

Thawing Off a Cliff: Organic Chemicals in Surface Waters Connected to a Degrading Yedoma Bank Outcrop (Kolyma, Siberia)

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1. INTRODUCTION

Permafrost landscape consists of a variety of frozen grounds, including the ice- and carbon-rich yedoma (occurring in Siberia, Alaska, and northern Canada), which sheds significant amounts of carbon into surface waters as a result of climate warming (Mann et al. 2022). The ice in yedoma had been formed through a variety of processes, including syngenetic ice-wedge expansion (Shur et al. 2022). Yedoma may thus contain refrozen meteoric waters of various age with various chemical traces. Permafrost has been shown to include not only a large organic matter burden, but also mercury (Fabre et al. 2024) and polycyclic aromatic compounds (PACs) of mixed origin (Muir et al. 2025; Muir and Galarneau 2021). We have demonstrated recently (Szumińska et al. 2023) that it may also be a source of other metals and metalloids released into the surrounding waters with thaw. Here, we have further investigated into the organic chemistry of various surface waters connected to and more distant from a yedoma cliff on the bank of the great Arctic river Kolyma to determine what other effects may be associated with its thaw and thermoerosion-driven input into the river.

2. MATERIALS AND METHODS

In July 2021, we collected 28 water samples from the lower Kolyma river and tributaries, two thermokarst lakes, yedoma ice and meltwater creeks (Fig. 1). PAHs were determined using GC-MS. Having analysed their concentrations of dissolved and suspended sediment fraction of PAHs and further organic compounds, we also drew parallels with the Szumińska et al. (2023) study on metals and metalloids, determined with ICP-MS and ICP-OES.

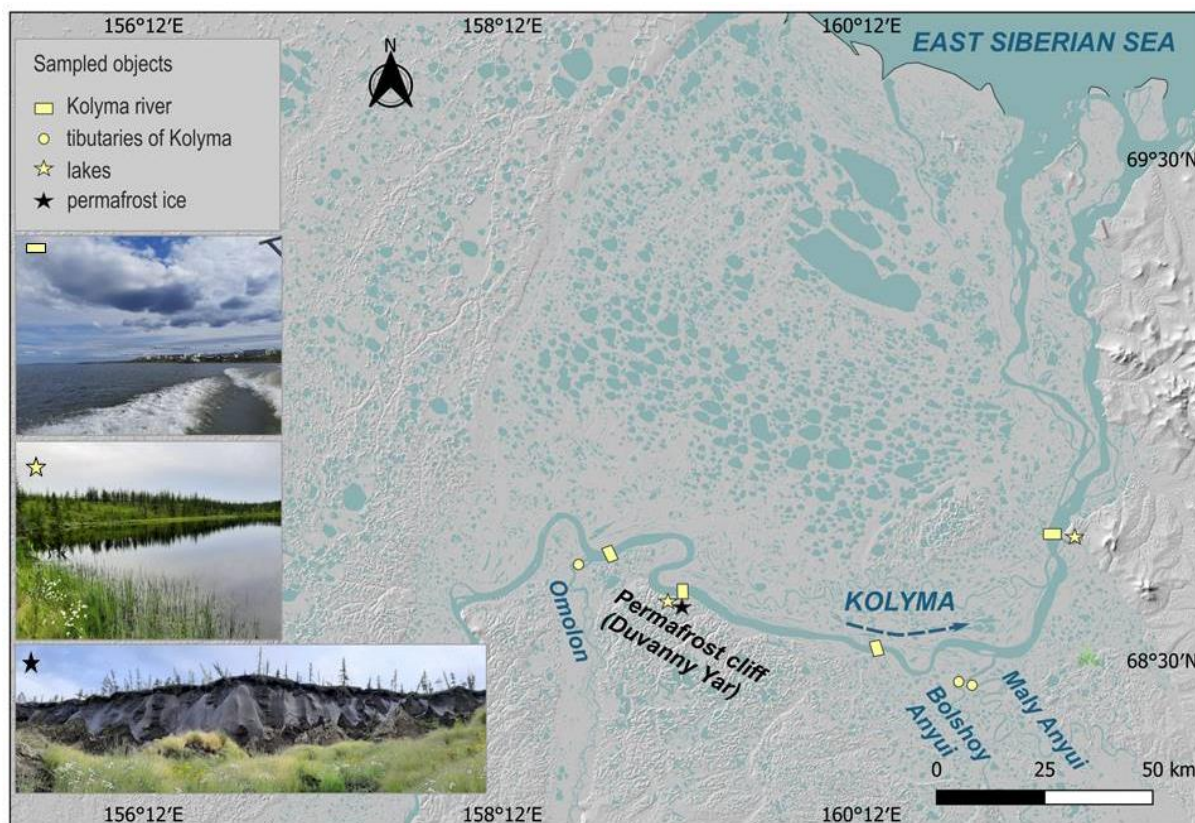


Fig. 1. Location map and example photographs of the sampled objects in the Kolyma river watershed.

3. RESULTS

PAHs concentrations in the collected samples ranged $1.12\text{--}30.2 \times 10^3$ ng/L, predominantly in the suspended sediment fraction. The highest concentrations pertained to two yedoma meltwater creeks and the current of Kolyma downstream of the yedoma cliff. High suspended sediment PAHs concentrations were also observed in other samples in the area, potentially connected to permafrost thaw. We explored also PAHs congener profile of the permafrost creeks and other organic compounds in these waters.

4. CONCLUSIONS

Thawing yedoma may lead to increased concentrations of various inorganic and organic chemicals in surface waters, with potential impact on downstream ecosystems. The mechanisms and dynamic of such transfers warrant further study.

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