

Monitoring of Pond Water near Syowa Station

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昭和基地周辺の湖沼水のモニタリング

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要旨：昭和基地付近の露岩地帯には多数の湖沼が存在し、その溶存塩の濃度も広い範囲にまたがっている。塩化物イオン濃度で溶存塩の多寡を示すと、最低値 1.3 mg/l, 最大値 210 g/l (20°C の密度 1.223) である。これら溶存している塩類の供給源はさまざまであり、夏季には生物活動が盛んな湖沼も多い。これら湖沼の水質が長年月にどのように変動するかは、地球化学的立場から興味がある。また、これら湖沼に対して昭和基地を中心に活動する人の影響がどのように現れるかを知るために、環境科学の立場から、次の5つの湖沼を地球化学的継続観測定点に選び、モニタリングをはじめた；水汲み沢（東オングル島）、大池（西オングル島）、ぬるめ池（ラングホブデ）、舟底池（スカルブスネス）、スカーレン大池（スカーレン）。これらの池は1) 接近・採水がしやすく、2) 基地からの距離が適当であり、3) 複数の人が調査し、結果が公表されている、などの理由から選ばれた。現在までに知り得た化学成分の組成を表に示す。

Abstract: Since 1957 with the commencement of the activities of the Japanese Antarctic Research Expedition, geochemical investigations of lakes in the vicinity of Syowa Station have been carried out. There are various kinds of lakes in the chemical composition of water. As to the chloride ion, its concentration ranged from 1.3 mg/l to 210 g/l. It is one of the interesting problems to pursue the long-term change of chemical composition of water in the various lakes relating to the change of the meteorological conditions. The long-term observation

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of lake water also contributes to the monitoring of human impacts on the natural environment. Five lakes were selected as the objects for the long-term geochemical observation, which started in the 1978 winter season. The data collected up to 1978 on the five lakes were compiled.

There are many lakes in the ice-free areas near Syowa Station ($69^{\circ}00'S$, $39^{\circ}35'E$). Since 1957 when the scientific research by the Japanese Antarctic Research Expedition (JARE) commenced, the limnological studies were carried out to get the general knowledge on the inland lakes of Antarctica and also to clarify the geochemical processes in the lakes of the Syowa Station area. The results obtained were already reported by SUGAWARA and TORII (1959), MINAMI *et al.* (1961), MEGURO (1962,) WATANUKI (1962), HIGANO (1977), MURAYAMA (1977), SANO *et al.* (1977), HIRABAYASHI and OSSAKA (1977), WATANUKI *et al.* (1977) and KARASAWA and FUKUSHIMA (1977).

MURAYAMA (1977) reported that the chloride ions contained in the lake waters varied considerably, ranging from 1.3 mg/l to 210 g/l, and pointed out that most of the saline lakes of this region seemed to be relict lakes. Consequently, the present water and chemical components of the lakes were mainly supplied by the melt water of the snow drift and by the snow itself. The salts in the lake waters were mainly supplied by the air-borne salts. Chemical compounds in some lakes may be derived from the rock and sand. Therefore, it is expected that the concentration of salts in the lake water varies depending upon the long-term change of the meteorological conditions. It is one of the interesting problems to observe such variation of chemical components of the lake waters as mentioned above. For this observation, it is desirable that different kinds of lakes are comparatively dealt with.

The human impact on the natural environment possibly increases corresponding to the expansion and duration of the research activities. To monitor the effects of human activities the long-term observation of lakes must be useful. For this purpose, it is advantageous to select the lakes which are exposed to the various degrees of impact.

Furthermore, it is hoped that the sampling sites should be accessible to continue the observation. To study the data which will be acquired in the future it would be helpful to select the lakes on which background information is available.

