Russian Federation, Moscow,
Institute of Geochemistry and Analytical Chemistry

Trends in elements speciation in Imandra lake and small lakes of the Kola Peninsula

PhD Chemistry
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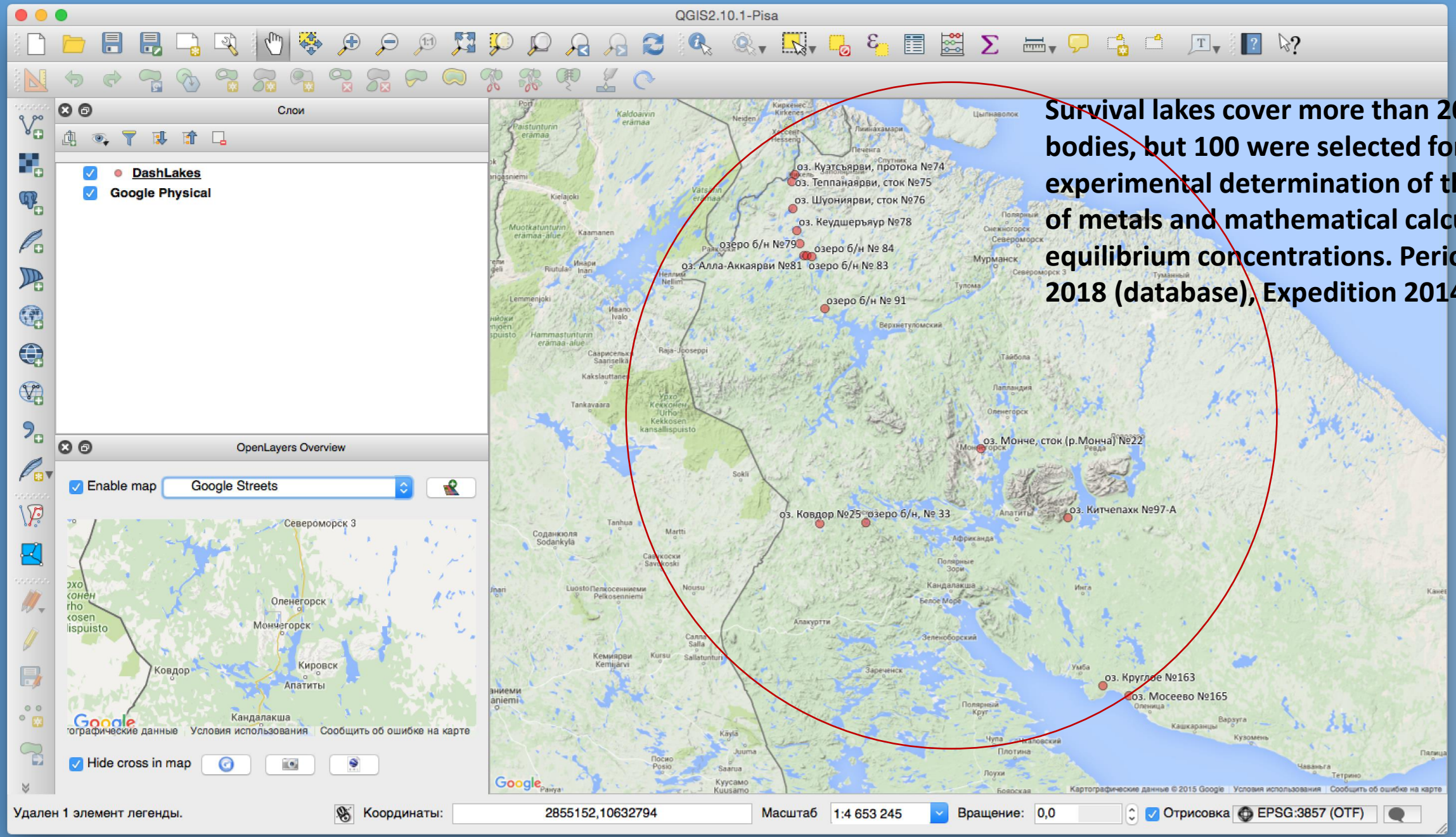
ICP Integrated Monitoring and ICP Waters, 2019

The issue of research

Speciation of metals in natural waters is an important information about the level of toxicity of a natural object. According to numerous published data the most dangerous form of migration of heavy metals (except mercury) is an ionic form.
However, the study of metals distribution forms in each water object is a task that requires a huge physical-chemical work.

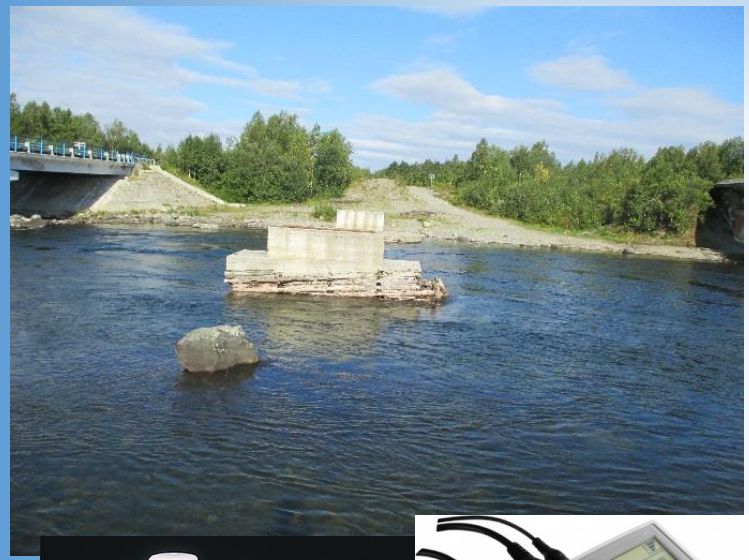
Understanding the patterns of element distributions in surface water and the reasons for the increase in their concentrations at the regional and global level is one of the most urgent problems facing the environment. Enrichment of surface water by metals is the result of both natural processes and human activities. The anthropogenic impact in the discharge of trace elements in the environment has increased dramatically over the last century, which is associated with the ever-increasing volumes of extracted metals and their dispersal in the environment.

