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

GBW07401-GBW07408

Certificate of Certified Reference Material

Soil

Date of Certification

Date of Modification

Date of Expirate

Institute of Geophysical and Geochemical Exploration

(Langfang China)

The set of eight soil CRMs is mainly used in geology, exploration geochemistry, mineral reconnaissance, agriculture and the related fields for carrying out chemical analysis as calibration samples and for monitoring the quality of measurements.

1. Sample collection and preparation

The soil samples were collected from the representative soil zones, different geological backgrounds or mineralized areas in China. GBW07401: A dark brown podzolitic soil was collected from a lead-zinc ore area, Heilongjiang. GBW07402: A chestnut soil sample was obtained from Bainaimiao and Bayan Obo, Nei Mongol. GBW07403: A yellow-brown soil sample was collected from Shandong. GBW07404: A limy-red soil sample was obtained from Guangxi. GBW07405: A yellow-red soil sample was collected from a skarn polymetallic ore field, Hunan. GBW07406: A red soil sample was obtained from a polymetallic ore area, Guangdong. GBW07407: A laterite soil sample was collected from Leizhou Peninsula, Guangdong. Basalt is the underlying bedrock. GBW07408: A loess sample was obtained from Shaanxi.

The raw samples were dried in air, passed through a 1mm sieve to remove impurities. After fully mixed, the samples were dried and sterilized at 120℃ for 24 hours. A high-alumina porcelain ball mill was used to grind them until more than 99% 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 eight 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 eight sets (but not less than four) 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.

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Certified values of chemical composition for soil CRMs

