Chemical Stratification of the Water of Lake Inogaike, Fukui Prefecture

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INTRODUCTION

Lake Inogaike is a small lake near the coast of the Japan Sea, located at the head of Tateishi Peninsula near Tsuruga, Fukui Prefecture, Japan.

In June, 1963, the author investigated the vertical distribution of the chemical properties of the water of this lake. Significantly higher concentrations of chlorine ion and other elements in the surface layer were found, indicating the influence of wind borne sea salt.

As shown on fig. 1, the topography of the lake basin is simple, as a bowl, elongated in the west-east direction, with dimensions of 400m x 200m. The deepest point is at the center of the lake (7.5m), and the level of the water surface of the lake is slightly higher than the sea level.

While the mountains are close to the south and north coasts of the lake, both the east and west coasts are nearly flat, and are only 70m and 200m from the sea and bay shores respectively. Though the basin has no channel to the sea and sea water can not flow in the lake directly, sea salt seems to be easily transported as particles by the wind to the lake through this topographical wind gap.

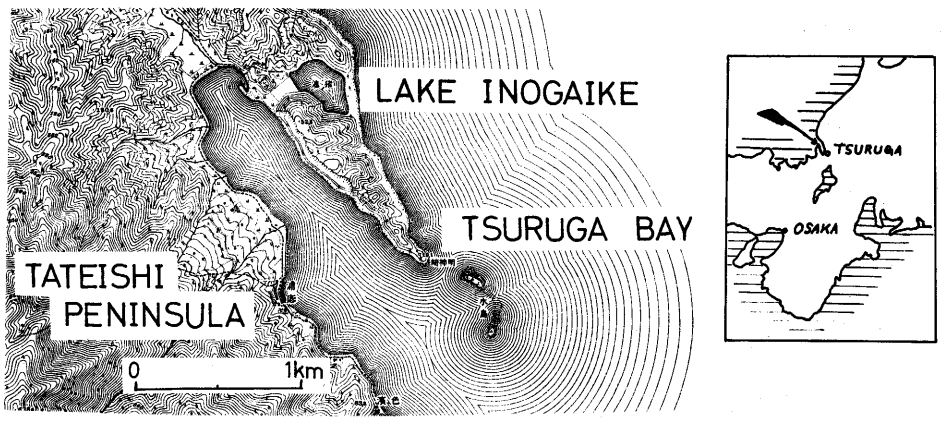

Fig. 1 Location of Lake Inogaike

METHODS OF ANALYSIS

Samples of lake water were taken at depth of one meter at the center of the lake with a Kitahara-type water sampler.

The chemical elements of the water were determined by the following methods.

Cl^-	;	Mohr's method
Ca^{2+}	;	EDTA titration
Mg^{2+}	;	EDTA titration
Alkalinity (pH 4.3)	;	HCl titration
Dissolved oxygen	;	Winkler's method

RESULTS AND CONSIDERATIONS

The results of chemical analysis of the water and some characteristics of the pattern of vertical distribution are shown in table 1 and fig. 2.

Table 1 Chemical Components of the Water of Lake Inogaike

(12:00, June 18, 1963)

Depth (m)	Water Temp. (C^o)	pH	Cl^- (mg/l)	Ca^{2+} (mg/l)	Mg^{2+} (mg/l)	Alkalinity (pH 4.3) (meq/l)	D.O. (O_2ml/l)
0	22.9	6.0	122.0	4.9	7.4	0.14	6.07
1	22.8	6.4	21.4	1.6	2.3	0.14	6.30
2	22.5	6.2	18.5	1.6	2.4	0.10	5.92
3	22.2	6.0	20.0	1.6	1.3	0.10	5.28
4	21.8	6.0	19.2	1.6	1.4	0.10	6.16
5	21.4	6.0	18.5	1.6	1.4	0.10	6.74
6	19.6	6.0	18.5	1.6	1.8	0.14	2.24
7	17.7	6.0	20.7	1.6	2.4	0.19	0.26

Water temperature

Vertical distribution of water temperature was almost uniform, decreasing slightly at the bottom layer. The depth of the lake is considered to be insufficient for the formation of summer thermal stratification.

