LEVELS OF PAHs, PCBs AND CHLORINATED PESTICIDES IN BOTTOM SEDIMENTS FROM GUBA PECHENGA, THE BARENTS SEA, RUSSIA

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Introduction

Guba Pechenga lies in the western coast of Kola Peninsula and is approximately 16 km long with Pechenga-city located in the innermost part and settlement Liinakhamari in the outmost part. Except from effluents from communities situated along the fjord, emission and runoff from the nickel smelter "Pechenganickel" is a major source of contamination of this area. Murmansk regional environmental committee reports that in 1997 air emission from smelter was 263.87 thousand tons of contaminants. "Pechenganickel" also has discharged into the surface waters 11.5 thousand tons different contaminants, the total volume of discharges was 24.592 mln m^3, among them - 16.8% without treatment (1). At present no data exist on polycyclic aromatic hydrocarbon (PAH) and organochlorine (OC) levels in this region.

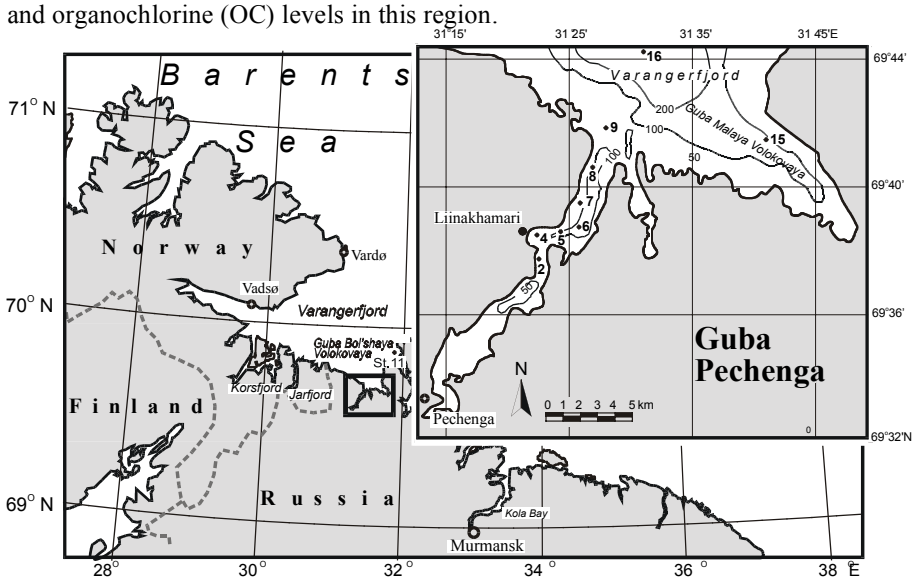

Figure 1. Map of Guba Pechenga and sampling locations.

The aim of the present survey has been to study levels of selected contaminants in marine sediments collected in Guba Pechenga, and to compare the observed levels with those previously found in the Barents Sea area. In addition, patterns and individual compounds or groups of compounds have been used to assess the source(s) of pollutants in the area.

Material and methods

The pollutants selected for analyses are those recommended by AMAP to which some additional parameters have been added. A 40 kg 0.1 m^2 van Veen grab was used to collect surface sediment samples. Duplicate grabs were taken on each station, of which one was analyzed for PAH, PCB and pesticides, and one for grain size. All samples were frozen at -20°C immediately after collection and processing. PAHs have been analyzed according UNESCO method with slight modification (2). Analyses of PAH were performed by GC/MSD equipped with a split/splitless injector and a 25 m x 0.20 mm ID HP Ultra 1 column. For analysis of chlorinated hydrocarbons was used standard method (3). The gas chromatographic optimization/quantification follows the ICES guidelines using a 60 m x 0.25 mm i.d. capillary column with 0.25 μm crossbonded phase of 95% dimethyl-5% diphenyl polysiloxane.

Results and discussion

Relative contents of material with grain size <0.063mm (pelite) in sediment samples were 14% (St. 2), 55% (St. 4), 89% (St. 5), 59% (St.6), 84% (St. 7), 51% (St. 8 and 9), 66% (St. 11), 22% (St. 15) and 84% (St. 16). Mean concentrations of environmental contaminants in ten bottom sediment samples from Guba Pechenga and adjacent areas are presented in Table 1.

Table 1. Chlorinated and polycyclic aromatic hydrocarbons in bottom sediments from the Guba Pechenga and adjacent areas (ng/g d.w.) and probabilities of significant differences between contaminant levels (according to Median-test).

