SUPPLEMENTARY INFORMATION

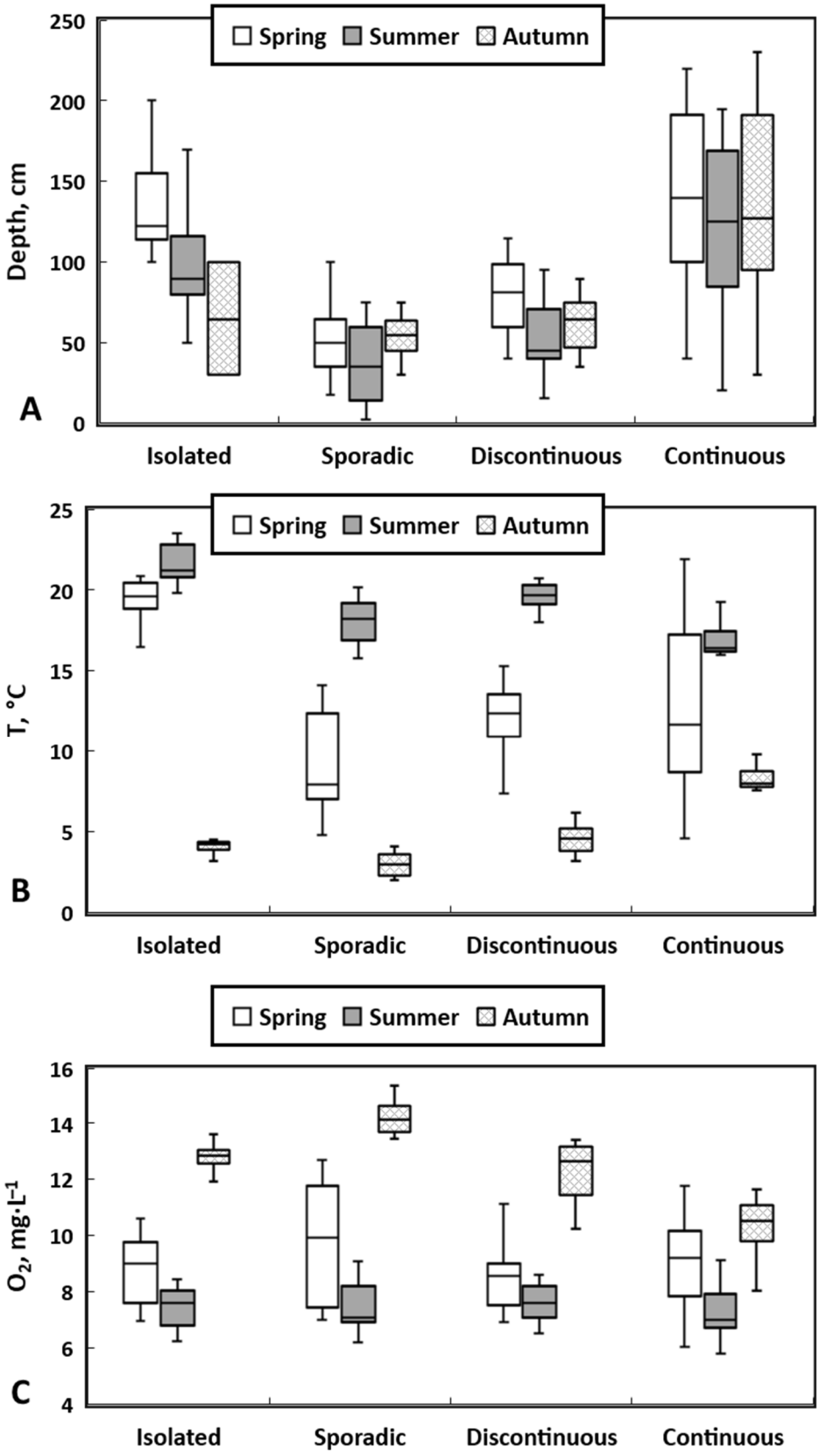

Figure S1. Changes in lake depth (**A**), water temperature (**B**) and oxygen concentration (**C**) across different permafrost zones of Western Siberia over 3 hydrological seasons.

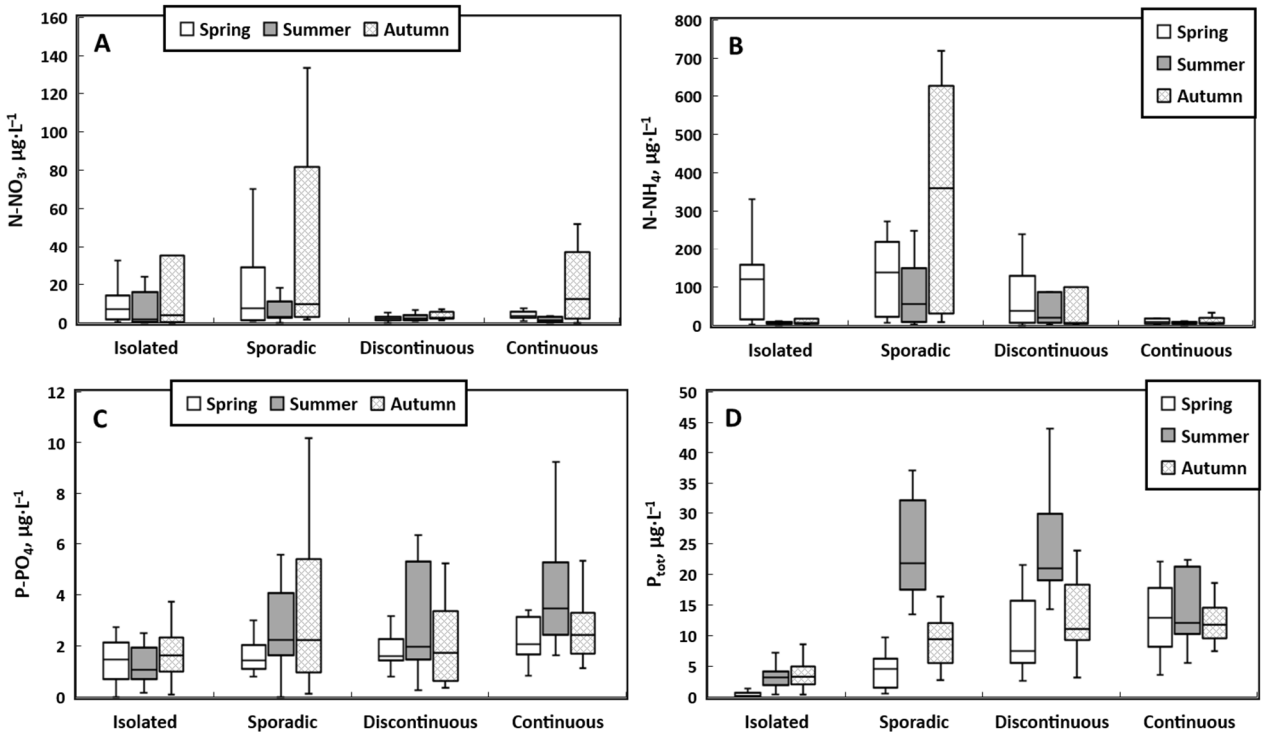

Figure S2. Dependence of nutrient concentrations on the permafrost gradient (latitude): $N\text{-}NO_3$ (**A**), $N\text{-}NH_4$ (**B**), $P\text{-}PO_4$ (**C**) and P_{tot} (**D**).

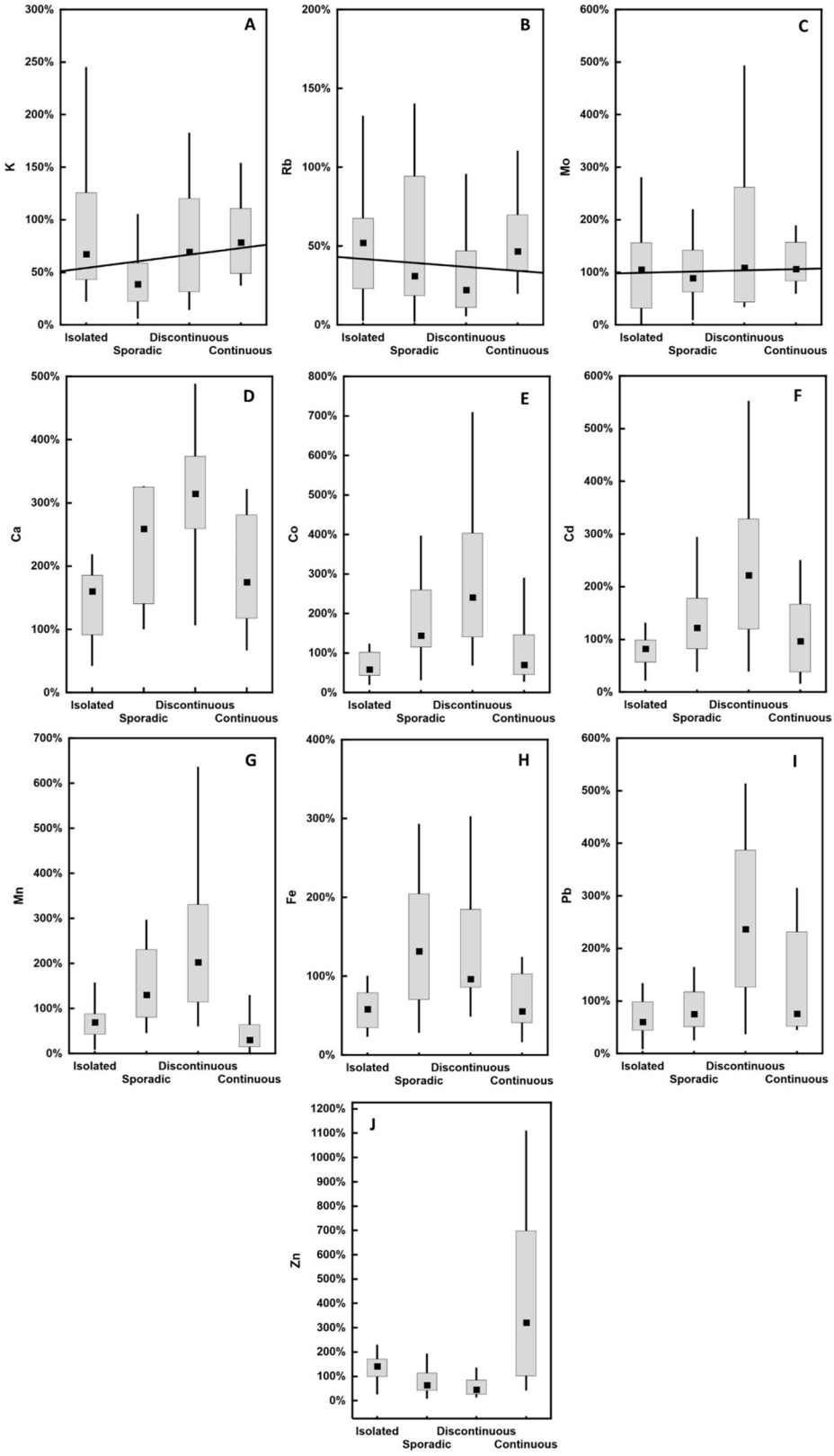

Figure S3. Elements that do not show a significant latitudinal change in stocks in lake waters between spring and summer: K (**A**), Rb (B) and Mo (**C**), the elements that increase their concentration in summer relative to spring in the sporadic and discontinuous permafrost zones: Ca (**D**), Co (**E**), Cd (**F**), Mn (**G**), Fe (**H**) and Pb (**I**). Zinc (**J**) demonstrates a sharp increase in summer stocks in lakes of the continuous permafrost zone.