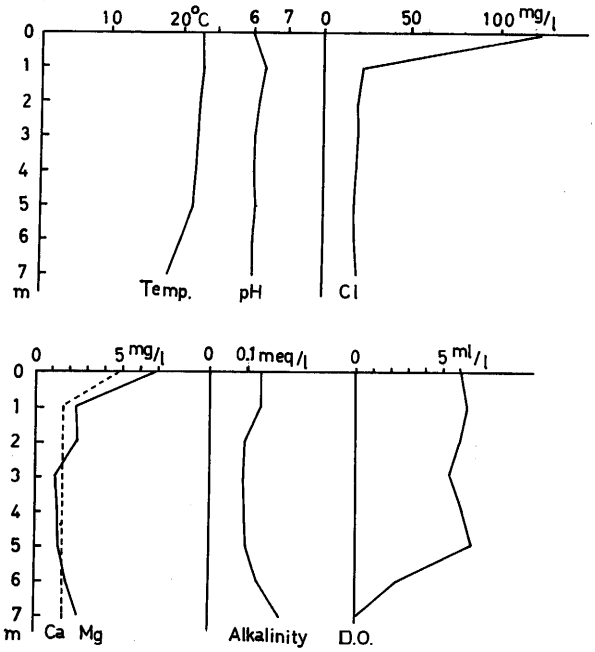

Fig. 2 Vertical distribution of some chemical components in the lake water of Inogaike

pH

The value of pH was also almost uniform vertically throughout the lake, except for slightly higher values at 1 m and 2 m depths.

Cl^-

The vertical distribution of chlorine ion was most characteristic, showing a remarkably high value of 122 mg/l at the surface layer. In the layer below 1 m, the concentration was almost similar with about 20 mg/l.

Ca^{2+}

Calcium ion showed a similar distribution pattern as chlorine ion. In the surface layer, the content of Ca^{2+} was about three times that of the lower layer.

Mg^{2+}

Magnesium ion also had a similar pattern but increased slightly toward the bottom layer.

Alkalinity

Alkalinity was high at the bottom and the surface layers. In the middle layer the value was rather uniform.

Dissolved oxygen

The content of dissolved oxygen was nearly saturated in the layer above 5 m and showed a sharp reduction at the bottom layer where no oxygen is dissolved and anaerobic condition was formed.

Compiling these distribution patterns of each chemical component, three water layers -- surface layer (0 – 1 m), middle layer (1 m – 5 m) and bottom layer (5 m – 7.5 m) -- are distinguished. From the comparison of the chemical components of the water of Lake Inogaike with those of other lake water in Japan (Yoshimura, 1937), the main body of water of this lake does not show any remarkable differences from the normal fresh water lake. The surface layer, however, shows somewhat of a special character, having higher Cl^-, Ca^{2+} and Mg^{2+} contents. This chemical stratification is thought to originate by the flowing of sea salt into the surface of the lake, transported by the wind as particle form or as droplets from sea spray.

Although the ratio of Mg/Cl (= 0.06) in the surface layer is nearly similar to that of the sea water (= 0.07), the ratio of Ca/Cl (= 0.04) is twice that of sea water (= 0.02).

These facts suggest some chemical fractionations of sea salt in the course from the sea to the lake (Sugawara, 1960), or chemical and biological processes thereafter. The mechanism of the stability of this chemical stratification is also a problem for future studies.

REFERENCES CITED

SUGAWARA, K., 1960: Chemistry of ice, snow and other substances in Antarctica. Antarctic Record no. 11, p. 116-120.

YOSHIMURA, S., 1937: Limnology (in Japanese).