

Supplementary Material

# Testing Landscape, Climate and Lithology Impact on Carbon, Major and Trace Elements of the Lena River and Its Tributaries during a Spring Flood Period

Sergey N. Vorobyev <sup>1</sup>, Yuri Kolesnichenko <sup>1</sup>, Mikhail A. Korets <sup>2</sup> and Oleg S. Pokrovsky <sup>3,4,\*</sup>

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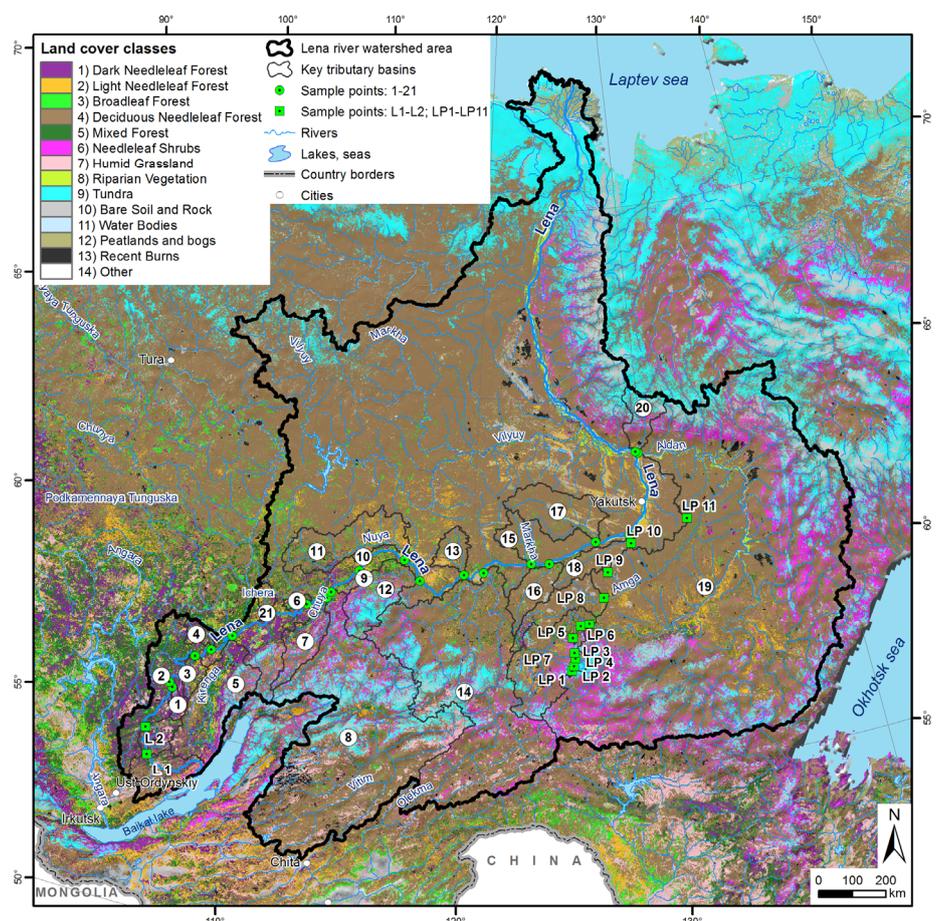
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- <sup>1</sup> BIO-GEO-CLIM Laboratory, Tomsk State University, 35 Lenina, 634050 Tomsk, Russia; soil@green.tsu.ru (S.N.V.); vancansywork@mail.ru (Y.K.)
  - <sup>2</sup> V.N. Sukachev Institute of Forest of the Siberian Branch of Russian Academy of Sciences – Separated Department of the KSC SB RAS, 660036, Krasnoyarsk, Russia; mik@ksc.krasn.ru
  - <sup>3</sup> Geosciences and Environment Toulouse, UMR 5563 CNRS, University of Toulouse, 14 Avenue Edouard Belin, 31400 Toulouse, France
  - <sup>4</sup> N. Laverov Federal Center for Integrated Arctic Research, Russian Academy of Sciences, 23 Nab. Northern Dvina, 163002 Arkhangelsk, Russia
- \* Correspondence: oleg.pokrovsky@get.omp.eu



**Figure S1.** Landscape map of the Lena River and tributaries (RLC based). The identification of tributaries (numbers in circles) is provided in Table S1.