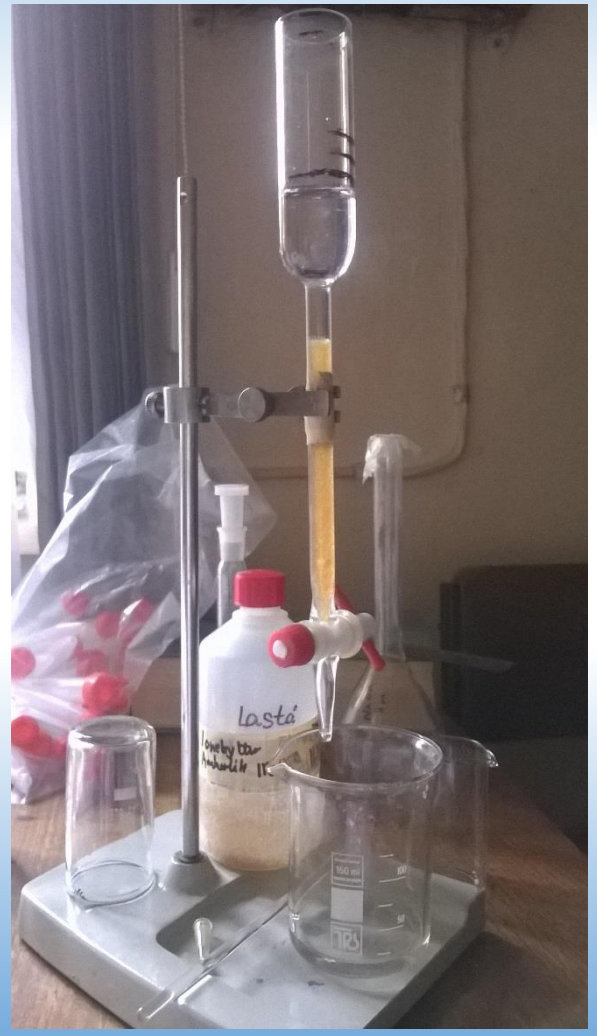
The aim of our research was to investigate the distribution of the metals speciation in water lakes on the Kola Peninsula under different anthropogenic load



Survival lakes cover more than 200 water bodies, but 100 were selected for the experimental determination of the forms of metals and mathematical calculation of equilibrium concentrations. Periods 1990 – 2018 (database), Expedition 2014, 2018

Survey Methodology





Analysis of real natural waters and practical application of developed membranes

Naturel samples and samples isolated by freezing

or filtration with a syringe near the lake

Shkinev V.M.

Filtrate system

1. Zetasizer analyses
2. Specification of HS
3. Concentration of metals
4. Metals forms
etc

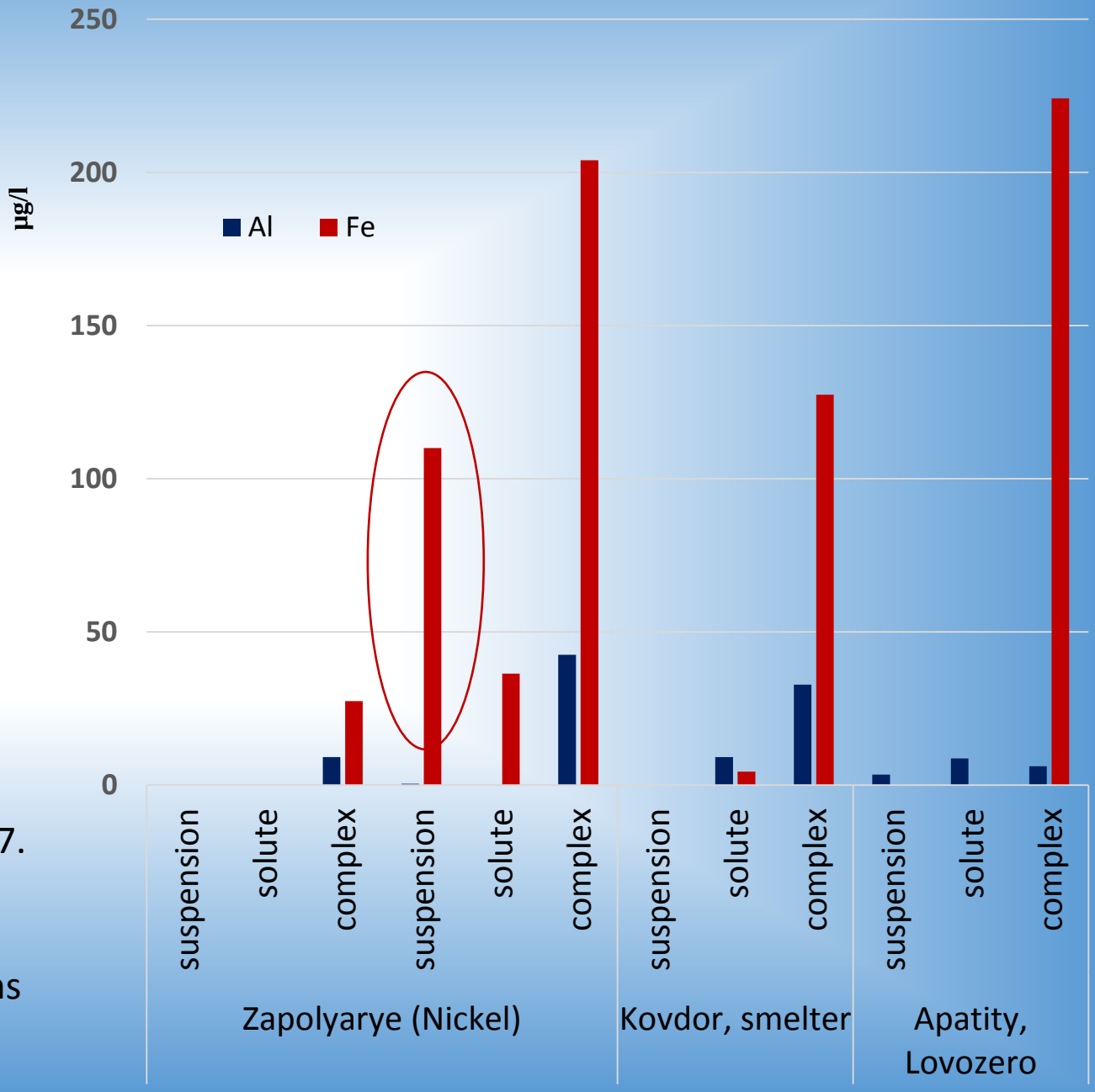
8,
1.2,
0,45,
0,2,
0,1,
0,05 µm
And
100 KDa

Lakes with direct source of pollution (2014-2018)