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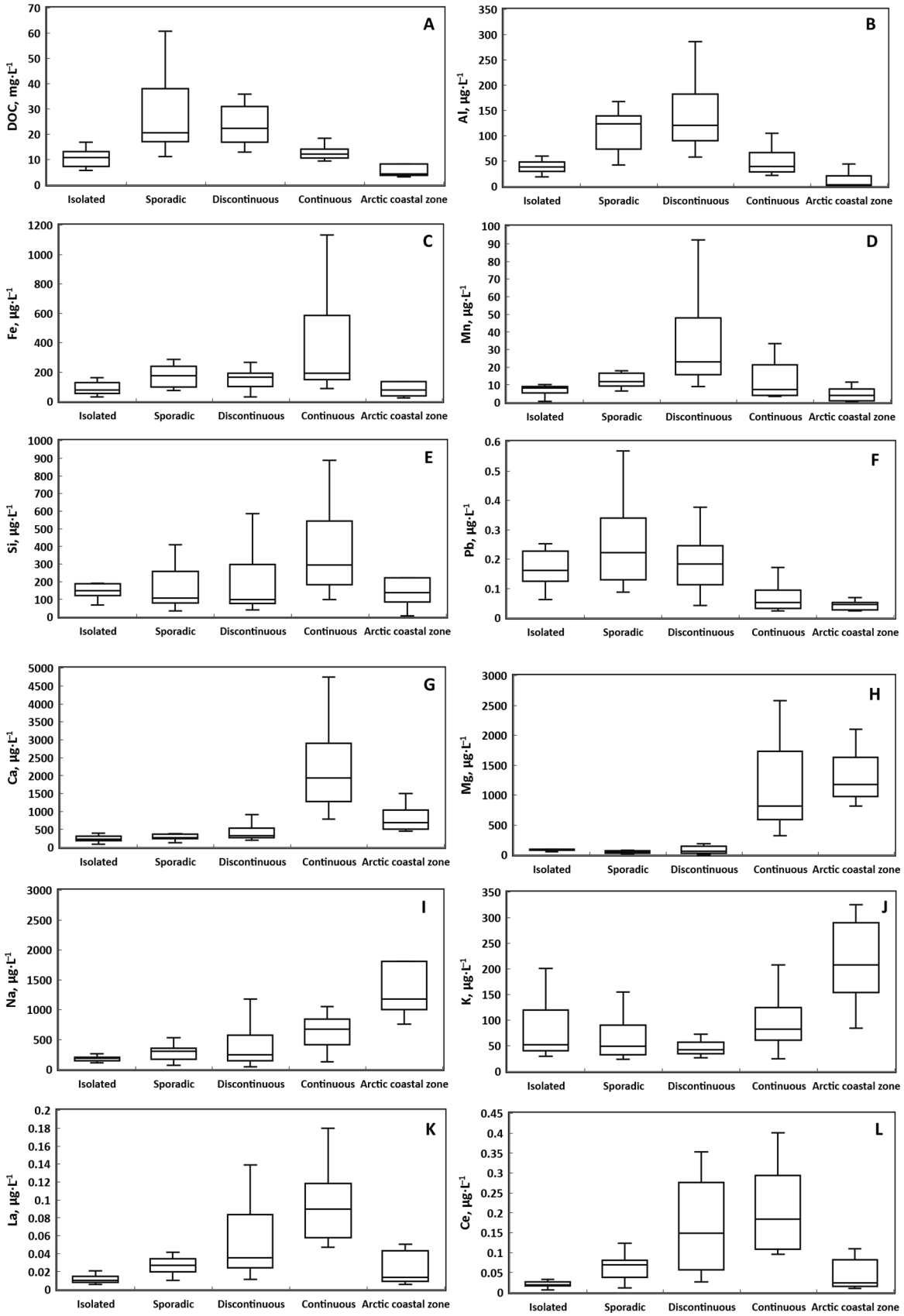

Figure S4. Summer element concentrations dependence of the permafrost gradient (latitude): DOC (**A**), Al (**B**), Fe (**C**), Mn (**D**), Si (**E**), Pb (**F**), Ca (**G**), Mg (**H**), Na (**I**), K (**J**), La (**K**), Ce (**L**). The data for the Arctic coastal zone of Western Siberia are from ref. [13].

Table S1. A. Dependence of physicochemical parameters and element concentrations on the water surface area for each permafrost zone during different hydrological seasons (Spearman's rank correlation coefficient Rs, $p < 0.05$, shown in bold).

Element	Isolated			Sporadic			Discontinuous			Continuous		
	Spring	Summer	Autumn	Spring	Summer	Autumn	Spring	Summer	Autumn	Spring	Summer	Autumn
O_2	0.07	0.34	−0.28	−0.3	0.17	−0.28	0.36	**0.83**	0.22	0.26	0.04	0.18
S.C.	−0.26	−0.28	**−0.54**	**−0.54**	**−0.65**	**−0.71**	−0.30	**−0.65**	**−0.77**	0.40	**0.51**	0.20
pH	0.29	0.25	0.27	−0.07	0.23	**0.60**	**0.58**	**0.58**	**0.56**	0.09	**0.62**	0.27
CH_4	−0.26	**−0.61**	**−0.55**	**−0.72**	−0.43	**−0.54**	−0.49	**−0.59**	**−0.58**	−0.12	0.03	0.10
CO_2	−0.14	**−0.50**	−0.38	0.09	−0.19	−0.41	0.24	0.02	−0.38	0.16	0.11	0.44
Cl^-	**0.61**	0.44	−0.18	**0.84**	0.05	0.09	−0.14	0.24	0.39	−0.35	0.11	−0.17
SO_4^{2-}	**0.76**	**0.83**	**0.77**	**0.61**	0.31	**0.61**	0.03	−0.34	0.15	0.14	0.02	0.01
$SUVA_{245}$	−0.17	−0.08	0.06	**0.60**	0.40	**0.65**	**0.84**	0.34	**0.61**	−0.12	−0.38	−0.33
DOC	**−0.72**	**−0.79**	**−0.76**	**−0.79**	**−0.51**	**−0.51**	−0.02	−0.36	−0.49	0.14	0.21	−0.09
DIC	−0.25	−0.38	0.21	−0.31	−0.05	0.27	0.39	0.05	0.14	0.31	0.46	0.41
$P\text{-}PO_4$	−0.12	0.16	−0.38	−0.38	0.39	**0.58**	−0.14	0.19	−0.07	−0.03	0.50	−0.07
$N\text{-}NO_3$	**0.60**	0.02	0.58	**0.90**	**0.73**	**0.90**	0.34	−0.56	−0.12	0.24	0.32	0.03
$N\text{-}NH_4$	−0.15	0.39	0.20	**0.60**	0.37	0.35	−0.17	−0.06	**−0.57**	−0.27	0.15	−0.18
Li	−0.30	**−0.63**	**−0.78**	−0.14	−0.35	0.03	**0.66**	**0.65**	**0.79**	0.10	0.07	0.05
B	**0.60**	−0.06	**−0.49**	0.22	−0.18	0.04	−0.33	0.30	**0.64**	0.49	0.20	0.34
Na	−0.45	0.36	0.04	−0.21	0.17	−0.05	0.25	0.51	0.49	0.24	0.27	0.42
Mg	−0.37	−0.28	−0.41	−0.44	−0.38	0.31	0.46	0.36	0.38	0.32	**0.56**	0.39
Al	0.08	−0.05	0.05	0.43	0.25	−0.05	**0.65**	0.36	0.42	0.01	0.12	−0.19
Si	−0.09	−0.09	0.07	0.25	−0.19	0.04	**0.64**	0.31	0.34	−0.34	−0.47	−0.14
P_{tot}	−0.15	0.38	0.17	0.47	−0.37	**0.49**	0.35	0.50	0.32	−0.16	0.34	0.16
K	**0.51**	0.10	0.29	**0.70**	**0.64**	0.24	0.30	0.25	−0.35	0.09	−0.04	0.38
Ca	0.04	−0.16	0.18	−0.02	−0.13	0.02	**0.70**	0.27	0.31	0.29	**0.52**	0.46
Ti	−0.27	−0.12	−0.03	−0.19	0.17	**0.50**	**0.64**	−0.16	0.09	0.29	0.12	0.06
V	−0.21	−0.19	−0.20	**0.50**	0.44	**0.68**	**0.55**	0.06	0.19	0.28	0.44	0.27
Cr	−0.36	**−0.50**	**−0.54**	0.05	−0.13	−0.10	**0.56**	0.46	0.26	0.39	0.04	−0.22
Mn	0.20	0.29	−0.04	0.08	−0.04	0.03	**0.87**	**0.64**	**0.72**	−0.08	−0.27	−0.16
Fe	−0.14	−0.43	−0.40	0.05	−0.28	0.20	**0.81**	0.09	0.26	−0.16	−0.33	−0.39
Co	**0.65**	0.29	−0.11	0.00	−0.23	−0.11	**0.88**	**0.58**	**0.61**	−0.13	−0.16	−0.24
Ni	−0.36	−0.36	−0.16	0.06	0.06	−0.17	**0.54**	0.42	0.40	0.24	0.29	0.01

