TRACE ELEMENT CONCENTRATION OF POND AND LAKE WATERS NEAR SYOWA STATION, ANTARCTICA

Shyu NAKAYA[1], Tetsuhiro KURIBAYASHI[1] and Tetsuya TORII[2]

[1]*Department of Earth Sciences, Faculty of Science, Hirosaki University, Bunkyo-cho 3, Hirosaki 036*

[2]*Chiba Institute of Technology, Tsudanuma, Narashino 275*

Abstract: The pond and lake water samples which were collected from near Syowa Station by the JARE-22, -23 and -24 activities were analyzed for the trace elements. The correlatinos of chemical compositions between snow samples and the waters of Lakes Nurume, Suribati, Hunazoko and Ô-ike indicate that trace elements in these lake waters might have been derived mostly from snow.

An environmental monitoring program of the Lützow-Holm Bay region based on the chemical analysis of pond and lake waters started in the 1978 winter season (MURAYAMA *et al.*, 1981). Since then, pond and lake water samples have been collected from the geochemical and environmental points of view (MURAYAMA *et al.*, 1981, 1984).

On the pond and lake, water samples were collected at the environmental monitoring points in the Lützow-Holm Bay region, Antarctica by HIDAKA in JARE-22, SHIMAOKA in JARE-23 and KANDA in JARE-24, and trace elements, such as aluminum, iron, manganese and copper were determined by using a Hitachi 180–50 atomic absorption and a Hitachi Z-7000 polarized zeeman atomic absorption spectrophotometers.

The concentrations of main elements and nutrient matters in these water samples, and general geomorphological characters of these ponds and lakes had been reported by MURAYAMA *et al.* (1984).

The vertical concentration profiles of iron, manganese and copper of Lake Nurume are shown in Figs. 1, 2 and 3 together with the results of SANO *et al.* (1977b). From these results, the concentrations of these elements and the stratification are throught to have been stable in the last seven years. The concentrations of these elements in the surface water were changed. This change may be caused by the different amount of supply of the meltwater from snow and ice.

The concentration of iron is almost constant from the surface to a 10 m depth, but below this depth it increases abruptly.

The maximum concentration of manganese is found at a 10 m depth.

The vertical concentration profiles of these trace elements may be accounted for by an oxidizing or a reducing environment. SANO *et al.* (1977b) reported that high hydrogen sulfide concentrations were found below the 10 m depth.

In a reducing environment, iron and manganese are more abundant than in an oxidizing environment, because of the increased solubility.

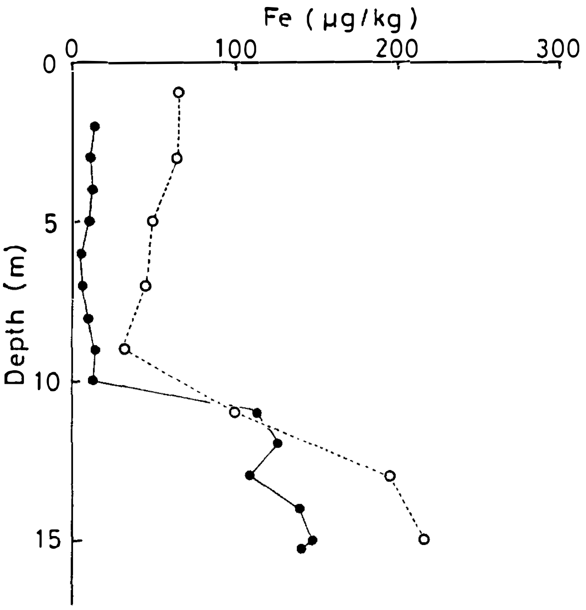

Fig. 1. Vertical distribution of iron in Lake Nurume. ○-○ *after* SANO *et al. (1977).* ●-● *this work.*