**Table S1.** Physico-geographical parameters of the studied Lena River tributaries. For samples No 1–20, the numbers in parentheses indicate the distance on the river from Zhigalovo (0 km). Other physio-geographical, landscape and lithological parameters of watersheds are provided in the Mendeley Database: Pokrovsky, O. (2021), “Physio-geographical, landscape and lithological parameters of the Lena River watersheds”, Mendeley Data, V1, doi: 10.17632/gftmykzpk.1

Watershed		Area,		Average annual temperature, °C				Average annual precipitation, mm				
ID	Name, km	Lat, °N	Long, °E	Km <sup>2</sup>	Mean	STD	Min	Max	Mean	STD	Min	Max
1	Orlinga (208)	56.031	105.881	3650	-5.81	0.24	-6.3	-5.1	409	5	396	421
2	Nizhnaya Kytyma (228)	56.145	105.680	985	-4.68	0.34	-5.1	-3.9	392	4	381	398
3	Tayura (416)	56.997	106.545	5726	-5.34	0.22	-6.0	-5.0	395	5	387	406
4	Bolshaya Tira (529)	57.270	107.222	5127	-5.47	0.21	-5.8	-4.7	390	3	380	396
5	Kirenga (579)	57.761	108.087	46669	-5.62	1.01	-8.7	-4.3	398	12	377	437
6	Chaika (1025)	59.011	111.476	2524	-5.65	0.05	-5.8	-5.5	402	4	394	413
7	Chuya (1110)	59.265	112.458	18332	-6.84	0.62	-8.4	-5.5	426	10	400	446
8	Vitim (1132)	59.443	112.637	234219	-7.5	1.75	-12.3	-2.3	417	27	342	465
9	Yukte (1265)	60.126	113.966	564	-7.17	0.17	-7.5	-6.8	414	3	409	419
10	Kenek (1312)	60.423	114.301	1050	-6.84	0.07	-7.0	-6.7	400	2	395	404
11	Nuya (1331)	60.547	116.319	38207	-7.45	0.38	-8.3	-6.3	389	18	339	417
12	Bolshoi Patom (1670)	60.031	117.263	26816	-8.6	0.69	-10.0	-6.9	427	29	352	463
13	Biryuk (1712)	60.268	119.619	9819	-7.22	0.14	-7.5	-6.7	322	7	307	338
14	Olekma (1750)	60.343	120.696	209378	-7.73	1.26	-12.3	-5.7	426	48	334	575
15	Markha (1948)	60.606	123.255	8823	-8.37	0.38	-9.0	-7.6	342	11	319	375
16	Tuolba (2008)	60.600	124.257	15880	-7.49	0.38	-8.4	-6.2	406	15	378	444
17	Sinyaa (2118)	61.142	126.854	30875	-9.08	0.22	-9.8	-8.5	324	10	306	354
18	Buotama (2170)	61.245	128.770	12539	-8.85	0.43	-9.5	-7.4	382	26	317	435
19	Aldan (2381)	63.406	129.714	717203	-10.5	3.06	-20.8	-6.0	445	98	273	671
20	Tumara (2635)	63.465	129.593	14051	-15.9	2.29	-19.1	-11.0	325	21	277	356
21	Ichera	58.5612	109.7584	4637	-5.79	0.33	-6.33	-5.18	386	2	383	391
LP 1	Medvedevka	57.7056	125.2803	11.8	-8.77	0.03	-8.80	-8.73	597	0.3	596	597
LP 2	Vasilievka	57.8308	125.3897	48.6	-8.79	0.06	-8.90	-8.68	597	0.5	596	598
LP 3	Bolshoi Nimnyr	58.0397	125.4847	1849.7	-8.38	0.33	-8.93	-7.42	588	6.6	570	598
LP 4	Yukhtochka	58.1886	125.4361	32.9	-7.92	0.07	-8.06	-7.78	587	0.4	586	587
LP 5	Orto-Sala	58.5869	125.3831	69.8	-6.86	0.16	-7.13	-6.56	567	2.9	561	572
LP 6	Yakokit	58.9014	125.8267	3.6	-6.40	0.02	-6.42	-6.38	526	0.2	525	526
LP 7	Aldan (incl. LP1-LP6)	58.9569	126.2800	49593	-7.32	0.82	-9.48	-6.00	523	36.5	436	598
LP 8	Amga	59.6483	127.1158	21907	-7.23	0.57	-8.97	-6.08	452	18.5	407	502
LP 9	Ulu	60.3133	127.4283	821.8	-9.15	0.04	-9.22	-9.05	388	6.8	375	404
LP 10	Lutenge	61.0344	128.8156	82.2	-9.31	0.06	-9.44	-9.21	336	3.3	330	342
LP 11	Mende	61.4761	129.3453	6.2	-10.6	0.01	-10.6	-10.6	305	0.2	305	305
	Lena above Aldan			1661606	-8.76	2.95	-21	-2.1	418	77	267	671
	Lena below Aldan			825793	-11.6	2.96	-22	-6.3	311	29	197	400
	Total Lena watershed			2487399	-9.7	3.24	-22	-2.1	383	83	197	671

