

Table S1 Information table of standard measurements and standard values of stable isotopes

Stable isotope ratio	Standard	Measured value										Mean	SD	Certified values
		1	2	3	4	5	6	7	8	9	10			
$\delta^{15}\text{N}_{\text{air}}$	USGS61	-2.80	-2.78	-2.86	-2.84	-2.79	-2.91	-2.88	-2.87	-2.90	-2.77	-2.84	0.05	-2.87
	USGS61	-34.98	-34.97	-34.95	-35.03	-34.95	-35.02	-34.98	-35.01	-35.01	-35.00	-34.99	0.03	-35.05
	USGS43	-196.25	-195.72	-196.59	-196.86	-194.68	-199.75	-199.51	-195.15	-195.86	-195.02	-196.54	1.77	-50.30
$\delta^2\text{H}_{\text{VSMOW}}$	USGS54	-259.30	-257.02	-261.86	-258.00	-259.66	-256.97	-260.04	-256.18	-258.32	-262.07	-258.94	2.02	-150.40
	USGS56	-198.62	-196.85	-192.55	-194.82	-193.67	-200.96	-195.96	-194.78	-195.73	-196.09	-196.00	2.41	-44.00
	USGS43	17.58	16.54	16.89	16.79	17.28	17.12	17.55	16.01	17.05	16.36	16.92	0.51	14.11
$\delta^{18}\text{O}_{\text{VSMOW}}$	USGS54	23.00	23.20	22.22	22.57	22.36	22.60	22.75	22.79	22.37	22.69	22.66	0.30	17.79
	USGS56	30.21	30.05	31.01	30.72	30.36	31.32	31.73	30.81	30.82	30.91	30.79	0.51	27.23

Table S2 Methodological validation details

Method	Determination of elements	(GSB-30a) Certified value	(GSB-30a) Measured value	Recovery (%)	RSD (%)	Correlation coefficient R2	LOD	LOQ
ICP-MS	Li	0.20±0.03	0.198±0.024	98.9±12.2	7.76	0.9997	0.001	0.004
	Be	12±2	10.7±0.7	89.1±5.42	3.65	0.9996	0.5	2.0
	Ga	Scalar, 12.5ng	12.3±0.3	98.4±2.4	1.82	0.9999	0.004	0.016
	Ge	7.5±1.6	6.56±0.44	87.5±5.87	4.13	0.9996	1.0	4.0
	Rb	81±6	81.3±4.8	100±5.93	3.22	0.9997	0.001	0.004
	Nb	(0.15)	0.12±0.014	82.4±9.29	6.97	0.9997	0.004	0.016
	Cs	0.42±0.05	0.43±0.03	103±6.95	3.51	0.9999	0.001	0.004
	Th	25±8	22.0±4.8	87.8±19	14.1	0.9998	0.001	0.004
	Sc	54±10	51.1±7.1	94.6±13.1	8.36	0.9997	0.6	2.4
	Y	0.51±0.05	0.5±0.034	98.8±6.70	4.58	0.9997	0.0003	0.0012
	La	0.34±0.04	0.34±0.04	98.9±10.3	6.33	0.9998	0.0004	0.0016
	Ce	0.51±0.07	0.51±0.06	99.9±11.3	6.20	0.9997	0.0003	0.0012
	Pr	64±7	63.3±5.3	98.9±8.28	6.65	0.9998	0.2	0.8
	Nd	0.25±0.04	0.245±0.031	97.9±12.3	7.08	0.9999	0.0002	0.0008
ICP-MS	Sm	54±6	53.3±4.9	98.7±9.01	6.36	1.0000	0.2	0.8
	Eu	20±4	20.9±2.3	104±11.4	6.28	0.9999	0.06	0.24
	Gd	58±7	55.9±4.8	96.3±8.32	5.24	0.9997	0.1	0.4
	Tb	9±1	8.9±0.87	99.2±9.64	7.98	0.9997	0.06	0.24
	Dy	54±8	52±5.5	96.4±10.2	8.23	0.9998	0.08	0.32
	Ho	11±2	11.4±1.6	103±14.2	9.66	0.9996	0.03	0.12
	Er	33±5	31.9±3.7	96.7±11.2	8.63	0.9997	0.06	0.24
	Tm	5.4±0.9	5.42±0.74	100±13.8	10.4	0.9997	0.03	0.12
	Yb	36±5	34.4±3.2	95.6±8.93	6.42	0.9999	0.06	0.24
	Lu	6±1	5.6±0.6	94.3±10.4	8.44	1.0000	0.03	0.12
	V	0.26±0.03	0.26±0.026	99.8±9.89	5.11	0.9997	0.002	0.008
	Cr	0.6±0.1	0.55±0.04	91.2±6.77	3.59	0.9998	0.05	0.2
	Co	0.23±0.02	0.23±0.02	99.6±7.83	3.86	1.0000	0.001	0.004
	Ni	4.4±0.3	4.2±0.15	95.8±3.45	2.14	0.9998	0.2	0.8
ICP-MS	Cu	13.2±0.9	12.9±0.6	97.7±4.27	3.02	1.0000	0.05	0.20
	Zn	26±3	24.7±1.7	95.0±6.50	3.01	0.9999	0.5	2.0
	Sr	14.0±1.3	14.5±0.7	103±5.07	2.79	0.9997	0.2	0.8
	Cd	0.2±0.02	0.21±0.01	104±4.67	3.00	0.9999	0.002	0.008
	Ba	32±3	33.5±1.4	105±4.25	2.45	0.9998	0.02	0.08
	Tl	0.057±0.011	0.057±0.005	100±9.30	6.96	0.9998	0.0001	0.0004
ICP-OES	Mo	0.053±0.012	0.054±0.008	102±15.6	8.12	0.9999	0.01	0.04
	Al	1200±200	1052±49	87.7±4.04	2.91	0.9998	0.5	2.0
	Ca	3450±250	3507±135	102±3.92	1.76	0.9999	5.0	20.0