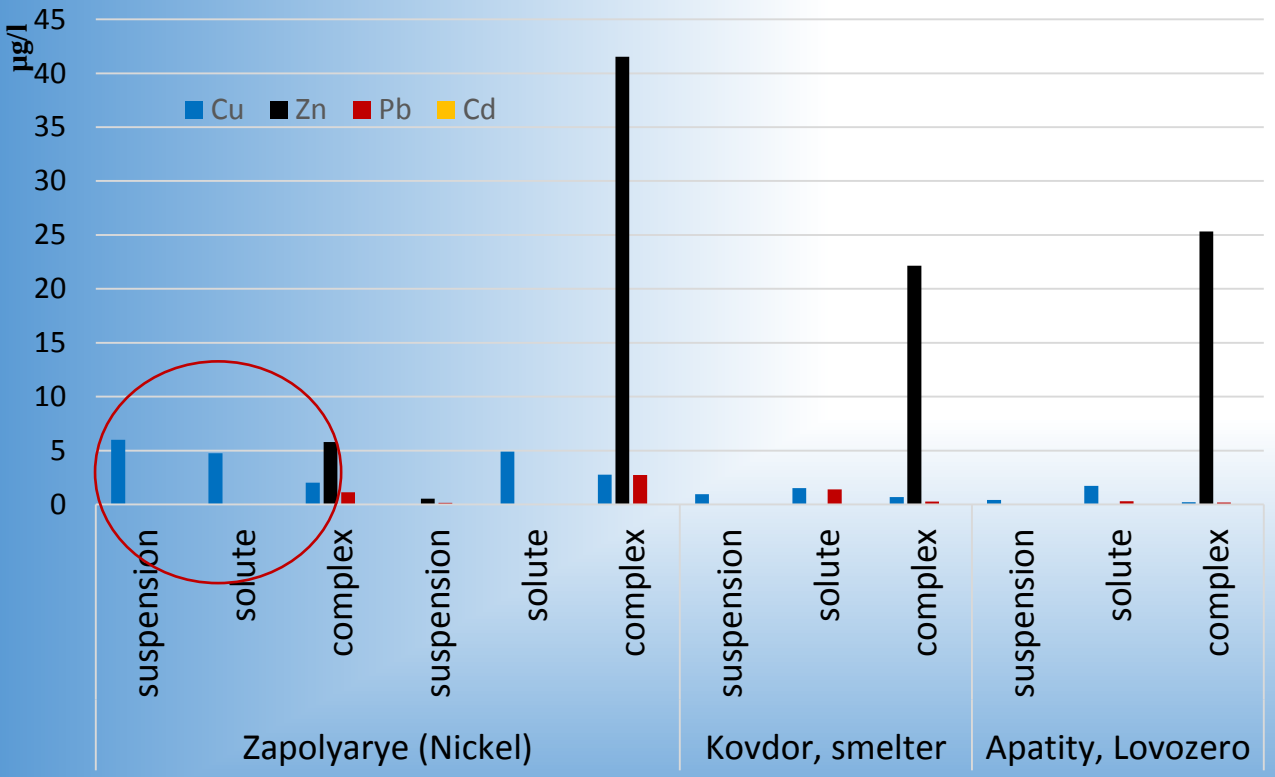
Parameters	Zapolyary (Nickel)		Kovdor, (Smelter)	Apatity, (Lovozero)
pH	7.01	6.50	8.21	6.62
Cond20	99	56	273	28
Color	121	158	143	215
AlK	299	316	1156	169

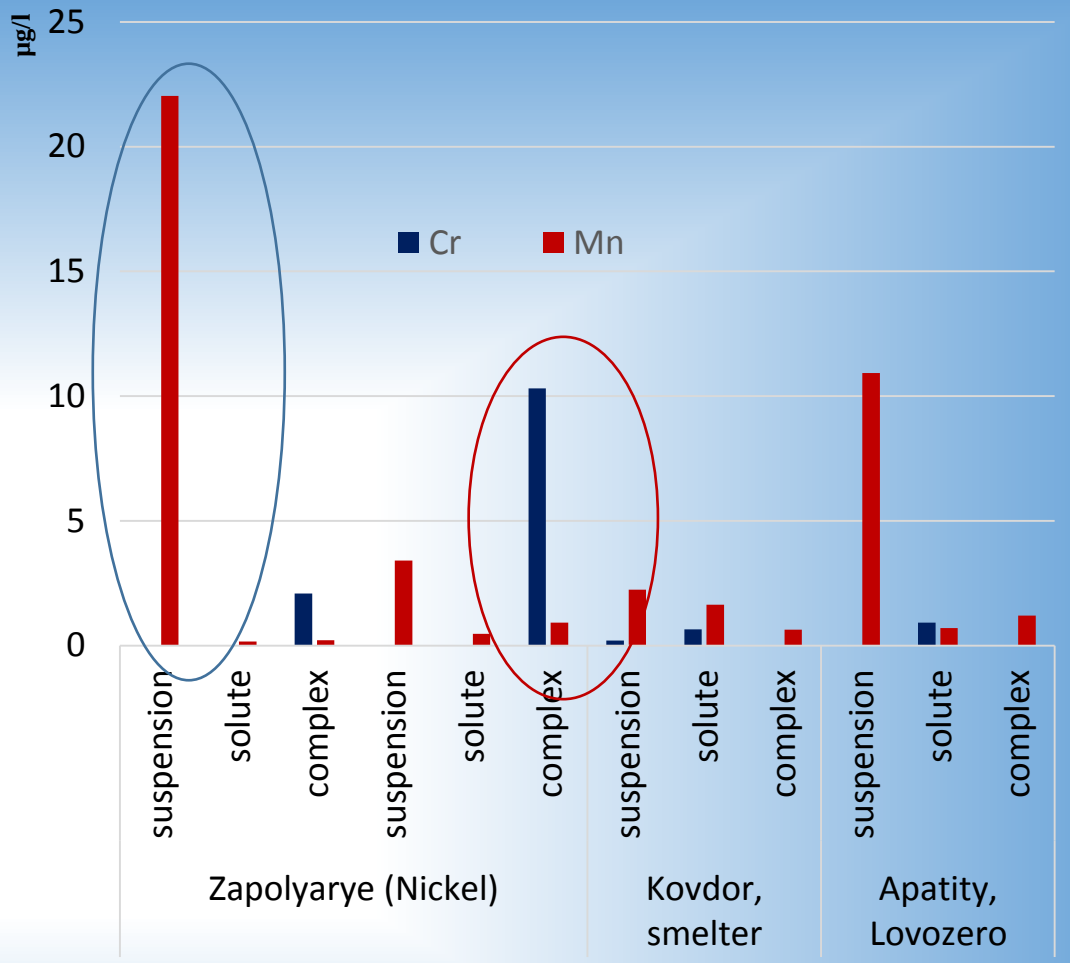
Samples of akes near industrial sites were selected for the study of finding forms of metals. were taken near the Arctic village, near the plant, was selected near the mining processing complex in Kovdor, from Lake Monche (Lovozero) near the copper-nickel manufacture

Natural waters characterized by high alkalinity and pH about 7. The iron ions at such pH values are more form hydrox-compounds and sorption aggregation compared with aluminum ions. Therefore, iron is characterized by three forms of being in natural waters.

