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Report from the cruise aboard RV Join Us and scientific fieldwork conducted from 22nd June to 25th September 2022 following the Licence for scientific research for natural resources on the Norwegian continental shelf Licence no.: 821/2022.

The marine scientific research cruises were conducted by Poland with the research vessel "JOIN US Sailing yacht", call sign SPS3259, within the period: from 22nd June to 25th September 2022:

- from 22nd to 30th June 2022 (cruise Reload 1)
- from 21st to 28 July 2022 (cruise Reload 2)
- from 18 to 26 August 2022 (cruise Reload 3)
- from 15th to 25th September 2022 (cruise Reload 4)

Reload 1 (22-30.06.2022)

Due to very bad weather cruise started with 3.5 days delay on 26.06.2022. We spend several hours anchored close to the Polish Polar Station and then only one day at the front of Storbreen in Brepollen (Hornsund) where we have collected samples of seawater by bathometer. We did CTD measurements during sampling. We made ADCP profiles at Storbreen front (within safe distance of 250m). We also settled 3 months multisediment trap 1km from the Storbreen front and two 1 months sediment traps on the sides of multisediment trap (all instruments are underwater and had no buoy on water surface). We settled and collected one day sediment traps. We came back to Longyearbyen on 29.06.2022.

Reload 2 (21-28.07.2022)

Fieldwork was successful. We started on 21.07 evening and we arrived to Hornsund on 22.07. We conducted seawater sampling by bathometer at the front of Storbreen and Hornbreen in

Brepollen. We performed CTD measurements during sampling. We made ADCP profiles at Hornbreen front (within safe distance of 250m). We settled and collected one day sediment traps. We collected two month sediment traps from Storbreen glacial bay. We used remotely operated surface vehicle to collect samples at the glacier fronts of Storbreen and Hornbreen. We came back to Longyearbyen on 27.07.2022.

Reload 3 (18-26.08.2022)

The weather was very bad at the time when fieldwork was planned. The winds of even 50knt did not allow to realize whole fieldwork plan. We left Longyearbyen two days later than planned - on 20.08.2022. We sailed to Hornsund and we spent only 1,5 day in the fjord. We collected seawater samples by bathometer at fronts of Storbreen and Hornbreen glaciers. We conducted CTD measurements. We tried to use remotely operated vehicle to collect seawater samples directly from the glacier meltwaters but there was a lot of calving and it was impossible to reach glacier fronts. On 23.08.2022 we sailed back to Longyearbyen and we stayed in the harbour till 26.08.2022.

Reload 4 (13-23.09.2022)

Fieldwork was successful. We started on 13.09 evening and we arrived to Hornsund on 14.09. We sampled seawater by bathometer at the Storbreen at Hornbreen glacial bays. During sampling we performed CTD casts. We removed anchored 3 months sediment trap. From 18.09 to 19.09 we were anchored in Hansbukta and worked at Polish Polar station laboratory. The time spent in Hornsund was few days shorter since the weather was worsening. On 19.09 night we sailed to Longyearbyen and from 20.09 we stayed safe at the Longyearbyen harbour.

The measurements and samples:

At Storbreen and Hornbreen glaciers 4 sampling points were performed within 300m, 500m, 1000m and 5000m distance from the glacier fronts. Seawater from three depths was collected: 1m, 15m and 50m.