Element	Isolated			Sporadic			Discontinuous			Continuous		
	Spring	Summer	Autumn	Spring	Summer	Autumn	Spring	Summer	Autumn	Spring	Summer	Autumn
Cu	−0.01	−0.13	0.25	0.26	0.03	0.18	0.22	0.36	0.20	**0.65**	**0.65**	**0.59**
Zn	−0.12	**−0.55**	−0.08	−0.10	−0.18	−0.45	−0.06	−0.29	−0.48	0.17	0.02	−0.27
Ga	−0.33	**−0.47**	−0.30	−0.13	0.21	−0.15	**0.74**	−0.13	0.05	−0.21	0.40	0.13
As	0.09	−0.04	−0.08	−0.21	−0.05	−0.04	**0.56**	0.27	0.17	0.29	0.33	0.16
Rb	**0.66**	0.36	**0.53**	**0.74**	**0.55**	0.22	0.12	−0.08	**−0.58**	0.01	0.03	−0.23
Sr	−0.08	0.11	0.18	0.00	0.04	0.15	**0.72**	0.13	0.26	0.26	**0.51**	0.41
Y	−0.01	0.29	0.31	0.44	**0.67**	0.52	**0.82**	0.31	0.44	0.32	0.04	−0.06
Zr	−0.43	−0.41	−0.22	0.43	**0.58**	0.19	**0.66**	0.43	0.33	0.16	−0.10	−0.24
Nb	−0.33	−0.25	−0.14	−0.37	0.17	−0.18	**0.65**	−0.02	−0.14	0.30	−0.05	−0.04
Mo	0.30	0.28	0.39	**0.59**	0.23	**0.63**	0.23	−0.08	0.34	**0.58**	0.50	0.43
Cd	0.45	0.45	**0.61**	**−0.52**	−0.39	−0.22	0.07	−0.49	**−0.56**	**0.74**	−0.24	−0.27
Sb	0.48	**0.49**	**0.62**	−0.23	−0.27	−0.09	0.18	−0.49	−0.40	**0.56**	**0.56**	0.39
Cs	**0.62**	**0.62**	0.48	0.14	0.47	**0.49**	**−0.56**	−0.07	−0.38	−0.16	0.39	0.15
Ba	−0.40	0.20	0.25	0.20	0.17	0.19	**0.51**	−0.03	−0.34	0.12	0.21	0.39
La	0.09	−0.21	−0.30	−0.36	0.28	0.07	0.26	0.53	0.41	**0.56**	0.21	0.10
Ce	0.10	−0.17	0.06	0.38	0.41	0.15	**0.67**	0.26	0.49	0.27	0.17	−0.02
Pr	−0.16	0.22	0.07	0.25	0.41	0.18	**0.82**	0.45	**0.54**	0.31	0.10	−0.02
Nd	−0.28	0.05	0.08	0.27	0.43	0.24	**0.79**	0.44	0.49	0.40	0.12	−0.05
Sm	0.03	−0.18	−0.37	0.21	0.48	0.01	**0.72**	0.26	0.38	0.24	0.10	−0.06
Eu	−0.20	0.03	0.17	0.22	**0.61**	0.33	**0.74**	0.28	0.25	0.41	0.16	−0.04
Gd	−0.16	0.15	0.13	0.37	**0.58**	0.50	**0.71**	0.38	0.40	0.26	0.09	0.04
Tb	−0.28	0.31	0.30	0.32	**0.59**	**0.58**	**0.90**	0.29	0.34	0.40	0.05	0.03
Dy	−0.09	0.08	0.33	0.45	**0.60**	**0.57**	**0.80**	0.35	0.46	0.28	0.04	−0.07
Ho	0.20	0.18	0.40	0.24	**0.63**	0.38	**0.76**	0.24	0.46	0.33	0.05	−0.08
Er	−0.01	0.03	0.35	0.44	**0.69**	0.47	**0.83**	0.28	0.42	0.25	−0.02	−0.03
Tm	0.21	0.15	0.07	0.33	**0.71**	0.50	**0.78**	0.38	0.42	0.31	−0.09	0.01
Yb	0.00	0.22	0.20	0.27	**0.74**	0.45	**0.66**	0.34	**0.52**	0.32	0.02	−0.11
Lu	0.07	0.00	0.26	0.23	**0.69**	**0.56**	**0.87**	**0.57**	0.44	0.21	−0.03	−0.12
Hf	−0.26	−0.18	−0.04	0.35	**0.51**	0.36	0.49	0.41	0.43	0.08	−0.13	−0.09
Pb	−0.12	−0.11	−0.15	−0.37	−0.48	0.28	0.01	−0.40	−0.08	0.33	−0.14	−0.03
Th	−0.30	−0.01	0.00	0.13	0.46	**0.57**	**0.76**	0.37	**0.55**	0.11	−0.06	−0.11
U	0.16	0.28	0.12	0.48	0.34	0.36	**0.56**	0.17	0.24	**0.50**	**0.59**	0.39

Table S1. B. Dependence of physicochemical parameters and element concentrations on the water surface area for all permafrost zones in different hydrological seasons (Spearman's rank correlation coefficient Rs, $p < 0.05$, shown in bold).

Element	Spring	Summer	Autumn
S.C.	−0.101	**−0.255**	**−0.405**
pH	**0.414**	**0.535**	**0.627**
CH_4	−0.170	**−0.322**	**−0.445**
CO_2	0.317	0.173	0.045
Cl^-	0.370	0.216	0.034
SO_4^{2-}	0.219	0.169	0.222
$SUVA_{245}$	**0.532**	−0.010	0.080
DOC	**−0.437**	**−0.391**	**−0.416**
DIC	**0.318**	**0.272**	**0.429**
$P\text{-}PO_4$	0.000	**0.338**	0.111
$N\text{-}NO_3$	**0.474**	0.031	**0.411**
$N\text{-}NH_4$	−0.144	0.086	**−0.273**
Li	**0.352**	**0.284**	**0.319**
B	0.214	**0.315**	0.153
Na	0.212	**0.425**	**0.421**
Mg	**0.354**	**0.286**	**0.435**
Al	0.207	−0.036	**0.067**
Si	0.172	0.129	**0.314**
P_{tot}	**0.331**	0.096	**0.273**
K	**0.570**	**0.463**	**0.503**
Ca	**0.474**	**0.311**	**0.518**
Ti	0.233	0.087	0.150
V	**0.569**	**0.271**	0.230
Cr	**0.303**	0.057	0.077
Mn	**0.579**	0.012	0.117
Fe	**0.498**	0.051	0.193
Co	**0.592**	**0.272**	**0.297**
Ni	**0.379**	**0.372**	**0.353**
Cu	**0.399**	**0.391**	**0.464**
Zn	−0.144	0.046	**−0.387**

Element	Spring	Summer	Autumn
As	**0.378**	**0.323**	**0.288**
Rb	**0.514**	0.195	**0.344**
Sr	**0.505**	**0.373**	**0.495**
Y	**0.626**	**0.503**	**0.503**
Zr	**0.432**	**0.316**	**0.313**
Nb	0.121	−0.039	−0.080
Mo		**0.424**	**0.492**
Cd	−0.110	**−0.395**	**−0.390**
Sb	−0.064	−0.154	−0.159
Cs	−0.240	0.042	−0.125
Ba	0.163	**0.310**	0.138
La	0.162	**0.424**	**0.414**
Ce	**0.532**	**0.367**	**0.443**
Pr	**0.551**	**0.472**	**0.461**
Nd	**0.534**	**0.455**	**0.461**
Sm	**0.523**	**0.390**	**0.390**
Eu	**0.491**	**0.482**	**0.467**
Gd	**0.569**	**0.493**	**0.482**
Tb	**0.614**	**0.473**	**0.521**
Dy	**0.620**	**0.456**	**0.507**
Ho	**0.600**	**0.442**	**0.516**
Er	**0.590**	**0.466**	**0.510**
Tm	**0.611**	**0.479**	**0.482**
Yb	**0.554**	**0.516**	**0.490**
Lu	**0.571**	**0.501**	**0.532**
Hf	**0.440**	**0.296**	**0.371**
Pb	**−0.249**	**−0.504**	**−0.461**
Th	**0.434**	**0.333**	**0.428**
U	**0.596**	**0.474**	**0.450**

Table S2. Mann-Whitney U test of the difference in element concentration between different seasons. Statistically significant (at $p < 0.05$) differences are in bold red.

Isolated permafrost zone.

