CHEMICAL CHARACTERISTICS OF VERTICAL PROFILES OF THE TWO THERMOKARST LAKES IN THE RUSSIAN ARCTIC (THE LOWER KOLYMA BASIN)

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STUDY DESIGN

The continuing rapid climate warming leads to forecasts of permafrost degradation in the north Siberia, leading to various hydrological effects, i.a. changes in thermokarst lakes (their area, number, connection with non-frozen ground, and the chemical properties of lake water). Here, we aim to explore the **vertical chemical profiles in two small arctic lakes** (in the lower Kolyma basin) (Fig. 1). Water samples (n = 9) were collected in July 2021 and the dissolved phase concentration of 30 analytes: **inorganic ions, metals, non-metals and organic carbon** (OC) was determined in them. Enrichment factors of elements were calculated based on published mean concentrations in dissolved phase of World's rivers (Viers et al., 2009; Taylor, 1964).

Viers et al., 2009. Chemical composition of suspended sediments in World Rivers: New insights from a new database, Sci.Total.Environ. 407(853 – 868);
Taylor S.R., 1964. Abundance of chemical elements in the continental crust: a new table. Geochim. Cosmochim. Acta 28(1273-1285).

SAMPLING AREA

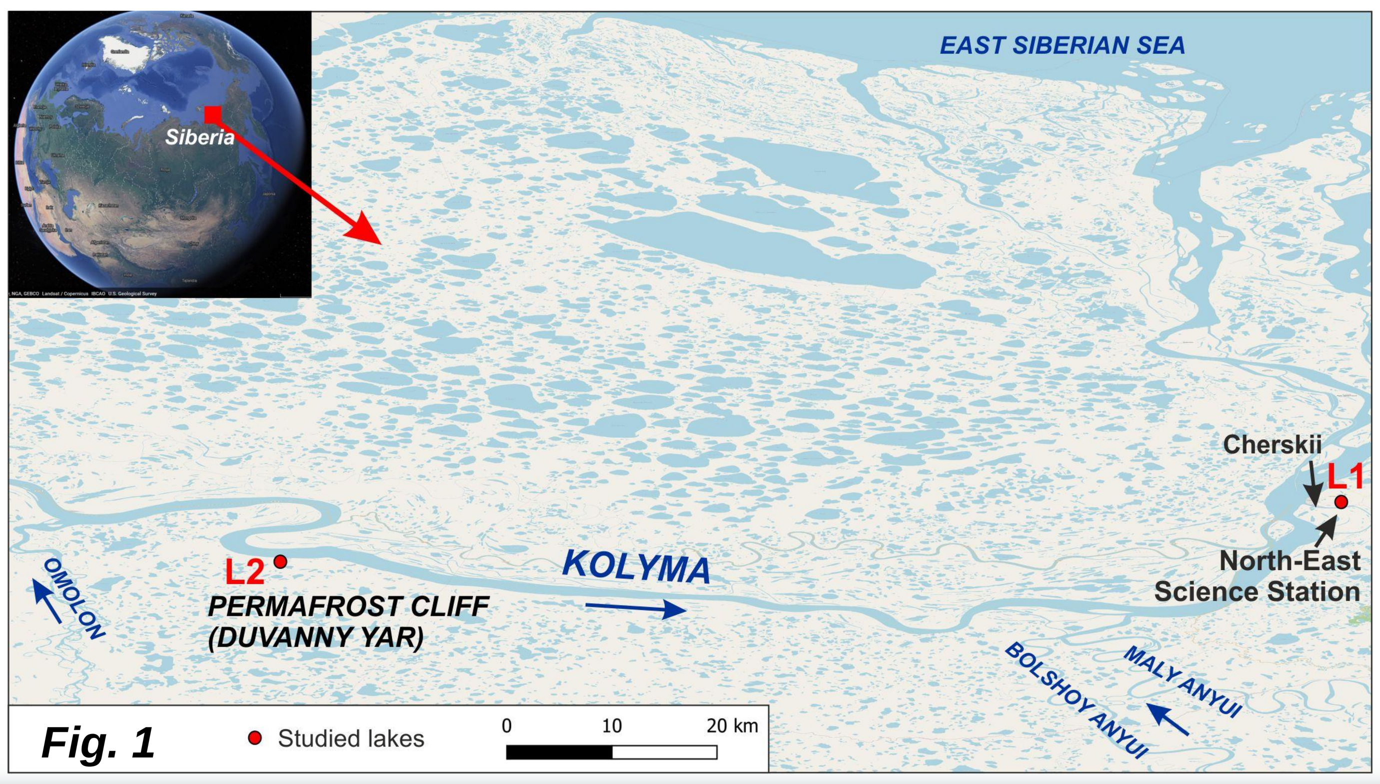


Fig. 1

RESULTS and DISCUSSION

The first of the studied lakes (Lake 1) is located close to the Cherskii town, and the second (Lake 2) is located far from the settlements, within the yedoma permafrost extent. Dissolved OC (DOC) concentrations ranged 17.8-29.5 $mg \cdot L^{-1}$ in Lake 1 (max depth 10.2 m) and 11.6-14.2 $mg \cdot L^{-1}$ in Lake 2 (max depth 5 m) (Table 1). Fe, Mn, Ni and Zn concentrations increased with depth in both lakes; as did Al, Sr in Lake 1, and Cu, Pb, Sb in Lake 2 (Figure 2, Sr & Sb not shown). The extremely high concentration of [Mn] = 1580-4610 $\mu g \cdot L^{-1}$ in Lake 1 were found, and [Cu] = 1370 $\mu g \cdot L^{-1}$, [Zn] = 687 $\mu g \cdot L^{-1}$ in the bottom waters in Lake 2. Near lake bottoms, an increased concentration of phosphorus was also found, 14.3 $\mu g \cdot L^{-1}$ in Lake 1 and 34.7 $\mu g \cdot L^{-1}$ in Lake 2. Enrichment factor calculated for the both lakes suggested contamination by several heavy metals.

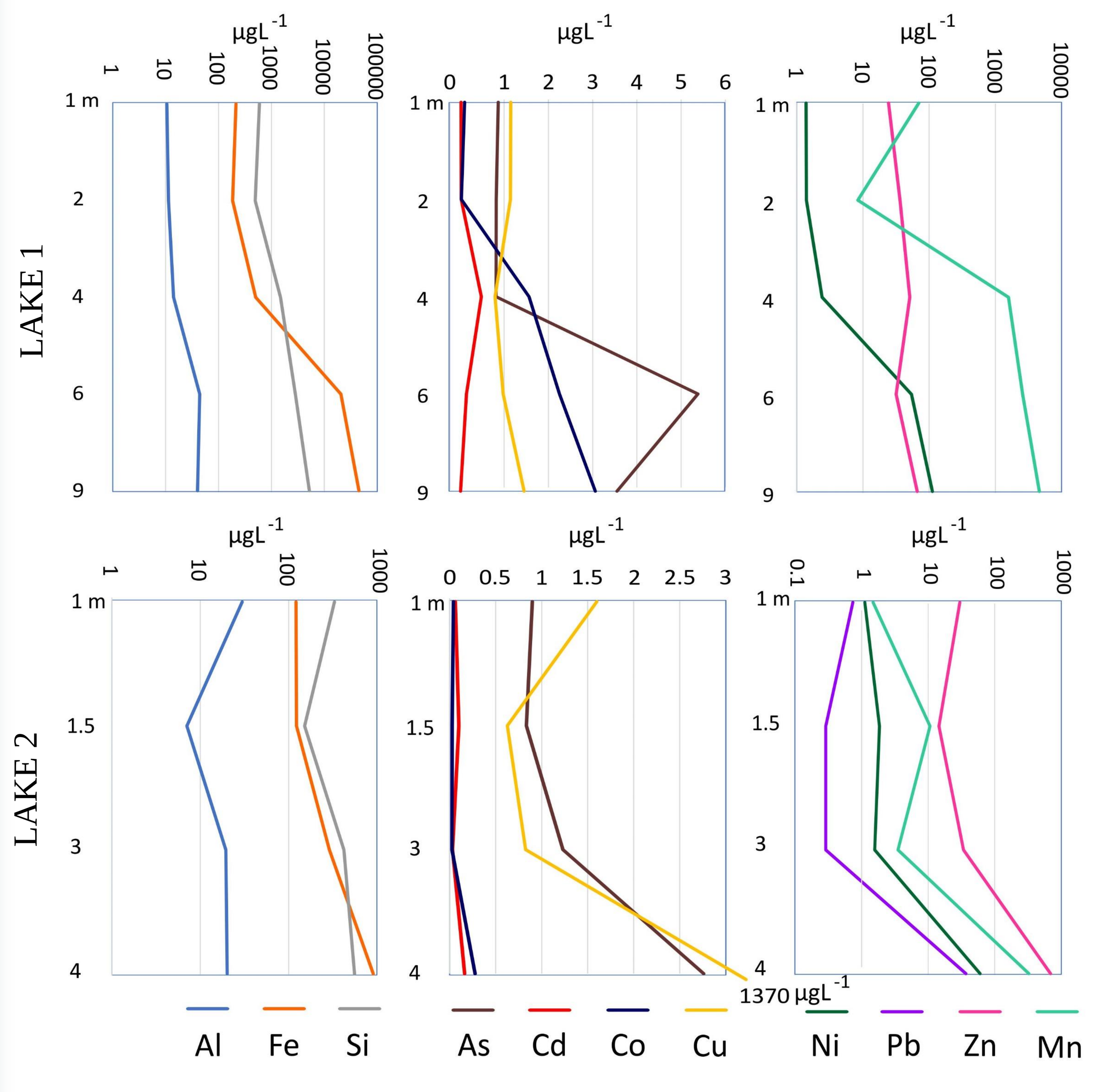
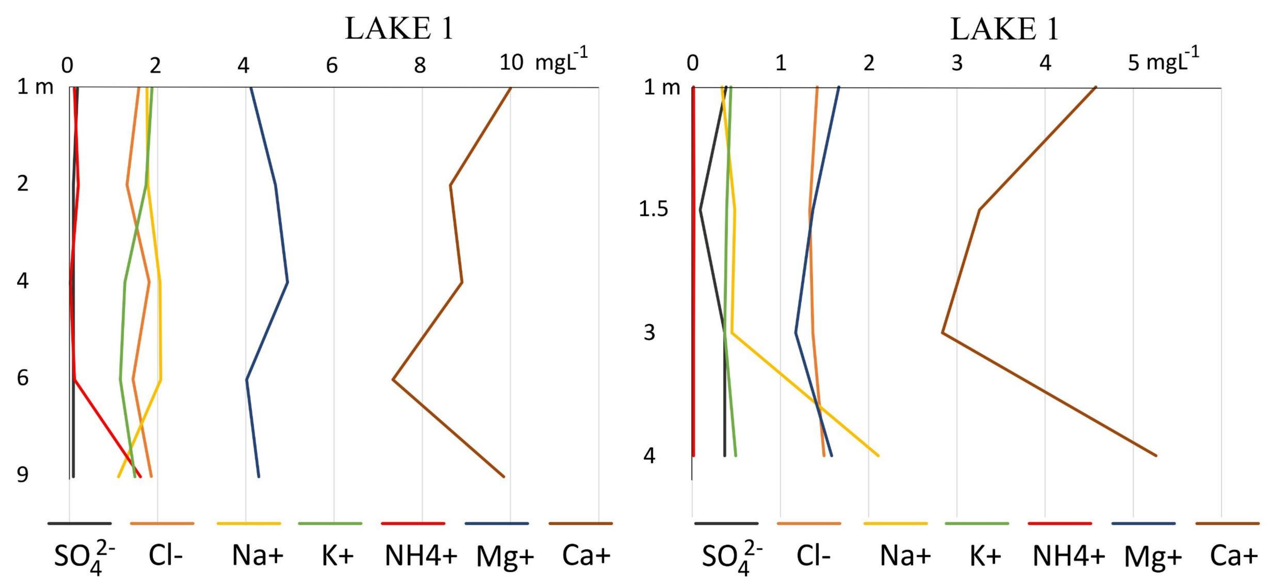


