Supplementary Table S1. Reagents used in this study

reagent	grade and company
68 wt.% HNO_3	TAMAPURE-AA-10 (Tama Chemicals, Japan)
70 wt.% $HClO_4$	TAMAPURE-AA-100 (Tama Chemicals, Japan)
38 wt.% HF	TAMAPURE-AA-100 (Tama Chemicals, Japan)
30 wt.% HCl	TAMAPURE-AA-100 (Tama Chemicals, Japan)
Na_2CO_3, anhydrous	JIS special grade (Wako Pure Chemical Industries, Japan)
1000 μg/g single-element standard solutions (Rb, Sr, Zr, Nb, Cs, Ba, Hf, Pb)	standard solution for ICP (SPEX CentriPrep Int., US)
10 μg/g multi-element standard solution (containing Y, Th, U, REEs)	standard solution for ICP (SPEX CentriPrep Int., US)
ultrapure deionized water (DIW)	> 18.0 MΩ with 0.22 μm final filtration (Millipore, France)

Supplementary Table S2. Operating conditions of ICP-QMS

Instrument	7500ce, Agilent
Plasma power	1500 W
Tourch	Quartz glass torch with a Pt injector
Nebuliser	micro-flow PFA-100, self-aspiration
Plasma Ar gas flow rate	15 l/min
Nebliser Ar gas flow rate	0.75 ~ 0.8 l/min
Make-up Ar gas flow rate	0.2 ~ 0.3 l/min
Sampling cone orifice	1 mm (made of Pt)
Skimmer cone orifice	0.8 mm (made of Pt)
Scan mode	peak jump
Rince time	120 s
Acquisition time	75 s × 5

Supplementary Table S3. Integration parameters, detection limits and blanks (ng) for acid digestion and alkali fution after acid digestion and total blanks shown the maximum values for each analysis

			AD		AFAD	
	Isotope measured	Integration time (s)	3s DL (ng/g)	Total blank (ng)	3s DL (ng/g)	Total blank (ng)
Rb	85	0.3	0.9	< 1	34	< 57
Sr	88	0.3	2	< 6	37	< 66
Y	89	0.3	0.08	< 0.08	0.9	< 0.6
Zr	90	0.3	4	< 5	21	< 4
Nb	93	1.5	0.2	< 0.4	1	< 0.4
Cs	133	1.5	0.05	< 0.07	5	< 7
Ba	137	0.3	15	< 7	18	< 13
La	139	0.9	0.09	< 0.1	0.4	< 0.4
Ce	140	0.3	0.10	< 0.2	2	< 3
Pr	141	2.1	0.02	< 0.06	0.2	< 0.2
Nd	146	0.9	0.05	< 0.09	0.6	< 0.6
Sm	147	2.1	0.06	< 0.08	0.5	< 0.5
Eu	153	2.1	0.03	< 0.09	0.2	< 0.1
Gd	157	2.1	0.06	< 0.2	0.5	< 0.3
Tb	159	2.1	0.03	< 0.06	0.2	< 0.2
Dy	163	2.1	0.03	< 0.09	0.4	< 0.4
Ho	165	2.1	0.04	< 0.07	0.2	< 0.2
Er	166	2.1	0.04	< 0.08	0.2	< 0.3
Tm	169	2.1	0.03	< 0.07	0.3	< 0.3
Yb	172	2.1	0.05	< 0.09	0.4	< 0.3
Lu	175	2.1	0.02	< 0.08	0.2	< 0.2
Hf	178	2.1	0.08	< 0.04	0.6	< 0.4
Pb	208	2.1	0.2	< 0.3	16	< 22
Th	232	2.1	0.09	< 0.09	0.4	< 0.5
U	238	2.1	0.04	< 0.06	0.3	< 0.3

Supplementary Table S4. Trace element concentrations (μg g-1), precision (% RSD) of reference materials in this study and difference in % from GSJ recommended value (Imai et al., 1995)

