Svalbard Science Conference

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

Pogojeva M.[1], Yakushev E.[2, 3], Ilinskaya A.[3, 4], Braaten H.-F.[2] ([1]State Oceanographic Institute, Moscow, Russia; [2]Norwegian Institute for Water Research; Norway; [3]Shirshov Institute of Oceanology RAS, Moscow, Russia; [4]Moscow State University, Russia)

Goal

To study possible changes of the sea water composition connected with the permafrost thawing:

- Nutrients
- Carbonate system
- Pollutants

Sampling

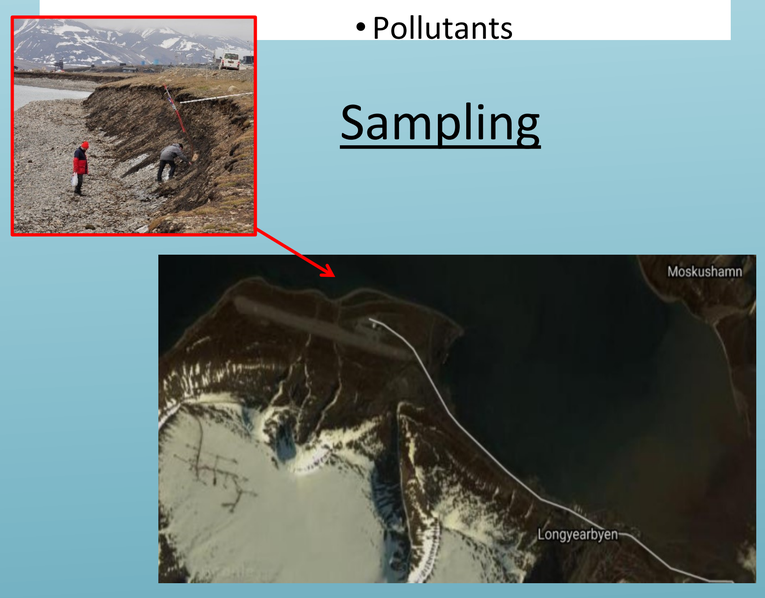

Fig. 1: Sampling

Samples of permafrost (PF) were collected from an abrasive cliff located about 10 km west from Longyearbyen during the joint Norwegian-Russian expedition to Svalbard 11–17 of June 2017.

Experiment

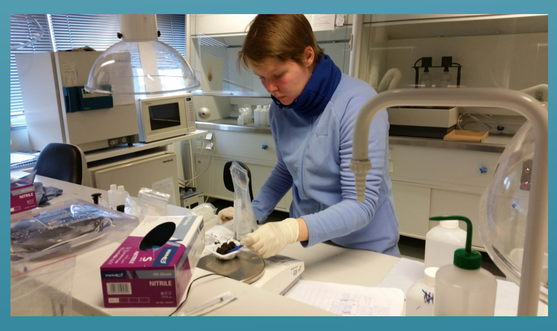

Fig. 2: Laboratory experiment

Samples of 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.

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 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).

The sampling was organized in accordance to standard procedures. 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.

Results

The results of the experiment have showed the possible changes of the sea water composition connected with the permafrost thawing.