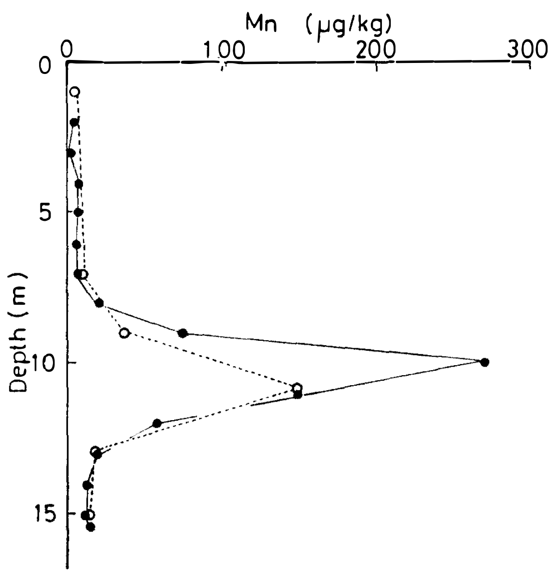

Fig. 2. Same as Fig. 1 but for manganese.

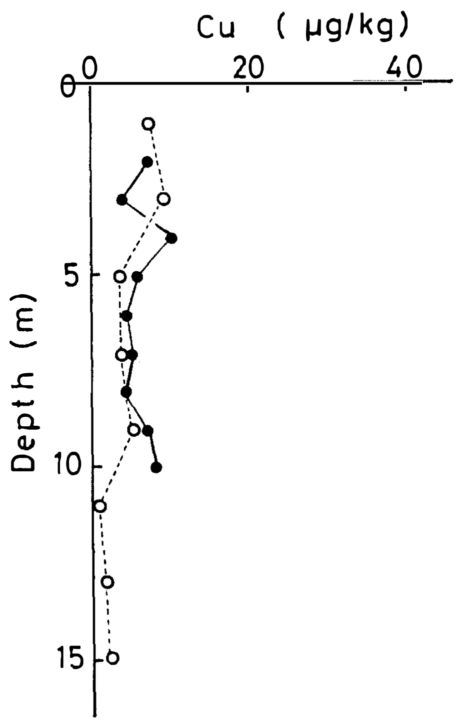

Fig. 3. Same as Fig. 1 but for copper.

Also seasonal variations of the concentration of these elements in the other ponds and lakes are observed (Table 1). But in order to monitor in detail the changes in concentration of elements in these ponds and lakes, it is thought to be necessary to continue the chemical analysis with such water samples for a long time.

Table 1. Trace element concentrations in lake waters near Syowa Station.

Lake	Sampling date	Sampling depth (m)	Al	Fe (μg/kg)	Mn	Cu
Lake Nurume	Aug. 27, '81[1)]	2.0	17.5	16.6	5.0	7.6
		3.0	13.0	13.4	3.0	4.6
		4.0	13.2	14.4	8.7	10.4
		5.0	13.5	11.2	8.4	6.6
		6.0	7.3	6.7	7.0	4.9
		7.0	10.0	6.5	7.7	5.2
		8.0	11.3	10.4	20.3	4.7
		9.0	10.4	14.6	74.0	7.4
		10.0	13.4	12.2	257	7.9
		11.0	14.0	113	144	ND
		12.0	14.4	122	56.2	ND
		13.0	14.8	107	19.0	ND
		14.0	17.9	136	12.2	ND
		15.0	18.2	144	12.3	ND
		15.4	18.5	143	14.5	ND
	Nov. 28, '81[1)]	2.3	16.6	20.6	4.5	7.0
	Oct. 7, '82[2)]	2.0	75.2	10.6	6.3	41.1
		15.8	272	238	36.5	1.3
	Aug. 23, '83[3)]	surface	29.9	32.3	3.6	21.5
Lake Suribati	Oct. 17, '81[1)]	1.4	69.3	20.4	54.2	12.4
		12.8	65.4	125	876	2.6
Lake Hunazoko	Oct. 16, '81[1)]	surface	407	56.1	1780	8.9
	Oct. 7, '82[2)]	surface	941	589	2430	12.9
	Sep. 12, '83[3)]	surface	296	313	1930	26.6
Lake Ô-ike*	Dec. 19. '81[1)]	surface	7.18	37.7	1.1	18.9
	Mar. 18, '81[1)]	0.6	9.94	18.4	ND	13.2
		11.5	9.72	21.7	ND	0.5
	June 3, '81[1)]	1.4	8.46	21.2	ND	4.2
		10.6	9.38	39.5	7.1	0.8
	Aug. 31, '81[1)]	2.0	9.36	21.6	2.4	8.0
		9.0	6.70	148	27.8	1.1
	Nov. 27, '82[2)]	2.0	88.8	391	11.2	54.5
		9.5	12.1	61.2	6.6	6.0
	Aug. 6, '83[3)]	surface	19.7	16.7	1.2	4.3
Lake Skallen Ô-ike*	Dec. 19, '81[1)]	2.5	10.3	23.3	13.6	13.7
	Oct. 6, '82[2)]	2.5	49.5	106	29.3	36.9
		3.8	60.9	130	33.6	27.6
	Jan. 14, '84[3)]	surface	29.1	36.4	1.32	0.2
Lake Azarashi*,♯	Apr. 1, '81[1)]	1.5	19.9	14.6	1.36	0.1
	June 10, '81[1)]	1.5	17.5	10.2	1.3	2.0
	Aug. 31, '81[1)]	0.7	11.1	26.6	1.9	11.9
	Jan. 10, '82[2)]	surface	26.6	36.7	8.6	1.1
Daiichi Dam*	Mar. 16, '81[1)]	0.3	21.5	21.8	3.8	0.6
	Jan. 10, '82[2)]	surface	1070	350	26.9	1.5
Mizukumi Stream	Dec. 22, '82[2)]		1800	2060	37.7	17.3
	Jan. 26, '84[3)]	surface	3200	2340	30.3	5.2