质量分数 (10^{-6})	GBW07401 (GSS-1)	GBW07402 (GSS-2)	GBW07403 (GSS-3)	GBW07404 (GSS-4)	GBW07405 (GSS-5)	GBW07406 (GSS-6)	GBW07407 (GSS-7)	GBW07408 (GSS-8)
Ag	0.35±0.05	0.054±0.007	0.091±0.007	0.070±0.011	4.4±0.4	0.20±0.02	0.057±0.011	0.060±0.009
As	34±4	13.7±1.2	4.4±0.6	58±6	412±16	220±14	4.8±1.3	12.7±1.1
Au	(0.00055)	(0.0017)		(0.0055)	0.260±0.007	(0.009)	(0.0008)	(0.0014)
B	50±3	36±3	23±3	97±9	53±6	57±5	(10)	54±4
Ba	590±32	930±52	1210±65	213±20	296±26	118±14	180±27	480±23
Be	2.5±0.3	1.8±0.2	1.4±0.2	1.85±0.34	2.0±0.4	4.4±0.7	2.8±0.6	1.9±0.2
Bi	1.2±0.1	0.38±0.04	0.17±0.03	1.04±0.13	41±4	49±5	0.20±0.04	0.30±0.04
Br	2.9±0.6	4.5±0.7	4.3±0.8	4.0±0.7	(1.5)	8.0±0.7	5.1±0.5	2.5±0.5
Cd	4.3±0.4	0.071±0.014	0.060±0.009	0.35±0.06	0.45±0.06	0.13±0.03	0.08±0.02	0.13±0.02
Ce	70±4	402±16	39±4	136±11	91±10	66±6	98±11	66±7
C1	70±9	62±10	57±11	(39)	(76)	95±7	100±6	68±12
Co	14.2±1.0	8.7±0.9	5.5±0.7	22±2	12±2	7.6±1.1	97±6	12.7±1.1
Cr	62±4	47±4	32±4	370±16	118±7	75±6	410±23	68±6
Cs	9.0±0.7	4.9±0.5	3.2±0.4	21.4±1.0	15±1	10.8±0.6	2.7±0.8	7.5±0.7
Cu	2l±2	16.3±0.9	11.4±1.1	40±3	144±6	390±14	97±6	24.3±1.2
Dy	4.6±0.3	4.4±0.3	2.6±0.2	6.6±0.6	3.7±0.5	3.3±0.3	6.6±0.6	4.8±0.4
Er	2.6±0.2	2.1±0.4	1.5±0.3	4.5±0.7	2.4±0.3	2.2±0.3	2.7±0.5	2.8±0.2
Eu	1.0±0.1	3.0±0.2	0.72±0.04	0.85±0.07	0.82±0.04	0.66±0.04	3.4±0.2	1.2±0.1
F	506±32	2240±112	246±26	540±25	603±28	906±45	321±29	577±24
Ga	19.3±1.1	12±1	13.7±0.9	31±3	32±4	30±3	39±5	14.8±1.1
Gd	4.6±0.3	7.8±0.6	2.9±0.4	4.7±0.5	3.5±0.3	3.4±0.3	9.6±0.9	5.4±0.5
Ge	1.34±0.20	1.2±0.2	1.16±0.13	1.9±0.3	2.6±0.4	3.2±0.4	1.6±0.3	1.27±0.20
Hf	6.8±0.8	5.8±0.9	6.8±0.8	14±2	8.1±1.7	7.5±0.8	7.7±0.5	7.0±0.8
Hg	0.032±0.004	0.015±0.003	0.060±0.004	0.59±0.05	0.29±0.03	0.072±0.007	0.061±0.006	0.017±0.003
Ho	0.87±0.07	0.93±0.12	0.53±0.06	1.46±0.12	0.77±0.08	0.69±0.05	1.1±0.2	0.97±0.08
I	1.8±0.3	1.8±0.2	1.3±0.2	9.4±1.1	3.8±0.5	19.4±0.9	19±2	1.7±0.2
In	0.08±0.02	0.09±0.03	0.031±0.010	0.12±0.03	4.1±0.6	0.84±0.18	0.10±0.03	0.044±0.013
La	34±2	164±11	21±2	53±4	36±4	30±2	46±5	36±3
Li	35±1	22±1	18.4±0.8	55±2	56±2	36±1	19.5±0.9	35±2
Lu	0.41±0.04	0.32±0.05	0.29±0.02	0.75±0.06	0.42±0.05	0.42±0.05	0.35±0.06	0.43±0.04
Mn	1760±63	510±16	304±14	1420±75	1360±71	1450±82	1780±113	650±23
Mo	1.4±0.1	0.98±0.11	0.31±0.06	2.6±0.3	4.6±0.4	18±2	2.9±0.3	1.16±0.10
N	1870±67	630±59	640±50	1000±62	610±31	740±59	660±62	370±54
Nb	16.6±1.4	27±2	9.3±1.5	38±3	23±3	27±2	64±7	15±2
Nd	28±2	210±14	18.4±1.7	27±2	24±2	2l±2	45±2	32±2
Ni	20.4±1.8	19.4±1.3	12±2	64±5	40±4	53±4	276±15	31.5±1.8
P	735±28	446±25	320±18	695±28	390±34	303±30	1150±39	775±25
Pb	98±6	20±3	26±3	58±5	552±29	314±13	14±3	21±2
Pr	7.5±0.5	57±6	4.8±0.4	8.4±1.7	7.0±1.2	5.8±0.6	11±1	8.3±0.8

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Certified values of chemical composition for soil CRMs (continued)

