MONITORING OF POND WATERS NEAR SYOWA STATION (II)

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Abstract: The water samples collected in 1981 and 1982 were analyzed from the geochemical and environmental viewpoints. The water samples were collected from the following five lakes which have been selected as monitoring stations since 1978: Mizukumi Stream (East Ongul Island), Lake Ô-ike (West Ongul Island), Lake Nurume (Langhovde), Lake Hunazoko (Skarvsnes) and Lake Skallen Ôike (Skallen). Comparing the data obtained in this work with available previous data, the authors point out the results as follows.

1) Five lakes selected in 1978 were found suitable as monitoring stations.

2) Chemical compositions and dissolved salts in Lake Nurume and Lake Hunazoko have not changed markedly in the last fifteen years.

3) The amount of dissolved salts in three lakes, Mizukumi Stream, Lakes Ô-ike and Skallen Ôike, has changed considerably.

To examine the environment in the Lützow-Holm Bay region, Antarctica, a monitoring plan of pond waters near Syowa Station started in the 1978 winter season (MURAYAMA *et al.*, 1981). At that time, five lakes were selected as the monitoring stations for the following reasons.

1) As shown in Fig. 1, these lakes are aligned in the north-south direction at suitable distances from Syowa Station.

2) The access to the lakes is easy and water samples can be collected rather easily.

3) Some lake waters are fresh and the others saline.

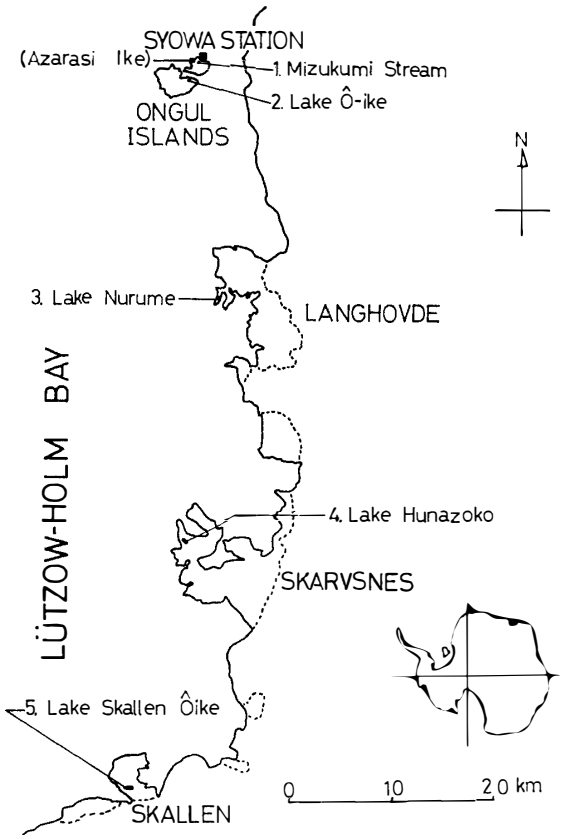

Fig. 1. Possition of the monitoring lakes. (Azarasi Ike): tentative name (JARE-22, HIDAKA).

Table 1. Geomorphological characters of the monitoring lakes.

Lake name	Mizukumi Stream	Lake Ô-ike	Lake Nurume	Lake Hunazoko	Lake Skallen Ôike
Location	East Ongul Isl.	West Ongul Isl.	Langhovde	Skarvsnes	Skallen
Distance from Syowa Station (km)	0.3	2.5	25	50	75
Distance from the sea shore (m)	360	170	30	290	135
Elevation above the sea level (m)	14	13	±0	−23	10
Depth of the lake (m)	2.5	11.2	16.0	9.2	8.5
Long diameter of the lake (m)	78	370	305	675	1180
Short diameter of the lake (m)	30	215	155	250	275
Area of the lake (m^2) $\times 10^4$	0.16	5.2	3.1	14.2	20.9

4) Some of these lakes were already studied by the members of the Japanese Antarctic Research Expedition (JARE).

General geomorphological characters of these lakes are summarized in Table 1. Chemical compositions of dissolved salts in the lake waters are shown in Tables 2 to 6. Water samples were collected at the monitoring points by H. HIDAKA in JARE-22 and by K. SHIMAOKA in JARE-23.