Variable	Spring/Summer			Summer/Autumn		
	U	Z	p-level	U	Z	p-level
S.C.	102	−1.9	0.0598	76.5	**−2.7**	**0.0072**
pH	86	**2.4**	**0.0169**	148	0.4	0.6693
CH_4	161	−0.02	0.9874	156	0.2	0.8619
CO_2	113	1.5	0.1249	58	**−3.3**	**0.0011**
Cl^-	93	**2.2**	**0.0302**	87	**−2.4**	**0.0184**
SO_4^{2-}	144	−0.6	0.5798	137	−0.8	0.4383
$SUVA_{245}$	78	**2.6**	**0.0082**	120	1.3	0.1892
DOC	129	−1	0.3038	142.5	−0.6	0.5478
DIC	86	**2.4**	**0.0169**	50	**−3.5**	**0.0004**
$P\text{-}O_4$	101	0.4	0.7064	102	−0.9	0.3451
$N\text{-}O_3$	57	1	0.3058	39	−0.4	0.6534
$N\text{-}H_4$	45	**3.1**	**0.002**	82	−1.2	0.2134
Li	27	**−4.3**	**<0.0001**	86	**−2.4**	**0.0169**
B	77	**−2.7**	**0.0075**	146	−0.5	0.6239
Na	133	0.9	0.3672	81	**2.5**	**0.0109**
Mg	117	−1.4	0.1592	46	**−3.7**	**0.0003**
Al	86	**−2.4**	**0.0169**	139	−0.7	0.4765
Si	72	**2.8**	**0.0046**	37	**−3.9**	**0.0001**
P_{tot}	16	**−4.6**	**<0.0001**	149	−0.4	0.6925
K	142	0.6	0.5373	125	−1.2	0.2482
Ca	47	**−3.5**	**0.0005**	88	**−2.1**	**0.0333**
Ti	131	−0.4	0.6663	124	−1.2	0.2354
V	75	**2.7**	**0.0062**	91	**−2.2**	**0.0257**
Cr	95	**2.1**	**0.0354**	17	**−4.6**	**<0.0001**
Mn	156	0.2	0.8619	133	−0.9	0.3672
Fe	119	1.3	0.1787	145	0.5	0.6016
Co	127	1.1	0.275	107	−1.7	0.0847
Ni	121	−1.3	0.2001	101	1.9	0.0556
Cu	113.5	1.1	0.2935	109	1.2	0.228
Zn	44	**−3.7**	**0.0002**	9	**4.8**	**<0.0001**
Ga	33	**−4.1**	**<0.0001**	158	−0.1	0.9118
As	49	**−3.6**	**0.0004**	80	**2.6**	**0.0099**
Se	114	−1.5	0.1329	145	0.5	0.6016
Rb	109	1.7	0.0967	156	0.2	0.8619
Sr	156	0.2	0.8619	150	−0.4	0.716
Y	63	**−3.1**	**0.0018**	136	0.8	0.4198
Zr	116	−1.4	0.15	124	−1.2	0.2354
Nb	124	1.2	0.2354	108	−1.7	0.0905
Mo	105	−0.02	0.9826	91	0.6	0.5557
Cd	154	−0.2	0.8124	140	−0.7	0.4964
Sb	112	−1.6	0.1173	130	−1	0.319
Cs	130	1	0.319	126	−0.3	0.7586
Ba	144	−0.3	0.7791	126	0.9	0.3818
La	110	1.2	0.2477	124.5	0.7	0.5121
Ce	150	0.4	0.716	145	0.5	0.6016

Variable	Spring/Summer			Summer/Autumn		
	U	Z	p-level	U	Z	p-level
Pr	131	1	0.3346	152	−0.3	0.7637
Nd	134	0.9	0.3843	148	−0.4	0.6693
Sm	118	1.4	0.1687	57	**−3.3**	**0.0009**
Eu	93.5	−1.7	0.082	122	0.8	0.4486
Gd	105	−1.8	0.0738	158	0.1	0.9118
Tb	116	−1.4	0.15	158	0.1	0.9118
Dy	58	**−3.3**	**0.0011**	119	1.3	0.1787
Ho	79	**−2.6**	**0.0091**	148	0.4	0.6693
Er	49	**−3.6**	**0.0004**	142	0.6	0.5373
Tm	59	**−3.2**	**0.0012**	130	−1	0.319
Yb	122	−1.2	0.2114	142	0.6	0.5373
Lu	121	1.3	0.2001	149	−0.4	0.6925
Hf	117	0.9	0.3524	85	**−2**	**0.0421**
Pb	102	1.7	0.0956	132	−0.7	0.4987
Th	122	−1.2	0.2114	148	−0.4	0.6693
U	160	−0.05	0.9621	125	1.2	0.2482

Sporadic permafrost zone.

Variable	Spring/Summer			Summer/Autumn		
	U	Z	p-evel	U	Z	p-evel
S.C.	32.5	**−3.7**	**0.0002**	108	−1	0.3219
pH	25	**4**	**0.0001**	58	**−2.8**	**0.0052**
CH_4	135	−0.3	0.7566	123	−0.7	0.4695
CO_2	40	**−3.6**	**0.0003**	111	−1.1	0.2557
Cl^-	125	−0.7	0.5128	113	−1.1	0.2856
SO_4^{2-}	108	−1.2	0.215	128	−0.6	0.5816
$SUVA_{245}$	27	**−4**	**0.0001**	127	0.6	0.5582
DOC	22	**−4.2**	**<0.0001**	133	−0.4	0.7048
DIC	78	**−2.3**	**0.023**	88	−1.9	0.0538
$P–PO_4$	65	−1.4	0.1568	85	−0.5	0.6259
$N–NO_3$	46	0.9	0.3579	30	−1.4	0.1489
$N–NH_4$	73	1.3	0.2069	49	**−2.3**	**0.0201**
Li	10	**−4.6**	**<0.0001**	89	−1.9	0.0582
B	11	**−4.6**	**<0.0001**	41	**2.7**	**0.0074**
Na	111	−1.1	0.2557	69	1.4	0.1501
Mg	118	−0.6	0.5284	105	−1.3	0.1792
Al	23	**−4.2**	**<0.0001**	68	1.5	0.138
Si	136	−0.3	0.7829	121	0.2	0.8208
P_{tot}	0	**−5**	**<0.0001**	3	**4.9**	**<0.0001**
K	124	0.7	0.4909	84	0.8	0.4384
Ca	3	**−4.9**	**<0.0001**	92	0.4	0.674
Ti	10	**−4.6**	**<0.0001**	141	−0.1	0.9177
V	91	−1.8	0.0679	140	−0.1	0.8904
Cr	0	**−5**	**<0.0001**	77	−1.1	0.278
Mn	11	**−4.6**	**<0.0001**	123	0.7	0.4695
Fe	11	**−4.6**	**<0.0001**	119	0.9	0.3892
Co	6	**−4.8**	**<0.0001**	133	0.4	0.7048
Ni	63	**−2.8**	**0.0053**	144	0	1

Variable	Spring/Summer			Summer/Autumn		
	U	Z	p-evel	U	Z	p-evel
Cu	31	**−3.9**	**0.0001**	10	**4.1**	**0.0001**
Zn	94	−1.7	0.085	69	1.4	0.1501
Ga	19	**−4.3**	**<0.0001**	89	0.6	0.5799
As	10	**−4.6**	**<0.0001**	119	0.9	0.3892
Se	1	**−4.9**	**<0.0001**	143	0	0.9725
Rb	130	0.5	0.6297	92	0.4	0.674
Sr	44	**−3.4**	**0.0006**	83	0.8	0.4127
Y	14	**−4.5**	**<0.0001**	64	1.7	0.0968
Zr	27	**−4**	**0.0001**	87	0.6	0.5208
Nb	26	**−4.1**	**<0.0001**	110	1.2	0.2416
Mo	131	−0.4	0.6543	78	**−2.3**	**0.023**
Cd	24	**−4.1**	**<0.0001**	137.5	0.2	0.8228
Sb	54	**−3.1**	**0.0019**	133	−0.4	0.7048
Cs	127	−0.6	0.5582	89	−1.9	0.0582
Ba	53	**−3.1**	**0.0017**	59.5	1.9	0.0629
La	45	**3.4**	**0.0007**	84	0.8	0.4384
Ce	46	**−3.4**	**0.0007**	90	0.5	0.6106
Pr	36	**−3.7**	**0.0002**	85	0.7	0.465
Nd	33	**−3.8**	**0.0001**	86	0.7	0.4925
Sm	16	**−4.4**	**<0.0001**	93	0.4	0.7066
Eu	22	**−4.2**	**<0.0001**	80.5	0.9	0.3524
Gd	19	**−4.3**	**<0.0001**	70	1.4	0.1631
Tb	11	**−4.6**	**<0.0001**	75	1.2	0.2406
Dy	14	**−4.5**	**<0.0001**	61	1.8	0.0729
Ho	16	**−4.4**	**<0.0001**	57.5	1.9	0.0514
Er	8	**−4.7**	**<0.0001**	62	1.7	0.0803
Tm	7	**−4.7**	**<0.0001**	64	1.7	0.0968
Yb	33	**−3.8**	**0.0001**	80	1	0.3411
Lu	37	**−3.7**	**0.0002**	79	1	0.3191
Hf	36	**−3.7**	**0.0002**	89	0.6	0.5799
Pb	68	**−2.6**	**0.0089**	114	−1	0.3015
Th	20	**−4.3**	**<0.0001**	144	0	1
U	47	**−3.3**	**0.0008**	66	1.6	0.116

Discontinuous permafrost zone.

Variable	Spring/Summer			Summer/ utumn		
	U	Z	p-evel	U	Z	p-evel
S.C.	43	**−3.2**	**0.0014**	113.5	−0.5	0.5977
pH	41.5	**3.2**	**0.0012**	32	**−3.6**	**0.0003**
CH_4	48	**3**	**0.0027**	71	**−2.1**	**0.0332**
CO_2	51	**2.9**	**0.0039**	79	−1.8	0.0676
Cl^-	67	−1.9	0.062	90	−0.9	0.3615
SO_4^{2-}	54	**2.8**	**0.0056**	93	−1.3	0.1935
$SUVA_{245}$	70	**−2.2**	**0.0302**	100	1	0.3
DOC	8	**−4.5**	**<0.0001**	125.5	−0.1	0.9399
DIC	100	1	0.3	86	−1.6	0.1178
$P\text{-}O_4$	70	−1.5	0.1321	70	1.2	0.2136
$N\text{-}O_3$	62	0.2	0.8294	39	−1.1	0.2751

