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Observations of Particulate Matter in the Ice of the Sea of Okhotsk and Saroma-ko Lagoon*, **

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Abstract : During February-March 1999 ice samples were collected in the Sea of Okhotsk and Saroma-ko Lagoon in order to study the properties of solid impurities in the ice. Total particulate matter (TPM) and the organic portion of TPM were determined. The amount of TPM varied from 2.7-48.6 mgl^{-1} and 2.5-51.6 mgl^{-1} in Saroma-ko and the Sea of Okhotsk, respectively, with somewhat higher values in Saroma-ko Lagoon on average. TPM consisted mainly of organic material, probably sea ice algae, 72% and 75% on average in Saroma-ko Lagoon and the Sea of Okhotsk, respectively. These observed TPM are fairly similar to those in the coastal Baltic Sea, however, the organic content was substantially lower in the Baltic Sea. Furthermore, the TPM concentrations were substantially higher in the ice than in the water beneath the ice cover in Saroma-ko Lagoon.

Key words : Particulate Matter, Sea Ice, Saroma-ko Lagoon, Sea of Okhotsk

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I. Introduction

Sea ice in the high Arctic is known to carry a substantial particle load, subsequently sea ice can be a transportation agent and source of heavy and trace elements adhered to sedimentary particles (e.g., Pfirman and Lange, 1998). However, the role of material carried by sea ice is not well known; e.g., Ackley (1996) discusses about the possible contribution of sea ice in the geochemical cycles of the Sea of Okhotsk. This study was conducted in order to get an initial view of the content of sedimentary matter in the sea ice in Saroma-ko Lagoon and the Sea of Okhotsk. However, for more detailed information of the role of sea ice in biogeochemical cycles geochemical studies of sea ice are needed, in order to assess the importance of sea ice as a transportation agent and source of trace elements and other constituents.

II. Material and Methods

A total of 24 ice core samples were collected in 19 locations in Saroma-ko Lagoon, in some of which there were two sampling occasions (Fig. 1 and Table 1). In addition, some water samples were collected beneath the ice cover in order to compare suspensions to the material within the ice cover. Ice samples were melted in washed buckets with lids at room temperature. A subsample of 1 litre was taken from a well stirred sample of melt water, and filtered through a pre-washed and weighed glassfiber filter (Millipore). TPM was determined by weighing the dried filter. Loss on ignition (LOI), i.e., the portion of organic matter of TPM, was determined by combustion at 550°C for 15 minutes.

Furthermore, some sea ice samples from 14 different locations (Fig. 2 and Table 2), were obtained from the Sea of Okhotsk during the Soya-cruise conducted in early February 1999 (T. Toyota, personal communication, 1999). The same procedure, as described above, was performed to determine TPM and LOI. The sample 7 was divided into two parts; the upper part (7a) and lower part (7b), whereas the sample 13 was divided into three parts; the top (13a), middle (13b) and bottom (13c).

III. Results

Table 1 lists the results for total particulate matter (TPM), particulate inorganic matter (PiM), and loss on ignition (LOI) i.e., the portion of organic material in TPM, together with ice thickness, water depth and surface water salinity (at 0.5 m depth) for the samples from Saroma-ko Lagoon. TPM varies between 2.7-48.6 mgl^{-1}, with a mean value of 10 mgl^{-1}. These values are similar to the observed values in the coastal Baltic Sea (e.g., Granskog, 1998). On the other hand the portion of organic material on average, about 72%, is almost twice as large as the observed value in the Baltic Sea (Granskog, 1998). Surface water samples (n=4), taken from about 1 m depth, contained less than 2 mgl^{-1} of suspended solids, indicating that ice during melting is a potential source of sedimentary matter and adhered constituents.

Fig. 3 shows the spatial distribution of TPM in the ice samples from Saroma-ko Lagoon.

The results for the Sea of Okhotsk are similar to the values from Saroma-ko Lagoon (Table 2); the values for TPM range between 2.5 and 51.6 mgl^{-1}, with a mean value of 8 mgl^{-1}. Also the portion of organic material, 75%, is very close to the value observed in Saroma-ko Lagoon.

Fig. 4 shows the spatial distribution of TPM in the ice samples from the Sea of Okhotsk.

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Table 1: Observations of total particulate matter (TPM), particulate inorganic matter (PiM), loss on ignition (LOI) i .e. portion of organic material in TPM in the ice samples from Saromako and surface water salinity (0.5 m).