Considering the requirements mentioned above, Mizukumi Stream, Lake

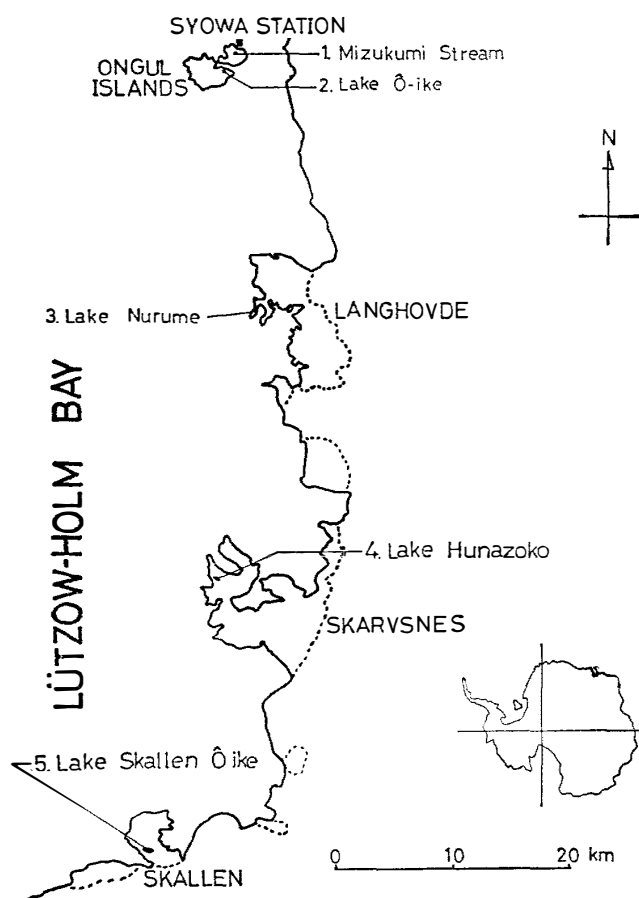


Fig. 1. Position of the monitoring lakes.

Table 1. Geomorphological character of the monitoring ponds.

Lake Name	Mizukumi Stream	Lake Ô-ike	Lake Nurume	Lake Hunazoko	Lake Skallen Ôike
Location	East Ongul	West Ongul	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	16.6	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) × 10 ⁴	0.16	5.2	3.1	14.2	20.9

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

Investigator	HIGANO	SETO	IWANAGA	MURAYAMA	HIRABAYASHI	KUBOTA	
	1969 1-7	1970 1-7	1972 1-7	1973 1-31	1973 2-15	1979 4-15	1979 12-25
Depth of the sample (m)	S*	S*	S*	S*	S*	0.6	S*
Water temperature (°C)	9.3	—	5.6	3.0	1.7	0.4	3.5
pH	—	6.97	6.97	6.8	6.9	6.8	6.8
O ₂ (ml/l)	—	8.62	8.37	—	—	—	—
Na (mg/l)	—	114.0	—	51	54.5	—	—
K (mg/l)	—	2.4	—	2.1	1.97	—	—
Ca (mg/l)	—	20.8	—	7.2	6.5	—	—
Mg (mg/l)	—	22.2	—	7.5	9.1	—	—
Cl (mg/l)	193	236.9	107.1	84.4	100	8.4×10	2.3×10
SO ₄ (mg/l)	360	107.0	—	35	17.8	—	—
SiO ₂ -Si (μg atom/l)	13	41	33	—	—	64.7	4.0
NH ₃ -N (μg atom/l)	0.6	—	0.2	—	—	0.4	0.7
NO ₂ -N (μg atom/l)	0.04	0.15	0.02	—	—	<0.25	<0.25
NO ₃ -N (μg atom/l)	0.0	0.03	0.05	—	—	<0.1	0.3
PO ₄ -P (μg atom/l)	0.13	0.33	0.15	—	—	<0.5	<0.5

* S: Samples were collected from the lake shore. Depth of the sampling ranges was 0-20 cm.