These lakes are isolated from a glacier or the ice sheet beyond one col at least, and at present the lake waters are not nourished by melt water of glaciers. Con-

Table 2. Chemical compositions of Mizukumi Stream (East Ongul Island).

	Mean value and range of variation from 1969 to 1979		JARE-22 (HIDAKA)		JARE-23 (SHIMAOKA)
	Range of variation	Mean value	1981 Mar. 16	1982 Jan. 10	1982 Dec. 22
pH	6.80– 6.97	6.90	6.96	6.55	6.66
O_2 (ml/l)	8.37– 8.62	8.50	ND	ND	ND
Na (mg/l)	51 –114	73	174	72	31
K (mg/l)	2.0 – 2.4	2.2	6.1	2.4	1.3
Ca (mg/l)	6.5 – 20.8	12.0	35.2	11.4	4.2
Mg (mg/l)	7.5 – 22.2	13.0	36.0	11.2	4.6
Cl (mg/l)	23 –237	118	334	125	54
SO_4 (mg/l)	17.8 –360	107	97.5	32	11
SiO_2-Si (μg atom/l)	4.0 – 64.7	31.1	35	18	10
NH_3-N (μg atom/l)	0.2 – 0.7	0.5	ND	ND	ND
NO_2-N (μg atom/l)	0.02– 0.15	0.04	<0.1	<0.1	<0.1
NO_3-N (μg atom/l)	0.00– 0.30	0.08	0.71	0.76	1.06
PO_4-P (μg atom/l)	0.33– 0.00	0.12	0.2	0.3	0.3

ND: not determined.

sequently, the water and dissolved constituents in the lakes are thought to be supplied from melt water of drifted snow or snowfall itself.

As shown in Tables 2, 3 and 6, the amount of dissolved salts in water of some lakes changed considerably. Changes in the amount of dissolved salts should be due to the influence of the amount of inflow water during the austral summer (dilution effect) or of evaporation and freezing (concentration effect) of lake water in winter. Moreover, water of these lakes can overflow through a water channel in summer, when the water level of lakes rises markedly. As a result of repeating such phenomena, the character of these lake waters should have been kept fresh. Especially in the Mizukumi Stream, seasonal variation in the amount of dissolved salts was remarkable because of the shallow depth of the stream.

It was suggested by SANO *et al.* (1977) that the water of Lake Nurume had a two-layer structure. The stratification of the lake water is due to its density variation. The lake would have been supplied with sea water at the first stage, and after evaporation of the original sea water, the second sea water having a lower density would enter into the lake. The upper layer, more than 10 m deep, contains the same amount of salts as that in sea water, while the salt content of the lower layer is about one and a half times of the upper layer, as shown in Table 4. The stratification is thought to have been stable in the last fifteen years, and the lower layer water contains hydrogen sulfide due to the reduction of sulfate ion by microbiological activities. The study of Lake Nurume may be necessary to compare it with other lakes, such as Lake Suribati, for clarifying the stratification and accumulation of metals, such as iron, manganese and zinc.

As shown in Table 5, the amount of dissolved salts in Lake Hunazoko, is about seven times that in sea water, and the elevation of the lake is lower than the sea level by 23 m. The amount of dissolved salts in the lake did not change in fifteen years. In this lake, the amount of inflow water may be balanced with the amount of evapora-

Table 3. Chemical compositions of Lake O-ike (West Ongul Island).