Variable	Spring/Summer			Summer/ utumn		
	U	Z	p-evel	U	Z	p-evel
$N\text{-}H_4$	108	0.5	0.6494	104	0.3	0.74
Li	40	**−3.1**	**0.0017**	104	−0.9	0.3758
B	25	**−3**	**0.0026**	69	−1	0.2968
Na	66	−1.4	0.1478	82	0.4	0.68
Mg	68	−0.8	0.4119	61	−1.9	0.0624
Al	29	**−3.6**	**0.0003**	125	−0.1	0.9249
Si	68	1.1	0.2749	35	**−3.2**	**0.0015**
P_{tot}	17	**−4.1**	**0.0001**	29	**3.6**	**0.0003**
K	128	0.02	0.985	89	0.6	0.5249
Ca	21	**−3.6**	**0.0003**	108	−0.5	0.6494
Ti	79	−1.6	0.1094	86	−1.6	0.1178
V	100	−1	0.3	128	0.02	0.985
Cr	27	**−3.8**	**0.0002**	115	−0.5	0.6376
Mn	47	**−3**	**0.0024**	121	0.2	0.8065
Fe	76	−1.5	0.1354	90	−0.9	0.3615
Co	28	**−3.8**	**0.0002**	126	0.1	0.9549
Ni	31	**−3.3**	**0.0008**	90	1.2	0.2436
Cu	29	**−3.7**	**0.0002**	76	1.9	0.0523
Zn	80	1.6	0.1184	7	**4**	**0.0001**
Ga	27	**−3.8**	**0.0002**	85	−1.6	0.1092
As	22	**−4**	**0.0001**	112.5	0.6	0.5718
Se	0	**−4.8**	**<0.0001**	96	1.2	0.2351
Rb	32	**3.6**	**0.0003**	99	0.2	0.8436
Sr	39	**−3.3**	**0.0009**	115	−0.2	0.8588
Y	34	**−3.5**	**0.0004**	123	0.2	0.8653
Zr	71	−1.9	0.0552	92	−0.5	0.614
Nb	63	**−2.2**	**0.0255**	93	−1	0.2949
Mo	112	0	1	91	−1.1	0.2599
Cd	12	**−4.1**	**<0.0001**	94	0.7	0.4553
Sb	22	**−4**	**0.0001**	128	−0.02	0.985
Cs	45	**2.8**	**0.0055**	89	−0.02	0.9805
Ba	70	**−2.2**	**0.0302**	90	0.6	0.5538
La	68	−1.1	0.2749	93	0.5	0.6452
Ce	51	**−2.9**	**0.0039**	105	0.8	0.3964
Pr	74	**−2**	**0.0438**	102	−1	0.3365
Nd	79	−1.8	0.0676	92	−1.3	0.1809
Sm	47	**−3**	**0.0024**	90	−1.4	0.1576
Eu	68	**−2.2**	**0.0249**	100	0.2	0.878
Gd	55	**−2.7**	**0.0063**	114.5	−0.5	0.6242
Tb	36	**−3.1**	**0.0017**	127	0.02	0.985
Dy	35	**−3.5**	**0.0005**	118	0.4	0.7203
Ho	29	**−3.7**	**0.0002**	111	0.6	0.534
Er	30	**−3.4**	**0.0007**	121	0.2	0.8065
Tm	34	**−3.2**	**0.0012**	110	−0.1	0.9339
Yb	41	**−2.9**	**0.0032**	108	−0.2	0.8682
Lu	47	**−2.3**	**0.0203**	77	−0.9	0.3462
Hf	40	**−3.3**	**0.001**	99	−1.1	0.2828
Pb	26	**−3.8**	**0.0001**	71	−1.9	0.0552
Th	59	**−2.6**	**0.0098**	101	−1	0.3179

Variable	Spring/Summer			Summer/ utumn		
	U	Z	p-evel	U	Z	p-evel
U	101	−1	0.3179	95	−1.2	0.2206

Continuous permafrost zone.

Variable	Spring/Summer			Summer/Autumn		
	U	Z	p-evel	U	Z	p-evel
S.C.	87	−1.5	0.1269	83.5	−1.4	0.1547
pH	42	**−3.2**	**0.0013**	79	1.8	0.0676
CH_4	94	1.3	0.2067	65	**2.4**	**0.0185**
CO_2	122	0.2	0.8358	97	1.1	0.2503
Cl^-	117	0.1	0.9213	59	**−2.4**	**0.0168**
SO_4^{2-}	118	−0.1	0.9527	91	−1.1	0.2599
$SUVA_{245}$	75	**2**	**0.0479**	116	0.4	0.6647
DOC	36	**−3.4**	**0.0006**	76	−1.9	0.0523
DIC	123	−0.2	0.8653	114	−0.5	0.6109
$P\text{-}O_4$	36	**−2.6**	**0.009**	57	**2.1**	**0.0382**
$N\text{-}O_3$	8	**2.3**	**0.024**	10	**−2.4**	**0.0168**
$N\text{-}NH_4$	62	1	0.2993	89	−1	0.3401
Li	46	**−3.1**	**0.0021**	89	−1.5	0.1468
B	16	**−4.2**	**<0.0001**	31	**3.5**	**0.0005**
Na	54	**−2.8**	**0.0056**	90	1.2	0.2436
Mg	91	−1.4	0.1689	92	−1.3	0.1809
Al	64	**−2.4**	**0.0167**	70	**−2.2**	**0.0302**
Si	79	−1.4	0.1711	44	**−3**	**0.0028**
P_{tot}	107	−0.8	0.4397	107	0.8	0.4397
K	66	**2.3**	**0.0205**	49	**−2.8**	**0.0053**
Ca	64	**−2.4**	**0.0167**	108	−0.7	0.4624
Ti	63	**−2.4**	**0.0151**	80	−1.8	0.0734
V	32	**3.6**	**0.0003**	120	−0.3	0.7774
Cr	69	**−2.2**	**0.0275**	58	**−2.6**	**0.0088**
Mn	36	**3.4**	**0.0006**	115	−0.5	0.6376
Fe	74	**2**	**0.0438**	110	−0.7	0.5095
Co	106	0.8	0.4178	120	−0.3	0.7774
Ni	46	**−3.1**	**0.0021**	88	−1.5	0.1366
Cu	53	**−2.8**	**0.005**	128	0	0.985
Zn	33	**−3.4**	**0.0006**	18	**3.8**	**0.0002**
Ga	102.5	−0.4	0.6936	111	0	0.9669
As	77	−1.9	0.057	70	**2.2**	**0.0302**
Se	31	**−3.6**	**0.0003**	117	−0.4	0.6923
Rb	31	**3.6**	**0.0003**	39	**−3.3**	**0.0009**
Sr	63	**−2.4**	**0.0151**	121	0.2	0.8065
Y	68	**−2.2**	**0.0249**	69	**−2.2**	**0.0275**
Zr	79	−1.8	0.0676	63	**−2.4**	**0.0151**
Nb	88	0.4	0.6625	29	**−3.1**	**0.0016**
Mo	100	−1	0.3	124	−0.1	0.8951
Cd	68	1.8	0.068	80	−1.3	0.1844
Sb	83	−1.7	0.0935	86	−1.6	0.1178
Cs	83	−0.7	0.5053	55	−1.7	0.0849
Ba	49	**−3**	**0.0031**	52	**2.7**	**0.0076**

Variable	Spring/Summer			Summer/Autumn		
	U	Z	p-evel	U	Z	p-evel
La	57	**−2.7**	**0.0079**	81	−1.8	0.0797
Ce	88	−1.5	0.1366	79	−1.8	0.0676
Pr	85	−1.6	0.1092	71	**−2.1**	**0.0332**
Nd	89	−1.5	0.1468	70	**−2.2**	**0.0302**
Sm	98	−1.1	0.2662	60	**−2.5**	**0.011**
Eu	22	**−4**	**0.0001**	94	1.3	0.2067
Gd	65	**−2.4**	**0.0185**	73	**−2.1**	**0.04**
Tb	74	**−2**	**0.0438**	71	**−2.1**	**0.0332**
Dy	66	**−2.3**	**0.0205**	74	**−2**	**0.0438**
Ho	75	**−2**	**0.0479**	70	**−2.2**	**0.0302**
Er	89	−1.5	0.1468	66	**−2.3**	**0.0205**
Tm	73	**−2.1**	**0.04**	70	**−2.2**	**0.0302**
Yb	74	**−2**	**0.0438**	61	**−2.5**	**0.0122**
Lu	85	−1.6	0.1092	61	**−2.5**	**0.0122**
Hf	73	−1.8	0.0661	56	**−2.7**	**0.007**
Pb	93.5	0.5	0.6312	94	−0.7	0.4669
Th	68	**−2.2**	**0.0249**	59	**−2.6**	**0.0098**
U	58	**−2.6**	**0.0088**	116	−0.4	0.6647

Table S3. Mann-Whitney U test of the difference in element concentration between different permafrost zones. Statistically significant (at $p < 0.05$) differences are in bold red.

Spring.