Fig. 2 *Selected metals concentration in lake waters*

Table 1 *DOC,pH, conductivity and enrichment factor >1 for heavy metals*

Lake - depth	DOC [mgL^{-1}]	pH	SpC [$\mu S\ cm^{-1}$]	EF>1
L1 - 1m	18.4	7.1	65	As, Co, Mn, Ni, Zn
L1 - 2m	17.8	7.2	65	As, Ni, Zn
L1 - 4m	19.4	6.8	90	As, Cd, Co, Mn, Ni, Zn
L1 - 6m	20.5	6.8	253	As, Co, Mn, Ni
L1 - 9m	29.5	6.9	318	As, Co, Mn, Ni, Zn
L2 - 1m	12.1	6.9	48	
L2 - 1.5m	13.0	7.0	47	As, Cd, Ni, Zn
L2 - 3m	14.2	7.0	48	As, Ni, Zn
L2 - 4m	11.6	6.7	51	As, Cd, Co, Cu, Mn, Ni, Pb, Zn

Fig. 3 *Cations and anions in lake waters*



Lake 1

Lake 2

MEASUREMENT INSTRUMENTATION

Table 2 *Technical specifications used in the applied analytical procedures*

ANALYTES/ PARAMETERS	MEASUREMENT INSTRUMENTATION
Metals & metalloids	ICP-MS & ICP-OES Elan DRC, PerkinElmer, USA
DOC	Analyzer TOC-$V_{CSH/CSN}$, Shimadzu
cations & anions	ION CHROMATOGRAPH DIONEX 3000 chromatograph, USA
pH & conductivity	YSI multiparameter probe, Digital Professional Series
Sampling preparation	filtering through Whatman® GFF 0.7 µm pore size membrane

CONCLUSIONS

- The highest concentrations of most of the studied elements were found in the lake bottom waters, suggesting that thermokarst lakes act as local traps for elements, including heavy metals.
- The notable increase in Cu, Ni, Pb and Zn concentrations in deep lake waters indicate the likely source of these elements in permafrost thaw, talik water, or enhanced mobility of suprapermafrost water eluting them from soils.
- Due to the dynamically increasing number of thermokarst lakes, and their predicted drainage with the advancing climate change, the sedimentation in these lakes and the biogeochemical processes happening in them will likely be of high importance in studies of continental permafrost areas

ACKNOWLEDGMENTS

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