	Mean value and range of variation from 1968 to 1979		JARE-22 (HIDAKA) 1981							JARE-23 (SHIMAOKA) 1982	
	Range of variation	Mean value	Mar. 18		June 3		Aug. 31		Dec. 29	Nov. 27	
Sampling depth (m)	Surface		0.5	11.0	1.4	10.6	2.0	9.0	Surface	2.0	9.5
pH	6.78– 7.30	7.20	7.58	7.66	7.68	7.55	7.61	7.44	7.60	7.04	7.12
O_2 (m*l*/*l*)	8.30– 9.22	8.69	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na (mg/*l*)	36.0 – 48.5	42.3	68	58	77	84	79	84	70	46	86
K (mg/*l*)	1.4 – 2.0	1.7	2.5	2.2	2.9	3.2	3.0	3.2	2.5	2.2	3.2
Ca (mg/*l*)	3.9 – 5.2	4.6	6.0	5.6	6.7	8.1	7.2	7.7	6.2	3.7	8.0
Mg (mg/*l*)	5.0 – 6.2	5.6	8.2	7.3	9.5	11.0	10.1	10.7	8.5	5.2	11.3
Cl (mg/*l*)	62.8 –110.6	86.9	112	99	131	147	138	144	120	83	151
SO_4 (mg/*l*)	12.7 – 20	15.9	34	30	38	40	38	37	36	23	37
SiO_2-Si (μg atom/*l*)	13.1 – 31.3	19.6	16	16	18	15	18	12	ND	19	18
NH_3-N (μg atom/*l*)	<0.3 – 0.8	0.36	ND	ND	ND	ND	ND	ND	ND	ND	ND
NO_2-N (μg atom/*l*)	0.01– 0.05	0.02	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1
NO_3-N (μg atom/*l*)	0.00– 0.04	0.01	0.9_2	1.4_4	0.7_5	0.6_0	0.5_6	1.1_9	ND	0.5_6	0.5_6
PO_4-P (μg atom/*l*)	0.01– 0.06	0.03	0.2	<0.2	<0.2	0.3	<0.2	0.5	ND	<0.2	0.3

ND: not determined.

Table 4. Chemical compositions of Lake Nurume (Langhovde).

	Mean value and range of variation from 1969 to 1973		JARE-22 (HIDAKA)			JARE-23 (SHIMAOKA)	
	Range of variation	Mean value	Aug. 27, 1981			Oct. 7, 1982	
Sampling depth	Surface		5.0	10.0	15.4	2.0	15.8
pH	7.50 – 8.30	7.92	7.84	8.14	7.25	8.16	8.34
O_2 (ml/l)	7.54 –12.84	10.19	ND	ND	ND	ND	ND
Density (at 20°C)	1.007– 1.014	1.011	1.022	1.033	1.033	1.022	1.031
Na (g/l)	3.18 – 5.54	4.36	10.8	15.9	15.9	10.8	15.3
K (g/l)	0.18 – 0.22	0.20	0.39	0.54	0.53	0.39	0.54
Ca (g/l)	0.133– 0.295	0.214	0.38	0.52	0.38	0.40	0.35
Mg (g/l)	0.394– 0.743	0.569	1.27	1.90	1.80	1.26	1.85
Cl (g/l)	2.503–10.45	7.20	18.7	26.8	27.1	18.7	26.2
SO_4 (g/l)	0.975– 1.414	1.195	2.7	4.3	3.6	2.6	3.3
SiO_2-Si (μg atom/l)	8 –10	9	9	67	ND	9	ND
NH_3-N (μg atom/l)	0.2 – 1.4	0.8	ND	ND	ND	ND	ND
NO_2-N (μg atom/l)	0.03 – 0.03	0.03	<0.1	<0.1	<0.1	<0.1	<0.1
NO_3-N (μg atom/l)	0.00 – 0.01	0.01	0.6_0	0.7_2	ND	0.4_0	ND
PO_4-P (μg atom/l)	0.11 – 0.21	0.17	0.8	7.4	ND	1.1	ND

ND: not determined.

Table 5. Chemical compositions of Lake Hunazoko (Skarvsnes).

	Mean value and range of variation from 1967 to 1979		JARE-22 (HIDAKA)	JARE-23 (SHIMAOKA)
	Range of variation	Mean value	Oct. 16, 1981	Oct. 7, 1982
pH	7.0 – 7.7	7.49	7.29	7.41
O_2 (ml/l)	1.82 – 4.09	3.00	ND	ND
Density (at 20°C)	1.137– 1.148	1.144	1.145	1.153
Na (g/l)	62.7 – 66.6	64.4	72.5	76.0
K (g/l)	2.55 – 2.80	2.65	2.7	2.9
Ca (g/l)	2.30 – 2.61	2.40	2.38	2.57
Mg (g/l)	8.95 – 9.37	9.17	9.40	10.01
Cl (g/l)	120 –150	131	135	144
SO_4 (g/l)	2.73 – 3.40	3.04	1.9	2.6
SiO_2-Si (μg atom/l)	116 –173	152	ND	ND
NH_3-N (μg atom/l)	ND (1.9) ND	—	ND	ND
NO_2-N (μg atom/l)	0.08 – 0.34	0.25	0.49	0.49
NO_3-N (μg atom/l)	0.4 – 4.8	3.0	3.1_9	3.3_0
PO_4-P (μg atom/l)	0.0 – 1.9	0.5	1.0	1.0

