Supporting Information

Rapid online fractionated analysis of rare earth elements in a dinosaur fossil by mass spectrometry

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Table S1 Distribution of total REEs in different samples

	m_s/mg	La_2O_3	CeO_2	Pr_6O_{11}	Nd_2O_3	Sm_2O_3	Eu_2O_3	Gd_2O_3	Tb_4O_7	Dy_2O_3	Ho_2O_3	Er_2O_3	Tm_2O_3	Yb_2O_3	Lu_2O_3	Y_2O_3
#1	2.01	4.71	16.83	2.22	12.54	4.72	1.38	8.39	1.21	6.04	0.97	2.06	0.19	0.86	0.10	37.77
#2	1.82	4.71	17.03	2.27	12.48	5.06	1.47	8.61	1.24	6.11	0.98	2.06	0.20	0.87	0.10	36.80
#3	2.09	4.62	16.93	2.26	12.38	4.96	1.44	8.37	1.20	5.96	0.95	1.99	0.19	0.84	0.10	37.81
#4	2.08	4.52	12.31	1.49	7.88	3.37	1.12	7.52	1.23	6.89	1.23	2.79	0.28	1.23	0.15	47.99
#5	1.78	7.16	14.39	2.19	9.53	2.88	0.81	6.18	1.19	6.01	1.16	2.69	0.30	1.32	0.23	43.94
#6	1.96	4.52	12.31	1.49	7.88	3.37	1.12	7.52	1.23	6.89	1.23	2.79	0.28	1.23	0.15	47.99
#7	2.07	4.06	8.53	1.06	4.85	1.63	0.60	4.48	0.81	5.13	1.16	3.31	0.42	2.18	0.29	61.50
#8	2.43	3.98	9.27	1.07	5.63	2.47	0.88	6.08	1.04	6.51	1.28	3.05	0.32	1.44	0.17	56.82
#9	1.97	4.32	10.96	1.42	7.33	2.92	1.01	6.71	1.11	6.34	1.19	2.80	0.29	1.32	0.17	52.11
powder1	2.08	4.86	13.33	1.83	9.54	3.68	1.13	7.19	1.13	6.18	1.11	2.56	0.27	1.25	0.16	45.78
powder2	1.47	4.54	13.59	1.76	9.31	3.68	1.15	7.15	1.11	6.09	1.09	2.54	0.26	1.23	0.16	46.31
Particle average		4.73	13.17	1.72	8.94	3.49	1.09	7.1	1.14	6.21	1.13	2.62	0.27	1.25	0.16	46.97
Powder average		4.67	13.49	1.79	9.40	3.68	1.15	7.16	1.12	6.13	1.10	2.55	0.26	1.24	0.16	46.10
Traditional digestion	96.8	4.38	13.38	1.64	8.86	3.65	1.11	6.65	1.06	5.69	1.04	2.36	0.25	1.17	0.14	48.62