	JG-1a							JG-2						
	AD (n=4)		AFAD (n=8)		Difference (%)		reference*	AD (n=9)		AFAD (n=9)		Difference (%)		reference*
	(μg/g)	RSD(%)	(μg/g)	RSD(%)	AD	ADAF	(μg/g)	(μg/g)	RSD(%)	(μg/g)	RSD(%)	AD	ADAF	(μg/g)
Rb	164	3.5	159	2.4	92.1	89.3	178	280	1.4	267	3.0	92.9	88.7	301
Sr	173	3.5	176	3.1	92.5	94.1	187	15.2	3.8	16.1	2.4	84.7	90.1	17.9
Y	24.9	5.1	27.5	2.2	77.6	85.7	32.1	67.4	4.1	70.4	3.8	77.9	81.3	86.5
Zr	56.9	9.8	122	4.1	48.2	103	118	91.9	3.9	96.8	3.6	94.2	99.2	97.6
Nb	9.06	9.5	9.85	3.5	79.5	86.4	11.4	12.0	12.8	13.1	4.8	81.6	88.8	14.7
Cs	10.1	5.9	9.00	2.2	95.3	84.9	10.6	6.18	4.5	5.54	4.5	91.0	81.6	6.79
Ba	445	1.2	457	2.7	94.7	97.2	470	54.5	1.8	54.4	5.7	67.3	67.1	81
La	19.8	4.0	20.8	2.5	93.0	97.7	21.3	16.5	4.9	18.5	4.2	82.9	93.2	19.9
Ce	42.4	3.9	44.0	2.5	94.2	97.8	45	41.2	4.9	42.9	4.0	85.4	88.7	48.3
Pr	4.78	4.3	5.00	2.6	84.9	88.8	5.63	5.41	4.3	5.83	3.9	87.3	94.1	6.2
Nd	18.1	4.5	19.2	3.0	88.7	94.1	20.4	22.2	3.9	24.5	3.6	84.1	92.7	26.4
Sm	4.12	4.9	4.38	3.2	90.9	96.7	4.53	6.86	3.9	7.58	3.1	88.2	97.5	7.78
Eu	0.593	6.7	0.659	2.4	84.7	94.1	0.7	0.077	5.7	0.086	3.9	76.6	86.4	0.1
Gd	3.94	5.5	4.36	2.7	96.6	107	4.08	7.84	3.9	8.74	3.7	97.9	109	8.01
Tb	0.703	5.3	0.779	3.3	86.8	96.2	0.81	1.51	3.8	1.67	3.7	93.1	103	1.6
Dy	4.29	4.6	4.81	3.0	96.6	108	4.44	9.9	4.0	11.3	3.9	94.7	107	10.5
Ho	0.880	4.5	1.002	3.0	107	122	0.82	2.15	4.0	2.47	3.3	129	148	1.67
Er	2.65	3.6	3.05	3.4	103	119	2.57	6.70	4.0	7.71	3.0	111	128	6.04
Tm	0.394	2.9	0.458	3.7	104	121	0.38	1.02	3.5	1.19	4.6	87.9	103	1.16
Yb	2.64	2.8	3.10	3.3	97.8	115	2.7	6.83	3.4	7.94	4.8	99.6	116	6.85
Lu	0.392	2.4	0.463	3.5	89.1	105	0.44	1.02	3.4	1.17	4.8	83.3	95.5	1.22
Hf	2.21	6.7	4.08	4.4	61.6	114	3.59	4.45	5.0	4.99	4.5	94.1	106	4.73
Pb	23.3	1.3	23.9	2.7	88.3	90.5	26.4	26.7	1.6	25.4	5.0	84.8	80.8	31.5
Th	11.9	1.8	12.9	4.2	93.0	101	12.8	27.6	3.0	29.5	4.5	87.3	93.5	31.6
U	4.23	4.1	4.68	4.7	90.2	99.8	4.69	9.38	1.6	10.5	4.5	83.0	92.6	11.3

