Table S1. Ionic composition of riverine waters sampled on the western coast of the Lake Baikal, mg/L.

Stream No.	K^+	Na^+	Mg^{2+}	Ca^{2+}	Cl^-	SO_4^{2-}	HCO_3^-
Marituisky area							
1	0.98	1.87	0.33	7.75	1.03	8.30	23.4
2	0.83	2.03	0.99	6.12	0.21	9.74	19.4
3	1.23	2.13	1.77	11.1	0.32	11.0	35.8
4	1.02	1,78	1.33	6.56	0.15	8.85	19.8
5	0.76	2.11	1.33	6.20	0.21	6.93	23.0
6	1.23	1.96	0.56	7.84	0.35	7.48	24.2
7	1.04	2.18	0.77	7.84	0.19	7.86	27.8
8	1.19	2.68	0.33	9.37	0.22	7.85	27.6
9	1.32	2.21	2.88	6.56	0.29	7.48	32.5
10	0.76	1.83	1.57	6.20	0.41	8.29	16.7
11	1.67	2.19	1.11	9.05	0.30	8.65	30.2
12	1.14	2.38	2.43	8.75	0.33	8.32	36.1
Baikalsky area							
13	0.39	2.11	0.99	6.20	0.54	6.58	20.8
14	0.44	1.88	0.56	7.48	0.66	9.19	19.1
15	0.57	2.21	0.77	8.39	0.64	7.67	24.7
16	0.92	1.94	5.09	15.3	0.59	7.30	80.0
17	0.32	2.10	1.44	6.56	1.64	9.56	18.4
18	0.96	1.54	3.67	15.6	0.57	12.4	58.6
19	0.68	2.29	3.99	11.3	0.45	13.7	43.9
20	0.73	2.31	4.20	10.4	0.56	14.0	41.9
21	1.02	3.38	3.83	18.7	0.32	15.7	70.1
22	1.08	1.92	9.07	24.8	0.66	16.1	107
Listvyansky area							
23	1.37	3.77	6.63	27.8	2.23	23.5	106
24	2.03	2.74	1.88	9.28	0.47	16.3	26.8
25	0.79	4.12	4.14	19.8	3.22	20.7	66.7
26	1.79	3.75	5.11	18.7	3.19	18.9	71.2
27	0.46	2.10	1.33	16.7	0.47	20.3	37.5
28	0.41	3.01	2.66	12.8	0.47	22.6	31.5
29	0.29	3.68	2.32	10.2	0.32	19.1	28.1
30	0.25	4.20	5.87	12.1	0.80	27.9	35.5
31	0.35	5.11	7.41	10.2	0.32	23.2	52.8
32	0.58	5.13	15.5	24.8	0.47	52.1	102
Goloustnensky area							
33	0.41	2.12	6.09	17.7	0.47	19.4	65.6
34	0.47	0.47	1.48	11.1	5.91	0.32	20.8
35	0.53	1.38	10.4	23.0	0.22	9.56	115
36	0.65	1.75	1.66	6.56	0.47	7.48	23.8
37	0.59	1.76	15.5	34.5	0.56	22.8	159
Buguldeyisky area							
38	0.52	1.95	16.0	42.0	0.47	29.8	177
39	1.42	4.75	8.30	33.6	0.80	28.1	123
40	1.75	8.93	16.0	64.3	2.28	1.91	313
41	1.87	6.39	24.8	48.5	1.84	10.3	292
42	1.11	1.12	6.31	21.5	4.32	1.12	135
43	1.95	11.1	7.29	48.0	2.11	18.7	189
44	1.23	1.23	6.14	29.9	3.27	2.20	92.2
45	2.65	11.9	18.9	54.7	2.34	54.9	230

