

Table S1 The values of LOD and LOQ of all measured elements

Seq.	Sample name	SiO ₂ (%)	TiO ₂ (%)	Al ₂ O ₃ (%)	TFe ₂ O ₃ (%)	MnO (%)	MgO (%)	CaO (%)	Na ₂ O (%)	K ₂ O (%)	S (%)	Cu (%)	Pb (%)	Zn (%)
1	KONG	0.02	0	0.01	0.09	0	0.08	0.04	0.02	0.01	-0.02	0	0.06	0
2	KONG	0.01	0	0.01	0.09	0	0.09	0.05	0.01	0.01	0	0	0.06	0
3	KONG	0.03	0	0.02	0.09	0	0.08	0.04	0.01	0.01	0	0	0.08	0
4	KONG	0.01	0	0	0.09	0	0.08	0.04	0.03	0.02	-0.02	0	0.06	0
5	KONG	0.02	0	0	0.09	0	0.09	0.04	0.02	0.01	0	0	0.06	0
6	KONG	0.06	0	-0.03	0.1	0	0.07	0.03	0.03	0.01	-0.02	0.01	0.08	0
7	KONG	0.05	0	0.01	0.1	0	0.07	0.03	0.01	0.01	-0.02	0.01	0.08	0
8	KONG	0.06	0	0	0.1	0	0.07	0.03	0.05	0	-0.02	0.01	0.08	0
SD	σ	0.023	0.00	0.015	0.005	0.00	0.008	0.007	0.014	0.005	0.01	0.005	0.01	0.00
LOD	3 σ	0.07	0.00	0.04	0.02	0.00	0.03	0.02	0.04	0.02	0.03	0.02	0.03	0.00
LOQ	10 σ	0.23	0.00	0.15	0.05	0.00	0.08	0.07	0.14	0.05	0.10	0.05	0.11	0.00

1

Table S2 The recommended values of twelve standards used in this paper

Constituent /%	SiO ₂	TiO ₂	Al ₂ O ₃	TFe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	S	Cu	Pb	Zn
GBW07233													
(GSO-Cu-1)	9.27	0.079	1.73	55.58	0.6	3.91	9.61	0.044	0.071	0.72	1.15	9.1*	0.059
GBW07234													
(GSO-Cu-2)	53.36	0.5	15.18	12.25	0.12	1.3	4.95	3.21	2.71	0.14	0.19	13*	0.013
GBW07235													
(GSO-Pb-1)	43.63	0.53	12.88	4.37	1.4	1.62	19.51	1.61	1.42	0.86	0.2	4.17	0.062
GBW07236													
(GSO-Pb-2)	30.51	0.44	8.95	3.79	1.53	2.06	34.56	0.066	0.82	0.38	0.035	0.61	0.092
GBW07237													
(GSO-Zn-1)	82.95	0.017	2.8	3.5	0.026	0.082	1.91	0.56	0.99	2.87	0.71	0.25	2.75
GBW07162													
(GSO-1)	63		14.1	6.69	0.12	1.55	1.52	0.68	3.85	2.67	0.264	0.43	0.83
GBW07163													
(GSO-2)	47.9		11.2	12.01	0.491	1.39	4.7	0.24	3.1	6.74	1.05	2.17	4.26
GBW07164													
(GSO-3)	40.6		7.8	16.3	0.31	2.33	17.2	0.54	1.79	5.95	2.8	0.056	0.143
GBW07165													
(GSO-4)	14.1		2.5	28.02	0.09	0.59	6.5	0.03	0.78	29	0.096	5.13	13.9
JZn-1	44	0.2	6.32	16.87	1.49	1.94	18.1	0.45	0.83	1.3	0.0029	0.161	2.22
CAN RTS-3a	39.11	0.586	9.67	29.29	0.205	4.11	2.99	0.922	0.554	9.59	0.235	0.021	0.289
CAN SU-1b	32.58		8.12	36.51	0.091	2.97	3.09	2.157	0.723	14.14	1.185	58*	235*

PS: the value with * means the unit is ppm

Table S3 The values of U_s and RMS of the 13 analysis elements

Constituent	SiO ₂	TiO ₂	Al ₂ O ₃	TFe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	S	Cu	Pb	Zn
U_s	0.005	0.042	0.011	0.009	0.037	0.062	0.016	0.091	0.037	0.028	0.022	0.022	0.021
RMS	0.308	0.011	0.109	0.245	0.010	0.036	0.111	0.015	0.047	0.0757	0.018	0.025	0.049

Table S4 The calculation example of uncertainties in table 4

CAN RTS-3A	SiO ₂	S
Average	39.14	9.34
SD	0.08	0.007
U_m	0.00118	0.00043
U_f	0.00789	0.0081
(Type A) U_A	0.008	0.0081
U_s	0.0054	0.0276
U_b	0.00051	0.00051
(Type B) U_B	0.0055	0.0276
U_C	0.38	0.27
U	0.76	0.54

Table S5 The detailed information of the recognised comparison methods that used in table 5

Constituent	Technique	Literature
SiO ₂	Combination with gravimetry and AAS; alkali fusion with Na ₂ CO ₃ / H ₃ BO ₃	S. Terashima, Bull. Geol. Surv. Japan, 1979; 30: 37. S. Terashima, T. Yamashige and A. Ando, Bull. Geol. Surv. Japan, 1984; 35: 171
TiO ₂ / Al ₂ O ₃ / TFe ₂ O ₃ / MnO / MgO / CaO / Na ₂ O / K ₂ O	ICP-AES; acid digestion with HF / HNO ₃ / HClO ₄	S. Terashima, Geostandards Newsletter, 2003; 27:259
S	Combustion and infrared absorption spectrometry	S. Terashima Geostandards Newsletter, 1988; 12:249
Cu / Pb / Zn	AAS; acid digestion with HF / HNO ₃ / HClO ₄	S. Terashima and A. Ando Geostandards Newsletter, 1987; 11: 75