Variable	Isolated/Sporadic			Sporadic/Discontinuous			Discontinuous/Continuous		
	U	Z	p-level	U	Z	p-level	U	Z	p-level
S.C.	123.5	1	0.3385	132	−0.1	0.8997	104.5	−0.9	0.386
pH	118	−1.1	0.2548	108	1	0.3219	3	**−4.7**	**<0.0001**
CH_4	76	**2.5**	**0.0116**	8	**−4.6**	**<0.0001**	61	**2.5**	**0.0122**
CO_2	67	**2.8**	**0.0048**	3	**−4.8**	**<0.0001**	46	**−3.1**	**0.0021**
Cl^-	54	**3.3**	**0.0012**	118	−0.3	0.734	65	**−2.2**	**0.0312**
SO_4^{2-}	45	**3.5**	**0.0004**	128	0.3	0.787	107	−0.8	0.4397
$SUVA_{245}$	125	0.9	0.3641	109	−1	0.3398	73	**−2.1**	**0.04**
DOC	109	−1.4	0.1511	135	0	0.9856	63	**2.4**	**0.0151**
DIC	148	−0.1	0.8819	17	**−4.3**	**<0.0001**	2	**−4.7**	**<0.0001**
P-PO_4	74	−0.2	0.849	68	−0.8	0.4253	54	−1.5	0.1292
N-NO_3	83	−0.5	0.6381	40	1.6	0.1166	26	−1.7	0.0972
N-NH_4	85	−0.7	0.465	62	1.6	0.1199	47	**2**	**0.0457**
Li	88	**2.1**	**0.0333**	111	−0.6	0.5457	10	**−4.3**	**<0.0001**
B	122	1	0.3141	73	1.3	0.2069	57	−1.8	0.0739
Na	125.5	−0.9	0.3729	96	0.9	0.3718	36	**−3.1**	**0.0017**
Mg	75	**2.4**	**0.0181**	101	0.1	0.9127	0	**−4.5**	**<0.0001**
Al	134	−0.6	0.5415	90	−1.4	0.1623	70	2	0.0504
Si	32	**4**	**<0.0001**	81	−1.2	0.2249	89	0.4	0.7125
P_{tot}	17	**−4.5**	**<0.0001**	50	**−3.1**	**0.0021**	91	−1.4	0.1689
K	144	0.3	0.7791	95	1.5	0.1446	19	**−4.1**	**<0.0001**
Ca	94	1.9	0.0535	88	−0.9	0.3572	1	**−4.5**	**<0.0001**
Ti	85	−1.8	0.0689	93	−1.3	0.1992	112	0.3	0.7669
V	129	0.8	0.438	134	0.1	0.9569	36	**−3.4**	**0.0006**
Cr	107	−1.5	0.1332	135	0	0.9856	116	−0.4	0.6647
Mn	54	**3.3**	**0.0012**	103	−1.2	0.2417	43	**−3.2**	**0.0014**
Fe	52	**3.3**	**0.0009**	70	**−2.2**	**0.0314**	28	**−3.6**	**0.0003**
Co	74	**2.6**	**0.0096**	58	**−2.8**	**0.0052**	15	**−4.2**	**<0.0001**
Ni	88	**−2.1**	**0.0333**	86	−1.3	0.197	11	**−4.2**	**<0.0001**
Cu	79	**−2.2**	**0.0252**	110.5	0.9	0.3678	34	**−3.5**	**0.0004**
Zn	148	0.1	0.8819	58	**−2.8**	**0.0052**	18	**4.1**	**<0.0001**
Ga	79	**−2.4**	**0.0153**	128	−0.3	0.787	102	−0.7	0.4891
As	30	**4**	**0.0001**	42	**3.4**	**0.0008**	9	**−4.5**	**<0.0001**
Se	147	0.2	0.856	31	**3.8**	**0.0002**	57	**−2.7**	**0.0079**
Rb	151	0.05	0.9605	116	0.7	0.4824	51	**−2.9**	**0.0039**
Sr	107	1.5	0.1332	135	0	0.9856	5	**−4.6**	**<0.0001**
Y	130	0.7	0.4577	89	−1.7	0.0939	8	**−4.5**	**<0.0001**
Zr	33.5	**−3.9**	**<0.0001**	120	−0.3	0.7915	64	**−2.2**	**0.0282**
Nb	65	**−2.9**	**0.0039**	126	−0.3	0.7322	108	−0.1	0.8843
Mo	114	−0.5	0.6235	108	−0.7	0.4731	6	**−4.5**	**<0.0001**
Cd	36	**3.8**	**0.0001**	122	0.2	0.8502	91	0.9	0.3837
Sb	40	**3.7**	**0.0002**	14	**4.4**	**<0.0001**	119	0.3	0.7487
Cs	111	−1.4	0.1708	93	1.3	0.1992	3	**4.4**	**<0.0001**
Ba	130	−0.7	0.4577	60	**−2.7**	**0.0065**	98	1.1	0.2662

Variable	Isolated/Sporadic			Sporadic/Discontinuous			Discontinuous/Continuous		
	U	Z	p-level	U	Z	p-level	U	Z	p-level
La	51	**−3.4**	**0.0008**	54	**2.6**	**0.0105**	41	**−2.9**	**0.0034**
Ce	141	0.4	0.7043	88	−1.7	0.0871	33	**−3.6**	**0.0004**
Pr	114	1.3	0.2038	71	**−2.3**	**0.0202**	19	**−4.1**	**<0.0001**
Nd	132	0.7	0.4987	72	**−2.3**	**0.0222**	17	**−4.2**	**<0.0001**
Sm	35	**3.9**	**0.0001**	54	**−2.9**	**0.0033**	26	**−3.8**	**0.0001**
Eu	132	0.4	0.6794	64	**−2.6**	**0.01**	25	**−3.9**	**0.0001**
Gd	120	1.1	0.2834	87	−1.7	0.0806	11	**−4.4**	**<0.0001**
Tb	97	1.8	0.067	72	−1.8	0.0649	12	**−4.1**	**<0.0001**
Dy	150	0.1	0.9342	96	−1.4	0.1548	17	**−4.2**	**<0.0001**
Ho	146	−0.2	0.8301	97	−1.4	0.1655	7	**−4.5**	**<0.0001**
Er	112	1.3	0.1813	50	**−2.7**	**0.0065**	8	**−4.3**	**<0.0001**
Tm	147	0.2	0.856	77	−1.9	0.059	15	**−4.1**	**<0.0001**
Yb	143	0.3	0.7539	85	−1.6	0.1127	20	**−3.8**	**0.0001**
Lu	105	1.6	0.1169	63	**−2.2**	**0.0276**	57	**−2.5**	**0.0135**
Hf	58	**−3**	**0.0031**	120	0.6	0.5766			
Pb	73	**2.6**	**0.0087**	77	**2.1**	**0.0351**	85	−1.6	0.1092
Th	68	**−2.8**	**0.0053**	113	−0.8	0.4177	1	**−4.8**	**<0.0001**
U	74	**−2.6**	**0.0096**	85	1.8	0.0689	15	**−4.1**	**<0.0001**

Summer.

Variable	Isolated/Sporadic			Sporadic/Discontinuous			Discontinuous/Continuous		
	U	Z	p-level	U	Z	p-level	U	Z	p-level
S.C.	44.5	**−3.4**	**0.0006**	113.5	0.5	0.5977	109	0.7	0.4857
pH	32.5	**3.8**	**0.0001**	120.5	0.3	0.7919	0	**−4.8**	**<0.0001**
CH_4	81	**2.4**	**0.0183**	62	**−2.6**	**0.0081**	85	1.6	0.1092
CO_2	91	**−2**	**0.0424**	70	**−2.4**	**0.0183**	18	**−4.1**	**<0.0001**
Cl^-	148	−0.1	0.8819	91	−1.4	0.174	86	1.1	0.2808
SO_4^{2-}	74	**2.6**	**0.0096**	44	**3.3**	**0.001**	53	**−2.6**	**0.0086**
$SUVA_{245}$	14	**−4.6**	**<0.0001**	114	0.8	0.4387	75	**2**	**0.0479**
DOC	16	**−4.5**	**<0.0001**	135	0	0.9856	22	**4**	**<0.0001**
DIC	43	**−3.6**	**0.0003**	132	0.1	0.8997	16	**−4.2**	**<0.0001**
$P\text{-}PO_4$	82	−1.9	0.054	111	−0.3	0.7369	81	−1.3	0.1985
$N\text{-}NO_3$	43	−0.5	0.6485	33	1.8	0.0762	22	1.4	0.1473
$N\text{-}NH_4$	60	**−2.5**	**0.0114**	102	0.9	0.3451	48	**2.7**	**0.0079**
Li	82	**−2.3**	**0.02**	125	0.4	0.7053	22	**−4**	**<0.0001**
B	15	**−4.5**	**<0.0001**	11	**4.3**	**<0.0001**	20	**−3.8**	**0.0001**
Na	88	**−2.1**	**0.0333**	118	0	0.9842	51	**−2.5**	**0.0119**
Mg	63	**3**	**0.0031**	103	−0.3	0.7696	4	**−4.4**	**<0.0001**
Al	20	**−4.4**	**<0.0001**	109	−1	0.3398	29	**3.7**	**0.0002**
Si	126	0.9	0.3818	118	0	0.9842	42	**−2.7**	**0.0064**
P_{tot}	0	**−5**	**<0.0001**	126	0	0.9699	51	**2.7**	**0.0068**
K	129	0.8	0.438	113	0.8	0.4177	42	**−3.2**	**0.0013**
Ca	82	**−2.1**	**0.0327**	102	−1.2	0.2275	3	**−4.7**	**<0.0001**
Ti	9	**−4.7**	**<0.0001**	79	**2**	**0.0418**	127	0	0.985
V	2	**−5**	**<0.0001**	81	**2**	**0.0496**	108	−0.7	0.4624
Cr	4	**−4.9**	**<0.0001**	109	1	0.3398	81	1.8	0.0797
Mn	53	**−3.3**	**0.001**	62	**−2.6**	**0.0081**	51	**2.9**	**0.0039**
Fe	59	**−3.1**	**0.002**	122	0.2	0.8502	80	−1.6	0.1184

Variable	Isolated/Sporadic			Sporadic/Discontinuous			Discontinuous/Continuous		
	U	Z	p-level	U	Z	p-level	U	Z	p-level
Co	15	**−4.5**	**<0.0001**	38	**−3.5**	**0.0004**	110	−0.7	0.5095
Ni	18	**−4.4**	**<0.0001**	92	−1.6	0.1171	25	**−3.9**	**0.0001**
Cu	5	**−4.8**	**<0.0001**	123	0.5	0.6525	53	**−2.8**	**0.005**
Zn	122	1	0.3141	97.5	−1.1	0.2653	57	**−2.3**	**0.0225**
Ga	7	**−4.8**	**<0.0001**	82	1.9	0.054	41	**3.1**	**0.0019**
As	146	0.2	0.8301	66	**2.5**	**0.0123**	15	**−4.2**	**<0.0001**
Se	12	**−4.6**	**<0.0001**	91	1.6	0.1089	109	0.7	0.4857
Rb	135	−0.6	0.5635	80	**2**	**0.0456**	118	0.4	0.7203
Sr	78	**−2.5**	**0.0139**	104	−1.1	0.2565	11	**−4.4**	**<0.0001**
Y	38	**−3.8**	**0.0002**	121	−0.5	0.6015	35	**−3.5**	**0.0005**
Zr	9	**−4.7**	**<0.0001**	92	1.6	0.1171	71	**−2.1**	**0.0332**
Nb	1	**−5**	**<0.0001**	52	**2.8**	**0.0046**	38	**2.9**	**0.0037**
Mo	94	−1	0.3308	118	−0.3	0.734	15	**−4.1**	**<0.0001**
Cd	121	−1	0.2985	126	0	0.9699	4	**4.5**	**<0.0001**
Sb	153	0	0.9868	60	**2.7**	**0.0065**	69	**2.2**	**0.0275**
Cs	95	−1.9	0.0577	47	**3**	**0.0025**	57	**2.1**	**0.0382**
Ba	31	**−3.9**	**<0.0001**	77	**−2.1**	**0.0351**	65	**−2.4**	**0.0185**
La	51	**−3**	**0.0023**	64	−1.9	0.0542	50	**−2.3**	**0.019**
Ce	41	**−3.7**	**0.0002**	71	**−2.3**	**0.0202**	98	−1.1	0.2662
Pr	34	**−3.9**	**<0.0001**	105	−1.1	0.2719	36	**−3.4**	**0.0006**
Nd	28	**−4.1**	**<0.0001**	117	−0.7	0.5052	37	**−3.4**	**0.0006**
Sm	40	**−3.7**	**0.0002**	99	−1.3	0.1886	58	**−2.6**	**0.0088**
Eu	54	**−3.1**	**0.0019**	113	−0.8	0.4177	14	**−4.3**	**<0.0001**
Gd	42	**−3.6**	**0.0003**	106	−1.1	0.2879	42	**−3.2**	**0.0013**
Tb	34	**−3.9**	**<0.0001**	115	−0.7	0.4602	45	**−3.1**	**0.0019**
Dy	39	**−3.7**	**0.0002**	120	−0.6	0.5766	45	**−3.1**	**0.0019**
Ho	25	**−4.2**	**<0.0001**	119	−0.6	0.5523	48	**−3**	**0.0027**
Er	36	**−3.8**	**0.0001**	120	−0.6	0.5766	48	**−3**	**0.0027**
Tm	27	**−4.1**	**<0.0001**	114	−0.5	0.6235	35	**−3.3**	**0.0008**
Yb	46	**−3.5**	**0.0004**	107.5	−0.7	0.4615	35	**−3.3**	**0.0008**
Lu	45	**−3.5**	**0.0004**	107	−0.5	0.648	29	**−3.4**	**0.0006**
Hf	5	**−4.8**	**<0.0001**	110	0.9	0.3583	88	−1.5	0.1366
Pb	114	−1	0.3015	107	1	0.3046	17	**3.9**	**<0.0001**
Th	12	**−4.6**	**<0.0001**	128	0.3	0.787	86	−1.6	0.1178
U	26	**−4.2**	**<0.0001**	52	**3**	**0.0026**	6	**−4.6**	**<0.0001**

