

Determination of complex chloroorganic compounds in bottom sediments of lake Baikal

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Introduction

Chloroorganic compounds (COCs) are widespread in the environment at present, mainly because of anthropogenic activities.

Effluents and sewages from industries and settlements located on the coast of the lake Baikal and its catchment area are sources of water contamination.

Airborne COCs from distant sources are transported by air masses and can enter bottom sediments of the lake.

Material and methods

Sediments and waters from the Southern depression of the Baikal were studied for organic chlorine; special attention was given to the impact zone (IZ) of the Baikalsk Pulp and Paper Mill (BPPM), the most important industry on the coast.

Sediment and water samples were taken by a modified dredger ("Ocean" type, covering an area of 0.16 m²) from depths between 15 and 1100 m. Organic carbon, humic acids (HA), and extractable organics (EO) were measured in sediments. Organically bound chlorine levels were measured in HA's, and in extractable organic chlorite compounds (EOCI); adsorbable organic chlorine (AOCl) was quantified in supernatant waters.

ENV

Lithologic composition of bottom sediments was variable; sand matter of coarse to fine fractions, aleuritic silts and diatomaceous ooze. The upper layer (1 - 4 cm) in the Observed BPPM Impact Zone differed from the sediments in other areas of the lake because of its reddish-brown colour and less viscous consistency.

Samples of sediments were extracted with ethanol/benzene (1 :1). Extracted organic compounds were isolated by conventional scheme into the following groups: acids, phenols and neutral compounds.

Humic acids were isolated from sediments with 0.5 M NaOH at 80 °C, followed by precipitation at pH = 1-2. Isolated HA's were freed of inorganic chloride by means of reprecipitation and washing with acidified distilled water. Contents of organically bound chlorine were measured in all groups using an "AOX-Analyzer" and by neutron activation analysis.

Supernatant waters were kept for 2 hours to settle particulate matter and passed through chlorine-free activated carbon. Adsorbable organic chlorine (AOCl) was determined also with an "AOX-Analyzer"

Results

Results of total organically bound chlorine (TOCl), EOCl and AOCl are given in the table.

Data obtained show the IZ to be characterized by increased levels of chlorinated organic compounds, but also of organic carbon and humic acids.

Using gas chromatography-mass-spectrometry, di- and trichlorophenols and trichlorogujacols were identified in extracts of sediments taken in the IZ.

TOCl in HA's is the most characteristic parameter for sediment pollution with chlorinated lignins, being the main components of pulp bleaching effluents. In the BPPM effluents entering the lake there were about 8 % TOCl as low molecular-weight organic matter, and about 92 % TOCl as high molecular-weight chlorolignins and related compounds adsorbable on activated carbon.

TOCI levels in HA's of the southern depression of the lake and at background sites were found to be 0.02 - 0.05 %; in IZ 0.05 - 0.17.

The area of increased chlorolignin levels in the southern depression of the lake was found to stretch 7 km to the west and north-west, 7 - 10 km to the north-east and 18 - 20 km to the east, in the shelf zone from the discharge point of the mill (see figure). Such pollution of the shelf zone sediments extending to the east, coincides with the direction of the coastal currents.

Character and spreading of sediment pollution can be compared with data of similar studies done in Finland and Sweden. Though the levels of chlorinated organics in sediments in the Baikal are considerably lower than in the lakes of those countries, the chlorine burden should be minimized, considering their harmful effects on lake ecosystems.

Table

Measurements of sediments and supernatant waters, Southern depression of the Balkal

1 - Observed Impact Zone

2 - Background sites

Measurements

Sites	<i>Extractable organic matter</i> <i>mg/g d. w.</i>									
	C org. %	Humic acids mg/g d. w.	Cl-levels in humic acids %	<i>neutral compounds</i>	<i>phenols</i>	<i>acids</i>	Σ	EOCl $\mu\text{g/g}$ d.w.	TOCl $\mu\text{g/g}$ d.w.	AOCl in supernatant water $\mu\text{g/g}$
1.	1,4 - 7,1	5,0 - 37,0	0,05 - 0,17	0,25 - 1,8	0,05 - 1,0	0,1 - 0,6	0,55 - 3,27	1,3 - 4,7	4 - 45,0	12 - 135
2.	1,1 - 3,0	3,0 - 13,3	0,02 - 0,05	0,02 - 0,05	< 0,1	< 0,05	0,48 - 0,81	0,5 - 1,0	2,3 - 4,0	4 - 10