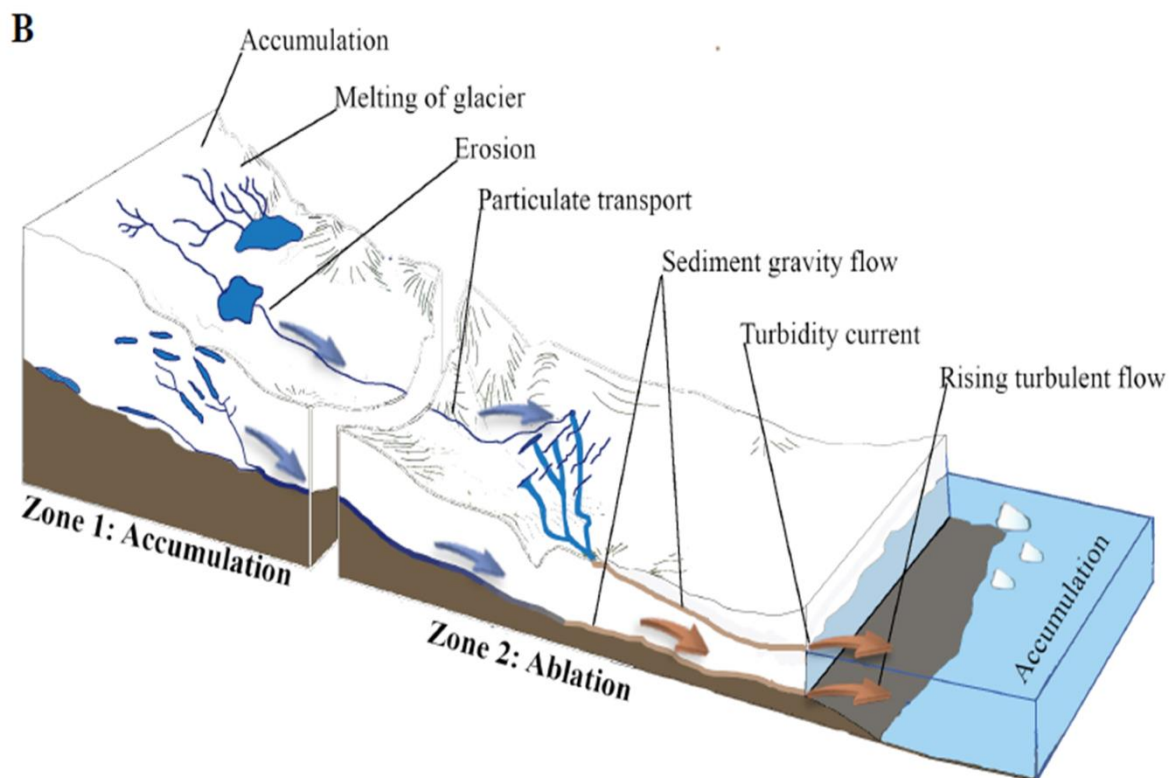
Seawater measurements: temperature, salinity (zip text file attached) pH, redox, oxygen content, DOC concentration, SPM content, heavy metal concentration (database attached)

Attached you will also find scientific report with first project results. The project will end in November 2024, the final results will be ready and published at that time.

HEAVY METAL CONCENTRATIONS AND ORIGIN IN SUSPENDED PARTICULATE MATTER TRANSPORTED WITH GLACIER MELTWATERS (HORNSUND, SVALBARD)

Introduction

The most important anthropogenic source of heavy metals in the Arctic is a long-range atmospheric transport. The pollutants carried by air masses deposit on the land, and glacier surfaces with precipitation. When snow and ice melt heavy metals are transported to the fjord with glacier meltwaters. Svalbard is warming almost four times faster than the rest of our planet, leading to increased melting of glaciers and permafrost, which in turn causes an increase in the supply of meltwater to the marine ecosystem.



Transport of meltwaters containing airborne pollutants within the tidewater glacier system

The 70% of Hornsund area is covered by glaciers. The largest glaciers discharge meltwater to Brepollen Bay. Since Brepollen is separated from the fjord by Treskelen peninsula and an underwater sill at the depth of 50m, the water exchange in inner part of the fjord is limited. Thus Brepollen can act as a trap for contaminants discharged by glaciers.

Our aim is to study distribution of heavy metals in Brepollen and further to calculate heavy metal discharge with the glacier meltwaters.

Materials and methods

Samples of seawater were collected at 2 glaciers: Hornbreen and Storbreen (Hornsund) in June, July, August and September 2022. Meltwater samples at the glacier fronts were collected by ROV equipped in CTD while seawater samples at 300m, 500m, 1000m, 5000m distance from the glacier front were collected at 3 different depths using a rosette with CTD.



