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Experimental study on influence of thawing permafrost on chemical properties of the sea water

Key words: permafrost thawing, sea water biogeochemistry, acidification, pollution

During the joint Norwegian-Russian expedition to Svalbard 11–17 of June 2017, experimental studies of the effect of melting permafrost on the biogeochemical parameters of sea water were carried out. Samples of permafrost were collected from an abrasive cliff (Fig. 1) located about 10 km west from Longyearbyen.

Fig. 1. Abrasive cliff in Svalbard

In the process of the experiment, samples of permafrost, PF (about 50–55 g) were added to the 1 liter flasks with sea water (SW). The bottles with opened lids were exposed for 24 hours in the air temperature in plastic boxes covered with lids to simulate the natural conditions. The samples were collected after 0, 3, 6, 12 and 24 hours of exposition for pH, carbonate system, nutrients and heavy metals, including mercury and methylmercury. In parallel we measured changes after 24 hours in the sea water without PF and distilled water with PF (Table).

Sample	Exposition period and sampling, hours				
	0	3	6	12	24
SW					
SW+PF 3					
SW+PF 6					
SW+PF 12					
SW+PF 24					
SW w/o PF					
DW+PF					

The sampling techniques for the measured parameters were organized in accordance to previously described standard procedures [1]. We used standard techniques of analytical measurements in Norway and Russia. Nutrients were sampled into 100 ml plastic bottles and preserved with sulfuric acid. Samples for Alk and TIC were preserved with mercury chloride. Water samples for Hg species analysis were collected in 250 mL fluorinated polyethylene (FLPE) bottles [2].

Samples for carbonate system, nutrients and mercury forms were measured in Norwegian Institute for Water Research, Oslo, forms of total metals were measured in Zubov State Oceanographical Institute, Moscow.

The results of the experiment have showed the possible changes of the sea water composition connected with the permafrost thawing. In Figures 2, 3 we plotted changes of concentrations in 1 liter of the sea water after addition of 1 g of permafrost of the parameters under study.

The results show a clear enrichment of the main nutrients, PO4, NO3, Si, concentrations with a maximum after 3 hours, and decreasing concentrations afterwards (Fig.2). No clear signal was found for TOC.

Alk and TIC had minimum values in the 3 hours sample then the content increased. It should be pointed out, that the 1st measurement was done from the initial sea water without permafrost. An addition of permafrost should decrease the salinity of the sample, and therefore content of TIC (as one of the main ion) and Alk. During the experiment Alk and TIC increased and reached after 24 hours values close to initial ones. pH decreases all the 24 hours (better pronounced for pH calculated as a function of Alk and TIC than pH measured). Concentrations of total Hg increase with a peak after 3 hours and then continue to grow. Me Hg doesn't show a clear trend. Concentrations of the total metals generally increased with the exception of cadmium.

We plan to use the received data to estimate the flux of parameters under study due to Arctic coast permafrost thawing, and compare this with the supply by rivers and atmosphere.

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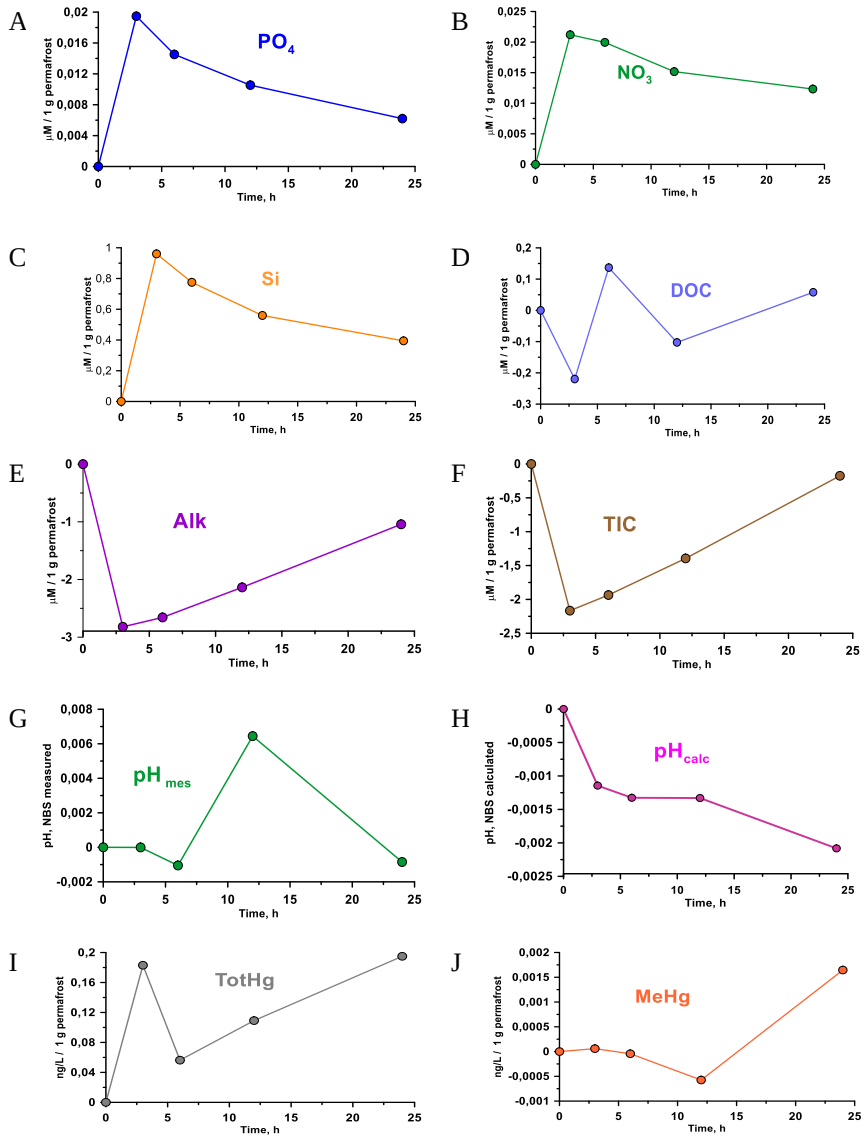