Autumn.

Variable	Isolated/Sporadic			Sporadic/Discontinuous			Discontinuous/Continuous		
	U	Z	p-level	U	Z	p-level	U	Z	p-level
S.C.	54.5	**−3.2**	**0.0012**	107	1	0.3046	119.5	0	1
pH	139	0.4	0.6559	75	**−2.2**	**0.0293**	4	**−4.7**	**<0.0001**
CH_4	132	0.7	0.4987	46	**−3.2**	**0.0013**	14	**4.3**	**<0.0001**
CO_2	138	0.5	0.6322	92	−1.6	0.1171	62	**−2.5**	**0.0136**
Cl^-	151	0.05	0.9605	100	−1	0.3079	95	1	0.3328
SO_4^{2-}	59	**3.1**	**0.002**	54	**2.9**	**0.0033**	50	**−2.9**	**0.0035**
$SUVA_{245}$	6	**−4.8**	**<0.0001**	106	1.1	0.2879	88	1.5	0.1366
DOC	12	**−4.6**	**<0.0001**	121	0.5	0.6015	49	**3**	**0.0031**

Variable	Isolated/Sporadic			Sporadic/Discontinuous			Discontinuous/Continuous		
	U	Z	p-level	U	Z	p-level	U	Z	p-level
DIC	89	**−2.1**	**0.0361**	130	0.2	0.843	19	**−4.1**	**<0.0001**
P-PO_4	63	−1.3	0.196	62	0.8	0.3992	67	−1.1	0.2541
N-NO_3	30	−1.2	0.2364	18	**2.2**	**0.0305**	27	−1.7	0.089
N-NH_4	17	**−3.5**	**0.0004**	44	**2.2**	**0.0264**	88	1	0.3195
Li	48.5	**−3.4**	**0.0006**	108	1	0.3219	12	**−4.4**	**<0.0001**
B	78	−1.2	0.2117	66	0.6	0.5316	88	−0.4	0.6784
Na	71	−1.5	0.1223	55	−1.2	0.221	43	**−2.5**	**0.0129**
Mg	138	0.5	0.6322	130	−0.2	0.843	0	**−4.8**	**<0.0001**
Al	10	**−4.1**	**<0.0001**	61	−1.6	0.1092	68	**2.2**	**0.0249**
Si	38.5	**3.5**	**0.0005**	36	**−3.3**	**0.001**	101	−1	0.3179
P_{tot}	32	**−4**	**<0.0001**	84	−1.9	0.0636	125	−0.1	0.9249
K	67	1.7	0.0864	76	−0.1	0.935	1	**−4.4**	**<0.0001**
Ca	96	0.5	0.6264	53	−1.8	0.0749	16	**−4.1**	**<0.0001**
Ti	7	**−4.8**	**<0.0001**	100	1.3	0.201	108	−0.7	0.4624
V	2	**−5**	**<0.0001**	94	1.5	0.1349	95	−1.2	0.2206
Cr	8	**−4.2**	**<0.0001**	63	1.5	0.1314	102	−1	0.3365
Mn	87	**−2.2**	**0.0306**	56	**−2.9**	**0.0042**	71	**2.1**	**0.0332**
Fe	47	**−3.5**	**0.0005**	101	−1	0.3262	75	−1.8	0.0786
Co	27	**−4.1**	**<0.0001**	25	**−4**	**<0.0001**	95	−1.2	0.2206
Ni	0	**−5**	**<0.0001**	96	−1.2	0.2417	1	**−4.7**	**<0.0001**
Cu	45	**−2.5**	**0.0124**	70	−1.2	0.2365	48	**−3**	**0.0027**
Zn	54.5	**−2.2**	**0.0249**	49	1.3	0.1939	50	1.7	0.0849
Ga	8	**−4.2**	**<0.0001**	95	0	0.9815	31	**3.5**	**0.0005**
As	121	−1	0.2985	62	**2.6**	**0.0081**	19	**−4.1**	**<0.0001**
Se	6	**−4.8**	**<0.0001**	48	**3.2**	**0.0016**	103	−0.9	0.3558
Rb	93	−0.6	0.5393	43	1.9	0.0606	14	**−3.9**	**<0.0001**
Sr	95	−0.5	0.5967	53	−1.8	0.0749	29	**−3.6**	**0.0003**
Y	61	**−2**	**0.049**	52	**−2**	**0.0434**	40	**−3.3**	**0.001**
Zr	10	**−4.1**	**<0.0001**	74	0.2	0.849	22	**−3.6**	**0.0004**
Nb	6	**−4.8**	**<0.0001**	98	1.4	0.1768	85	1.1	0.2706
Mo	24	**−3.9**	**0.0001**	123	0.5	0.6525	14	**−4.3**	**<0.0001**
Cd	152	−0.02	0.9868	113	0.5	0.597	16	**4**	**<0.0001**
Sb	151	0.05	0.9605	42	**3.4**	**0.0008**	111	0.6	0.534
Cs	45	**−3.1**	**0.002**	19	**3.7**	**0.0003**	72	0.3	0.7648
Ba	48	**−2.5**	**0.0118**	30	**−2.6**	**0.0098**	41	**2.6**	**0.0099**
La	34	**−3.1**	**0.0019**	61	−1.6	0.1092	29	**−3.7**	**0.0002**
Ce	32	**−3.2**	**0.0014**	52	**−2**	**0.0434**	32	**−3.6**	**0.0003**
Pr	43	**−2.7**	**0.0063**	47	**−2.3**	**0.0244**	26	**−3.8**	**0.0001**
Nd	41	**−2.8**	**0.0049**	44	**−2.4**	**0.0168**	25.5	**−3.8**	**0.0001**
Sm	63	−1.9	0.0596	36	**−2.8**	**0.0057**	49	**−3**	**0.0031**
Eu	42	**−2.6**	**0.0084**	47	−1.7	0.0971	2	**−4.5**	**<0.0001**
Gd	62	−1.9	0.0541	43	**−2.4**	**0.0148**	40	**−3.3**	**0.001**
Tb	64	−1.8	0.0655	53	**−2**	**0.0485**	29	**−3.7**	**0.0002**
Dy	62	−1.9	0.0541	53	**−2**	**0.0485**	34	**−3.5**	**0.0004**
Ho	70	−1.6	0.1124	55	−1.9	0.0601	40	**−3.3**	**0.001**
Er	64	−1.8	0.0655	53.5	−1.9	0.0512	35	**−3.5**	**0.0005**
Tm	71	−1.5	0.1223	53	−1.8	0.0749	45	**−2.9**	**0.0032**
Yb	55	**−2.2**	**0.0263**	51	−1.9	0.0603	43	**−3**	**0.0025**
Lu	58	**−2.1**	**0.0361**	41	**−2.2**	**0.0288**	41	**−2.9**	**0.0034**

Variable	Isolated/Sporadic			Sporadic/Discontinuous			Discontinuous/Continuous		
	U	Z	p-level	U	Z	p-level	U	Z	p-level
Hf	6	**−4.2**	**<0.0001**	77	−0.9	0.3904	67	**−2.3**	**0.0226**
Pb	100	−1.7	0.0831	119	0.3	0.7626	25	**3.7**	**0.0002**
Th	18	**−4.4**	**<0.0001**	125	−0.4	0.7053	34	**−3.5**	**0.0004**
U	28	**−3.4**	**0.0008**	74	1	0.3182	26	**−3.8**	**0.0001**

Table S4. Dependence of changes in the concentrations of the studied elements on the geographical latitude in different hydrological seasons (Spearman's rank correlation coefficient Rs, at $p < 0.05$, in bold red).