46	1.67	1.65	3.48	9.19	5.92	1.24	36.8
			Yelantsinsky area				
47	1.47	1.48	4.40	9.92	8.12	1.15	42.7
48	0.57	0.56	2.38	3.54	11.6	1.21	26.9
49	1.23	1.19	2.23	5.65	7.89	0.90	12.5
50	1.37	1.40	1.29	1.66	8.57	0.72	10.2
51	1.12	2.05	1.88	8.76	0.78	7.84	31.9
52	0.29	0.30	1.10	3.20	8.78	0.76	13.2
53	0.96	2.04	1.88	10.6	0.82	2.25	44.3
54	0.86	2.05	2.21	11.1	0.85	2.44	47.2
55	0.78	0.96	1.93	3.57	6.77	0.78	22.3
56	0.49	0.84	1.44	5.31	0.59	2.81	21.7
57	0.57	0.56	0.75	3.22	5.65	0.48	19.4
58	0.40	1.11	0.77	4.78	0.56	3.56	16.4
59	0.59	1.20	1.33	8.74	0.60	2.44	33.3
			Onguryonsky area				
60	0.56	1.48	4.87	14.7	2.45	4.50	64.6
61	1.13	2.19	4.87	14.7	0.76	5.81	68.7
62	1.56	1.13	8.63	26.3	0.51	18.9	104
63	1.67	1.05	10.2	25.6	0.58	4.12	129
64	1.19	3.66	2.88	12.6	1.14	5.81	55.1
65	1.47	2.20	7.41	23.0	0.56	22.5	86.5
66	0.92	1.40	5.42	16.9	0.42	7.84	73.6
67	2.20	1.56	14.8	41.6	0.57	21.0	182
68	2.02	1.85	22.6	35.0	0.69	34.2	185
69	0.84	1.10	11.1	24.3	0.48	8.02	124
70	1.21	1.20	4.29	2.01	0.33	0.42	29.5
71	0.66	1.92	5.86	16.9	0.24	5.61	79.7
72	0.50	2.38	8.96	12.0	0.63	11.2	73.9
73	1.74	3.76	38.1	83.7	0.78	43.0	406
74	0.26	1.10	18.9	53.6	0.60	17.2	240

Table S2. Trace element composition of water of Selenga river sampled at different stations and its basic statistical parameters, μg/L.