Location	Date	Ice thickness (cm)	TPM (mgl^{-1})	PiM (mgl^{-1})	LOI (%)	depth (m)	salinity (PSU)
St. 1	110299	30.0	7.7	2.7	63	4.8	-
St. 2	110299	30.0	3.0	0.0	100	9.8	30.95
St. 3	110299	28.0	3.8	0.6	84	11.9	31.05
St. 4	110299	25.5	12.5	7.6	39	12.4	30.18
B1	190299	29.0	6.2	2.1	66	2.4	29.62
B2	190299	26.5	4.1	0.3	93	6.4	26.61
B3	190299	41.0	10.2	3.9	62	10.3	30.18
B4	180299	31.5	3.3	0	100	11.6	28.91
B5	180299	30.0	4.4	0.6	86	6.1	26.37
River	190299	37.0	19.0	13.2	31	2.6	21.10
IS 1	190299	–	18.7	8.8	53	–	–
IS 2	190299	–	8.1	1.6	80	–	–
A1	230299	38.0	9.7	3.7	60	7.0	29.75
A2	230299	39.0	5.6	1.6	71	7.6	31.66
A3	230299	30.0	3.1	0	100	10.9	30.44
A4	230299	30.0	3.0	0	100	12.0	28.21
A5	230299	43.5	48.6	30.0	38	4.1	29.93
St. 1	030399	40.0	6.0	1.7	72	4.8	13.93
St. 2	030399	37.0	4.5	1.5	67	9.5	20.00
St. 3	030399	35.0	4.9	0	100	11.6	30.45
St. 4	030399	33.5	4.6	0	100	12.0	27.80
C1	250299	34.5	2.7	0	100	1.8	31.60
C2	250299	37.0	13.3	4.3	68	3.3	31.13
C3	250299	27.0	6.1	1.6	74	4.4	31.80
C4	250299	23.0	7.4	3.1	58	6.0	31.95

Table 2: Observations of total particulate matter (TPM), particulate inorganic matter (PiM) and loss on ignition (LOI) in the samples from Sea of Okhotsk.

Sample	Date	TPM (mgl^{-1})	PiM (mgl^{-1})	LOI (%)	Ice type
1	040299	2.7	0.0	100	nilas
2	040299	3.8	0.4	89	nilas
3	050299	2.5	0.0	100	young ice
4	050299	4.1	0.8	80	first-year
5	060299	4.8	0.8	83	young ice
6	060299	3.6	0.6	83	young ice
7a	060299	51.6	43.6	16	first year
7b	060299	4.7	0.9	81	–
8	070299	4.4	1.2	73	young ice
9	080299	7.3	3.2	56	young ice
10	080299	8.7	3.9	55	young ice
11	090299	4.2	0.5	88	young ice
12	090299	5.1	1.2	76	first-year
13a	090299	16.6	5.3	68	first-year
13b	090299	9.8	3.9	60	–
13c	090299	5.4	1.1	80	–
14	090299	2.5	0.3	88	young ice