The lake water was not covered with ice-sheet,

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

Investigator	TORII		HIGANO	HIGANO	SETO	IWANA- GA	MURAYAMA		IWANA- GA	HIRABA- YASHI	KUBOTA			
	1967 11-20		1968 1-23	1969 1-8	1970 1-7	1972 1-6	1972 11-18		1973 2-16	1973 2-16	1979 4-24		1979 10-30	
Depth of the Sample (m)	3.0	5.0	S*	S*	S*	S*	2.0	10.5	S*	S*	1.0	8.0	2.0	8.0
Water Temperature (°C)	7.0	7.0	7.4	7.3	—	6.4	0.8	2.3	3.9	4.0	2.1	4.0	4.9	5.0
pH	7.09	7.11	6.78	7.14	6.98	7.19	6.8	6.9	—	7.3	6.80	6.80	6.8	6.8
O ₂ (mg/l)	10.03	9.97	8.33	8.70	8.90	8.30	—	—	9.22	—	—	—	—	—
Na (mg/l)	57.5	57.5	—	—	48.5	—	60	65	—	36.0	—	—	—	—
K (mg/l)	2.3	2.3	—	—	2.0	—	3.0	2.9	—	1.41	—	—	—	—
Ca (mg/l)	6.67	6.50	—	—	5.2	—	5.9	6.6	—	3.9	—	—	—	—
Mg (mg/l)	7.11	6.82	—	—	6.2	—	9.6	9.6	—	5.0	—	—	—	—
Cl (mg/l)	137	104	75	83.5	86.0	110.6	120	125	101.5	62.8	8.9×10	2.8×10	8.7×10	4.0×10
SO ₄ (mg/l)	16.7	17.0	—	20	15.0	—	12	11	—	12.7	—	—	—	—
SiO ₂ -Si (μg atom/l)	1	1	15	19	19	23	—	—	17	—	31.3	19.2	13.1	22.2
NH ₃ -N (μg atom/l)	0±1	0±1	—	0.4	0.3	0.3	—	—	—	—	<0.3	0.5	0.8	<0.3
NO ₂ -N (μg atom/l)	0	0	0.01	0.03	0.04	0.03	—	—	0.05	—	<0.25	<0.25	<0.25	<0.25
NO ₃ -N (μg atom/l)	0.08	0.05	0.02	0.03	0.04	0.00	—	—	0.0	—	<0.1	<0.1	<0.1	<0.1
PO ₄ -P (μg atom/l)	0.15	0.1	0.03	0.01	0.02	0.06	—	—	0.08	—	<0.5	<0.5	<0.5	<0.5

* S: Samples were collected from the lake shore. Depth of the sampling ranges was 0-20 cm.

The lake water was not covered with ice-sheet.

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

Investigator	TORII			HIGANO			IWANAGA	MURAYAMA		IWANAGA	HIRA-BAYASHI
Sampling date	1967 10-12			1969 1-25			1972 1-30	1972 10-7		1973 2-7	1973 2-7
Depth of the sample (m)	5	10	15	0	4	6	S*	1.5	16.0	S*	S*
Water temperature (°C)	2.6	10.8	9.4	8.5	—	12.0	8.5	-3.2	2.2	4.6	4.6
pH	8.05	8.35	6.80	7.96	8.04	8.16	7.50	7.6	7.3	—	8.3
Density (at 20°C)	1.023**	1.033**	1.040**	1.007	1.028	1.030	—	1.022	1.036	—	1.014
O ₂ (ml/l)	—	—	—	—	—	—	7.54	—	—	12.84	—
Na (g/l)	10.6	13.9	15.7	3.18	11.6	12.1	—	11.0	17.0	—	5.54
K (g/l)	0.47 ₈	0.59 ₄	0.68 ₈	0.177	0.515	0.525	—	0.42	0.57	—	0.217
Ca (g/l)	0.42	0.68	0.80	0.133	0.493	0.561	—	0.42	0.60	—	0.295
Mg (g/l)	1.18	1.68	2.08	0.394	1.462	1.541	—	1.3	1.6	—	0.743
Cl (g/l)	17.53	25.24	31.10	6.03	22.06	23.05	2.503	19	29	10.45	9.82
SO ₄ (g/l)	2.43	3.52	3.96	0.975	3.06	3.09	—	2.8	3.3	—	1.414
SiO ₂ -Si (μg atom/l)	—	—	—	8	10	7	10	—	—	9	—
NH ₃ -N (μg atom/l)	—	—	—	0.2	0.3	0.1	1.4	—	—	—	—
NO ₂ -N (μg atom/l)	—	—	—	0.03	0.01	0.01	0.03	—	—	0.03	—
NO ₃ -N (μg atom/l)	—	—	—	0.01	0.00	0.00	0.01	—	—	0.0	—
PO ₄ -P (μg atom/l)	—	—	—	0.11	0.15	0.13	0.19	—	—	0.21	—

