Study of sea water chemistry changes due to thawing permafrost

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The main objectives of this work were to access the potential influence of thawing permafrost on chemical characteristics and pollution of sea waters. The data was obtained during the joint Norwegian-Russian expedition on 19-28 of June 2018 in the coastal zone of Svalbard. The studies were performed in the frame of the international project «ICOTA» funded by the Research Council of Norway (RCN). This multidisciplinary project of Norwegian-Russian collaboration in the Arctic region is devoted to data collection on chemical regime of coastal waters, carbonate system and biochemical parameters influenced by thawing permafrost and intercalibrations between laboratories in Norway and Russia. Field observations and estimations show that permafrost thawing can influence significantly on chemical parameters of marine waters which can also contribute to the processes in high polar marine ecosystems. The expedition was based in Longyearbyen (Fig. 2), water samples were collected in the harbor, samples of permafrost (PF) were collected from an abrasive cliff (Fig. 1) located about 10 km west from Longyearbyen near the airport.

Fig. 1: Sampling procedure

During this study a laboratory experiment was performed (Fig. 3-4) which showed the potential changes in sea water content due to thawing permafrost.

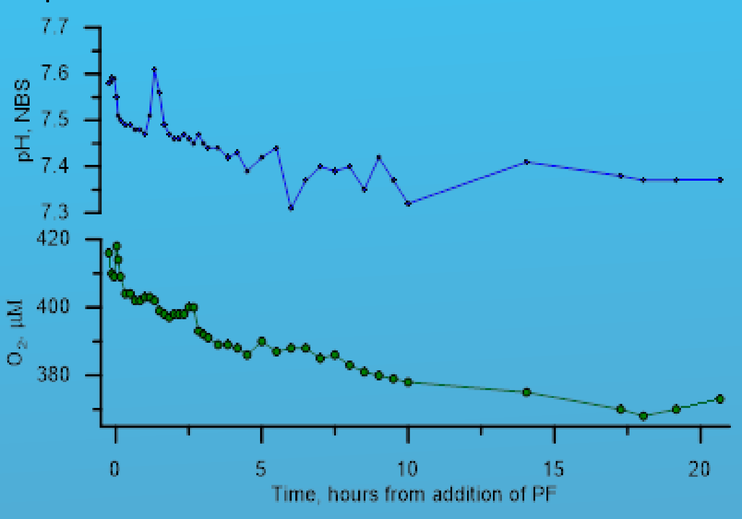

Fig. 3: Change of pH and oxygen concentrations due to melting of permafrost in the sea water.

The experiment consisted of two parts:
1. Permafrost samples were placed in a series of containers; 1 liter of sea water was added there. After a certain period of time, water was taken from tank No. 1 for various types of analysis (pH, nutrients, alkalinity, heavy metals), after the second time interval - from tank No. 2, etc.

Fig. 2. Research area
Longyearbyen is located in Isfjord on the west coast of Svalbard.

At the end, a series of seawater samples with different permafrost contact times were obtained. A total of 19 samples were taken within 5 days.
2. Permafrost samples were placed in a series of containers, 1 liter of sea water was added there, passive samplers (devices capable of accumulating heavy metals) were immersed in water. Tanks with samplers were installed on the shaker. After the 1st time interval, the sampler was removed from the tank No. 1, after the 2nd interval - from the tank No. 2, etc. The output was a series of samplers with different exposure time. The results of the experiment have showed the possible changes of the sea water composition connected with the permafrost thawing.
pH and dissolved oxygen measured with sensors in one of containers has shown decrease in values during the first 10-15 hours in a container with PF (Fig. 3). PF lead to an increase in the content of the studied parameters. It can be noted that enrichment with nutrients occurs in the first hours after the permafrost enters the water, while for some heavy metals (Fe, Mn, Cr, Ni, Zn) the concentration increases during the entire observation period. There was a significant difference in concentrations of dissolved metals and total metals.
As a result of the experiment, data were obtained on changes in the content of chemical parameters of sea water and pollutants as a result of contact with permafrost during the first 5 days.

Sample	Exposition period and sampling, hours									
	0	**2**	**3**	**4**	**12**	**24**	**72**	**73**	**97**	**98**
SW										
SW+PF										
SW+PF										
SW+PF										
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The exposure time and sampling intervals during the experiment (PF - permafrost, SW-seawater, the horizontal sampling interval is marked in hours).