Elements	Spring	Summer	Autumn
O_2	0.03	−0.06	**−0.57**
S.C.	0.07	0.22	0.21
pH	**0.51**	**0.34**	**0.64**
CH_4	**0.40**	0.20	0.01
CO_2	**0.66**	**0.75**	**0.57**
Cl^-	−0.22	0.14	0.05
SO_4^{2-}	**−0.50**	**−0.52**	**−0.47**
$SUVA_{245}$	**0.35**	**0.26**	**0.32**
DOC	−0.11	0.17	**0.25**
DIC	**0.80**	**0.72**	**0.62**
$P\text{-}PO_4$	**0.31**	**0.48**	0.26
$N\text{-}NO_3$	−0.21	−0.18	0.06
$N\text{-}NH_4$	**−0.38**	−0.04	−0.15
Li	**0.43**	**0.56**	**0.60**
B	−0.11	**0.41**	0.16
Na	**0.44**	**0.56**	**0.67**
Mg	**0.45**	**0.43**	**0.55**
Al	−0.04	0.16	**0.39**
Si	−0.06	0.24	**0.45**
P_{tot}	**0.76**	**0.43**	**0.67**
K	**0.26**	0.15	**0.30**
Ca	**0.49**	**0.72**	**0.61**
Ti	**0.40**	**0.44**	**0.52**
V	**0.49**	**0.53**	**0.52**
Cr	0.16	**0.41**	**0.56**
Mn	**0.41**	0.18	**0.27**
Fe	**0.48**	**0.50**	**0.66**
Co	**0.59**	**0.78**	**0.81**
Ni	**0.78**	**0.83**	**0.83**
Cu	**0.47**	**0.72**	**0.68**

Elements	Spring	Summer	Autumn
Zn	0.09	**0.28**	−0.12
As	0.06	0.24	**0.24**
Rb	0.12	−0.19	0.25
Sr	**0.44**	**0.73**	**0.70**
Y	**0.61**	**0.76**	**0.79**
Zr	**0.68**	**0.60**	**0.77**
Nb	**0.35**	**0.31**	**0.45**
Mo	**0.65**	**0.65**	**0.73**
Cd	**−0.57**	**−0.46**	**−0.53**
Sb	**−0.72**	**−0.53**	**−0.61**
Cs	**−0.49**	**−0.39**	**−0.35**
Ba	**0.43**	**0.72**	**0.58**
La	**0.32**	**0.75**	**0.85**
Ce	**0.50**	**0.80**	**0.84**
Pr	**0.61**	**0.81**	**0.84**
Nd	**0.64**	**0.80**	**0.84**
Sm	**0.45**	**0.80**	**0.81**
Eu	**0.65**	**0.76**	**0.84**
Gd	**0.59**	**0.78**	**0.81**
Tb	**0.58**	**0.74**	**0.79**
Dy	**0.62**	**0.73**	**0.80**
Ho	**0.67**	**0.73**	**0.79**
Er	**0.66**	**0.74**	**0.79**
Tm	**0.63**	**0.75**	**0.77**
Yb	**0.64**	**0.77**	**0.80**
Lu	**0.60**	**0.77**	**0.80**
Hf	**0.49**	**0.58**	**0.77**
Pb	**−0.66**	**−0.45**	**−0.39**
Th	**0.57**	**0.63**	**0.78**
U	**0.58**	**0.59**	**0.75**

Table S5. Change in pools of DOC, DIC and trace elements in lake waters in summer relative to spring. The ratio of 1.0 means no change in pool between 2 seasons.

Variable	Isolated		Sporadic		Discontinuous		Continuous	
	Mean ± SD	Median ± IQR	Mean ± SD	Median ± IQR	Mean ± SD	Median ± IQR	Mean ± SD	Median ± IQR
DOC	0.86 ± 0.3	0.82 ± 0.4	1.2 ± 0.7	1.1 ± 1	1.7 ± 0.8	1.5 ± 1	1.8 ± 0.7	1.6 ± 0.7
DIC	0.66 ± 0.3	0.55 ± 0.3	0.73 ± 0.7	0.47 ± 0.3	0.83 ± 0.2	0.77 ± 0.3	1.2 ± 0.5	1.1 ± 0.6
Li	1.2 ± 0.4	1.3 ± 0.4	3 ± 5	1.5 ± 2	2.7 ± 2	1.9 ± 2	2.3 ± 0.9	2.1 ± 1
B	1.2 ± 0.5	1.2 ± 0.6	2.9 ± 2	2.7 ± 2	6.9 ± 11	2.1 ± 5	7.7 ± 7	4.4 ± 11
Na	0.71 ± 0.3	0.73 ± 0.4	0.78 ± 0.7	0.51 ± 0.8	1.2 ± 0.8	0.95 ± 1	1.6 ± 0.7	1.4 ± 1
Mg	0.86 ± 0.4	0.83 ± 0.3	0.95 ± 0.9	0.51 ± 1	5.8 ± 12	1.5 ± 1	1.7 ± 0.8	1.6 ± 1
Al	1.3 ± 0.8	1.04 ± 0.8	2.2 ± 1	1.9 ± 2	3 ± 2	2.3 ± 2	3.8 ± 3	2.8 ± 3
Si	0.63 ± 0.5	0.46 ± 0.3	0.74 ± 0.6	0.6 ± 1	2 ± 2	0.94 ± 2	3.9 ± 2	3.05 ± 3
P_{tot}	12 ± 10	10 ± 12	5.7 ± 7	2.6 ± 6	1.6 ± 1	1.3 ± 1	1.2 ± 0.5	1.2 ± 0.8
K	1.04 ± 1	0.68 ± 0.8	0.54 ± 0.5	0.39 ± 0.3	0.81 ± 0.5	0.7 ± 0.9	1.1 ± 1	0.78 ± 0.6
Ca	1.7 ± 1.5	1.6 ± 0.9	3.1 ± 3	2.6 ± 2	3.8 ± 3	3.1 ± 1	1.9 ± 0.9	1.7 ± 1
Ti	1.01 ± 0.7	0.8 ± 0.4	3.3 ± 5	1.5 ± 1	1.5 ± 0.9	1.5 ± 1	2.8 ± 2	2.4 ± 2
V	0.4 ± 0.4	0.2 ± 0.2	0.74 ± 0.4	0.8 ± 0.4	1.04 ± 0.7	0.91 ± 1	0.49 ± 0.3	0.38 ± 0.3
Cr	0.64 ± 0.3	0.59 ± 0.3	1.8 ± 1	1.7 ± 1	3 ± 2	2.5 ± 3	3.4 ± 2	2.9 ± 3
Mn	0.67 ± 0.4	0.7 ± 0.4	1.6 ± 0.9	1.3 ± 1	3 ± 3	2.03 ± 2	0.43 ± 0.4	0.31 ± 0.4
Fe	0.62 ± 0.3	0.58 ± 0.4	1.4 ± 0.8	1.3 ± 1	1.4 ± 0.9	0.97 ± 0.9	0.8 ± 0.6	0.56 ± 0.6
Co	0.73 ± 0.5	0.59 ± 0.6	1.9 ± 1	1.4 ± 1	3.1 ± 2	2.4 ± 2	1.01 ± 0.8	0.71 ± 0.9
Ni	0.92 ± 0.6	0.75 ± 0.5	1.8 ± 1	1.1 ± 0.9	1.7 ± 0.9	1.6 ± 1	2.3 ± 1	2.2 ± 1
Cu	0.63 ± 0.4	0.5 ± 0.4	1.2 ± 0.7	1.1 ± 0.9	3 ± 4	1.8 ± 2	2.4 ± 1	2.3 ± 1
Zn	1.5 ± 0.9	1.4 ± 0.7	0.86 ± 0.7	0.64 ± 0.7	0.6 ± 0.4	0.46 ± 0.5	4.3 ± 4	3.2 ± 5
As	0.96 ± 0.3	1.02 ± 0.5	1.02 ± 0.6	0.87 ± 1	1.6 ± 0.7	1.6 ± 1	1.2 ± 0.4	1.2 ± 0.7
Se	0.80 ± 0.3	0.8 ± 0.4	1.1 ± 0.6	1.01 ± 0.9	1.8 ± 0.8	1.6 ± 1	1.8 ± 0.7	1.7 ± 0.8
Rb	0.52 ± 0.4	0.52 ± 0.4	0.47 ± 0.4	0.3 ± 0.5	0.31 ± 0.3	0.22 ± 0.3	0.71 ± 0.6	0.47 ± 0.3
Sr	0.79 ± 0.3	0.73 ± 0.3	1.1 ± 0.6	0.9 ± 0.8	2.1 ± 1	1.9 ± 1	1.7 ± 0.7	1.8 ± 1
Zr	0.95 ± 0.5	0.78 ± 0.2	1.9 ± .5	1.5 ± 2	1.8 ± 1	1.4 ± 1	2.6 ± 1	2.7 ± 1
Mo	1.1 ± 0.9	1.1 ± 1	1.01 ± 0.6	0.89 ± 0.6	2 ± 2	1.1 ± 2	1.3 ± 0.8	1.1 ± 0.7
Cd	0.78 ± 0.3	0.82 ± 0.4	1.7 ± 1.6	1.2 ± 0.9	3 ± 3	2.2 ± 2	1.01 ± 0.7	0.97 ± 0.9
Sb	0.8 ± 0.3	0.85 ± 0.3	0.78 ± 0.5	0.66 ± 0.5	1.4 ± 0.7	1.3 ± 1	1.5 ± 0.8	1.4 ± 0.8
Ba	0.9 ± 0.6	0.79 ± 0.7	1.1 ± 0.8	0.85 ± 0.5	1.4 ± 0.8	1.1 ± 1	21 ± 22	14 ± 34
La	0.99 ± 1.6	0.51 ± 0.8	0.3 ± 0.4	0.15 ± 0.2	1.4 ± 1	1.1 ± 2	2.1 ± 1	2.04 ± 2
Ce	0.64 ± 0.4	0.59 ± 0.4	1.5 ± 1	1.3 ± 1	3.9 ± 4	2.5 ± 2	1.9 ± 1	1.8 ± 2

Nd	0.85 ± 0.7	0.59 ± 0.6	1.6 ± 1	1.5 ± 1	2.2 ± 1	1.7 ± 2	2 ± 0.9	2 ± 1
Pb	0.69 ± 0.4	0.61 ± 0.5	0.93 ± 0.6	0.75 ± 0.6	2.6 ± 1	2.4 ± 2	1.8 ± 2	0.76 ± 2
Th	1.1 ± .9	0.87 ± 0.5	1.9 ± 1.7	1.3 ± 2	2.1 ± 1	1.4 ± 1	3.1 ± 2	2.8 ± 1
U	0.73 ± 0.3	0.71 ± 0.4	1.2 ± 0.7	0.97 ± 1	1.9 ± 2	1.2 ± 1	2.3 ± 1	2.1 ± 1