* S: Samples were collected from the lake shore. Depth of the sampling ranges was 0-20 cm.

The lake water was not covered with ice-steet.

** : measured at 26°C

Table 4 (continued).

Investigator	KUBOTA							KUBOTA						
	1979 5-2							1979 9-23						
Sample date	1.0	3.0	5.0	7.0	9.0	11.0	13.0	2.0	5.0	7.0	9.0	11.0	13.0	15.0
Depth of the sample (m)	1.0	3.0	5.0	7.0	9.0	11.0	13.0	2.0	5.0	7.0	9.0	11.0	13.0	15.0
Water temperature (°C)	-1.2	-1.1	-1.0	7.3	11.9	12.8	10.0	-0.6	-0.6	1.4	3.5	7.8	7.6	6.6
pH	7.0	6.9	6.9	6.9	7.0	7.6	8.0	7.1	7.0	7.0	7.0	7.7	8.1	8.2
Density (at 20°C)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O ₂ (ml/l)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Na (g/l)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
K (g/l)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ca (g/l)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mg (g/l)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cl (g/l)	6.6	7.2	7.7	13	21	22	24	11	14	13	16	23	29	28
SO ₄ (g/l)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SiO ₂ -Si (μg atom/l)	47.5	83.9	74.8	19.2	27.3	84.9	162	34.4	36.4	59.2	34.3	102	146	164
NH ₃ -N (μg atom/l)	2.0	1.4	2.3	2.2	8.3	2.0	8.1	2.2	2.1	1.7	3.8	28.0	33.7	159
NO ₂ -N (μg atom/l)	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
NO ₃ -N (μg atom/l)	<0.1	0.5	<0.1	<0.1	<0.1	0.5	<0.1	0.3	0.3	<0.1	<0.1	<0.1	<0.1	<0.1
PO ₄ -P (μg atom/l)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	125	52.6	<0.5	<0.5	<0.5	52.6	145	126

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

Investigator	TORII		IWA-NAGA	MURAYAMA		IWANAGA						HIRA-BAYASHI	KUBOTA	
Sampling date	1967 10-6		1972 2-1	1972 10-27		1973 2-6						1973 2-6	1979 5-17	1979 9-15
Depth of the sample (m)	0	2.5	S*	1.0	8.5	0	2	3	4	6	8	S*	0	7.0
Water temperature (°C)	-15.3	-15.7	8.7	-15.0	-17.5	6.3	7.9	1.7	-7.3	-10.0	-10.2	6.3	-2.3	-17.5
pH	7.45	7.26	7.62	7.0	6.9	—	—	—	—	—	—	7.7	7.7	7.2
Density (at 20°C)	1.146**	1.146**	—	1.148	1.156	—	—	—	—	—	—	1.137	—	—
O ₂ (ml/l)	—	—	1.82	—	—	4.09	2.09	2.45	1.81	1.78	3.80	—	—	—
Na (g/l)	66.6	66.7	—	64	66	—	—	—	—	—	—	62.7	—	—
K (g/l)	2.8	2.8	—	2.6	2.9	—	—	—	—	—	—	2.55	—	—
Ca (g/l)	2.61	2.54	—	2.3	2.5	—	—	—	—	—	—	2.3	—	—
Mg (g/l)	8.95	9.02	—	9.2	9.7	—	—	—	—	—	—	9.37	—	—
Cl (g/l)	133.3	133.6	120.2	130	140	133	145	156	150	154	147	122	150	140
SO ₄ (g/l)	2.73	2.83	—	3.4	2.9	—	—	—	—	—	—	2.994	—	—
SiO ₂ -Si (μg atom/l)	116	129	167	—	—	152	196	239	239	242	234	—	173	184
NH ₃ -N (μg atom/l)	191 ± 4	238 ± 4	—	—	—	—	—	—	—	—	—	—	1.9	3.3
NO ₂ -N (μg atom/l)	0.34	0.38	0.08	—	—	0.08	0.17	0.17	0.26	0.22	0.18	—	<0.25	<0.25
NO ₃ -N (μg atom/l)	3.27	3.78	3.49	—	—	4.8	3.8	3.7	3.7	3.6	3.6	—	0.4	3.3
PO ₄ -P (μg atom/l)	1.9	1.7	0.11	—	—	0.00	0.00	0.00	0.00	0.08	0.21	—	<0.5	<0.5