Stream No.	Sr	Al	Fe	Ti	Mn	Zn	Cu	V	Mo	Ni	Cr
Marituisky area											
1	66.4	65.8	81.9	4.50	5.30	1.81	2.51	0.60	0.53	0.87	0.43
2	56.8	153	187	18.1	24.8	3.68	4.12	1.38	0.85	1.87	0.58
3	55.9	30.4	51.4	5.42	5.97	1.24	3.04	0.64	0.65	1.66	0.37
4	60.2	138	193	24.2	19.9	3.71	5.85	1.55	0.80	1.69	0.52
5	55.7	72.3	81.4	6.71	16.1	1.87	3.56	1.05	0.53	0.99	0.31
6	98.3	87.7	165	13.4	56.2	2.73	2.14	1.25	0.77	1.65	0.42
7	114	17.0	74.1	13.2	9.42	6.70	13.3	1.43	1.59	2.03	0.32
8	87.2	43.5	59.7	7.21	7.20	2.68	3.80	0.87	0.27	0.64	0.19
9	121	67.6	52.9	4.73	3.84	2.11	4.36	0.80	0.80	0.74	0.16
10	109	54.8	52.3	5.14	11.2	2.48	3.84	0.49	0.36	0.77	0.24
11	134	170	77.6	19.6	12.4	5.89	4.67	1.59	1.11	1.53	0.36
12	112	98.2	61.4	6.70	8.23	2.60	2.79	0.83	0.62	0.87	0.19
Baikalsky area											
13	73.7	30.8	49.1	3.48	11.4	2.23	1.10	0.40	0.29	1.00	0.18
14	55.8	42.9	50.1	2.15	7.66	2.32	2.23	0.50	0.37	1.06	0.20
15	78.6	84.7	66.4	7.71	8.25	5.17	2.95	0.60	0.43	0.77	0.24
16	69.2	42.2	53.9	8.66	9.69	5.66	4.55	1.20	0.76	0.97	0.27
17	73.0	33.4	48.6	5.46	7.96	2.37	2.40	0.75	0.27	1.13	0.21
18	134	29.8	47.3	3.46	5.35	1.69	2.82	0.71	0.26	0.80	0.25
19	101	83.7	84.2	5.84	7.75	3.85	4.17	0.91	0.13	1.21	0.28
20	167	44.61	20.5	0.66	2.32	0.97	1.87	0.10	0.02	0.26	0.08
21	81.8	39.5	42.3	4.87	11.0	2.49	2.74	0.74	0.41	0.76	0.34
22	89.8	88.75	60.8	1.37	9.67	2.21	4.17	0.59	0.58	1.59	0.37
Listvyansky area											
23	67.0	13.21	82.5	1.56	8.49	4.95	2.45	0.50	1.25	1.27	0.37
24	89.3	20.9	50.6	4.40	9.08	2.70	2.12	0.37	0.58	0.76	0.24
25	123	13.2	60.6	1.27	9.05	6.17	3.95	0.58	0.66	1.09	0.30
26	112	22.7	34.3	3.55	6.70	2.43	3.11	1.00	1.59	0.48	0.36
27	168	30.5	85.3	4.27	8.53	2.04	2.50	0.63	0.80	0.77	0.18
28	109	17.4	45.2	3.23	8.75	2.37	3.39	0.40	0.65	0.58	0.24
29	143	31.0	46.7	3.09	6.75	1.47	1.32	0.39	0.75	0.68	0.24
30	205	12.4	39.5	1.50	7.63	2.93	2.42	0.47	0.48	0.66	0.28
31	167	75.4	45.7	6.17	9.21	1.62	2.36	0.48	0.59	0.41	0.29
32	256	10.7	13.8	1.11	7.57	2.33	1.38	0.41	0.12	0.46	0.25
Goloustnensky area											
33	136	25.9	49.5	2.74	16.9	2.42	4.98	0.75	0.29	1.69	0.49
34	258	13.8	29.2	3.87	3.24	2.05	3.14	0.57	0.27	0.52	0.36
35	79.7	14.4	90.4	1.93	8.10	1.87	2.61	0.49	0.63	0.44	0.28
36	75.1	24.3	41.7	2.83	4.28	1.20	1.87	0.24	0.92	0.41	0.12
37	134	9.87	91.1	1.81	7.82	1.81	2.60	0.63	0.13	0.36	0.46
Buguldeyisky area											
38	368	15.3	26.5	3.86	3.94	3.24	2.90	0.92	0.92	0.54	0.44
39	258	10.2	44.9	1.49	4.60	1.94	3.24	1.47	0.99	0.68	0.48
41	281	213	79.3	49.0	5.6	5.23	7.47	17.5	4.60	3.86	1.59
42	271	97.1	37.1	22.6	4.7	4.16	4.95	22.7	2.20	0.74	1.05
43	348	119	25.4	7.32	4.63	4.78	2.83	14.7	2.04	0.37	0.69
44	198	183	32.7	2.28	5.06	17.6	1.99	19.9	9.59	0.60	0.87
45	403	31.6	15.0	4.73	7.18	3.60	2.48	8.59	14.2	0.37	1.11
46	167	119	41.8	27.2	5.63	1.61	3.35	35.1	0.76	0.82	0.29