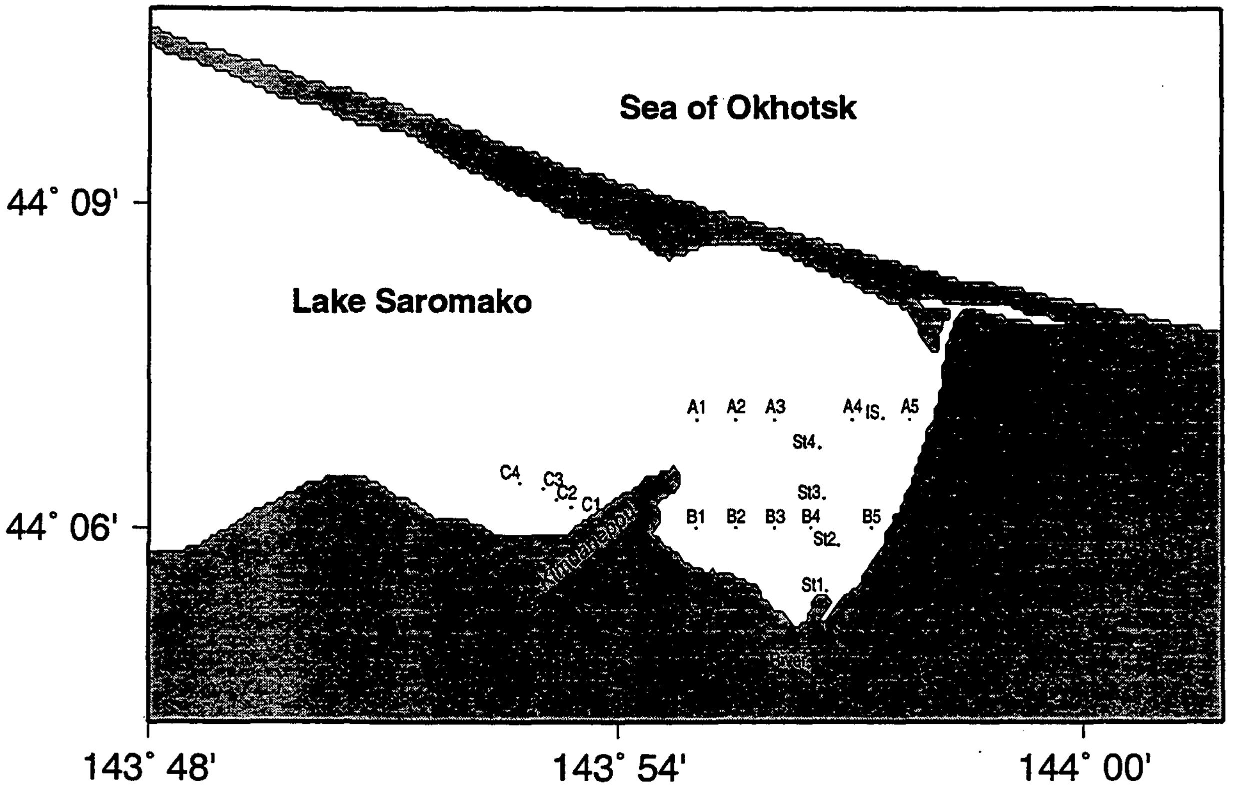

Figure 1: Location of ice samples taken in Saroma-ko Lagoon.

