

Table S1. Basic information of sample collection in lakes and rivers.

Sampling Sites	Station ID	Latitude (°N), Longitude (°E)	Altitude/(m)	Sampling Date (Day/Month/Year)
Qinghai lake	QHH1	37°11'52",99°48'34"	3200	18/6/2018
	QHGH1-T			18/6/2018
Qinghai-gahai	QHGH1-B	37°01'19",100°34'48"		18/6/2018
	QHGH2-T		3200	18/6/2018
	QHGH2-B	37°01'15",100°37'18"		18/6/2018
				18/6/2018
Xiligou lake	XLG1	36°49'10",98°26'52"		17/6/2018
	XLG2	36°49'03",98°26'41"	2945	16/6/2018
Gahai	GH1	37°07'51",97°34'58"	2859	15/6/2018
	KLK1-T			16/6/2018
	KLK1-M	37°17'24",96°53'34"	2815	16/6/2018
	KLK1-B			16/6/2018
Keluke lake	KLK2-T			16/6/2018
	KLK2-M	37°17'55",96°53'42"	2813	16/6/2018
	KLK2-B			16/6/2018
	KLK3-T			16/6/2018
	KLK3-M	37°18'27",96°53'55"	2818	16/6/2018
	TS1-T			16/6/2018
Tuosu lake	TS1-M	37°10'21",96°58'35"	2815	16/6/2018
	TS2-T			16/6/2018
	TS2-M	37°10'28",96°58'59"	2808	16/6/2018
	TS3	37°10'36",96°58'57"	2807	16/6/2018
	SL1	37°37'18",99°58'17"	3590	18/6/2018
Shaliu river	SL2	37°31'09",100°05'11"	3480	18/6/2018
	SL3	37°19'43",100°07'28"	3280	18/6/2018
Haergai river	HRG1	37°17'11",100°28'38"	3220	18/6/2018
	BH1	37°22'35",98°50'34"	3480	17/6/2018
Buha river	BH2	37°12'53",99°09'53"	3344	17/6/2018
	BH3	37°08'06",99°30'59"	3249	17/6/2018

Note: "T" means "Surface water", "M" means "Mid-water" and "B" means "Bottom water".

Table S2. Region I: The element concentration (pg/g) of the first type (elements related to the source of particulate detritus) and the third type (elements related to biological productivity). Region I: The element concentration (pg/g) of the second type (elements related to soluble in water and easy migration).

Location	Station	TSM/($\mu\text{g/L}$)	The First Type				The Third Type			
			^{232}Th	$^{27}\text{Al}\times 10^{-3}$	Al/Th	Th/U	$^{56}\text{Fe}\times 10^{-3}$	^{66}Zn	^{111}Cd	^{137}Ba
Keluke Lake	KLK1-S	95.56	4.54	19.19	4.23E+03	1.91E+00	12.70	538.64	0.23	373.16
	KLK1-M	1873.66	3.21	13.07	4.07E+03	9.08E-01	9.54	385.91	-	313.83
	KLK1-B	5169.81	3.08	10.84	3.53E+03	1.34E+00	8.44	631.93	0.14	281.48
	KLK2-S	2933.27	2.95	10.65	3.61E+03	2.10E+00	7.24	2389.7	-	223.06
	KLK2-M	3019.14	3.40	13.45	3.96E+03	1.79E+00	9.42	1288.8	0.41	279.50
	KLK2-B	6681.67	92.65	333.27	3.60E+03	7.43E+00	204.9	904.88	1.23	2971.0
	KLK3-S	7600.00	118.4	427.91	3.61E+03	7.82E+00	258.9	1230.4	3.54	3648.0
	KLK3-M	907.21	6.26	19.90	3.18E+03	3.57E-01	12.99	307.03	0.51	483.51
	TS1-S	11161.29	7.37	23.56	3.20E+03	5.96E-01	15.38	803.12	0.83	414.90
	TS1-M	3849.05	7.74	23.50	3.04E+03	8.40E-01	14.86	799.97	0.29	404.34
Tuosu Lake	TS2-M	10383.84	6.26	22.23	3.55E+03	5.03E-01	13.95	777.20	0.33	434.53
	TS3	9172.41	6.27	21.79	3.48E+03	5.58E-01	13.12	338.84	1.78	316.92