Fig. 2. Change of concentrations of phosphate, PO4 (A), nitrate and nitrite, NO3 (B), silicate, Si (C), Dissolved Organic Carbon, DOC (D), Alkalinity (E), Total Inorganic Carbon, TIC (F), pH measured (G), pH calculated (H), total mercury, TotHg (I), methyl mercury, MeHg (J) due to melting of 1 g of permafrost in 1 liter of the sea water.

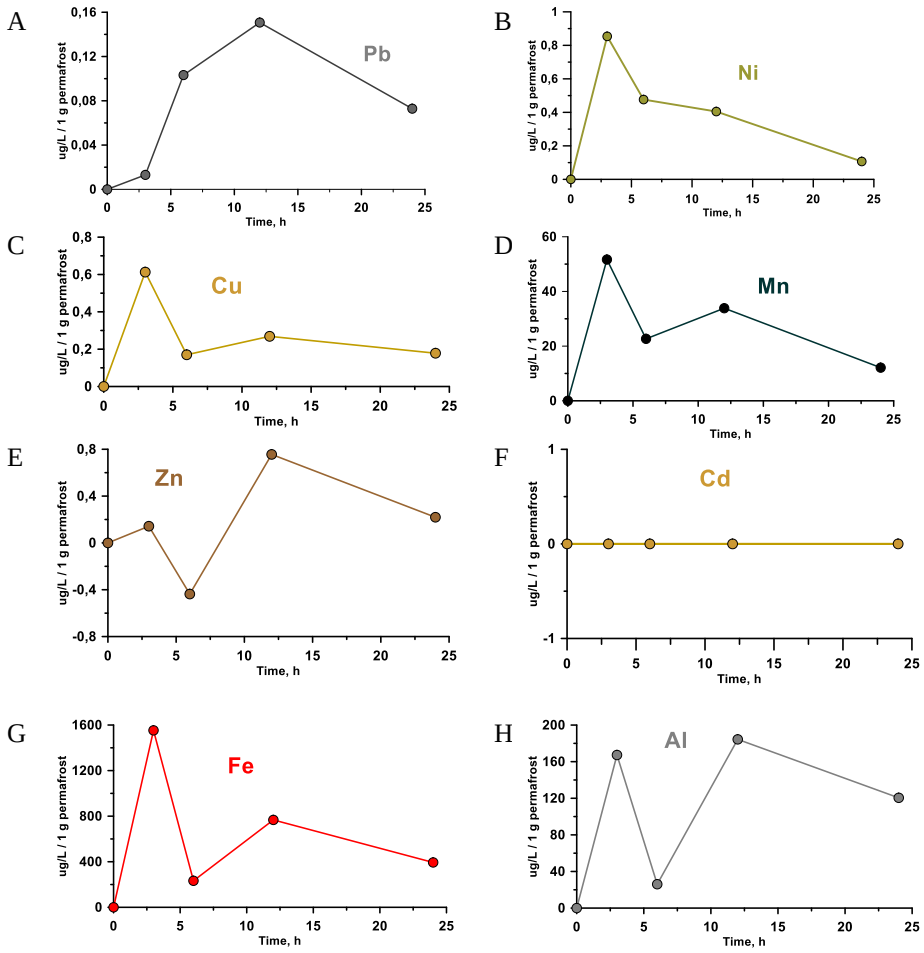

Fig. 3. Change of concentrations of lead, Pb (A), nickel, Ni (B), copper, Cu (C), manganese, Mn (D), zinc, Zn (E), cadmium, Cd (F), iron, Fe (G), aluminum, Al (H) due to melting of 1 g of permafrost in 1 liter of the sea water.