Yelantsinsky area											
47	168	122	30.5	0.30	5.73	5.92	4.84	59.6	0.59	1.04	0.87
48	33.7	147	23.3	7.81	8.84	8.59	2.99	1.44	1.20	0.75	0.16
49	124	74.3	25.1	35.1	4.73	2.88	0.87	3.42	0.48	0.27	0.27
50	33.4	90.9	15.8	26.3	4.96	1.94	1.61	0.85	3.24	0.32	0.16
51	33.9	164	33.4	22.7	6.68	4.28	2.22	0.39	1.32	0.71	0.16
52	33.3	123	37.3	34.9	5.29	3.11	8.88	0.87	0.58	0.58	0.19
53	22.6	188	90.0	66.5	3.45	1.93	1.87	0.27	1.60	0.66	0.44
54	45.1	39.5	97.1	31.1	9.76	4.38	3.71	0.36	1.55	0.76	0.28
55	21.8	60.3	121	10.2	10.1	7.59	2.99	0.31	1.59	0.57	0.18
56	269	44.5	21.6	22.8	7.81	6.64	3.06	0.57	0.63	0.30	0.21
58	56.7	72.9	24.3	24.2	16.9	2.72	3.32	0.97	2.43	0.50	0.29
59	67.4	40.4	45.1	21.6	10.6	5.17	4.23	1.59	1.58	0.67	0.49
Onguryonsky area											
60	80.1	93.3	71.5	75.9	5.73	13.1	5.51	0.63	0.41	0.94	0.38
61	123	72.5	24.0	11.4	7.22	3.24	3.48	1.22	3.61	0.55	0.12
62	167	393	240	16.2	12.4	4.60	5.92	1.10	1.99	0.85	0.65
63	112	188	89.8	24.9	9.89	7.47	6.47	0.63	1.21	0.60	0.40
64	78.8	130	87.1	29.9	3.99	3.84	4.28	1.99	0.71	1.20	0.30
65	225	185	38.2	28.2	5.39	42.3	6.53	1.75	1.56	0.94	0.35
66	89.8	146	91.1	57.7	7.59	9.05	8.84	0.75	0.52	1.24	0.52
68	391	95.5	73.5	7.22	7.87	2.59	2.99	0.93	1.36	0.74	0.58
70	33.4	177	33.2	15.8	4.83	3.11	2.92	0.36	2.99	0.50	0.21
71	22.7	87.1	27.3	11.2	14.2	3.49	2.83	0.36	0.63	0.58	0.26
72	7.81	55.1	49.8	3.52	7.35	5.35	3.11	0.37	0.25	0.87	0.28
73	358	122	68.7	5.73	10.9	4.96	3.56	1.37	0.46	1.09	1.03
74	89.3	84.2	61.0	9.05	7.31	4.36	3.62	0.91	0.06	0.73	0.55

Table S3. Average contributions of solute sources to trace element composition of water of western tributaties of Lake Baikal and Selenga River, %.

Area	**Sulfide-bearing silicates**	**Fe-Mn-bearing sedimentary rocks and clays**	**Carbonates**	**Ore-bearing silicates**	**Fe-Mn-bearing sedimentary rocks and clays**	**Carbonates**
	Sr/Fe-Ni/V daigram			Sr/Fe-Mo/V daigram		
Marituisky	34	65	1	2	92	6
Baikalsky	38	57	5	1	84	15
Listvyansky	47	42	11	11	65	24
Goloustnensky	41	49	9	14	62	24
Buguldeysky	1	63	35	2	41	58
Yelantsinsky	22	69	9	25	57	18
Onguryonsky	21	74	5	14	72	14
Selenga watershed	1	79	20	9	55	36
	Sr/Mn-Ni/V daigram			Sr/Mn-Mo/V daigram		
Marituisky	37	56	6	2	89	9
Baikalsky	39	48	13	1	78	22
Listvyansky	50	35	15	11	70	19
Goloustnensky	43	31	26	14	53	33
Buguldeysky	3	28	69	3	28	69
Yelantsinsky	23	64	13	24	63	13
Onguryonsky	26	56	18	15	65	20
Selenga watershed	3	75	22	9	69	22

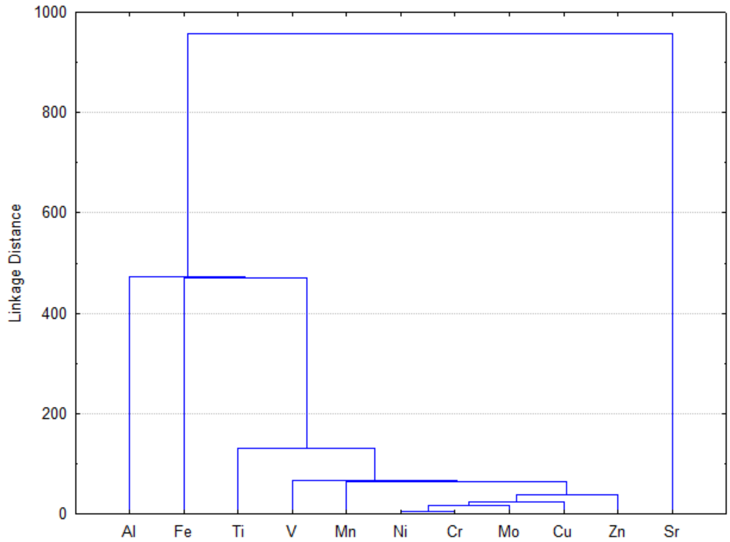

Figure S1. Hierarchical dendogram for 11 trace metals in water of western tributaries of Lake Baikal and Selenga River.