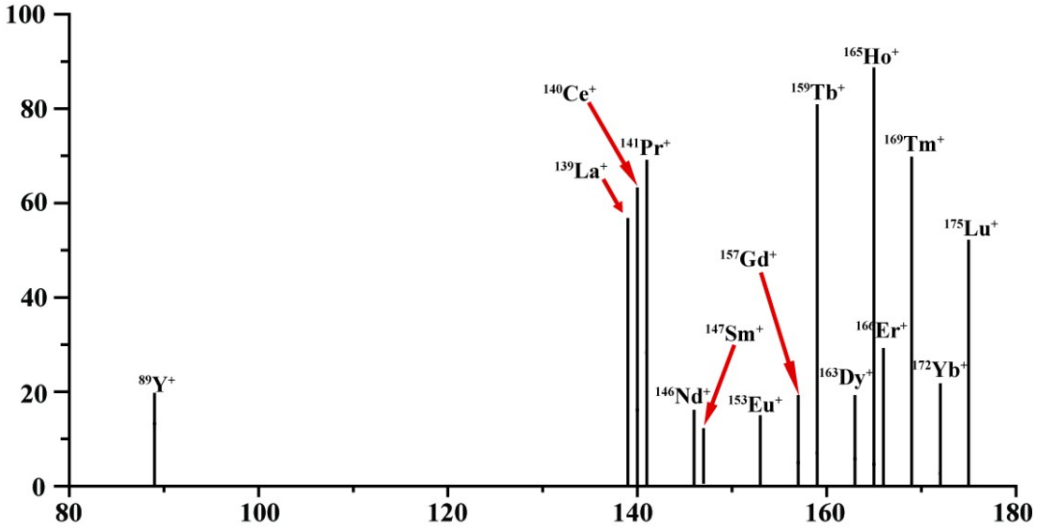

Figure S1 Mass spectra of 15 REEs from one sample

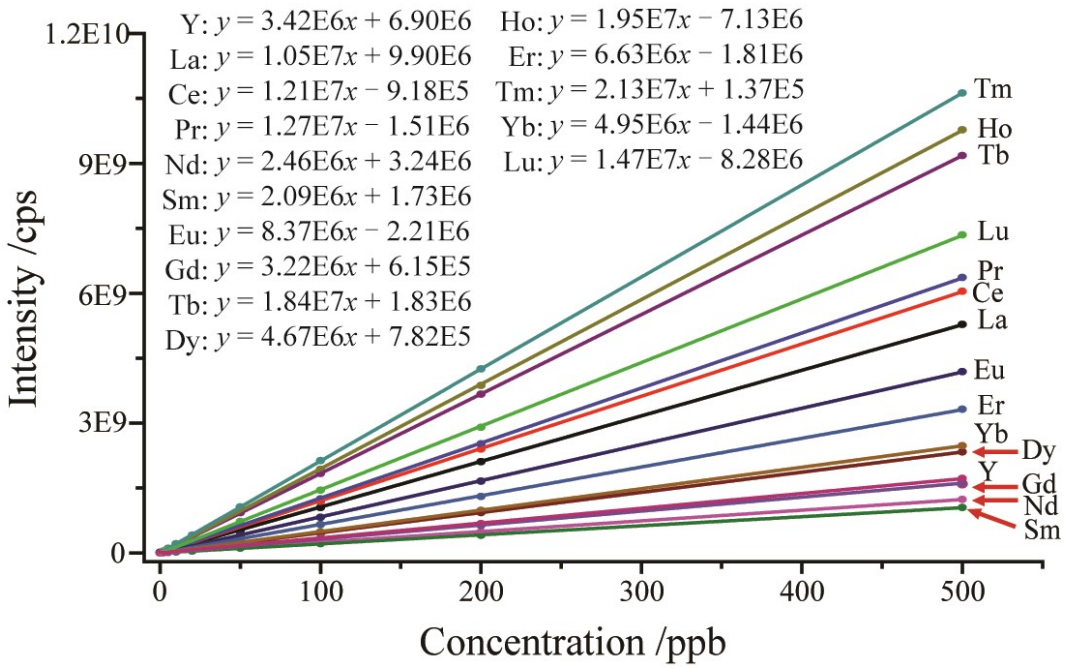

Figure S2 The calibration curves of 15 REEs

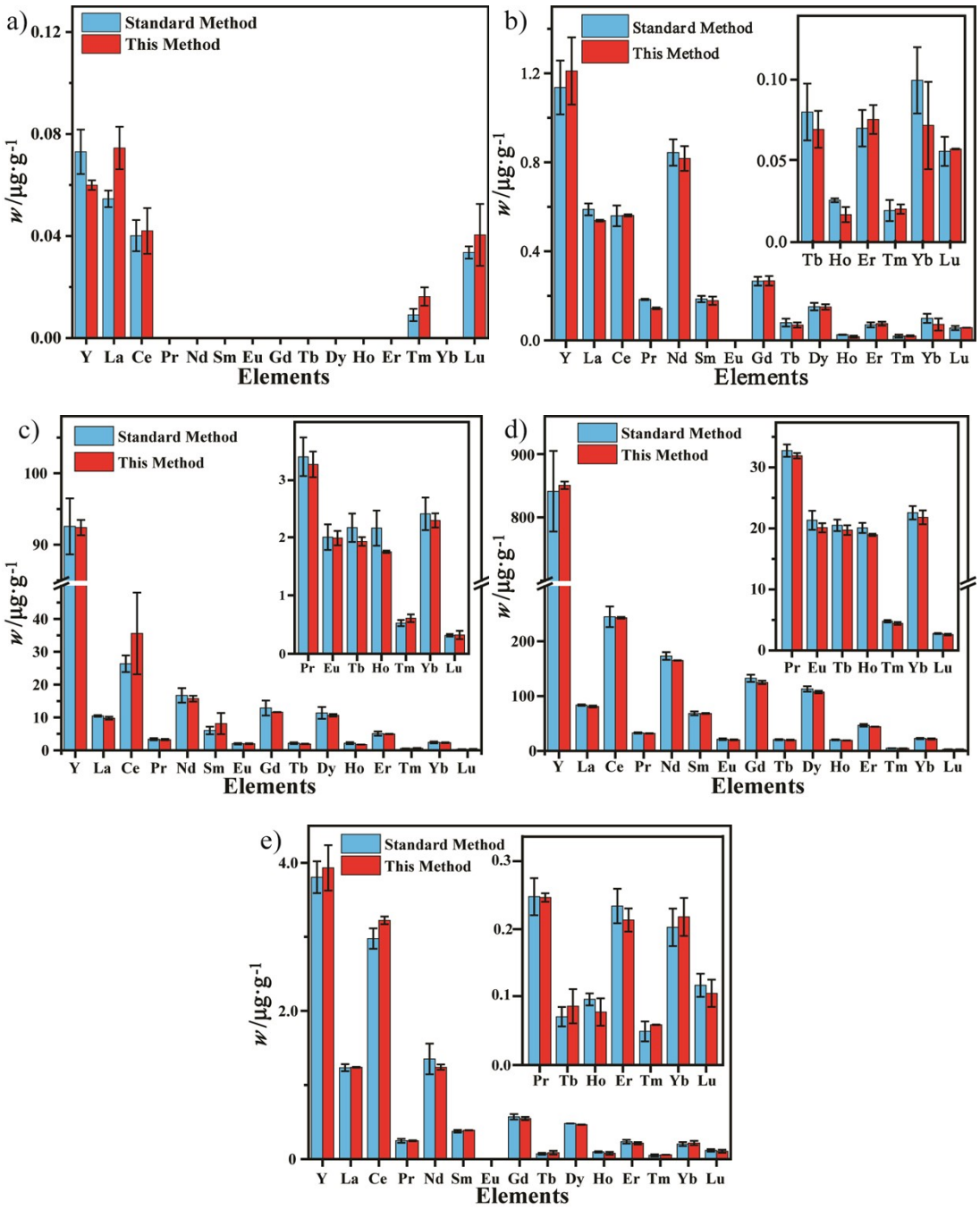

Figure S3 The fractional amount of 15 REEs and the accuracy of the analytical results obtained by the standard method and this method involved samples

a) Water soluble, b) Exchangeable, c) Reducible, d) Oxidable, e) Crystalline

These solutions: a) 5 mL water; b) 5 mL 0.3 mol/L NH_4Ac; c) 5 mL 0.1 mol/L $NH_2OH{\cdot}HCl$; d) 0.1 mol/L HNO_3 + 1% H_2O_2 (mixture); e) 5mL 0.1 mol/L HF and 3 mL 1 mol/L HNO_3 (respectively) were injected into the sample chamber at the flow rate of 0.3 mL/min by a peristaltic pump to dissolve REEs corresponding to different elementary fractions (Water