**Table S2.** Mann–Whitney test of the difference in element concentration in the upper (0–800 km) and middle (800 km – 2600 km) course of the Lena River main stem. Significant differences are in red.

	U	Z	p-level
pH	35.0	3.3684	0.0008
S.C.	10.0	4.2887	0.0000
Cl	42.0	3.1107	0.0019
SO <sub>4</sub>	26.0	3.6997	0.0002
DOC	97.0	1.0860	0.2775
DIC	21.0	3.8837	0.0001
Li	20.0	3.9205	0.0001
B	23.0	3.8101	0.0001
Na	32.0	3.4788	0.0005
Mg	22.0	3.8469	0.0001
Al	41.0	-3.1475	0.0016
Si	49.0	2.8530	0.0043
P	81.0	1.6750	0.0939
K	63.0	2.3376	0.0194
Ca	24.0	3.7733	0.0002
Ti	64.0	-2.3008	0.0214
V	52.0	2.7425	0.0061
Cr	106.0	-0.7547	0.4505
Mn	40.0	3.1843	0.0015
Fe	104.0	-0.8283	0.4075
Co	109.0	0.6442	0.5194
Ni	93.0	-1.2332	0.2175
Cu	112.0	0.5338	0.5935
Zn	105.0	-0.7915	0.4287
Ga	73.0	-1.9695	0.0489
Ge	113.0	-0.4970	0.6192
As	24.0	3.7733	0.0002
Rb	35.0	-3.3684	0.0008
Sr	26.0	3.6997	0.0002
Y	126.0	-0.0184	0.9853
Zr	125.0	0.0552	0.9560
Nb	43.5	-3.0554	0.0022
Mo	33.0	3.4420	0.0006
Cd	105.0	0.7915	0.4287
Sb	28.0	3.6260	0.0003
Cs	56.0	-2.5953	0.0095
Ba	23.0	3.8101	0.0001
La	32.0	-3.4788	0.0005
Ce	10.0	-4.2887	0.0000
Pr	44.0	-3.0370	0.0024
Nd	41.0	-3.1475	0.0016
Gd	79.0	-1.7486	0.0804
Tb	93.5	-1.2148	0.2244
Dy	104.0	-0.8283	0.4075
Yb	109.0	-0.6442	0.5194
Lu	103.0	-0.8651	0.3870
Hf	111.0	0.5706	0.5683
Pb	81.0	-1.6750	0.0939
Th	26.0	-3.6997	0.0002
U	47.0	2.9266	0.0034

**Table S3.** Pearson correlation coefficients ( $p < 0.05$ ) of major and trace elements with three main potential carriers – DOC, Fe and Al in the main stem of the Lena River and its tributaries. Significant correlations are in red font.

