Republic
Instituto de Technologia Ceramica, Campus Universitario Riu Sec, Castellón, Spain
Geosciences Laboratories, Ontario Geological Survey, Sudbury, ON, Canada

Original certification laboratories whose data was retained for the recertification:
Four laboratories within the Central Geological Laboratory, Mongolia
National Center for Standardization and Metrology, Mongolia
Central Chemical Laboratory of "Erdenet" Mongolian-Russian joint venture
Physics and Technology Institute of the Academy of Science, Mongolia
Amdel Laboratories, Ltd., Australia
Shimadzu Corporation, Japan
Geological Survey of Japan, Tsukuba, Japan
Institute for Nuclear Physics, Korea

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

Thomas Meisel, Certification Committee Chair

Michael Wiedenbeck, IAG President

Date of Issue: 10 March 2009

References:

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Erdenetsetseg D. and Gantsetseg D. (1998)
Report on the Preparation and Certification of Certified Reference Material- Serpentinite GAS Central Geological Laboratory of Mongolia (in Mongolian), (2006 English translation, personal communication), 20pp.

ISO Guide 33 (2000)
Uses of Certified Reference Materials (2nd edition). International Organization for Standardization (Geneva), 23pp.

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International Association of Geoanalysts' Protocol for the Certification of Geological and Environmental Reference Materials: A Supplement. Geostandards and Geoanalytical Research, 31, 285-288.

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