	JG-3							JB-2						
	AD (n=10)		AFAD (n=12)		Difference (%)		reference*	AD (n=20)		AFAD (n=23)		Difference (%)		reference*
	(μg/g)	RSD(%)	(μg/g)	RSD(%)	AD	ADAF	(μg/g)	(μg/g)	RSD(%)	(μg/g)	RSD(%)	AD	ADAF	(μg/g)
Rb	62.8	1.9	58.8	3.2	93.3	87.4	67.3	6.13	1.9	5.27	5.0	83.2	71.5	7.37
Sr	352	1.8	352	2.8	92.9	92.9	379	177	1.9	164	2.3	99.4	92.1	178
Y	13.9	1.8	14.6	2.4	80.3	84.4	17.3	21.6	1.3	21.4	1.8	86.7	85.9	24.9
Zr	35.6	7.7	155	4.7	24.7	108	144	45.8	1.6	45.9	2.5	89.5	89.6	51.2
Nb	4.76	16	5.17	3.6	81.0	87.9	5.88	0.456	3.4	0.416	4.9	28.9	26.3	1.58
Cs	1.75	4.0	1.53	4.8	98.3	86.0	1.78	0.777	1.0	0.539	8.1	91.4	63.4	0.85
Ba	444	1.5	445	3.2	95.3	95.5	466	220	0.9	200	2.3	99.1	90.1	222
La	19.2	3.0	20.1	3.6	93.2	97.6	20.6	2.20	0.9	2.19	2.5	93.6	93.2	2.35
Ce	38.8	3.2	40.5	3.2	96.3	100	40.3	6.43	0.9	6.37	2.2	95.1	94.2	6.76
Pr	4.33	2.9	4.53	2.9	92.1	96.4	4.7	1.12	0.8	1.11	1.4	111	110	1.01
Nd	16.1	2.6	16.8	2.8	93.6	97.7	17.2	6.24	0.9	6.19	1.5	94.1	93.4	6.63
Sm	3.10	2.4	3.23	3.0	91.4	95.3	3.39	2.24	1.2	2.23	1.8	97.0	96.5	2.31
Eu	0.782	3.3	0.815	2.7	86.9	90.6	0.9	0.815	1.0	0.812	1.4	94.8	94.4	0.86
Gd	2.74	4	2.88	2.9	93.8	98.6	2.92	3.20	1.2	3.18	1.6	97.6	97.0	3.28
Tb	0.443	2.8	0.464	3.2	96.3	101	0.46	0.584	1.3	0.585	1.8	97.3	97.5	0.6
Dy	2.53	2.5	2.67	3.3	97.7	103	2.59	3.95	1.3	3.92	1.8	106	105	3.73
Ho	0.516	2.5	0.547	3.3	136	144	0.38	0.865	1.4	0.862	1.7	115	115	0.75
Er	1.53	1.9	1.65	3.4	101	109	1.52	2.60	1.3	2.58	2.0	100	99.2	2.6
Tm	0.227	3.0	0.248	3.4	94.6	103	0.24	0.380	1.5	0.379	2.1	92.7	92.4	0.41
Yb	1.53	1.9	1.72	3.6	86.4	97.2	1.77	2.53	1.3	2.51	2.1	96.6	95.8	2.62
Lu	0.235	2.9	0.275	3.6	90.4	106	0.26	0.389	1.7	0.389	1.8	97.3	97.3	0.4
Hf	1.41	9.4	4.34	4.1	32.9	101	4.29	1.52	2.1	1.52	2.7	102	102	1.49
Pb	10.5	2.9	9.99	4.9	89.7	85.4	11.7	5.11	1.1	4.30	4.6	95.3	80.2	5.36
Th	7.77	5	8.23	4.3	93.8	99.4	8.28	0.258	1.9	0.262	3.9	73.7	74.9	0.35
U	2.16	5.5	2.36	4.6	97.7	107	2.21	0.155	2.2	0.156	4.3	86.1	86.7	0.18

*: data from Imai et al., 1995.