3.4. Identification of trace element sources

To identify trace element sources and their tracers all possible biplots for all combinations of trace element concentrations, normalized to each other were generated. The two negatively correlated pairs of element ratios, such as Sr/Fe and Sr/Mn on the one hand and Ni/V and Mo/V on the other hand, were finally chosen as tracers (Figure 5 and Figure 6).

The chemical composition of water samples characterized by high Sr/Fe and Sr/Mn ratio values (>5 and >20, respectively) was probably originated from dissolution of carbonates, because Sr substitutes Ca in $CaCO_3$:

$$Ca_{0.9}Sr_{0.1}CO_3 + H_2O + CO_2 \rightarrow 0.9Ca^{2+} + 0.1Sr^{2+} + 2HCO_3^- \quad (9)$$

Thus, the right vertex of mixing triangle was assumed to represent products of dissolution of carbonate rocks.

The chemical composition of water samples characterized by low Sr/Fe and Sr/Mn ratio values (<5 and <20, respectively) was probably originated from microbially mediated dissolution of bog Fe and Mn ores consisting of hydrated Fe oxide minerals enriched in Mn such as Mn-limonite and Mn-goethite (FeMnOOH), occurred in ancient lacustrine and swamp deposits [1, 2]:

$$CH_2O + 4Fe_{0.5}Mn_{0.5}OOH + 7H_2CO_3 \rightarrow 2Fe^{2+} + 2Mn^{2+} + 8HCO_3^- + 6H_2O \quad (10)$$

The Mn may also be released due to reduction of Mn ore minerals like pyrolusite (MnO_2) in the process of Fe oxidation in wetland sediments [3]:

$$2Fe^{2+} + MnO_2 + 2H_2O \rightarrow 2FeOOH + Mn^{2+} + 2H^+ \quad (11)$$

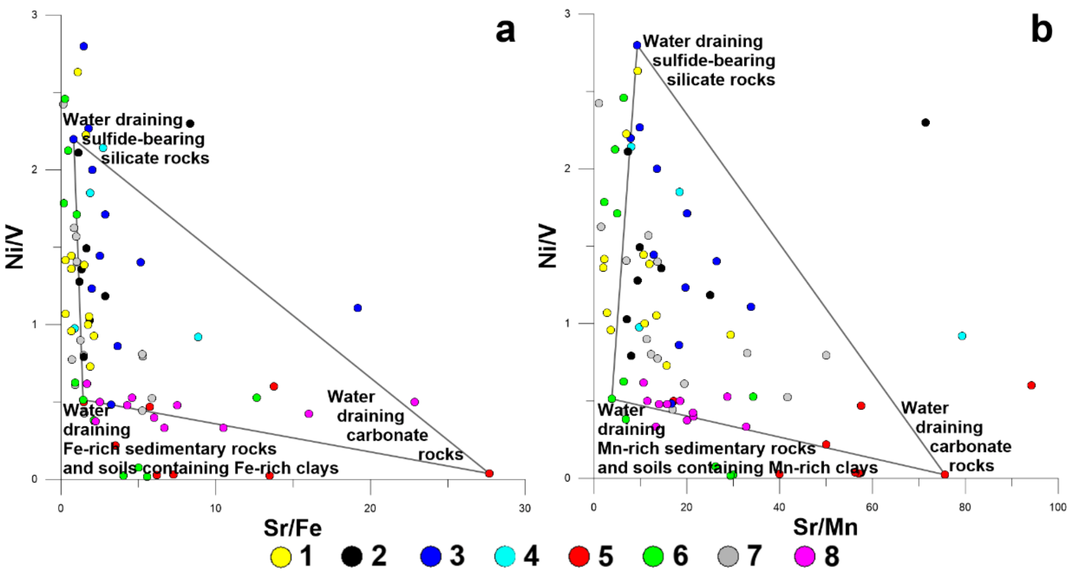

Figure 5. Trace element composition of waters of the western Baikal tributaries and Selenga River as the mixture of dissolution products of sulfide-bearing silicate rocks, carbonate rocks and Fe-Mn-rich sedimentary rocks and clays in coordinates of Sr/Fe-Ni/V (a) and Sr/Mn-Ni/V (b) ratios; colored circles are samples from: 1 – Marituisky area, 2 – Baikalsky area, 3 – Listvyansky area, 4 – Goloustnensky area, 5 – Buguldeisky area, 6 – Elantsinsky, 7 – Ongurensky area, 8 – Selenga River.