* S: Samples were collected from the lake shore. Depth of the sampling ranges was 0-20 cm.

The lake water was not covered with ice-sheet.

** : measured at 26°C

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

Investigator	TORII	HIGANO	HIGANO	SETO	IWA-NAGA	MURAYAMA	IWA-NAGA	HIRA-BAYASHI	KUBOTA				
Sampling date	1968 1-30	1968 2-1	1969 2-3	1970 2-4	1972 2-3	1972 11-17		1973 2-12	1973 2-12	1979 5-14		1979 8-18	
Depth of the sample (m)	S*	S*	S*	S*	S*	2.0	8.5	S*	S*	1.0	8.0	2.0	8.0
Water temperature (°C)	4.4	3.6	6.8	5.8	9.1	-1.4	1.4	1.5	1.5	1.9	5.6	1.3	3.1
pH	—	7.38	7.90	7.86	7.63	9.0	8.6	—	8.5	8.0	—	5.8	—
O ₂ (mg/l)	—	9.02	8.64	8.41	8.56	—	—	10.75	—	—	—	—	—
Na (mg/l)	31.0	12.0	32.1	35.5	—	48	49	—	26.5	—	—	—	—
K (mg/l)	2.1	0.7	2.2	2.3	—	3.4	2.9	—	1.84	—	—	—	—
Ca (mg/l)	8.5	37.0	8	7.4	—	9.4	12	—	8.9	—	—	—	—
Mg (mg/l)	4.9	—	6	6.1	—	9.5	9.5	—	5.2	—	—	—	—
Cl (mg/l)	52.3	50	56.5	60.3	61.0	85	86	—	46.1	36	58	88	77
SO ₄ (mg/l)	8.7	—	—	12.1	—	10	11	—	7.5	—	—	—	—
SiO ₂ -Si (μg atom/l)	—	98	106	99	95	—	—	—	—	108	113	150	80.9
NH ₄ -N (μg atom/l)	—	0.9	0.6	1.3	0.5	—	—	—	—	1.2	1.4	2.0	3.2
NO ₂ -N (μg atom/l)	—	0.01	0.01	0.02	0.03	—	—	—	—	<0.25	<0.25	<0.25	<0.25
NO ₃ -N (μg atom/l)	—	0.4	0.01	0.05	0.04	—	—	—	—	<0.1	<0.1	0.4	<0.1
PO ₄ -P (μg atom/l)	—	0.04	0.02	0.02	0.08	—	—	—	—	<0.5	<0.5	<0.5	<0.5

* S: Samples were collected from the lake shore. Depth of the sampling ranges was 0-20 cm.

The lake water was not covered with ice-sheet.

Ô-ike, Lake Nurume, Lake Hunazoko and Lake Skallen Ôike were selected according to the distance from Syowa Station as the long term geochemical observation sites (Fig. 1 and Table 1). Mizukumi Stream, Lake Ô-ike and Lake Skallen Ôike are of fresh water and the others are saline. Geochemical data on five lakes obtained by the previous workers are summarized in Tables 2 to 6. At the present state of the knowlege on the lake waters, it is difficult to mention the variation in the chemical components of the waters. Further continuous observation is necessary.

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