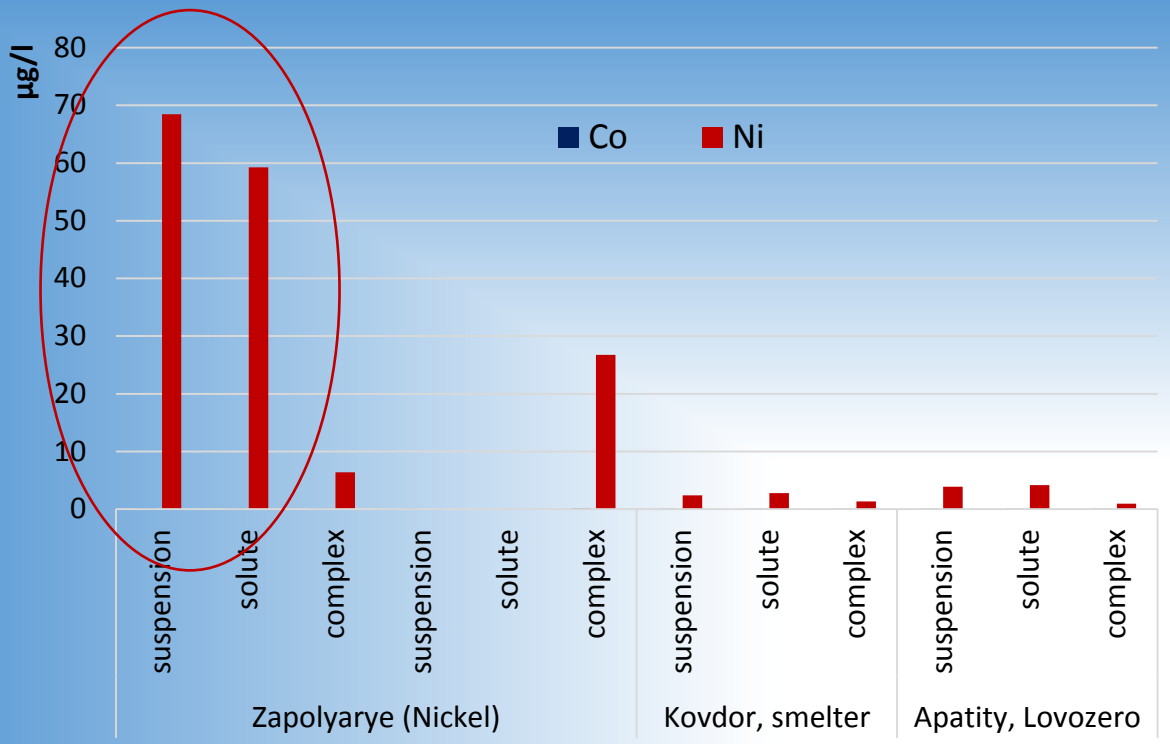


Under conditions of high load anthropogenic, chromium ions characterized by sufficient complexing capacity (pH 6.5), which may be due to an increase in the concentration of the metal is several times as compared with lakes without direct sources. Manganese in such conditions has a high capacity to form suspensions.

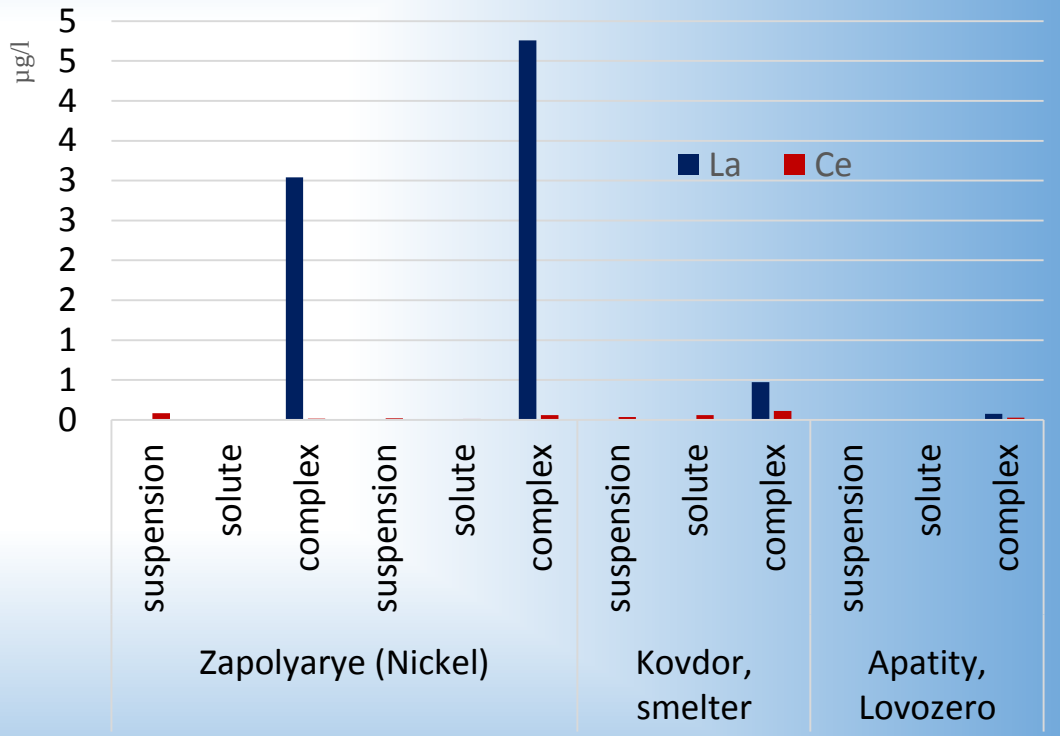




The complexation of heavy metals is modified as follows: as well as for lakes without a direct source of pollution, zinc is complexed by more than 50%, copper also forms complexes with organic matter actively due to a significant increase in concentration. Depending on the type of copper coming from the wastewater, copper may form sorption unit and the low-molecular inorganic compound.