soluble, Exchangeable, Reducible, Oxidable, Crystalline). Each fraction of the extracts was collected separately and then follow the GB/T 14506 (detailed in manuscript section 2.4) to digest step wisely. Finally transfer digests to volume flask and bring to 10 mL waiting for ICP-MS detection.

By compare the concentration from this standard method and the results obtained from our method the accuracy of the analytical results obtained by the standard method and this method involved samples are shown in figure S3

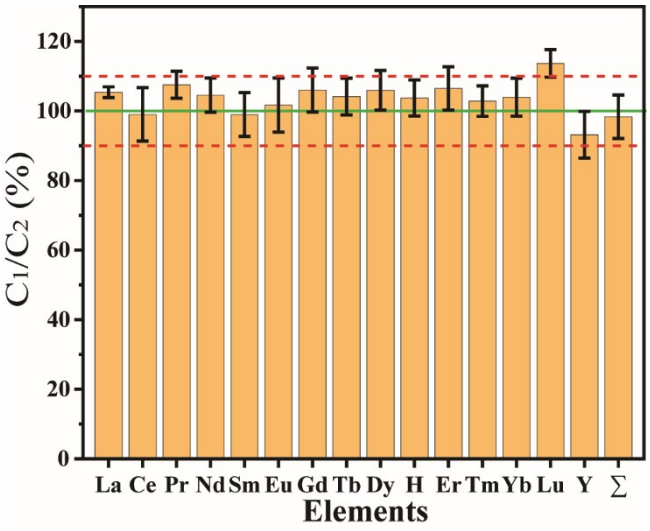

Figure S4 Ratio detected using our method and standard method. C1 means the concentration of sum up all the fraction obtained by our method and C2 means the concentration of sum up all the fraction obtained by the standard method detailed in figure S3