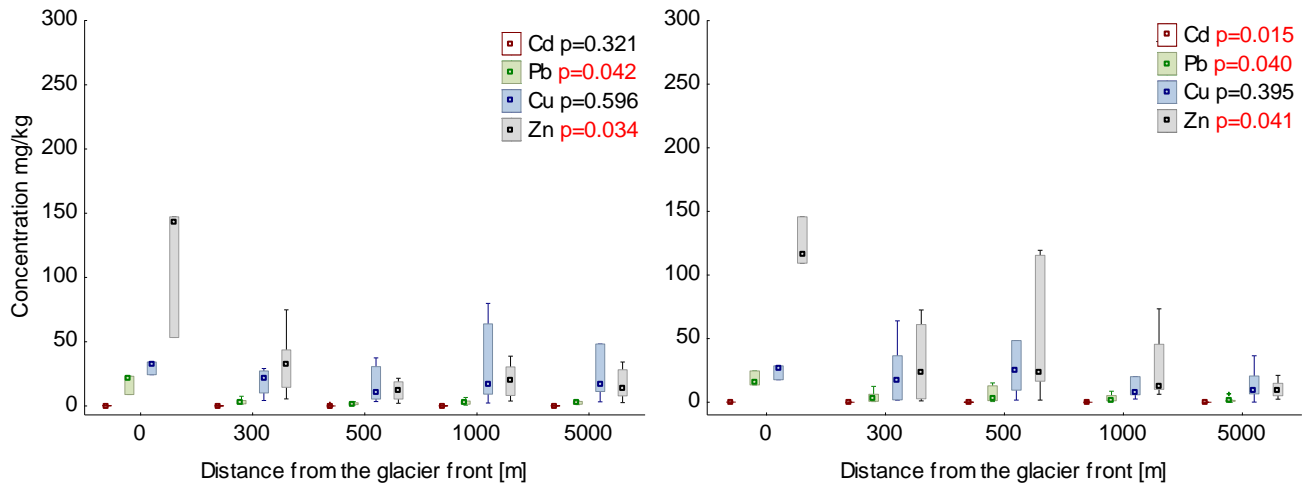
Study area with stations marked by red dots. The sampling by bathymeter rosette with CTD and surface remotely operated vehicle

Seawater samples for metal analysis were filtered through MF-Millipore filters. The SPM concentrations were obtained by sample filtration through pre-weighted paper filters. Frozen

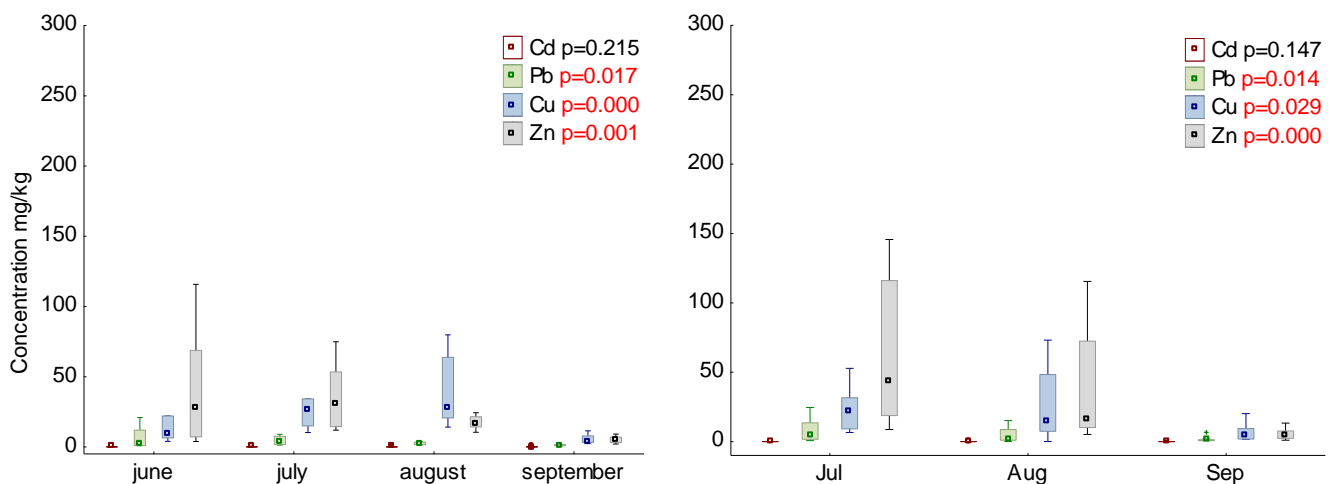
filters were transported to IO PAS laboratory. Filters were then mineralized in microwave mineralizator. The concentrations of selected heavy metals (Cd, Pb, Cu, Zn) were measured using ICP-MS. Pb isotopic composition was measured to identify Pb source.