	Lena River			Tributaries		
	DOC	Al	Fe	DOC	Al	Fe
Li	0.37	-0.63	-0.10	0.40	-0.52	0.07
B	0.46	-0.52	-0.03	0.46	-0.29	0.03
Na	-0.02	-0.37	-0.10	0.13	-0.33	-0.13
Mg	0.43	-0.65	-0.11	0.31	-0.49	-0.08
Si	0.12	-0.06	0.35	0.84	-0.14	0.63
P	0.47	0.13	0.50	0.76	0.04	0.81
K	0.74	-0.38	0.11	0.47	-0.18	0.19
Ca	0.43	-0.63	-0.08	0.39	-0.62	0.04
Ti	-0.15	0.77	0.86	0.47	0.69	0.57
V	0.42	-0.18	0.35	0.67	-0.07	0.45
Cr	0.11	0.16	-0.10	0.51	0.57	0.6
Mn	0.16	-0.01	0.49	0.04	0.04	0.23
Co	0.34	0.54	0.72	0.31	0.43	0.52
Ni	0.44	0.29	0.05	0.8	0.12	0.87
Cu	0.80	0.00	0.20	0.75	0.25	0.69
Zn	0.01	0.19	0.11	0.24	0	0.45
Ga	-0.15	0.84	0.81	-0.03	0.81	0.14
Ge	-0.21	-0.15	-0.35	0.61	-0.05	0.72
As	0.62	-0.50	0.07	0.72	-0.18	0.66
Rb	-0.58	0.71	0.23	0.29	0.33	0.61
Sr	0.31	-0.67	-0.16	0.38	-0.47	0.16
Y	0.03	0.58	0.39	0.53	0.46	0.5
Zr	0.72	0.40	0.64	0.95	-0.03	0.91
Nb	-0.38	0.71	0.66	0.2	0.84	0.4
Mo	-0.01	-0.60	-0.28	-0.07	-0.11	-0.2
Cd	-0.11	0.02	-0.07	0.34	0.39	0.56
Sb	0.46	-0.47	-0.06	0.69	-0.19	0.71
Cs	-0.26	0.72	0.79	-0.02	0.55	0.32
Ba	0.54	-0.54	0.01	0.28	0.08	0.1
La	-0.39	0.28	-0.05	0.41	0.11	0.64
Ce	-0.14	0.84	0.41	-0.22	0.74	-0.04
Pr	-0.31	0.77	0.32	-0.1	0.71	0.08
Nd	-0.23	0.79	0.36	0	0.71	0.14
Sm	-0.03	0.70	0.36	0.18	0.65	0.25
Gd	-0.06	0.75	0.42	0.29	0.6	0.32
Tb	0.02	0.65	0.41	0.37	0.54	0.37
Dy	0.00	0.61	0.39	0.45	0.52	0.42
Ho	-0.06	0.55	0.35	0.52	0.49	0.5
Er	-0.03	0.56	0.34	0.58	0.48	0.57
Yb	-0.11	0.65	0.42	0.69	0.38	0.68
Lu	-0.20	0.51	0.25	0.65	0.43	0.69
Hf	0.50	0.34	0.59	0.95	0.05	0.89
Pb	-0.10	0.24	0.15	0.07	0.42	0.35
Th	0.15	0.78	0.53	0.64	0.66	0.74
U	0.45	-0.36	0.11	0.03	0.19	-0.19

**Table S4.** Pearson correlation matrix of landscape parameters and river water chemistry. Significant correlations ( $p < 0.5$ ,  $N = 30$ ) are shown in red text and positive correlations are highlighted in pink. Abbreviations: DNLF, Dark Needleleaf Forest; LNF, Light Needleleaf Forest; BLF, Broadleaf Forest; DNF, Deciduous Needleleaf Forest; MF, Mixed Forest; NLS, Needleleaf Shrubs; HGL, Humid Grassland; RV, Riparian Vegetation; BSR, Bare Soil and Rock.