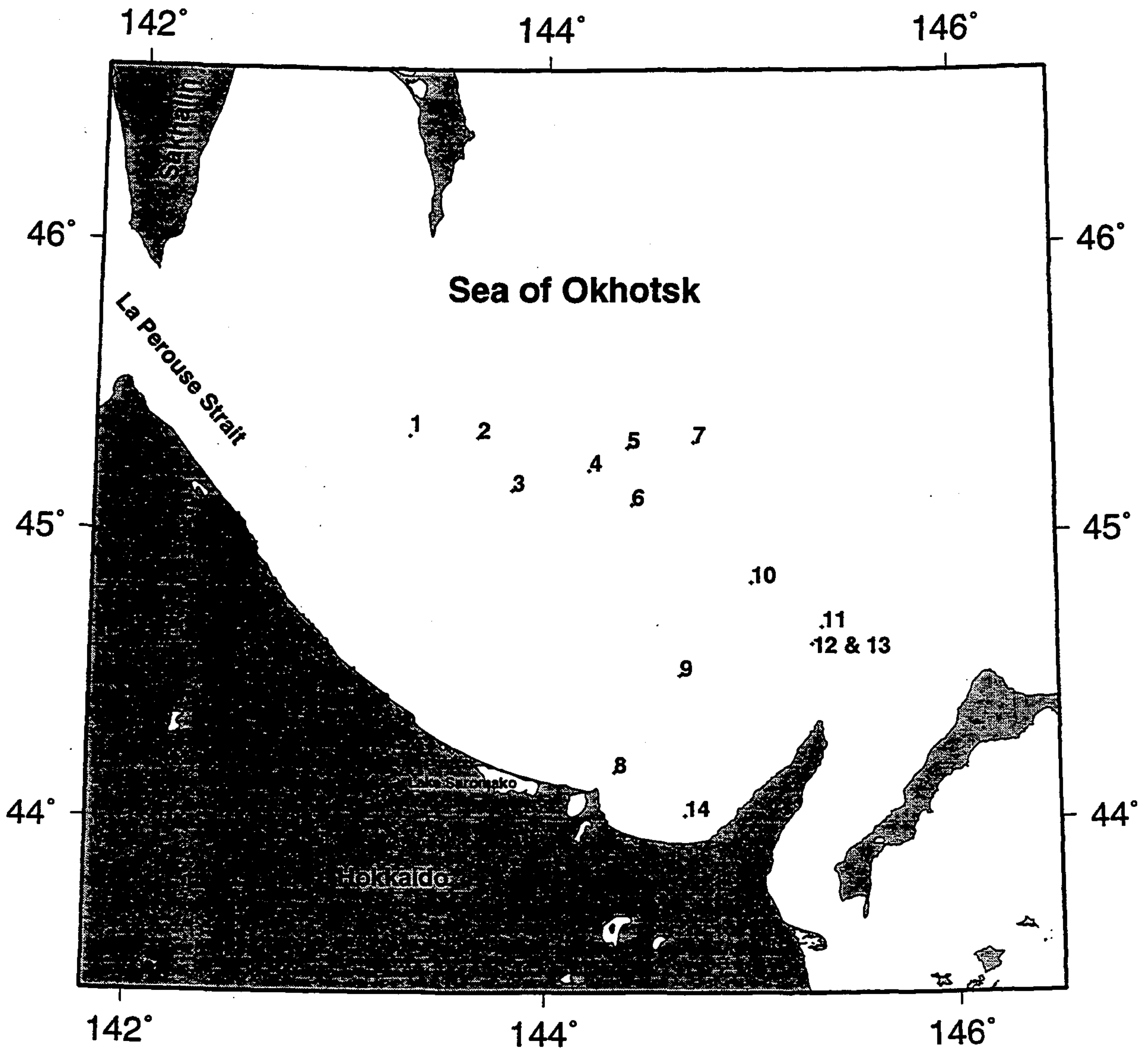

Figure 2: Location of ice samples taken from the Sea of Okhotsk.

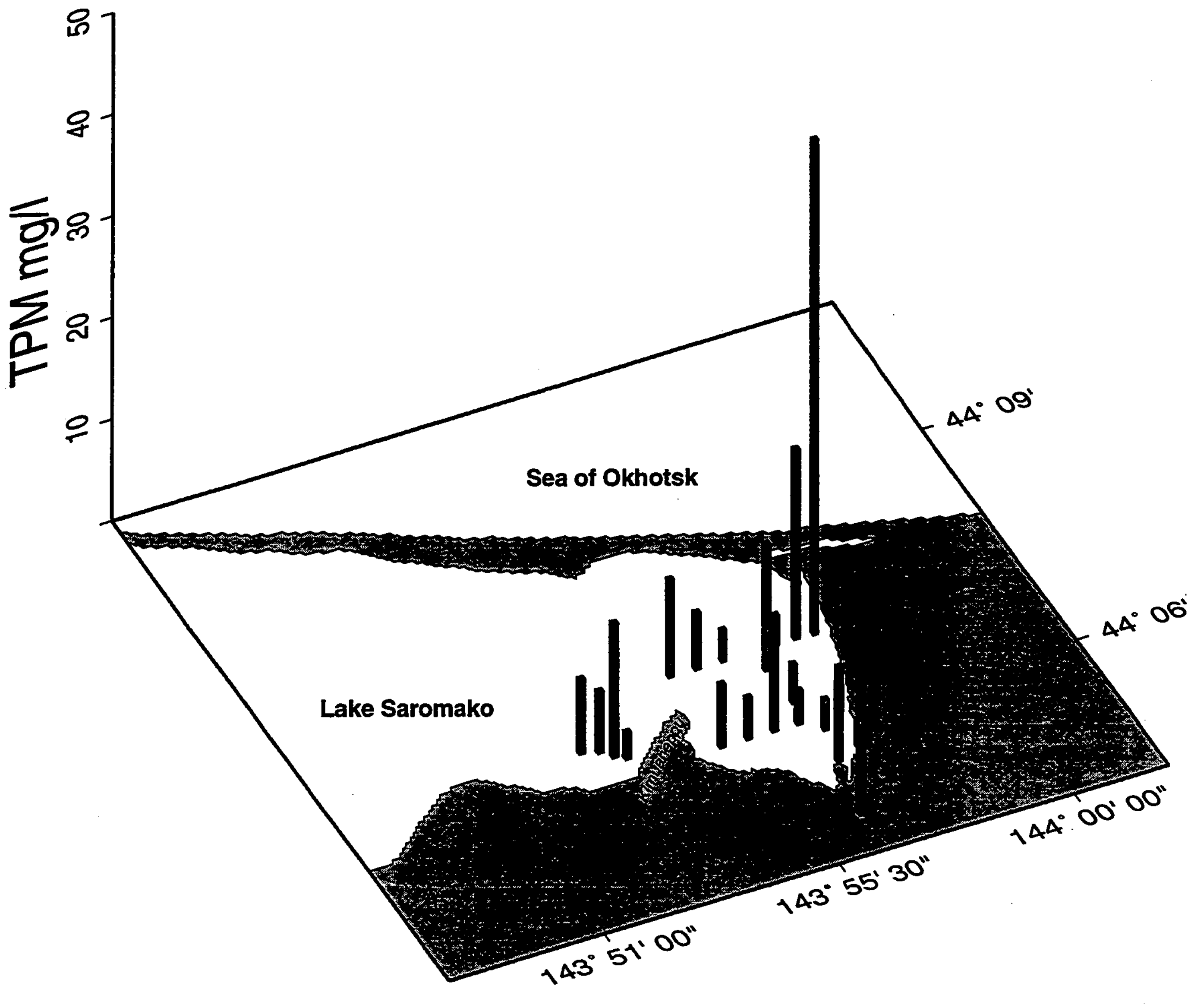

Figure 3: Spatial distribution of TPM in the ice samples from the Saroma-ko Lagoon.

