



Approved by General Administration of Quality Supervision,
Inspection and Quarantine of the People's Republic of China

GBW07103-GBW07108

GBW07120-GBW07122



Certificate of Certified Reference Material

Rock



Sample Number

Date of Certification

Date of Certification

Date of Modification

Institute of Geophysical and Geochemical Exploration

(Langfang China)



The series of nine rock CRMs is mainly used in geology, exploration geochemistry, environmental sciences and the related fields for carrying out chemical analysis as calibration samples and for monitoring the quality of measurements.

1. Sample collection and preparation

For rock samples, those widely distributed rocks, which are igneous rocks, sedimentary rocks and metamorphic rocks, were selected in China. GBW07103: A grey medium-grained biotite granite sample was collected from Hunan. GBW07104: A quartz hornblende andesite sample was obtained from Jiangsu. GBW07105: An alkali-olivine basalt sample was collected in Hebei. GBW07106: An arkosic quartz-sandstone sample was obtained from Anhui. GBW07107: A shale sample was collected from Tianjin. GBW07108: A banded argillaceous limestone sample was obtained from Anhui. GBW07120: A limestone composite sample was collected from Beijing. GBW07121: A granitic gneiss sample was obtained from Hebei. GBW07122: An amphibolite sample was collected from Liaoning.

The raw samples were washed and dried by airing. The rock samples were crushed until they were less than 3-5mm. After fully mixed, the samples were processed by a high-alumina porcelain ball mill and passed through a 1mm sieve. The samples were dried and sterilized at 120°C for 24 hours. A high-alumina porcelain ball mill was used to grind them until more than 98% passed through a 0.074mm sieve.

2. Test of homogeneity and stability

Randomly 18 sub-bottles of the samples were taken from the least package units. The representative major, minor and trace elements were analysed by AAS, XRFS and NAA in duplicate. A multi-level nested analysis of variance was carried out. It proved that the samples were homogeneous. The minimum sampling weight for analysis is 0.1g. Observations for a stability test were undertaken over many years. No significant statistical variations were observed, therefore, the samples can be considered to be stable.

3. Sample analysis

A multi-laboratory collaborative analysis scheme was adopted in the certification procedure. Tens of institutes and laboratories with high analytical level in China analysed these samples. About twenty reliable analytical methods based on different principles of measurement were employed in sample analysis, namely ICP-AES, AAS, COL, XRFS, NAA, AES, POL and VOL, etc.

4. Certified values and uncertainties

The certified values should meet the following requirements. The number of data sets taking part in the statistical analysis was not less than six sets. Two or more reliable analytical methods without obvious bias based on different principles were used. The analytical data were obtained from laboratories that could provide good precision. When the number of data sets was less than six sets (but not less than three) or the laboratory-method average data had higher divergence, the values obtained were defined as proposed values and indicated with parentheses. The uncertainty of certified values was calculated by using the formula $U = t \cdot s / \sqrt{N}$. Where t is listed values of Student's Distribution at the 99% confidence level, s the standard deviation and N the number of data sets used. When more than 20, N would be considered as if it were equal to 20.

5. Package and storage

The least sample package is 70g/bottle. It is recommended to seal the bottle cap after using and store samples in a shady, cool and dry place.