Compounds	Guba Pechenga*				Adjacent areas**				P
	N	Range	Mean ± SD	Median	N	Range	Mean ± SD	Median	
HCB	7	0.28 - 1.76	1.08 ± 0.57	1.15	3	0.74 - 1.33	1.05 ± 0.30	1.08	n.s.
α-HCH	7	0.04 - 0.23	0.13 ± 0.08	0.13	3	0.02 - 0.54	0.20 ± 0.29	0.04	n.s.
γ-HCH	7	0.04 - 0.45	0.17 ± 0.14	0.16	3	0.00 - 0.05	0.03 ± 0.03	0.03	<0.10
p,p'-DDE	7	0.09 - 1.34	0.52 ± 0.54	0.28	3	0.06 - 0.29	0.15 ± 0.13	0.09	n.s.
p,p'-DDD	7	0.08 - 10.1	3.07 ± 3.41	1.89	3	0.13 - 0.46	0.25 ± 0.19	0.15	<0.05
p,p'-DDT	7	0.10 - 31.3	6.87 ± 11.1	2.46	3	0.05 - 2.97	1.39 ± 1.47	1.16	n.s.
Tri-CB	7	0.10 - 1.25	0.61 ± 0.47	0.49	3	0.17 - 1.06	0.51 ± 0.48	0.29	n.s.
Tetra-CB	7	0.06 - 2.63	0.70 ± 0.90	0.36	3	0.07 - 0.36	0.17 ± 0.16	0.08	n.s.
Penta-CB	7	0.29 - 15.7	5.04 ± 5.31	2.81	3	0.24 - 1.65	0.76 ± 0.78	0.38	<0.05
Hexa-CB	7	0.32 - 12.3	4.31 ± 4.04	2.99	3	0.35 - 0.66	0.50 ± 0.16	0.48	<0.05
Hepta-CB	7	0.11 - 5.42	1.85 ± 1.78	1.61	3	0.10 - 0.30	0.18 ± 0.11	0.14	<0.05
Deca-CB	7	0.03 - 1.35	0.29 ± 0.47	0.12	3	0.01 - 0.07	0.03 ± 0.03	0.02	<0.05
ΣPAH	7	428 - 3257	1481 ± 954	1370	3	151 - 442	255 ± 162	173	<0.05

*Stations 2, 4, 5, 6, 7, 8 and 9; ** stations 11, 15 and 16. ; n.s. – not significant differences;
ΣPAH – sum of 2-6 ring aromatic hydrocarbons.

DDT group and PCBs were predominant among the persistent organochlorines. The average level of ΣDDT found in bottom sediments from Guba Pechenga exceeded those from all other fjords of the Barents Sea investigated (Tabl. 2) and from the southeastern part of the Barents Sea (the Pechora Sea) (3). DDT/DDE ratios at all stations, except st.11 were > 1; the highest ratio has been found at st.2 (30.4). Whereas, according literature data, this ratio in different components of Arctic marine ecosystems are usually < 1.

Table 2. Level of organic contaminants in bottom sediments from different fjords of the Barents Sea, ng/g dry weight. Arithmetic mean and standard deviation (SD)..

Area	n	HCB		ΣPCB		ΣHCH		ΣDDT		ΣPAH		Sources
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Varangerfjord*	4	<0.2		5.28	5.18	<0.2		0.48	0.82	3994	4297	4
Korsfjord	2	<0.2		2.30	3.25	<0.2		<0.2		421	390	4
Jarfjord	6	<0.2		1.54	2.23	<0.2		0.00		360	122	4
Kola Bay	5	0.78	0.52	93.67	98.08	0.22	0.13	6.12	3.61	6652	3385	5, 6
Guba Pechenga**	7	1.08	0.57	12.78	12.43	0.31	0.21	10.47	12.54	1481	954	present
Adjacent areas***	3	1.05	0.30	2.14	1.70	0.23	0.27	1.79	1.76	252	165	data

*coasts of Vardø and Vadsø; ** stations 2, 4, 5, 6, 7, 8 and 9; *** stations 11, 15 and 16.