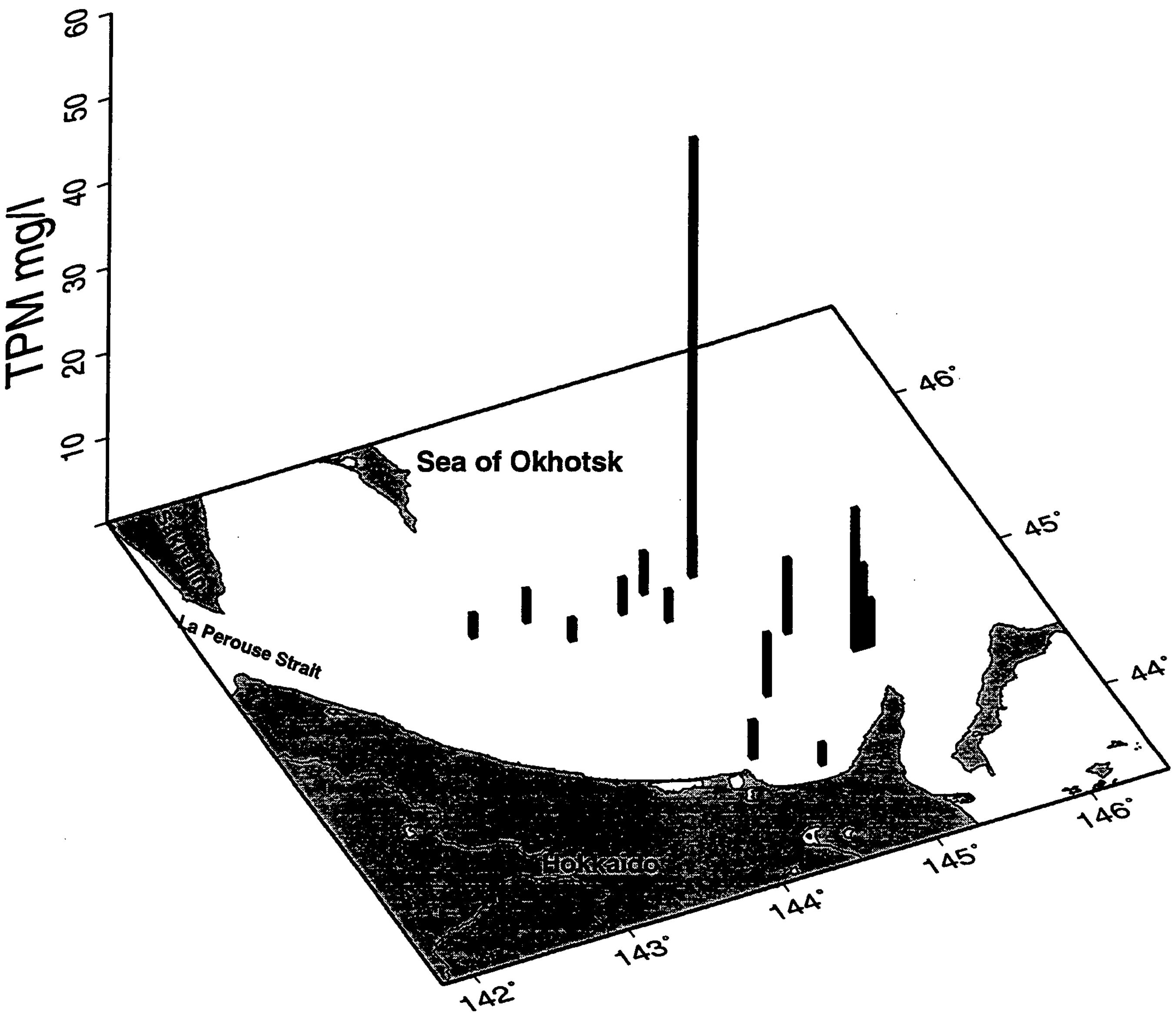

Figure 4: Spatial distribution of TPM in the ice samples from the Sea of Okhotsk.