Gahai	GH1	15598.00	83.96	261	-	-	165.6	2656.2	1.77	1234.5
7										
Location	Station	⁷ Li	²⁴ Mg × 10 ⁻³	⁴⁷ Ti	⁸⁸ Sr	⁹⁵ Mo	²³⁸ U			
Keluke Lake	KLK1-S	18.54	18.12	784.45	791.76	1.70	2.37			
	KLK1-M	15.57	26.44	495.66	863.45	2.56	3.54			
	KLK1-B	3.78	17.98	303.12	788.55	2.05	2.30			
	KLK2-S	-	13.56	386.39	485.16	1.03	1.40			
	KLK2-M	-	20.03	510.48	663.64	2.14	1.90			
	KLK2-B	304.37	114.20	9421.61	3013.34	7.37	12.47			
	KLK3-S	325.71	137.37	11471.13	4020.46	9.20	15.14			
Tuosu Lake	KLK3-M	296.35	753.44	758.78	3692.64	4.81	17.53			
	TS1-S	206.35	504.79	854.60	2976.37	4.38	12.36			
	TS1-M	128.15	352.84	933.89	2506.03	2.68	9.22			
	TS2-M	172.64	535.00	801.03	2804.23	3.76	12.45			
Gahai	TS3	139.38	472.94	720.91	2108.62	3.19	11.23			
	GH1	273.36	327.30	15768.01	4805.27	12.48	19.24			

Table S3. Region II: The element concentration (pg/g) of the first type (elements related to the source of particulate detritus) and the third type (elements related to biological productivity). Region II: The element concentration (pg/g) of the second type (elements related to soluble in water and easy migration).

Location	Station	TSM/($\mu\text{g/L}$)	The First Type			The Third Type		
			^{232}Th	$^{27}\text{Al}\times 10^{-3}$	$^{56}\text{Fe}\times 10^{-3}$	^{66}Zn	^{111}Cd	^{137}Ba
Qinghai Lake	QHH1	415960	262.89	855	536.2	1470	10.28	2702
	QHGH1-T	265940	6.84	20.7	13.62	108.87	0.31	371
Qinghaigahai	QHGH1-B	192940	3.97	9.02	5.90	445.6	0.58	282
	QHGH2-T	229250	2.89	8.00	5.69	1363.1	-	255
	QHGH2-B	148130	10.95	30.4	18.25	372.3	0.52	563
Xiligou Lake	XLG1	6012	0.63	2.93	2.28	443	-	133
	XLG2	59915	180	531	315	962	2.13	3990
Shaliu River	SL2	29340	253	1060	485	1270	4.08	7190
	SL3	165710	1060	4580	2450	5070	16.6	34400
Haergai River	HRG1	115930	89.79	307.7	160.0	678.77	1.26	2608.01
Buha River	BH1	242240	501.85	1780	934.8	2402.42	12.55	15221.07

Location	Station	^7Li	$^{24}\text{Mg} \times 10^{-3}$	^{47}Ti	^{88}Sr	^{95}Mo	^{238}U
Qinghai Lake	QHH1	985	527.1	52476.11	3767.82	5.85	41.12
	QHGH1-T	298	278.0	837.14	1080.32	1.73	4.89
Qinghaigahai	QHGH1-B	371	254.4	438.53	942.68	1.19	4.34
	QHGH2-T	186	204.0	313.20	758.42	0.82	3.31
	QHGH2-B	520	377.0	882.73	1848.08	2.45	6.26
Xiligou Lake	XLG1	22.4	98	107	1070	3.85	15
	XLG2	367	174	31000	3570	9.48	27
Shaliu River	SL2	631	138	25600	1340	8.65	25.5
	SL3	2180	453	148000	5940	42.9	123
Haergai River	HRG1	176.39	92213.48	14397.26	554.59	5.70	11.06
Buha River	BH1	1370.94	537490.57	62387.13	7241.33	8.45	66.10

Table S4. Region I: Composition characteristics of rare earth elements in lake particulate matter (ppm).