The Fe may release due to dissolution of hematite (Fe_2O_3) or magnetite ($FeO{\cdot}Fe_2O_3$) in weathering crusts of metamorphic silicate rocks like ferruginous quartzites (gespillites):

$$Fe_2O_3 + 6CO_2 + 3H_2O \rightarrow 2Fe^{3+} + 6HCO_3^- \quad (12)$$

The Fe may also release due to hydrolysis of Fe-rich clay minerals like chlorite ($Mg_3Fe_3AlSi_3O_{10}(OH)_8$) occurred in sedimentary rocks and soils [4]:

$$(Mg_{2.76}Fe_{1.90}Fe_{0.07}Al_{0.97})[Si_{2.48}Al_{1.52}O_{10}](OH)_8 + 18.08H^+ \rightarrow 2.76Mg^{2+} + 1.90Fe^{2+} + 0.07Fe^{3+} + 2.49Al^{3+} + 2.48H_4SiO_4 + 8.08H_2O \quad (13)$$

Organic matter released into groundwater from soils provided the delivery of Mn^{2+} and Fe^{2+} to surface waters in organic form. Thus, the left vertex of mixing triangle was assumed to represent products of dissolution of Fe-rich and Mn-rich sedimentary rocks and soils containing Fe-rich and Mn-rich clays.

The chemical composition of water samples characterized by high (>1) Ni/V ratio values was probably originated from bacteria mediated dissolution of Ni-bearing sulfides [5] such as Ni-bearing pyrite ($FeNiS_2$) and petlandite ($(Ni, Fe)_9S_8$) in the presence of sulfuric acid [6]:

$$2Fe_{0.5}Ni_{0.5}S_2 + 7O_2 + 2H_2O \rightarrow FeSO_4 + NiSO_4 + 2H_2SO_4 \quad (14)$$

$$(Ni, Fe)_9S_8 + 17.625O_2 + 3.5H_2SO_4 = 2.25Fe_2(SO_4)_3 + 3.5H_2O + 4.5NiSO_4 \quad (15)$$

Thus, the upper vertex of mixing triangle on Sr/Fe-Ni/V (Figure 5a) and Sr/Mn-Ni/V (Figure 5b) diagrams was assumed to represent products of dissolution of sulfide-bearing silicate rocks. The trace element composition of water samples characterized by low (<1) Ni/V ratio values was probably due to dissolution of V-bearing Fe-Mn ores occurred in both igneous and sedimentary rocks as well as due to dissolution V-bearing silicate minerals such as green mica, garnet, epidote and phlogopite [7, 8].