1) Collected by Mr. HIDAKA (JARE-22). 2) Collected by Mr. SHIMAOKA (JARE-23).
3) Collected by Dr. KANDA (JARE-24).
* μg/l. ♯ Tentative name (JARE-22, HIDAKA). ND: not determined.

Many reports presented the distribution and origin of main elements in the Antarctic lakes, but there exist few reports about trace elements in them.

Some reports proposed a seawater origin for main elements in ponds and lakes near Syowa Station (HIRABAYASHI and OSSAKA, 1977; MURAYAMA, 1977; SANO *et al.*, 1977a).

On the basis of chemical analysis on waters of saline lakes of the Dry Valleys area in the McMurdo Sound region, MASUDA *et al.* (1982, 1984) reported that the pathway of trace elements in Lake Vanda was tropospheric aerosol particle precipitation–glacier–glacier meltwater–Lake Vanda, and trace elements in the Antarctic saline lake waters might have been derived from aerosol particles based on the correlations of chemical constituents between aerosol particles and lake waters.

The most possible origins of trace elements in ponds and lakes near Syowa Station are considered almost the same as those in the saline lakes in the Dry Valleys area.

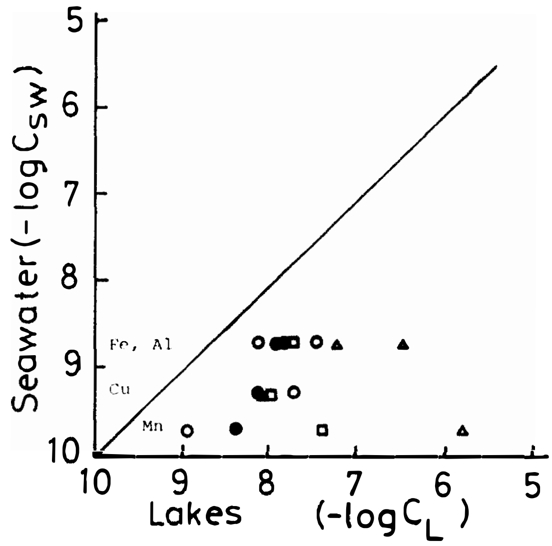

Fig. 4. Relationship of trace element concentrations between Lakes Nurume, Suribati, Hunazoko and Ô-ike and seawater (data of seawater are from BREWER, 1975). C_{SW} indicates the concentration of trace elements of seawater in kg/kg. C_L indicates the concentration of trace elements of Lakes Nurume (●), Suribati (□), Hunazoko (△) and Ô-ike (○) in kg/kg.

