



**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 <sub>2</sub>	38.54	0.23	43
Fe <sub>2</sub> O <sub>3</sub> (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 <sub>2</sub>	0.022	0.007	32
Al <sub>2</sub> O <sub>3</sub>	0.475	0.020	24
FeO	0.27	0.20	9
CaO	0.681	0.011	31
Na <sub>2</sub> O	0.038	0.021	9
K <sub>2</sub> O	0.018	0.009	24
P <sub>2</sub> O <sub>5</sub>	0.023	0.005	23
CO <sub>2</sub>	0.84	0.03	10
H <sub>2</sub> O <sup>-</sup>	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 <sub>2</sub>	0.19	0.40
Fe <sub>2</sub> O <sub>3</sub> (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 <sub>2</sub>	0.003	0.019
Al <sub>2</sub> O <sub>3</sub>	0.015	0.030
FeO	0.08	0.03
CaO	0.009	0.026
Na <sub>2</sub> O	0.006	0.011
K <sub>2</sub> O	0.002	0.016
P <sub>2</sub> O <sub>5</sub>	0.003	0.011
CO <sub>2</sub>	0.02	0.24
H <sub>2</sub> O <sup>-</sup>	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 °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<sub>2</sub>O<sub>3</sub>; 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 <sub>2</sub>	AAS, GRAV, ICP-AES, ICP-MS, PHOT, XRF
Fe <sub>2</sub> O <sub>3</sub> (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 <sub>2</sub>	ICP-AES, ICP-MS, XRF
Al <sub>2</sub> O <sub>3</sub>	ICP-AES, ICP-MS, VOL, XRF
FeO	VOL
CaO	AAS, ICP-AES, ICP-MS, VOL, XRF
Na <sub>2</sub> O	AAS, XRF
K <sub>2</sub> O	AAS, ICP-AES, XRF
P <sub>2</sub> O <sub>5</sub>	ICP-AES, XRF
CO <sub>2</sub>	VOL
H <sub>2</sub> O <sup>-</sup>	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 Geociências 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 Geoquímica, Instituto de Geología, UNAM, Mexico  
Central Laboratory, Czech Geological Survey, Prague, Czech Republic  
Instituto de Tecnología Cerámica, 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

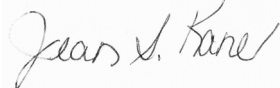
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**Issuing Organisation:**

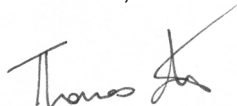
This certificate of analysis has been issued by the International Association of Geoanalysts. The contact address for this organisation can be found at the web address: <http://geoanalyst.org>

**Accepted as an IAG Certified Reference Material:**

Jean Kane, Certification Project Leader



Thomas Meisel, Certification Committee Chair



Michael Wiedenbeck, IAG President



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**References:****Ellison S.L.R., Rosslein M. and Williams A. (2000)**

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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 (2<sup>nd</sup> edition). International Organization for Standardization (Geneva), 23pp.

**Kane J.S., Potts P.J., Meisel T. and Wiedenbeck M. (2007)**

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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GeoPT12- An International Proficiency Test for Analytical Geochemistry Laboratories- Report on Round 12/January 2003 (GAS Serpentinite). International Association of Geoanalysts report, 38 pp.