Forms of a finding of nickel in natural waters with a direct source of pollution range from units to sorption complexes with organic matter. A significant increase in metal concentration shifts the equilibrium in the system towards formation of high-molecular compounds.



An interesting feature of the distribution of elements on the forms such natural waters is increasing the complexation with organic matter for the elements of the lanthanide series. Lanthanide elements is associated elements of many rocks of the Kola Peninsula, which explains the increase in their concentration in the areas near the plant.

The affinity of these elements to an organic substance as follows:

Fe>Al>Zn>Ni>Cu>Pb>La>Ce>Co

Lakes, with direct source of pollution (n=15) - membrane filtration

Filter	Zeta-potential, mV	Size, nm
8 μm	-30 (100%) / -35 (100%)	179 (100%) / 181 (100%)
1.2 μm	-17 (50%), -22 (50%) / -20 (70%), -25 (30%)	160.6 (70%), 70.5 (30%) / 167 (100%)
0.45 μm	-35 (100%) / -40 (100%)	180 (100%) / 185 (100%)
0.2 μm	-50 (50%), -52 (50%) / -60 (70%), -55 (30%)	35.6 (70%), 30.5 (30%) / 47.8 (100%)
0.1 μm	-27 (50%), -22 (50%) / -20 (70%), -25 (30%)	12.5 (70%), 10 (30%) / 30.6 (100%)
0.05 μm	-20 (60%), -20 (50%) / -15 (50), -15 (50)	<1
100 kDa	-25 (100%) / -25 (100%)	<1
< 0.25 μm After resin	-20 (50%), -25 (50%) / -25(70%), -25 (30%)	15.6 (70%), 10.5 (30%) / 45.8 (100%)
< 100 kDa After resin	--17 (100%), / --19 (100)	<1

General data (seasonal averages) - The numerator is a trial without preparation, the denominator is a sample after the release by freezing

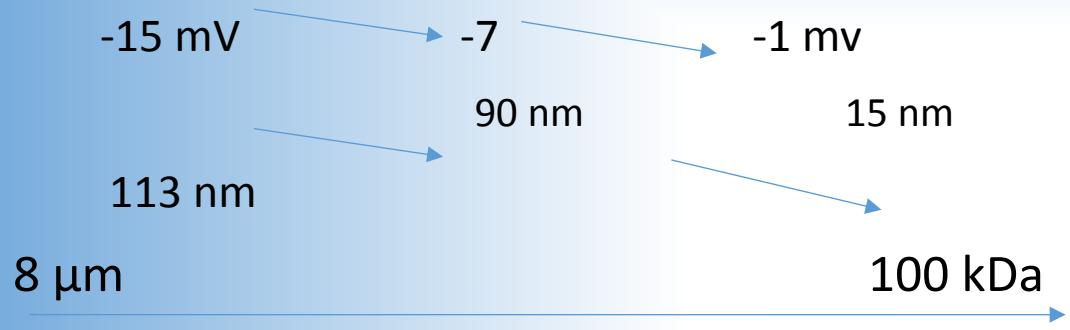
1-st results

- Polluted lakes are characterized by more different pH and concentration elements, high turbidity.
- High values of water turbidity determine a more diverse distribution of metals by fractions. Including associated with organic matter.
- High content of technogenic elements – Ni, Cu - create conditions for competition for organic ligand and the other formation of charge.
- Zeta potential change occurs dynamically and not smoothly.