	DNLF	LNF	BLF	DNF	MF	NLS	HGL	RV	Tundra	BSR	Water Bodies	Peatlands and bogs	Recent Burns	Soil OC, 100 cm
DOC	-0.23	0.16	0.36	0.41	-0.06	-0.65	-0.44	-0.21	-0.56	-0.26	-0.31	-0.07	-0.39	0.06
DIC	0.03	0.16	0.32	0.13	0.26	-0.63	-0.39	0.16	-0.57	-0.27	-0.51	-0.58	-0.29	0.19
Cl	0.04	0.56	0.53	-0.13	0.31	-0.20	-0.08	-0.11	-0.15	-0.21	-0.11	-0.22	-0.10	-0.32
SO <sub>4</sub>	0.02	0.42	0.54	0.00	0.17	-0.15	-0.11	0.31	-0.20	-0.12	0.00	-0.11	-0.07	-0.22
Li	0.03	0.51	0.58	0.17	0.13	-0.38	-0.11	0.13	-0.34	-0.11	-0.14	-0.27	-0.08	-0.11
B	0.08	0.83	0.33	0.04	0.18	-0.40	-0.06	-0.08	-0.34	-0.14	-0.17	-0.43	0.00	-0.17
Na	0.03	0.54	0.53	-0.10	0.30	-0.21	-0.09	-0.10	-0.17	-0.20	-0.11	-0.22	-0.11	-0.31
Mg	0.21	0.27	0.30	0.30	0.22	-0.41	-0.10	0.05	-0.55	-0.01	-0.34	-0.52	-0.24	0.03
Al	0.07	-0.01	0.10	-0.29	0.10	-0.03	0.39	-0.20	0.23	-0.25	0.39	0.08	0.28	-0.23
Si	0.10	0.26	0.40	0.49	0.23	-0.22	-0.02	-0.14	-0.81	0.02	-0.15	-0.56	-0.13	-0.03
P	0.10	0.20	0.32	0.15	0.13	-0.40	0.06	-0.17	-0.23	-0.29	-0.09	-0.20	0.12	-0.13
K	0.28	0.32	0.12	0.06	0.30	-0.18	0.10	-0.08	-0.40	-0.41	-0.16	-0.34	-0.03	-0.27
Ca	0.31	0.33	0.41	0.27	0.14	-0.43	0.00	0.12	-0.55	-0.07	-0.28	-0.50	-0.17	0.02
Ti	0.04	0.22	0.42	-0.07	0.11	-0.20	0.27	-0.27	-0.02	-0.33	0.26	-0.07	0.18	-0.23
V	0.19	0.37	0.36	0.15	0.34	-0.56	0.09	-0.21	-0.43	-0.16	-0.20	-0.48	0.07	-0.12
Cr	0.27	0.27	0.34	0.03	0.14	-0.20	0.33	0.13	-0.34	-0.19	0.33	-0.21	0.13	-0.24
Mn	-0.04	0.02	0.06	-0.29	-0.20	-0.06	0.15	0.21	0.51	-0.24	0.32	0.08	0.19	-0.02
Fe	-0.16	0.00	0.25	0.29	-0.14	-0.26	-0.13	-0.14	-0.05	-0.21	0.04	-0.07	-0.09	0.14
Co	-0.18	-0.06	0.48	0.07	0.15	-0.18	0.09	-0.15	0.01	-0.18	0.32	-0.16	0.06	-0.19
Ni	-0.20	0.04	0.33	0.50	-0.18	-0.31	-0.10	-0.07	-0.31	0.11	0.16	-0.17	-0.12	0.16
Cu	0.09	-0.01	0.19	0.22	0.22	-0.18	0.06	-0.29	-0.38	-0.12	-0.06	-0.30	-0.09	0.03
Zn	-0.16	-0.01	0.30	0.32	-0.18	-0.18	-0.02	0.17	-0.11	-0.12	0.25	-0.08	-0.02	0.02
Ga	0.02	0.16	0.28	-0.01	-0.05	0.03	0.45	0.00	-0.09	-0.20	0.53	-0.03	0.39	-0.13
Ge	-0.12	0.12	0.39	0.38	-0.10	-0.28	-0.03	0.05	-0.28	-0.10	0.17	-0.05	-0.03	0.02