Certified values of chemical composition for rock CRMs

	GBW07103 (GSR-1)	GBW07104 (GSR-2)	GBW07105 (GSR-3)	GBW07106 (GSR-4)	GBW07107 (GSR-5)	GBW07108 (GSR-6)	GBW07120 (GSR-13)	GBW07121 (GSR-14)	GBW07122 (GSR-15)
$\mu\text{g/g}$									
Ag	0.033±0.007	0.071±0.009	0.040±0.008	0.062±0.007	0.047±0.009	0.043±0.011	(0.025)	0.03±0.01	(0.05)
As	2.1±0.4	2.1±0.4	(0.7)	9.1±1.2	1.4±0.3	4.7±0.6	0.66±0.11	(0.25)	26±3
Au	(0.00055)	(0.00095)	(0.00066)	(0.0018)	(0.0010)	(0.00094)			
B	24±3	4.7±0.8	3.5±1.0	34±6	154±11	16±4	(12)	15±3	12±2
Ba	343±29	1020±45	527±26	143±14	450±29	120±12	9±2	1140±80	62±14
Be	12.4±1.4	1.1±0.2	2.5±0.4	0.97±0.10	3.0±0.3	0.8±0.2	0.14±0.03	1.7±0.3	0.34±0.06
Bi	0.53±0.06	0.081±0.016	0.048±0.017	0.18±0.03	0.23±0.03	0.16±0.04	0.032±0.007	0.096±0.016	(0.06)
Br					(0.4)		(0.3)		
Cd	0.029±0.009	0.061±0.014	0.067±0.016	0.060±0.016	0.033±0.012	0.07±0.02	0.016±0.006	(0.06)	(0.14)
Ce	108±7	40±3	105±8	48±4	109±8	25±3	4.6±0.4	48±3	7.7±1.0
Cl	127±17	(46)	(114)	(44)	41±6	78±15	(24)	(120)	(116)
Co	3.4±0.7	13.2±1.0	46.5±3.4	6.4±0.6	21±2	9±2	0.8±0.3	7.8±1.1	52±5
Cr	3.6±0.9	32±3	134±11	20±3	99±6	32±6	3.4±0.4	24±2	137±5
Cs	38.4±1.2	2.3±0.7	(0.7)	1.8±0.3	14±2	3.2±0.7	(0.10)	2.6±0.3	1.8±0.3
Cu	3.2±0.9	55±3	49±3	19±2	42±2	23±2	2.2±0.3	(3.1)	84±5
Dy	10.2±0.4	1.85±0.17	5.6±0.3	4.1±0.4	5.1±0.4	1.6±0.2	0.28±0.07	1.52±0.14	3.5±0.5
Er	6.5±0.3	0.85±0.13	2.0±0.2	2.0±0.3	2.7±0.4	1.0±0.2	(0.17)	0.76±0.08	2.3±0.4
Eu	0.85±0.07	1.02±0.05	3.2±0.2	1.02±0.08	1.7±0.2	0.51±0.05	0.082±0.019	1.0±0.2	0.91±0.15
F	2350±128	280±25	700±44	183±18	1290±64	406±29	249±18	670±84	200±20
Ga	19±2	18.1±1.4	24.8±0.9	5.3±0.8	26±3	7.1±0.8	0.87±0.17	18.2±1.6	17.2±1.0
Gd	9.3±0.7	2.7±0.4	8.5±0.6	4.5±0.4	6.7±0.5	1.9±0.2	0.36±0.08	2.4±0.3	2.8±0.3
Ge	2.0±0.3	0.93±0.15	0.98±0.21	1.16±0.27	3.1±0.5	0.67±0.20	0.14±0.03	0.93±0.07	1.46±0.20
Hf	6.3±0.8	2.9±0.5	6.5±0.8	6.6±0.7	2.9±0.5	1.8±0.3	0.22±0.05	3.3±0.5	1.5±0.2
Hg	0.0041±0.0012	0.012±0.003	0.006±0.002	0.008±0.002	0.010±0.002	0.016±0.002	0.005±0.002	0.0035±0.0016	0.003±0.0018
Ho	2.05±0.17	0.34±0.03	0.88±0.04	0.75±0.12	0.98±0.05	0.33±0.05	(0.045)	0.27±0.03	0.85±0.14
I		(0.14)		(0.2)	0.24±0.06	0.23±0.08	(0.1)		
In	(0.02)	0.037±0.013	0.064±0.022	(0.026)	0.082±0.028	(0.04)	(0.02)	(0.03)	(0.06)
La	54±4	22±2	56±5	21±2	62±4	15±4	2.3±0.2	25±2	2.9±0.4
Li	131±5	18.3±0.9	9.5±0.9	11.1±0.5	44±2	20±3	4.8±1.0	24.7±2.4	11.2±2.3
Lu	1.15±0.09	0.12±0.03	0.19±0.05	0.30±0.03	0.41±0.05	0.14±0.03	0.023±0.007	0.11±0.01	0.39±0.06
Mn	463±18	604±18	1310±61	155±7	173±11	434±27	28±4	430±14	1600±70
Mo	3.5±0.2	0.54±0.09	2.6±0.2	0.76±0.14	0.35±0.09	0.38±0.06	0.18±0.06	(0.27)	0.15±0.06
N					540±60	(170)	(68)		
Nb	40±3	6.8±1.4	68±8	5.9±0.9	14.3±1.6	6.6±1.7	0.8±0.2	4.5±0.8	2.7±0.9
Nd	47±4	19±2	54±4	21±2	48±3	12.0±1.0	1.96±0.14	21±4	6.5±1.4
Ni	2.3±0.8	17±2	140±7	16.6±1.1	37±3	18±2	(4)	13±2	117±10
P	405±20	1030±24	4130±122	970±39	690±34	226±31	57±7	570±40	360±20
Pb	31±3	11.3±1.8	(7)	7.6±0.8	8.7±1.8	18±3	5±2	7.6±2.0	(8)