Nutrients

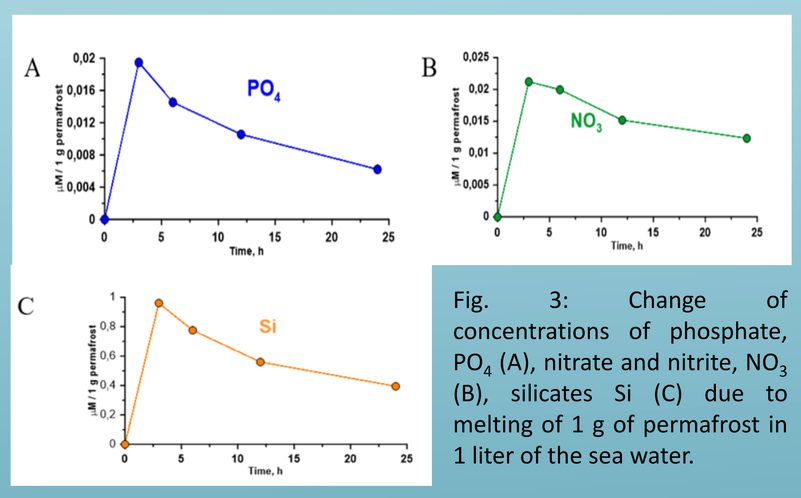

Fig. 3: Change of concentrations of phosphate, PO_4 (A), nitrate and nitrite, NO_3 (B), silicates Si (C) due to melting of 1 g of permafrost in 1 liter of the sea water.

The results show a clear enrichment of the main nutrients, PO_4, NO_3, Si, concentrations with a maximum after 3 hours, and decreasing concentrations afterwards.

Carbonate system

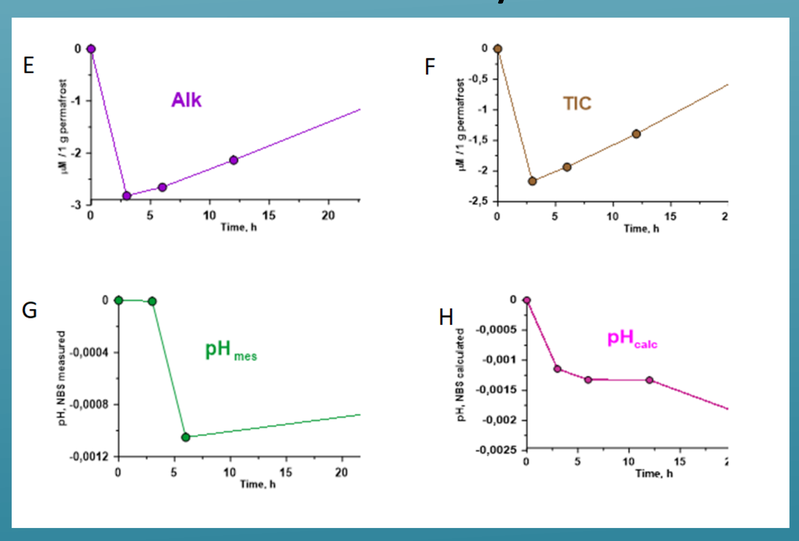

Fig. 5: Change of concentrations of Alkalinity (E), Total Inorganic Carbon, TIC (F), pH measured (G), pH calculated (H) due to melting of 1 g of permafrost in 1 liter of the sea water.

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.

Mercury and methylmercury

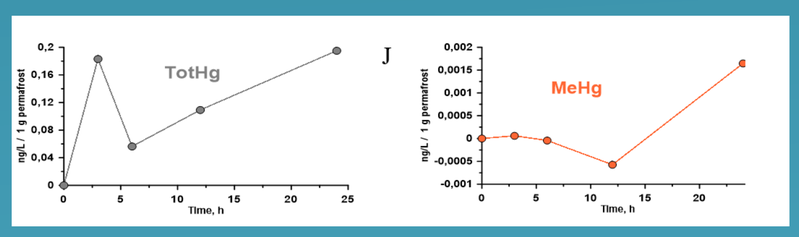

Fig. 5: Change of concentrations total mercury, TotHg (I) and methyl mercury, MeHg (J) due to melting of 1 g of permafrost in 1 liter of the sea water.

Concentrations of total Hg have generally increased. MeHg doesn't show a clear trend.