As	0.21	0.15	0.31	0.33	0.17	-0.49	-0.02	-0.12	-0.50	-0.09	-0.24	-0.44	-0.10	-0.06
Rb	-0.36	-0.25	0.16	0.19	-0.14	0.17	-0.11	-0.22	0.15	-0.24	0.22	0.17	-0.13	-0.08
Sr	0.02	0.37	0.72	0.14	0.24	-0.33	-0.15	0.10	-0.31	-0.24	-0.11	-0.27	-0.18	-0.23
Y	0.31	0.30	0.34	-0.04	0.33	-0.29	0.30	-0.35	-0.37	-0.15	0.05	-0.37	0.17	-0.24
Zr	-0.10	0.18	0.32	0.48	-0.04	-0.49	-0.17	-0.14	-0.39	0.07	-0.11	-0.32	-0.22	0.13
Nb	-0.09	-0.07	0.12	0.06	-0.09	-0.16	0.27	-0.27	0.08	-0.12	0.36	-0.07	0.12	0.05
Mo	0.17	-0.02	0.31	-0.15	0.65	0.23	0.03	-0.18	-0.32	-0.35	-0.15	-0.16	-0.12	-0.38
Cd	-0.02	0.06	0.39	0.10	-0.06	-0.16	0.33	-0.20	-0.10	-0.18	0.49	-0.09	0.30	-0.21
Sb	-0.14	-0.24	0.05	0.35	0.16	-0.16	-0.20	-0.10	-0.28	0.07	-0.09	-0.14	-0.26	0.06
Cs	-0.06	-0.01	0.15	-0.06	-0.10	0.09	0.37	-0.13	0.12	-0.26	0.50	0.09	0.36	-0.23
Ba	0.73	0.16	0.10	-0.25	0.61	-0.37	0.38	-0.15	-0.41	-0.35	-0.29	-0.41	0.12	-0.50
La	-0.14	-0.06	0.32	0.32	-0.15	-0.15	-0.08	-0.06	-0.13	-0.11	0.09	-0.03	-0.12	-0.03
Ce	-0.12	-0.03	0.14	-0.01	-0.09	0.16	0.37	-0.23	0.04	-0.04	0.53	0.00	0.32	-0.04
Pr	0.01	0.04	0.23	0.01	0.02	0.06	0.40	-0.30	-0.13	-0.02	0.44	-0.12	0.27	-0.09
Nd	0.08	0.11	0.26	-0.02	0.10	-0.01	0.39	-0.31	-0.18	-0.05	0.37	-0.17	0.26	-0.14
Sm	0.28	0.22	0.32	-0.11	0.27	-0.11	0.43	-0.31	-0.28	-0.15	0.24	-0.27	0.27	-0.25
Eu	0.43	0.28	0.30	-0.19	0.43	-0.28	0.41	-0.32	-0.32	-0.23	0.08	-0.38	0.22	-0.35
Gd	0.28	0.25	0.33	-0.10	0.31	-0.18	0.39	-0.35	-0.30	-0.16	0.16	-0.32	0.25	-0.26
Tb	0.31	0.28	0.34	-0.10	0.37	-0.22	0.34	-0.34	-0.34	-0.17	0.11	-0.35	0.20	-0.29
Dy	0.35	0.33	0.33	-0.11	0.37	-0.28	0.36	-0.33	-0.35	-0.20	0.08	-0.38	0.24	-0.30
Er	0.30	0.28	0.36	0.01	0.30	-0.33	0.32	-0.34	-0.39	-0.12	0.08	-0.39	0.19	-0.21
Yb	0.19	0.30	0.41	0.09	0.25	-0.36	0.20	-0.33	-0.39	-0.10	0.06	-0.37	0.09	-0.19
Hf	-0.03	0.25	0.36	0.39	0.03	-0.50	-0.09	-0.18	-0.40	0.01	-0.09	-0.33	-0.15	0.04
Pb	0.06	0.04	0.31	0.05	0.03	-0.09	0.48	-0.07	-0.16	-0.20	0.49	-0.15	0.43	-0.18
Th	-0.25	-0.06	0.15	0.44	-0.14	-0.26	-0.02	-0.29	-0.21	0.08	0.16	-0.21	-0.08	0.21
U	0.40	0.46	0.43	-0.20	0.53	-0.11	0.41	-0.26	-0.42	-0.42	0.05	-0.48	0.18	-0.45