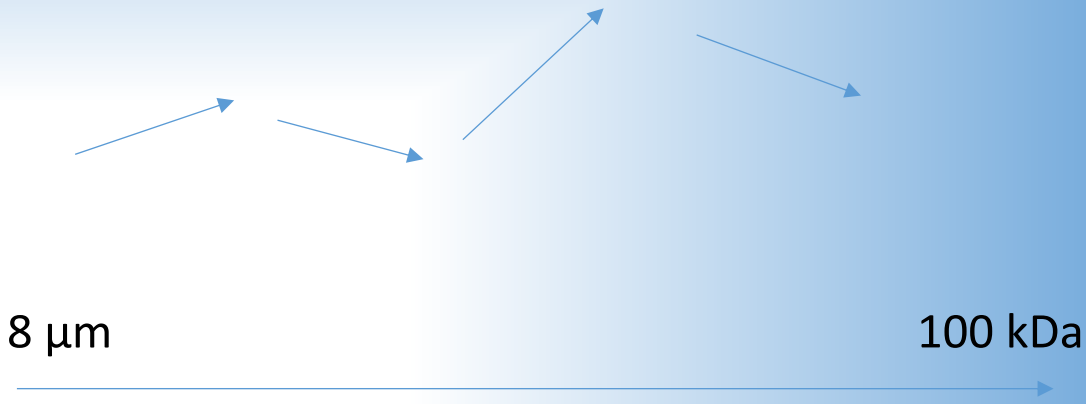
General conclusions

The outline of the main trends

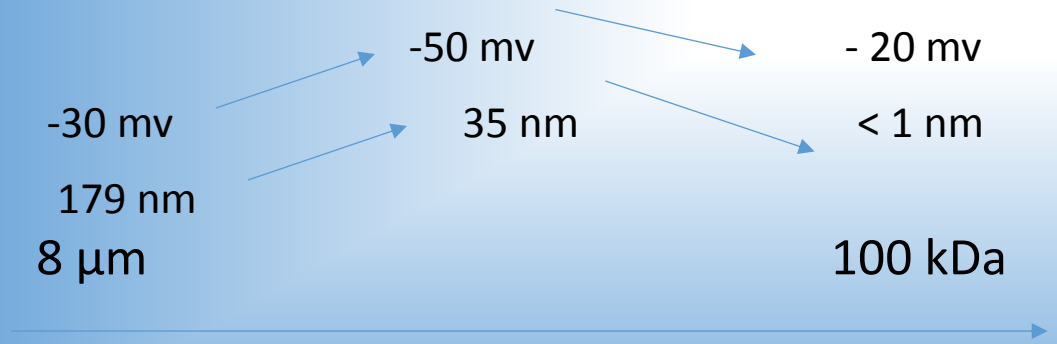
- Clear water



- Middle water



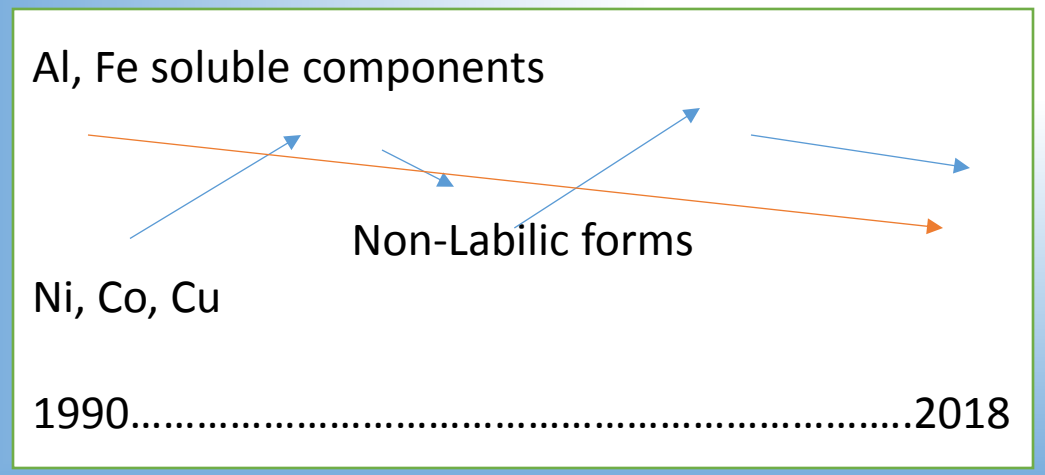
- Non-clear water



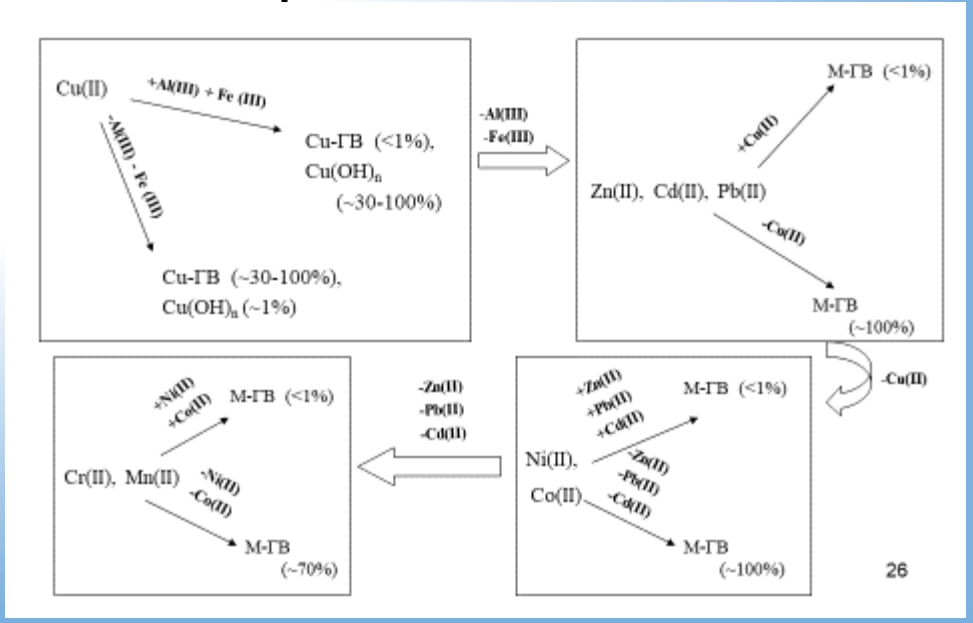
Middle waters (25 samples) are characterized by 2 maxima of zeta potential. The color of the solution does not change. Turbidity and pH vary widely.

Trends 1990-2014-2018

- 1990 - data (publications) Moiseenko T., Rodyushkin I. (ion exchange separation)
- 2014 - expedition data (ion exchange separation and membrane filtration)
- 2018 -expedition data (ion exchange separation and membrane filtration)



- 1995, 2000 and 2010 - calculation of labile and non-labile forms on the material balance and conditional stochastic constants of the complexes



Imandra Lake

- Yokostrovskaya
- Monche

Total: more than 15 points on the lake

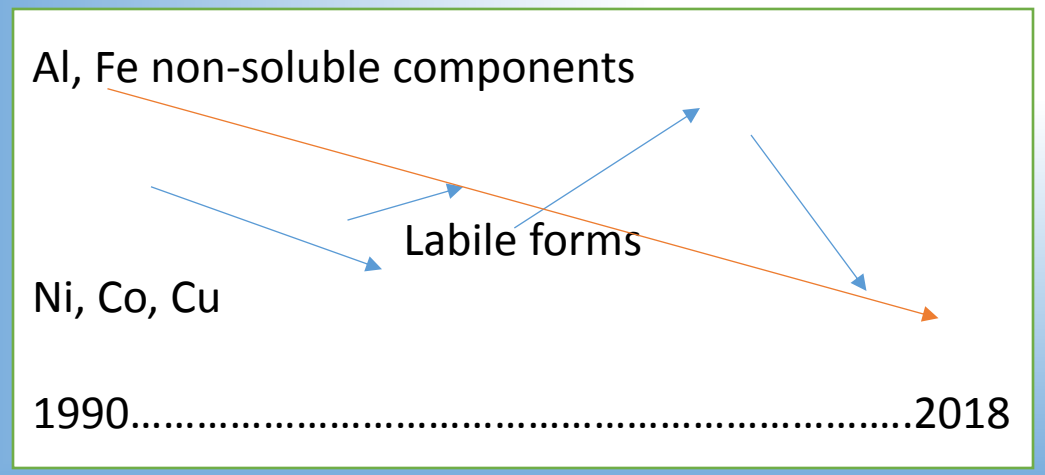
- Date of Moiseenko et al. about ion exchange separation 1990
- Database of chemical parameters from 1980s (every 4 years)

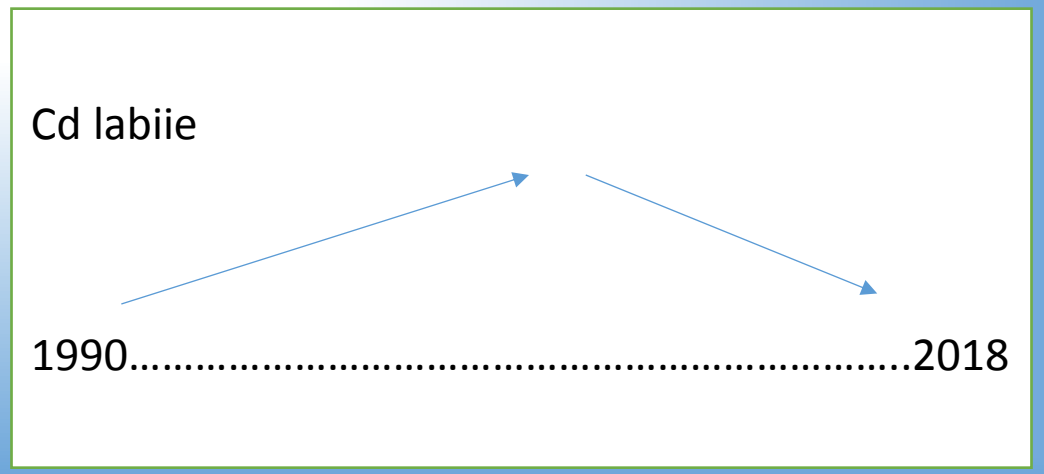
- ion exchange separation
- membrane filtration