质量分数 (10^{-6})	GBW07401 (GSS-1)	GBW07402 (GSS-2)	GBW07403 (GSS-3)	GBW07404 (GSS-4)	GBW07405 (GSS-5)	GBW07406 (GSS-6)	GBW07407 (GSS-7)	GBW07408 (GSS-8)
Rb	140±6	88±4	85±4	75±4	117±6	237±8	16±3	96±4
Re					(0.00053)	(0.00012)		
S	(310)	210±43	123±14	180±36	410±54	260±43	250±36	(126)
Sb	0.87±0.21	1.3±0.2	0.44±0.08	6.3±1.1	35±5	60±7	0.42±0.09	1.0±0.2
Sc	11.2±0.6	10.7±0.6	5.0±0.4	20±2	17±1	15.5±0.9	28±2	11.7±0.7
Se	0.14±0.03	0.16±0.03	0.09±0.02	0.64±0.14	1.6±0.2	1.34±0.17	0.32±0.05	0.10±0.01
Sm	5.2±0.3	18±2	3.3±0.2	4.4±0.4	4.0±0.4	3.8±0.4	10.3±0.4	5.9±0.4
Sn	6.1±0.7	3.0±0.3	2.5±0.3	5.7±0.9	18±3	72±7	3.6±0.7	2.8±0.5
Sr	155±7	187±9	380±16	77±6	42±4	39±4	26±4	236±13
Ta	1.4±0.2	0.78±0.19	0.76±0.15	3.1±0.3	1.8±0.3	5.3±0.6	3.9±0.6	1.05±0.25
Tb	0.75±0.06	0.97±0.26	0.49±0.06	0.94±0.09	0.7±0.1	0.6l±0.08	1.3±0.2	0.89±0.08
Te	0.058±0.020	(0.033)	0.039±0.013	0.16±0.06	(5)	0.4±0.l	(0.047)	0.045±0.010
Th	11.6±0.7	16.6±0.8	6.0±0.5	27±2	23±2	23±2	9.1±0.7	11.8±0.7
Ti	4830±160	2710±80	2240±80	10800±310	6290±210	4390±120	20200±500	3800±120
Tl	1.0±0.2	0.62±0.20	0.48±0.05	0.94±0.25	1.6±0.3	2.4±0.5	0.21±0.06	0.58±0.06
Tm	0.42±0.06	0.42±0.11	0.28±0.05	0.70±0.10	0.41±0.04	0.40±0.06	0.42±0.05	0.46±0.07
U	3.3±0.4	1.4±0.3	1.3±0.3	6.7±0.8	6.5±0.7	6.7±0.7	2.2±0.4	2.7±0.4
V	86±4	62±4	36±3	247±14	166±9	130±7	245±2l	81±5
W	3.1±0.3	1.08±0.22	0.96±0.12	6.2±0.5	34±2	90±7	1.2±0.2	1.7±0.2
Y	25±3	22±2	15±2	39±6	21±3	19±2	27±4	26±2
Yb	2.7±0.3	2.0±0.2	1.7±0.2	4.8±0.6	2.8±0.4	2.7±0.4	2.4±0.4	2.8±0.2
Zn	680±25	42±3	31±3	210±13	494±25	97±6	142±11	68±4
Zr	245±12	219±15	246±14	500±42	272±16	220±14	318±37	229±12
(10^{-2})								
SiO_2	62.60±0.14	73.35±0.18	74.72±0.19	50.95±0.14	52.57±0.16	56.93±0.18	32.69±0.18	58.61±0.13
Al_2O_3	14.18±0.14	10.31±0.10	12.24±0.09	23.45±0.19	21.58±0.15	21.23±0.16	29.26±0.34	11.92±0.15
TFe_2O_3	5.19±0.09	3.52±0.07	2.00±0.05	10.30±0.11	12.62±0.18	8.09±0.13	18.76±0.33	4.48±0.05
FeO	(1.27)	0.57±0.07	0.50±0.06	(0.41)	(0.22)	(0.57)	(1.05)	1.22±0.05
MgO	1.81±0.08	1.04±0.04	0.58±0.04	0.49±0.05	0.61±0.06	0.34±0.05	0.26±0.03	2.38±0.07
CaO	1.72±0.06	2.36±0.05	1.27±0.05	0.26±0.04	(0.10)	0.22±0.03	0.16±0.02	8.27±0.12
Na_2O	1.66±0.04	1.62±0.04	2.7l±0.06	0.11±0.02	0.12±0.02	0.19±0.02	0.08±0.02	1.72±0.04
K_2O	2.59±0.04	2.54±0.05	3.04±0.05	1.03±0.06	1.50±0.04	1.70±0.06	0.20±0.02	2.42±0.04
H_2O^+	(5.0)	(2.9)	(1.9)	(10.1)	(8.8)	(8.9)	(13.7)	(3.3)
CO_2	1.12±0.09	(0.97)	(0.13)	(0.12)	(0.10)	(0.084)	(0.11)	5.97±0.16
Corg.	1.80±0.16	0.49±0.07	0.51±0.03	0.62±0.08	(0.32)	0.81±0.09	0.64±0.07	(0.30)
TC	2.11±0.19	0.75±0.10	0.55±0.05	0.65±0.10	(0.35)	0.83±0.10	0.67±0.09	1.93±0.13
LOI	(8.59)	4.4±0.2	2.67±0.13	(10.9)	(9.1)	(10.0)	(14.3)	9.12±0.17

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

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