PCB levels varied from 1.1 to 37.9 ng/g. The average PCB concentration was found to be 2-6 times higher compared with adjacent areas and Norwegian fjords (Table 2), and 10 times exceeded those from the Pechora Sea (3). However, PCB levels in sediments from Guba Pechenga were lower then in Kola Bay (6). At all stations, except st. 16, *penta-* and *hexa*-CBs were predonimant, accounting from 40 to 59% for the total PCBs. The average HCB and ΣHCH levels in sediments from Guba Pechenga were the highest among all different the Barents Sea fjords investigated (Table.2). The ratio α-and γ-HCH varied from 0.36 to 2.17, indicating possible local source of contamination. The average level of ΣPAH found in sediments from Guba Pechenga was lower compared with Varangerfjord and Kola Bay (Table 2).

OC levels in Guba Pechenga sediments tend to decrease in the direction of the sea (Fig. 2). The same was typical for PAH also. Factor analysis has been applied for contamination sources identification. The analysis was performed on log-transformed data (PAHs and OCs concentrations), percent of material with grain size <63μm and distance from location of probably local contamination sources to the stations (mouth of the Pechenga River) and Liinakhamari. Station 11 was excluded from the analysis due to large remoteness from the other.

Result of factor analysis indicates that the first common factor accounts for 37.4% of the total variance. It has significant positive loadings on all PAHs (with the exeption of compounds with molecular mass 276), and γ-HCH, and significant negative loading on distance from the top of Guba Pechenga to the stations. The first factor is essentially the polyaromatic hydrocarbons factor, in which the abundance and distribution of these compounds are controlled by the distance from "Pechenganikel" smelter, as possible source of contamination. The second common factor (32.6% of total variance) has significant positive loadings on PAHs compounds with molecular mass 276, HCB, *p,p'*-DDE, *p,p'*-DDT, *p,p*'-DDD, *tetra-*, *penta-*, *hexa*-and heptachlorinated byphenyls and negative loading on distance from Liinakhamari to the stations. The second factor is the chlorinated hydrocarbons factor, in which the abundance and distribution of OCs are controlled by the distance from Liinakhamari. The third factor (10.9% of total variance has significant positive loadings on α-HCH and percent of sediments fraction with grain size <0.063 mm, and fourth factor (7.9% of total variance) wich has significant positive loading on tri-clorinated byphenyls. Both these factors reflect, probably, the long-range transportation of contaminats.

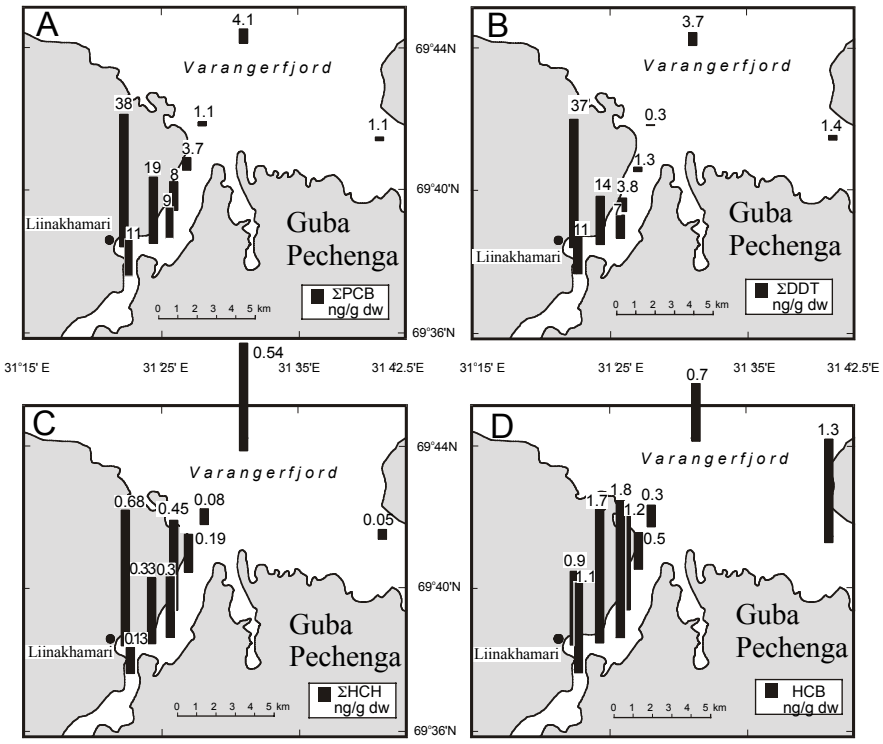

Figure 2. Distribution of chlorinated hydrocarbon concentrations in bottom sediments.

The results of this preliminary study indicated that in general the distribution of contaminants in sediments from Guba Pechenga seems to be strongly influenced by the discharges from the land.

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