Certified values of chemical composition for rock CRMs (continued)

	GBW07103 (GSR-1)	GBW07104 (GSR-2)	GBW07105 (GSR-3)	GBW07106 (GSR-4)	GBW07107 (GSR-5)	GBW07108 (GSR-6)	GBW07120 (GSR-13)	GBW07121 (GSR-14)	GBW07122 (GSR-15)
$\mu\text{g/g}$									
Pr	12.7±0.8	4.9±0.4	13.2±1.3	5.4±0.6	13.6±1.7	3.4±0.4	0.60±0.14	5.8±0.8	1.25±0.15
Rb	466±17	38±3	37±4	29±2	205±8	32±4	4.0±0.6	57±5	29±5
S	380±33	192±21	(100)	860±42	(66)	(370)	36±8	(50)	(60)
Sb	0.21±0.06	0.12±0.04	(0.08)	0.60±0.11	0.18±0.04	0.43±0.11	0.072±0.013	0.063±0.013	0.63±0.25
Sc	6.1±0.4	9.5±0.7	15.2±1.2	4.2±0.3	18.5±1.2	6.0±1.1	(0.7)	5.0±0.5	43±4
Se	(0.04)	(0.04)	0.073±0.024	0.08±0.03	0.075±0.015	0.09±0.02	0.021±0.004	0.019±0.007	0.083±0.009
Sm	9.7±0.8	3.4±0.2	10.2±0.5	4.7±0.3	8.4±0.4	2.4±0.2	0.40±0.05	3.3±0.3	2.1±0.2
Sn	12.5±1.5	0.79±0.17	2.0±0.4	1.1±0.2	2.0±0.4	(0.98)	(0.5)	0.8±0.2	(0.8)
Sr	106±6	790±35	1100±64	58±5	90±7	913±54	107±9	690±20	142±9
Ta	7.2±0.7	0.40±0.10	4.3±0.6	0.38±0.05	0.9±0.1	0.42±0.05	(0.05)	(0.34)	(0.18)
Tb	1.65±0.09	0.41±0.05	1.2±0.2	0.79±0.09	1.02±0.08	0.35±0.05	0.054±0.010	0.29±0.03	0.57±0.08
Te	0.021±0.006	0.017±0.005	(0.022)	0.038±0.012	(0.023)	(0.024)			
Th	54±3	2.6±0.3	6.0±0.8	7.0±0.4	12.8±0.9	4.1±0.5	0.86±0.07	1.9±0.2	(0.4)
Ti	1720±70	3090±90	14200±400	1580±80	3950±130	1960±90	230±30	1800±140	5510±160
Tl	1.93±0.38	0.16±0.05	(0.12)	0.36±0.06	0.71±0.09	0.33±0.07	(0.03)	(0.20)	(0.11)
Tm	1.06±0.09	0.15±0.05	0.28±0.04	0.32±0.04	0.43±0.03	0.17±0.04	(0.024)	0.11±0.02	0.37±0.10
U	18.8±1.4	0.90±0.19	1.4±0.3	2.1±0.3	1.5±0.3	1.9±0.3	0.24±0.04	(0.4)	(0.14)