Table S4. continued.

	Continuous PF, %	Discontinuous PF, %	Sporadic PF, %	MAAT	Precipitation	% Carbonate rocks
DOC	0.07	-0.05	-0.19	-0.06	-0.83	-0.28
DIC	-0.09	-0.36	0.21	0.13	-0.25	0.59
Cl	-0.30	-0.11	0.59	0.25	-0.13	0.15
SO4	-0.06	-0.18	0.30	-0.07	-0.40	-0.11
Li	-0.01	-0.25	0.25	-0.01	-0.51	-0.07
B	-0.17	-0.24	0.40	0.20	-0.36	0.12
Na	-0.27	-0.14	0.58	0.22	-0.18	0.11
Mg	0.01	-0.30	0.20	0.20	-0.35	0.38
Al	-0.17	0.08	-0.10	0.28	0.06	-0.33
Si	0.29	-0.59	0.15	0.16	-0.70	0.01
P	0.01	-0.20	0.02	0.14	-0.51	-0.34
K	-0.08	-0.34	0.26	0.06	-0.36	-0.05
Ca	0.03	-0.26	0.21	0.14	-0.52	0.18
Ti	-0.12	-0.05	0.01	0.28	-0.25	-0.39
V	0.00	-0.47	0.30	0.24	-0.57	-0.10
Cr	0.03	-0.26	-0.04	0.18	-0.52	-0.33
Mn	-0.09	0.25	-0.12	-0.18	0.02	-0.21
Fe	0.12	-0.01	-0.24	0.00	-0.36	-0.43
Co	0.01	-0.11	0.08	0.04	-0.23	-0.22
Ni	0.38	-0.29	-0.29	-0.15	-0.66	-0.51
Cu	0.18	-0.41	0.07	0.15	-0.37	-0.14
Zn	0.13	-0.03	-0.10	-0.04	-0.28	-0.29
Ga	0.09	-0.13	-0.05	0.09	-0.27	-0.46
Ge	0.28	-0.29	-0.03	-0.10	-0.56	-0.53
As	0.09	-0.33	0.04	0.09	-0.66	-0.12
Rb	0.02	0.20	-0.08	0.03	0.23	-0.16
Sr	-0.11	-0.18	0.35	0.08	-0.42	-0.04
Y	-0.07	-0.35	0.06	0.41	-0.52	-0.12
Zr	0.29	-0.36	-0.14	-0.01	-0.67	-0.33
Nb	0.14	-0.09	-0.21	0.16	-0.23	-0.53
Mo	-0.22	-0.29	0.55	0.41	0.20	0.42
Cd	0.00	0.00	-0.01	0.18	-0.26	-0.33
Sb	0.24	-0.34	0.07	-0.11	-0.22	-0.16
Cs	-0.03	0.07	-0.01	0.07	0.00	-0.32
Ba	-0.44	-0.13	0.32	0.45	-0.16	0.32
La	0.10	0.02	-0.12	-0.03	-0.27	-0.29
Ce	0.10	-0.04	-0.09	0.15	-0.02	-0.26
Pr	0.09	-0.17	-0.05	0.26	-0.22	-0.24
Nd	0.05	-0.22	-0.03	0.30	-0.29	-0.20
Sm	-0.06	-0.29	0.04	0.41	-0.39	-0.12
Eu	-0.19	-0.31	0.09	0.45	-0.42	-0.03
Gd	-0.08	-0.32	0.06	0.41	-0.43	-0.12
Tb	-0.10	-0.35	0.09	0.42	-0.46	-0.09
Dy	-0.12	-0.34	0.10	0.43	-0.49	-0.10
Ho	-0.08	-0.35	0.06	0.40	-0.52	-0.13
Er	-0.03	-0.35	0.04	0.41	-0.55	-0.16
Yb	0.00	-0.35	0.05	0.34	-0.59	-0.21
Lu	0.10	-0.41	0.00	0.30	-0.60	-0.27
Hf	0.20	-0.35	-0.09	0.07	-0.67	-0.31
Pb	0.04	-0.12	0.12	0.16	-0.26	-0.36
Th	0.39	-0.29	-0.29	0.02	-0.43	-0.48
U	-0.33	-0.28	0.60	0.58	-0.12	0.26