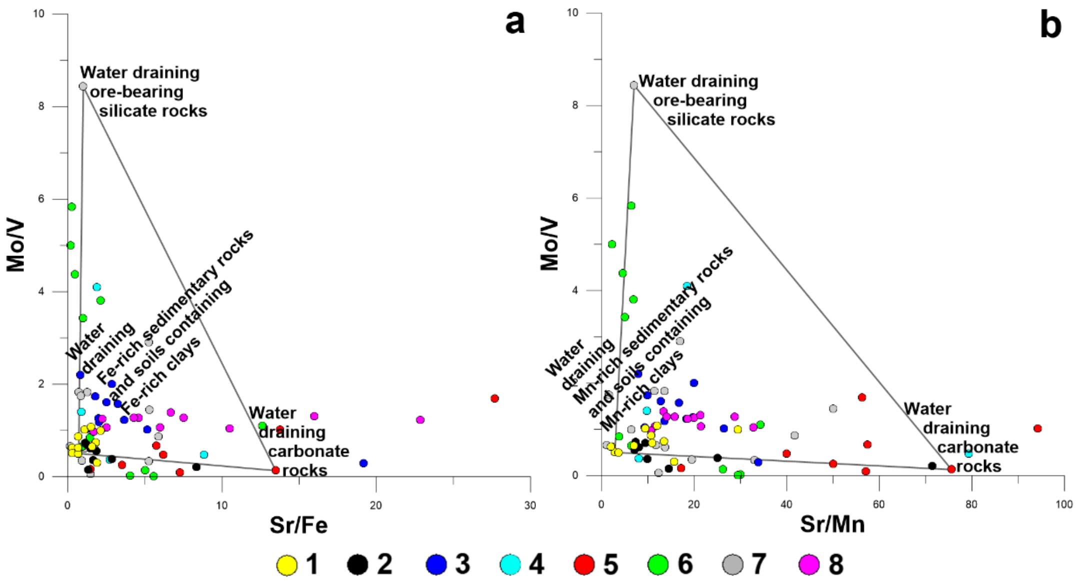

Figure 6. Trace element composition of waters of the western Baikal tributaries and Selenga River as the mixture of dissolution products of ore-bearing silicate rocks, carbonate rocks and Fe-Mn-rich sedimentary rocks and clays in coordinates of Sr/Fe-Mo/V (a) and Sr/Mn-Mo/V (b) ratios; colored circles are samples from: 1 – Marituisky area, 2 – Baikalsky area, 3 – Listvyansky area, 4 – Goloustnensky area, 5 – Buguldeisky area, 6 – Elantsinsky, 7 – Ongurensky area, 8 – Selenga River.

The chemical composition of water samples from western coast characterized by high (>1) Mo/V ratio values could have originated from Mo-bearing ferruginous quartzites as well as from weathering crusts of quartzites [9]. The Fe bands in such ores are of hematite (Fe_2O_3) and magnetite ($FeO·Fe_2O_3$), whereas the major Fe minerals in the weathered crusts of quartzites are hoethite ($FeOOH$) and hydrohoetite ($FeOOH·nH_2O$). To date, the existence of waters characterized by high Mo/V ratio values in the western coast (near the Bolshoy Cheremshaniy cape) have already been reported [10]. The enrichment of water of Selenga River with Mo could also be due to dissolution of primary Mo minerals like molybdenite (MoS_2), ferrimolybdite ($Fe_2(MoO_4)_3·8H_2O$) and povellite ($CaMoO_4$) contained in porphyry molybdenum deposits widely spread in upper Selenga basin [11]:

$$2MoS_2 + 9O_2 + 6H_2O \rightarrow 2MoO_4^{2-} + 4SO_4^{2-} + 12H^+ \quad (16)$$

$$Fe_2(MoO_4)_3 \cdot 8H_2O + 3H_2SO_4 \rightarrow 6H^+ + 3MoO_4^{2-} + 2Fe^{3+} + 3SO_4^{2-} + 8H_2O \quad (17)$$

$$CaMoO_4 + 2H_2O \rightarrow Ca(OH)_2 + MoO_4^{2-} + 2H^+ \quad (18)$$

The deposits of this type were formed as a result of mantle–crust interaction and are usually associated with silicate magmas varying in composition from mafic to intermediate and felsic [12, 13]. Since both Fe and Mo ores contain molybdenum, the upper vertex of mixing triangle on Sr/Fe-Mo/V (Figure 6a) and Sr/Mn-Mo/V (Figure 6b) diagrams was assumed to represent products of dissolution of ore-bearing silicate rocks, no matter whether it Fe ore-bearing silicate rocks or Mo ore-bearing silicate rocks.

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Weblinks for the used reference standards:

https://highpuritystandards.com/products/48-component-icp-ms-standard-at-10-g-ml-solution-a/
https://www.perkinelmer.com/product/magnesium-1-000-g-ml-2-hn03-icp-125-ml-n9300179
https://www.perkinelmer.com/product/sodium-1-000-g-ml-2-hno3-icp-125-ml-n9303785
https://www.perkinelmer.com/product/potassium-1-000-g-ml-2-hno3-icp-125-ml-n9303779
https://www.perkinelmer.com/product/ca-1-000-g-ml-2-hno3-icp-125-ml-n9303763