V	24±2	94±4	167±11	33±3	87±4	36±6	5.4±1.6	45±4	296±39
W	8.4±0.5	(0.45)	(0.4)	1.2±0.2	0.79±0.14	0.67±0.18	0.13±0.03	0.38±0.09	0.34±0.09
Y	62±5	9.3±1.2	22±4	21.5±2.2	26±2	9.1±1.6	1.9±0.4	7.3±0.9	20±3
Yb	7.4±0.5	0.89±0.13	1.5±0.4	1.9±0.2	2.6±0.3	0.90±0.11	0.15±0.05	0.69±0.08	2.4±0.4
Zn	28±3	71±5	150±10	20±2	55±4	52±4	7±2	47±3	100±12
Zr	167±9	99±11	277±20	214±9	96±9	62±13	11±3	(100)	(57)
%									
SiO ₂	72.83±0.10	60.62±0.14	44.64±0.11	90.36±0.15	59.23±0.16	15.60±0.06	6.65±0.14	66.27±0.27	49.62±0.15
Al ₂ O ₃	13.40±0.07	16.17±0.12	13.83±0.13	3.52±0.09	18.82±0.14	5.03±0.08	0.68±0.05	16.33±0.15	13.76±0.19
TFe ₂ O ₃	2.14±0.06	4.90±0.06	13.40±0.19	3.22±0.07	7.60±0.09	2.52±0.07	0.21±0.01	3.12±0.08	14.8±0.3
FeO	1.02±0.04	2.39±0.07	7.60±0.13	0.61±0.05	1.39±0.06	1.64±0.06	(0.06)	(1.6)	10.8±0.6
MgO	0.42±0.04	1.72±0.06	7.77±0.17	0.082±0.020	2.01±0.05	5.19±0.12	0.71±0.09	1.63±0.10	7.2±0.3
CaO	1.55±0.05	5.20±0.07	8.81±0.09	0.30±0.04	0.60±0.04	35.67±0.25	51.1±0.4	2.66±0.10	9.6±0.2
Na ₂ O	3.13±0.06	3.86±0.07	3.38±0.05	0.061±0.014	0.35±0.02	(0.08)	0.03±0.01	5.3±0.1	2.07±0.09
K ₂ O	5.01±0.07	1.89±0.05	2.32±0.06	0.65±0.03	4.16±0.10	0.78±0.04	0.15±0.02	2.60±0.06	0.48±0.05
H ₂ O ⁺	0.60±0.05	(1.5)	2.86±0.13	1.01±0.06	5.6±0.3	(2.12)	(0.4)	(1.0)	(1.7)
CO ₂	(0.15)	3.47±0.07	(0.19)	(0.19)	(0.10)	32.4±0.3	39.8±0.3	0.35±0.05	(0.16)
Corg.				(0.05)	(0.16)	(0.11)	(0.15)		
TC				(0.10)	(0.19)	9.0±0.2			
LOI	(0.70)	4.44±0.12	(2.24)	1.10±0.07	(5.95)	34.1±0.2	40.2±0.4	1.28±0.14	1.06±0.09

Note: Data following “±” are uncertainties. Data enclosed in brackets are proposed values.