Site	Station	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Keluke lake	KLK1-M	10.6 3	7.3 2	4.36	6.51	3.34	2.62	2.32	1.91	0.97	0.93	1.47	1.38	1.72	2.32
	KLK1-B	2.85	2.1 5	1.42	1.96	0.56	1.12	1.06	0.22	0.55	0.37	0.27	-	-	0.08
	KLK2-T	5.11	3.7 9	2.05	3.29	1.09	1.91	1.90	0.45	0.60	0.83	0.45	0.56	0.04	-
	KLK2-M	5.96	4.4 2	3.21	3.76	1.76	3.51	1.33	0.44	0.86	0.73	0.60	0.56	0.52	0.98
	KLK2-B	65.2 7	48. 09	34.05	45.21	24.43	16.84	21.66	15.06	9.46	8.27	8.08	9.00	6.85	7.45
	KLK3-T	70.1 6	52. 76	38.15	49.92	26.05	20.36	24.72	15.56	10.45	9.01	8.33	7.74	9.26	7.95
	KLK3-M	35.2 2	26. 25	20.65	22.34	9.50	13.63	11.54	11.57	6.02	6.60	3.64	11.5 9	2.51	9.95
Tuosu lake	TS1-T	3.49	2.4 0	1.95	2.28	1.18	1.62	1.29	0.92	0.70	0.76	0.49	1.14	0.50	0.89
	TS1-M	9.22	6.9 1	4.99	6.87	2.39	2.59	2.82	1.86	1.24	1.71	1.19	1.57	1.30	1.18
	TS2-T	1.87	1.5 0	1.12	1.22	0.70	0.91	0.63	0.60	0.24	0.47	0.45	0.33	0.18	0.03
	TS2-M	3.27	2.6 4	1.84	2.27	0.91	1.40	0.91	0.52	0.61	0.41	0.40	0.36	0.52	0.27
	TS3	3.95	2.9 9	2.20	2.84	1.42	1.71	1.44	1.03	0.76	0.64	0.39	0.79	0.55	1.12
Gahai	GH1	30.8 7	23. 43	17.44	21.49	11.44	7.42	11.06	6.73	5.09	4.75	4.84	4.55	4.58	4.46

Note: “-” represents “no data”.

Table S5. Region II: Composition characteristics of rare earth elements in lake and nearby river particulate matter (ppm).

Site	Station	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Shaliu river	SL2	43.77	32.66	24.45	29.39	16.48	11.63	13.23	7.80	4.79	4.60	4.18	4.50	4.80	4.48
	SL3	29.78	20.41	17.09	20.73	11.90	7.36	8.93	4.36	3.48	3.32	3.47	3.38	3.60	3.88
Haergai river	HRG1	3.85	2.84	2.05	2.59	1.47	0.93	1.38	0.99	0.70	0.58	0.59	0.59	0.66	0.57
	BH1	4.18	3.05	2.27	2.75	1.69	1.09	1.42	0.95	0.70	0.64	0.62	0.63	0.66	0.66
Buha river	BH2	8.60	6.37	4.76	5.82	3.39	2.23	3.09	2.07	1.55	1.36	1.38	1.41	1.46	1.32
	BH3	4.40	3.30	2.50	3.06	1.87	1.33	1.54	0.99	0.66	0.60	0.57	0.58	0.56	0.54
Qinghai lake	QHH1	3.40	2.55	1.87	2.24	1.34	0.69	1.13	0.76	0.53	0.46	0.48	0.49	0.52	0.48
	QHGH1-T	0.13	0.10	0.07	0.07	0.06	0.04	0.05	0.03	0.02	0.02	0.01	0.03	0.01	0.03
Qinghaigai lake	QHGH1-B	0.09	0.07	0.05	0.07	0.04	0.03	0.05	0.02	0.02	0.02	0.01	0.03	0.01	0.00
	QHGH2-T	0.12	0.09	0.06	0.10	0.07	0.06	0.04	0.02	0.01	0.03	0.01	0.04	0.02	0.00
	QHGH2-B	0.15	0.11	0.09	0.12	0.07	0.05	0.07	0.03	0.02	0.03	0.02	0.03	0.03	0.04
Xiligou lake	XLG2	17.31	12.85	9.64	11.79	6.78	4.10	6.07	4.02	2.69	2.46	2.23	2.30	2.50	2.01