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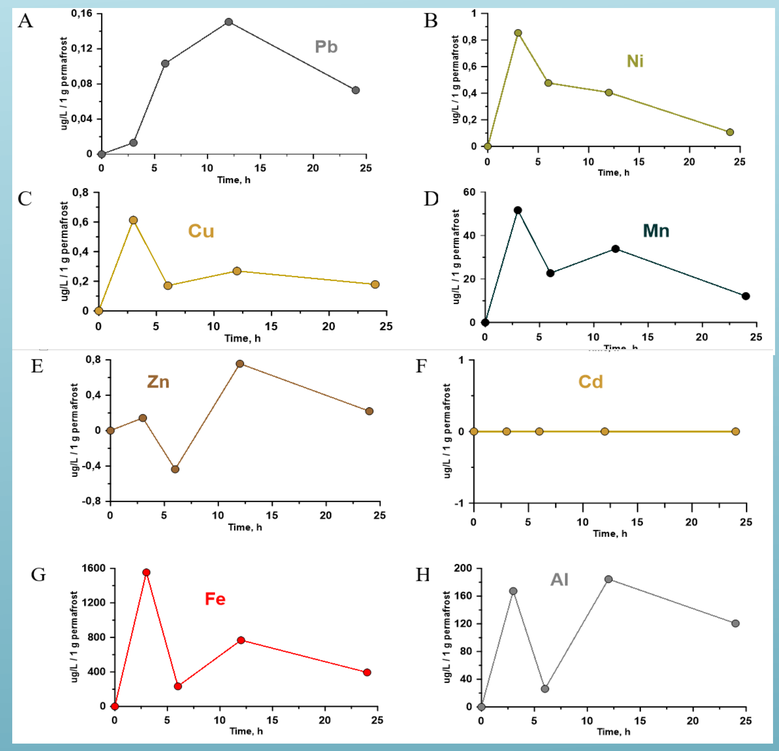
Metals



Concentrations of the total metals have generally increased. Maximum increase is shown for Fe and Al.

Discussions

We plan to use the received data to estimate the supply of parameters under study due to Arctic coast PF thawing, and compare this with the supply by rivers and atmosphere. If we suppose for the other Arctic region the same chemical composition of PF as in Svalbard we can get:

Parameter	PO_4	NO_X	Si
Content of parameter per g 1 of PF, estimated by an increase of concentrations in the seawater [g/g]	$6x10^{-7}$	$3x10^{-7}$	$2.7x10^{-5}$
Amount of parameter released from thawing of 20 mln t /yr of Arctic PF*, [10^3t/yr]	0.001	0.006	0.053
Anount of parameter supplied by rivers**, [10^3t/yr]	39	182	6062

* VONK JE, SÁNCHEZ-GARCÍA L, VAN DONGEN BE, ALLING V, KOSMACH D, CHARKIN A, SEMILETOV IP, DUDAREV OV, SHAKHOVA N, ROOS P, EGLINTON TI. ACTIVATION OF OLD CARBON BY EROSION OF COASTAL AND SUBSEA PERMAFROST IN ARCTIC SIBERIA. NATURE. 2012 SEP 6;489(7414):137-40.

** HOLMES RM, MCCLELLAND JW, PETERSON BJ, TANK SE, BULYGINA E, EGLINTON TI, GORDEEV VV, GURTOVAYA TY, RAYMOND PA, REPETA DJ, STAPLES R. SEASONAL AND ANNUAL FLUXES OF NUTRIENTS AND ORGANIC MATTER FROM LARGE RIVERS TO THE ARCTIC OCEAN AND SURROUNDING SEAS. ESTUARIES AND COASTS. 2012 MAR 1;35(2):369-82.

Our preliminary studies show that the amount of chemical parameters revealing with thawing PF into the Arctic Ocean are small compared with the rivers supply (**less than 0.01 %**). But the PF thawing can play an important role in the chemical regime, in the coastal areas, affecting the supply of metals, water acidification and nutrient inputs; and coastal ecosystems therefore will be exposed to new multistressor impacts associated with global warming.

Conclusions

- During these studies a new technique was tested of conducting experiments to study the influence of thawing PF on the chemical composition of coastal waters.
- Our preliminary results show that the revealing of chemical parameters from the PF thawing can be a significant factor in the coastal regions that should be further studied and taken into account in the Arctic Environment models.
- Studies in Svalbard give a unique possibility to perform such experiments.