ND: not determined.

tion from the lake surface, and the salts included in snow would be trapped in the lake. From the results obtained, the authors conclude that Lake Hunazoko and Lake Nurume will be useful for monitoring the human impacts on the Antarctic.

In Table 7, seasonal variations of the salt content in Azarasi Ike (tentative name) are shown. It was difficult to distinguish this pond from the sea at least 7 years ago, because this area had been covered with large snow drift. The geomorphological study of the pond was carried out as part of submarine geomorphology in JARE-18

Table 6. Chemical compositions of Lake Skallen Ôike (Skallen).

	Mean value and range of variation from 1968 to 1979		JARE-22 (HIDAKA)		JARE-23 (SHIMAOKA)	
	Range of variation	Mean value	Oct. 15, 1981		Oct. 6, 1982	
Sampling depth (m)	Surface		1.0	9.0	2.5	3.8
pH	7.38– 8.50	7.88	8.98	8.88	7.76	7.90
O_2 (ml/l)	8.41– 10.75	9.08	ND	ND	ND	ND
Na (mg/l)	12.0 – 35.5	27.4	57	56	54	56
K (mg/l)	0.7 – 2.3	1.8	3.1	3.1	3.0	3.0
Ca (mg/l)	7.4 – 37.0	14.0	14.7	15.1	12.9	13.0
Mg (mg/l)	4.9 – 6.1	5.6	9.1	9.3	9.1	8.7
Cl (mg/l)	36.0 – 61.0	51.7	93	94	92	91
SO_4 (mg/l)	7.5 – 12.1	9.4	14	14	14	13
SiO_2-Si (μg atom/l)	95 –108	101	107	108	62	64
NH_3-N (μg atom/l)	0.5 – 1.3	0.9	ND	ND	ND	ND
NO_2-N (μg atom/l)	0.01– 0.03	0.01	0.1	0.1	0.1	0.1
NO_3-N (μg atom/l)	0.01– 0.4	0.01	0.5_7	0.4_4	0.8_5	0.8_1
PO_4-P (μg atom/l)	0.02– 0.08	0.03	0.5	0.4	0.6	0.5

ND: not determined

Table 7. Chemical compositions of Azarasi Ike (pond) (East Ongul Island).*

Sampling date	Apr. 1, 1981	June 10	Aug. 31	Jan. 10, 1982
pH	8.72	8.80	8.52	8.28
Na (mg/l)	260	468	1.04×10^3	240
K (mg/l)	9.8	18	39	9.2
Ca (mg/l)	13.1	23.7	48.8	14.3
Mg (mg/l)	29.2	51.8	109	28.6
Cl (mg/l)	443	794	1.73×10^3	418
SO_4 (mg/l)	63	93	3.4×10^2	64
SiO_2-Si (μg atom/l)	18	31	13	ND
NO_2-N (μg atom/l)	0.1	0.1	0.1	ND
NO_3-N (μg atom/l)	1.03	0.46	3.55	ND
PO_4-P (μg atom/l)	0.5	0.3	0.2	ND

ND: not determined.
* Tentative name (JARE-22, HIDAKA).

(1977). As melting of snow drift became remarkable in recent years, the pond made its appearance on the surface. It was confirmed that the pond was isolated from the sea by a rock bar in 1981 (YOSHIDA, personal commun.). This pond may be useful as a typical case for examining the seasonal variation of chemical compositions of pond waters near Syowa Station.

In this report, the authors tried to show some typical phenomena of the lakes in the Syowa Station area. In order to check the changes in the Antarctic environment, it is thought to be necessary to continue the monitoring with such samples as lake waters for a long period of time.

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