	Fe	161±18	157±14	97.4±8.55	5.31	0.9999	1.0	4.0
	K	13100±500	12941±339	98.8±2.59	2.10	0.9996	7.0	28.0
	Mg	1500±50	1496±40	99.7±2.68	1.56	0.9999	5.0	20.0
	Mn	1170±40	1172±34	100±2.92	1.73	0.9998	0.10	0.40
	Na	15±4	15.7±2.5	105±16.5	10.5	0.9998	3.0	12.0
AFS	As	0.16±0.02	0.161±0.018	101±11.3	7.22	1.0000	0.01	0.04
	Se	0.09±0.03	0.083±0.003	92.2±3.33	3.74	1.0000	0.002	0.008

Table S3 Working parameters of ICP-MS

Parameter	Value
High frequency transmit power	1350 W
Plasma gas (Ar) flow rate	13.0 L/min
Auxiliary gas (Ar) flow	0.75 L/min
Atomizing gas flow rate	1.0 L/min
Sampling cone aperture	1.0 mm
Intercept the cone aperture	0.7 mm
Jump peak	3 Point/quality
Residence time	10 ms/point
Number of scanning	40
Measuring time	35

Table S4 Reference working conditions of ICP-OES

Parameter	Value
High frequency power	1.15 kW
Plasma gas flow rate	15L/min
Auxiliary gas flow rate	0.5L/min
Atomizing gas pressure	0.22 MPa
Peristaltic pump speed	100 rpm
Observed altitude	15 mm
Integration time	Long wave > 275 nm 15 s
	Short wave < 275 nm 25 s

Table S5 As working parameters measured by AFS

Parameter	Value
Negative pressure PMT	254 V
Lamp current	27 mA
Reading way	Peak area
Heating temperature	200 °C
Atomizer height	8 mm
Carrier gas flow rate	400 mL/min
Shielded gas flow rate	1000 mL/min
Method of measurement	Std.curve
Reading time	11 s
Delay time	1 s

Table S6 Se working parameters measured by AFS

Parameter	Value
Negative pressure PMT	291 V
Lamp current	83 mA
Reading way	Peak area
Heating temperature	200 °C
Atomizer height	8 mm
Carrier gas flow rate	300 mL/min
Shielded gas flow rate	800 mL/min
Method of measurement	Std.curve
Reading time	11 s
Delay time	1 s