- high electrical conductivity
- low color
- pH over 7

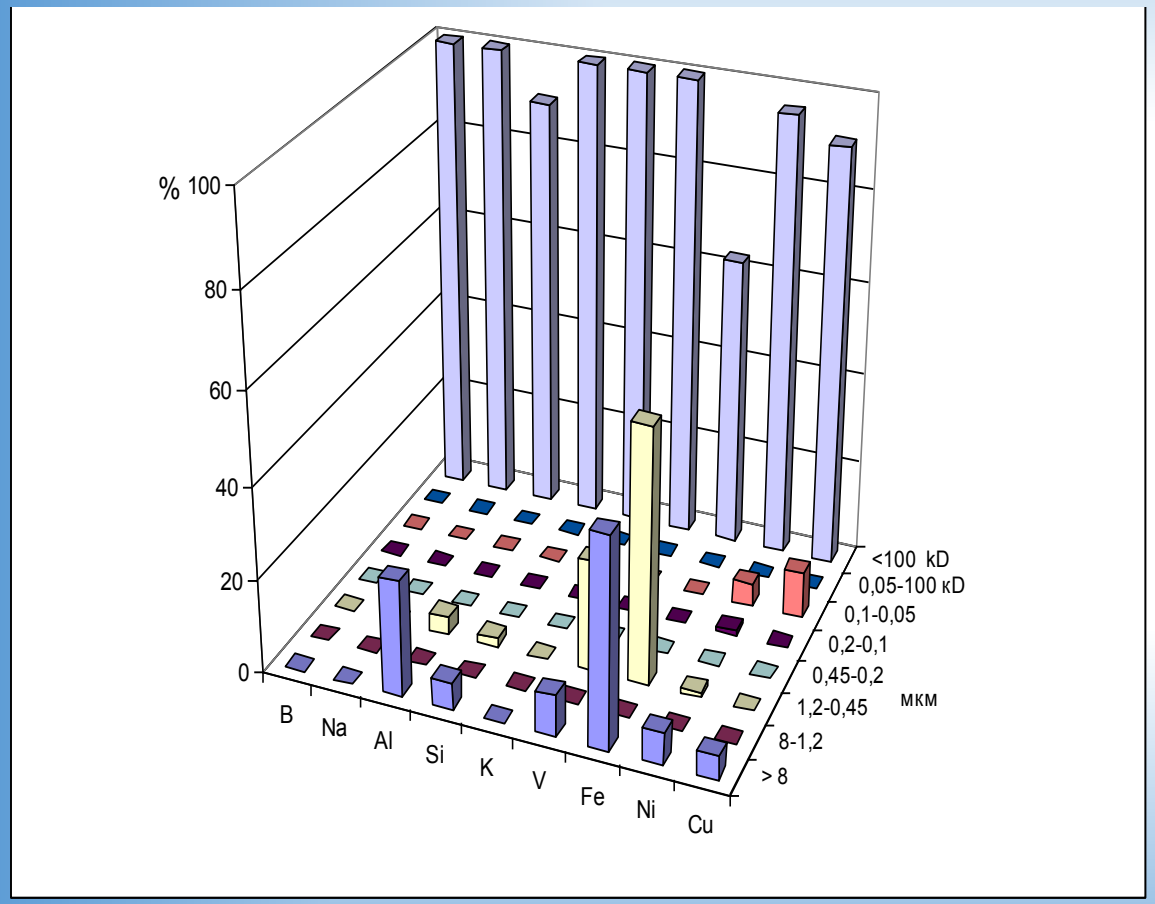
Trends 1990-…-2018 “Labile/non-labile”

- 1990 - data (publications) Moiseenko T., Rodyushkin I. (ion exchange separation)
- 2018 -expedition data (ion exchange separation and membrane filtration)
- Other - calculation of labile and non-labile forms on the material balance and conditional stochastic constants of the complexes