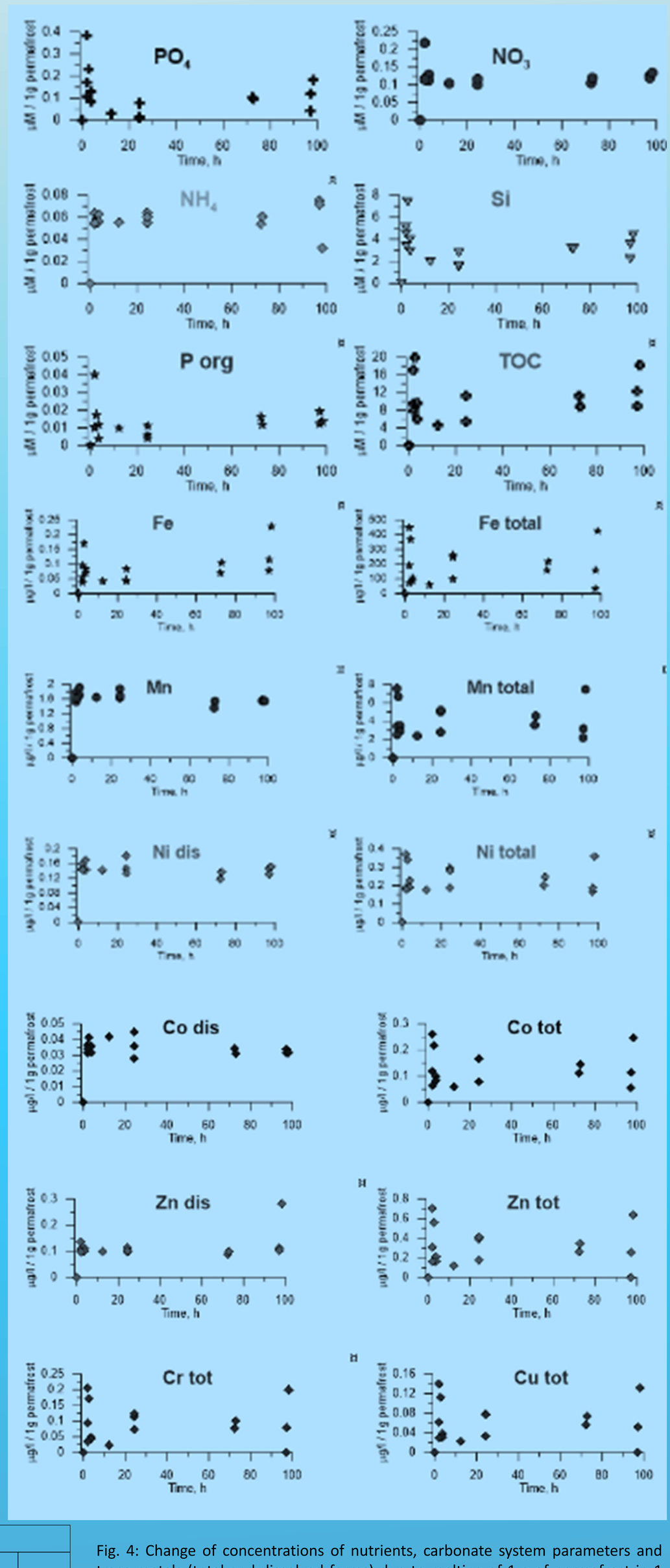

Fig. 4: Change of concentrations of nutrients, carbonate system parameters and trace metals (total and dissolved forms) due to melting of 1 g of permafrost in 1 liter of the sea water.

The data from 2018 supplement previous studies of the effect of river runoff and glacier melting on the chemical structure of coastal waters in the studied region in 2014-2017.

The studies were conducted only in one fjord of Svalbard, however, extrapolating the results to the entire Arctic region, we can assume a significant influence of this effect throughout the Arctic.

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This work was supported by the project of the Norwegian Research Council (NRC) 283482 IKOTA: "The influence of thawing permafrost on biogeochemical properties and marine pollution". We also thank the laboratory staff who participated in the processing of the selected samples.