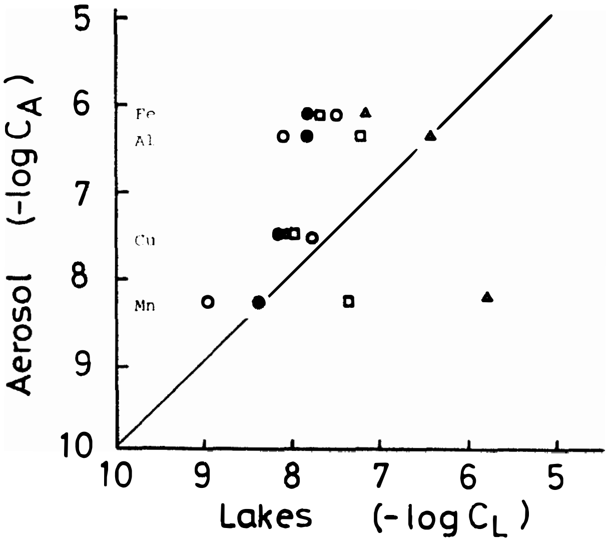

Fig. 5. Relationship of trace element concentrations between Lakes Nurume, Suribati, Hunazoko and Ô-ike and the aerosols at South Pole (data of aerosols are from ZOLLER et al., 1974). C_A indicates the concentration of trace elements in aerosol at the South Pole in kg/m³. C_L as in Fig. 4.

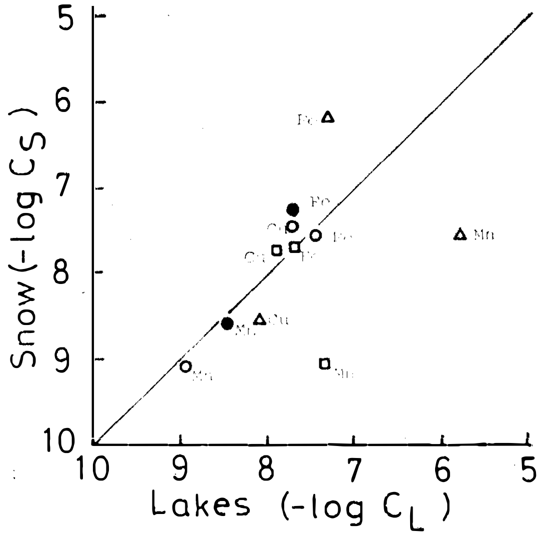

Fig. 6. Relationship of trace element concentrations between Lakes Nurume, Suribati, Hunazoko and Ô-ike and the snow surrounding these lakes (chemical compositions of the snow samples were analyzed by SANO *(unpublished data)).* C_S *indicates the concentration of trace elements of snow samples in kg/kg.* C_L *as in Fig. 4.*

The relationships of trace element concentrations between surface waters of Lakes Nurume, Suribati, Hunazoko and Ô-ike near Syowa Station and seawater, aerosols at the South Pole, snow meltwater surrounding these lakes are shown in Figs. 4, 5 and 6, respectively. The origin of trace elements in those lake waters is not considered seawater (Fig. 4).

The chemical compositions of surface waters in these lakes show a poor agreement with those of aerosols and a good agreement with those of snow except for manganese for Lakes Suribati and Hunazoko. In general, aerosol particles have a similar chemical composition to the Antarctic snow (BOUTRON and LORIUS, 1979; BOUTRON and MARTIN, 1980).

The crustal material was considered to be the major source of aluminium, iron and manganese in aerosols particle at Syowa Station (NAKAYA, 1982). The difference of this correlation of chemical composition for aerosols and snow to lake waters may be caused by different amount of supply of weathered rock matters from the bare rocky area near Syowa Station.

The good correlations of chemical composition between these lake waters and the snow indicate that these trace elements in these lakes near Syowa Station might been derived from the snow.

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