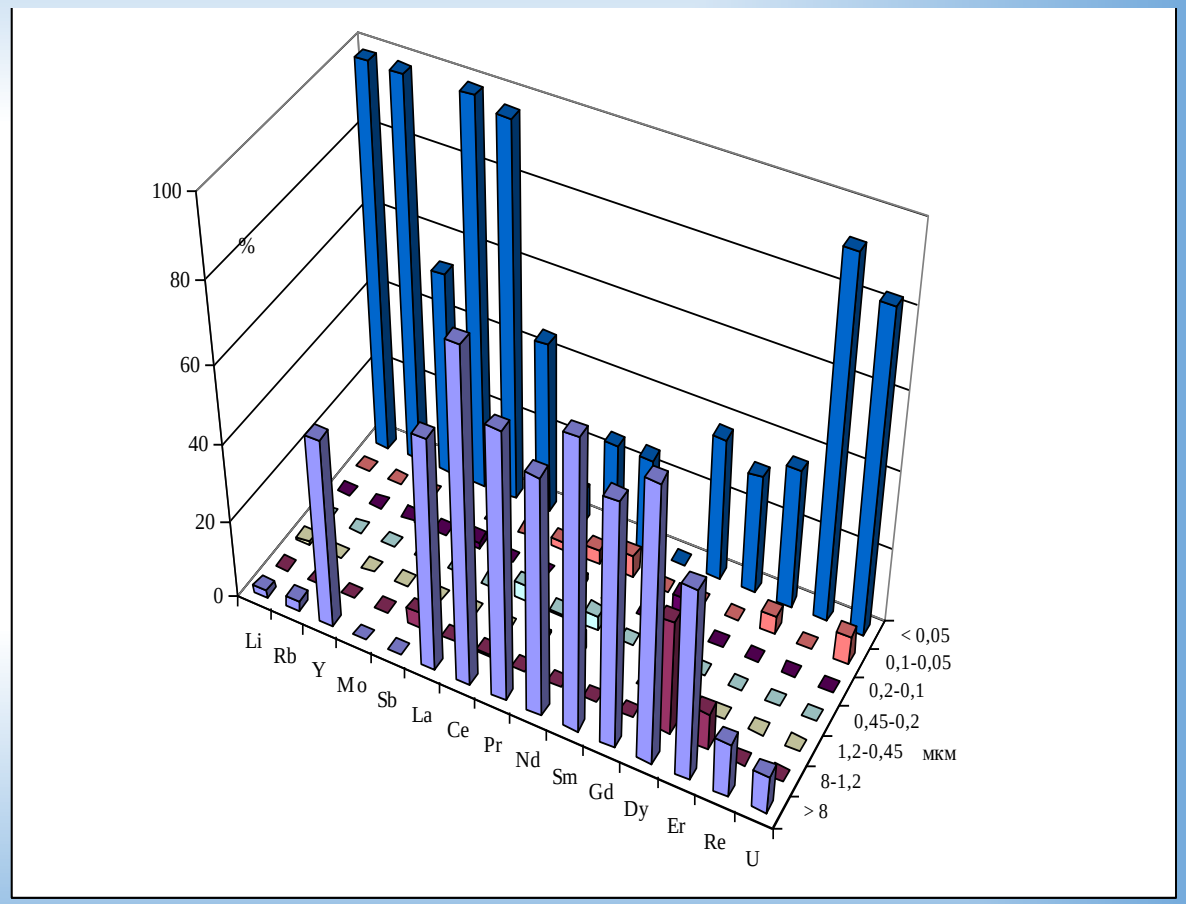


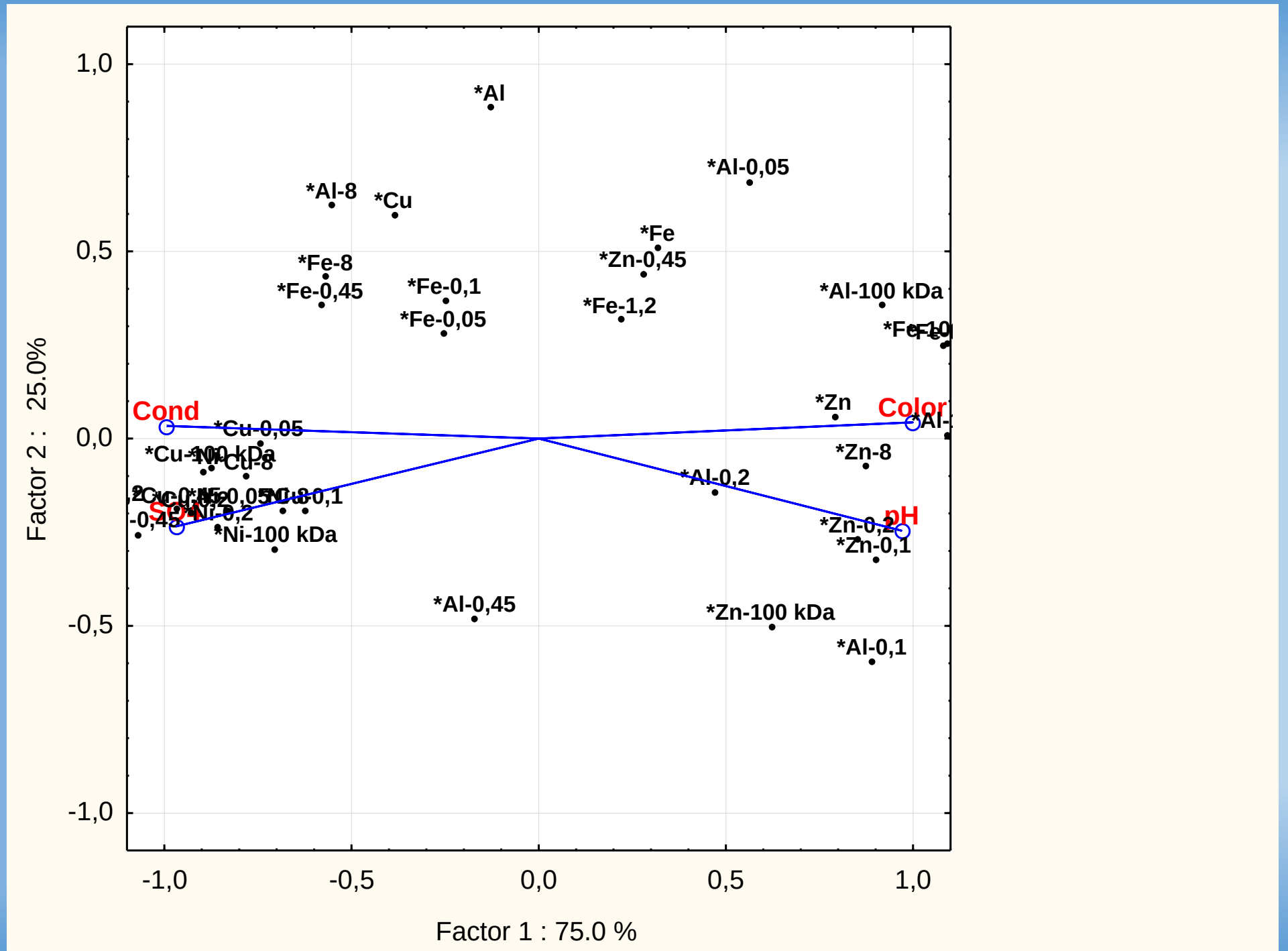


Yokostrovskaya



Monche




1,0
0,5
0,0
-0,5
-1,0
Factor 2 : 25.0%
-1,0
-0,5
0,0
0,5
1,0
Factor 1 : 75.0 %
*Al
*Al-0,05
*Al-8
*Cu
*Fe
*Zn-0,45
*Fe-8
*Fe-0,45
*Fe-0,1
*Fe-1,2
*Al-100 kDa
*Fe-0,05
*Zn
Color
Cond
*Cu-0,05
*Zn-8
*Al-0,2
pH
SO4
*Zn-0,2
*Zn-0,1
*Al-0,45
*Zn-100 kDa
*Al-0,1

Acknowledgment

Grant of the Russian Science Foundation 2018-2020

№ 18-77-00018 (for young scientists)

Laboratory of Evolutionary Biogeochemistry and Geoecology of GEOKHI RAS and Kola Scientific Center.

Thank you for your attention