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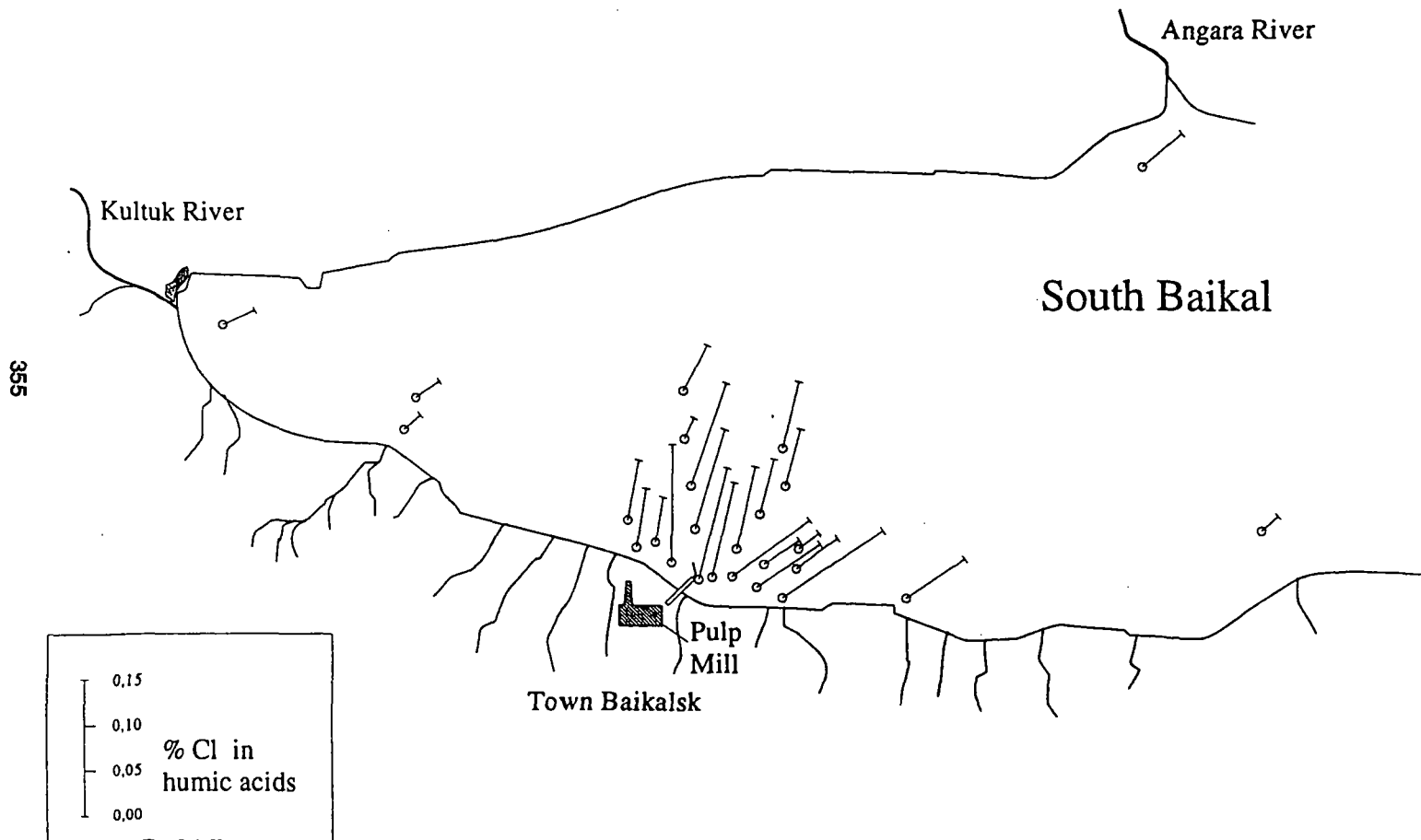


Fig 1 Organically bound chlorine (OCI) as percent in humic acids in the sediments in the Lake Baikal