Results and first conclusions

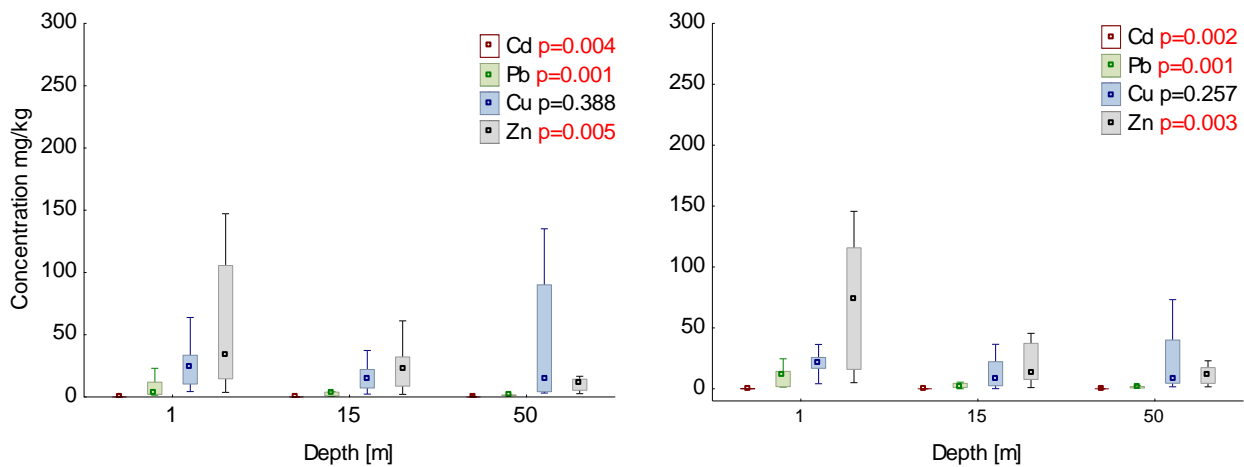
Higher concentrations of heavy metals were observed in samples collected closer to the glacier front, than in samples collected further away.



The concentrations of heavy metals showed statistically important monthly differences. The highest median of metal concentrations was measured in July.



The Cd, Zn and Pb concentrations were the highest in the surface water and decreased with increasing depth.



Conclusions

- The concentration of SPM in Storbreen and Hornsbreen glacial bays ranged from 0.03 to 0.34 g/L.
- The concentrations of heavy metals (Cd, Pb, Cu, Zn) in suspension varied with distance from the glacier front, time, and with sea depth.
- There are no statistically significant differences in concentrations of all analyzed heavy metals at both studied glaciers.
- The results obtained were higher than those measured in SPM in the central Hornsund (Zaborska et al., 2020) and comparable to values measured in marine sediments in Hornsund (Zaborska et al., 2017).

References

- Zaborska, A., Beszczyńska-Möller, A., Włodarska-Kowalczyk, M. 2017. *History of heavy metal accumulation in the Svalbard area: Distribution, origin and transport pathways*. Environmental Pollution, 231, 437–450.
- Zaborska, A., Strzelewicz, A., Rudnicka, P., Moskalik, M. 2020. *Processes driving heavy metal distribution in the seawater of an Arctic fjord (Hornsund, Spitsbergen)*. Mar. Poll. Bull. 161, 111719.

Acknowledgments

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