

Distribution of trace metals in Kagoshima Bay—I Sea water*

Akio INOUE**

Abstract

Trace metals (Fe, Mn, Co, Ni, Cu, Zn, Pb, Cd) in the sea water samples of Kagoshima Bay were concentrated by ion exchange resin and their concentrations were determined by atomic absorption spectrophotometry. Trace metal concentrations were 56–155 for Fe, 2.4–3.6 for Mn, 1.9–6.5 for Co, 27–72 for Ni, 1.0–4.7 for Cu, 12–66 for Zn, trace–34 for Pb, not detected —0.05 for Cd, respectively ($\mu\text{g/l}$). High correlation coefficients were obtained between the contents of Zn and Pb, and among those of Fe, Mn and Ni.

Introduction

Kagoshima Bay is located in the southeast part of Kyushu, Japan, occupying about 1,200 km² in area and having the rather vast deeper part more than 200 m nearly at its center. This bay can be divided geographically into two parts, namely inner and outer part, demarcated by active volcano Mt. Sakurajima, and is known not to have been severely affected by artificial wastes^{1,2)}. However, several fundamental figures on water quality are essential for the comprehension of present situation and together for the acquisition of basic data for possible changes in future. With these objects the author measured trace metal contents in sea water of Kagoshima Bay. The metals analysed here were Fe, Mn, Co, Ni, Cu, Zn, Pb and Cd.

Methods

Sea water samples, collected by Van Dorn water sampler from 0 m (surface), 50 m (middle) and bottom at 15 points of Kagoshima Bay in May, 1974, shown in Fig. 1, were filtered through millipore filters (pore size 0.45 μ) which had been washed in dil. HNO₃ and rinsed thoroughly with redistilled water. Conc. HNO₃ was added to these filtrates in a ratio of 1 ml to 500 ml filtered sea water which stored in polyethylene bottles until use. As far as the trace metals measured here concern, the stored sea water in this state showed no conspicuous changes in their concentrations at least within four months at room temperature.

Prior to process, sea water sample was adjusted to pH 5.2 ± 0.2 by NaOH solution. Concentration and extraction of trace metals were carried out principally according

* This work was partly supported by the grant of Ministry of Education, Japan, and presented at the annual meeting of the Japanese Society of Scientific Fisheries on November, 1974, Kyoto.

** Laboratory of Marine Botany and Environmental Science, Faculty of Fisheries, Kagoshima University.

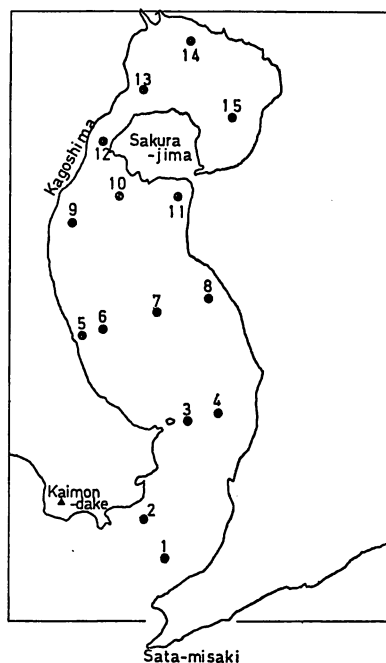


Fig. 1. Sampling stations.

to the procedure by D. G. Biechler³⁾ using ion exchange resin. Samples of 500 or 1,000 ml were passed through a column of 10×70 mm cation exchange resin Chelex 100 (50–100 mesh, Bio-Rad Laboratories) at a rate not excess 3 ml/min. After being run dried, an aliquot of distilled water was added, and trace metals adsorbed were eluted by 4.0 N nitric acid. The first 50 ml eluates were collected by a volumetric flask to the mark. Trace metal concentrations in these eluates were directly determined by Hitachi 208 atomic absorption spectrophotometer adopting air-acetylene flame. The recovery of each metal was practically same with the value reported previously⁴⁾.

Results and Discussions

As seen in Fig. 2, Fe was distributed almost evenly throughout the bay, and no remarkable difference among layers and stations were observed. Rather high contents ($56\text{--}155 \mu\text{g/l}$) observed here might be caused by frequent falling of volcanic ashes from Mt. Sakurajima on sea water surface⁵⁾. To check this possibility, the solubility of each metal to sea water was tested. 1.0 g of ashes collected on September, 1974, was immersed in 100 ml of sea water and 0.2 N HCl for 24 hours with temporal shakings. The results thus obtained were shown in Table 1 which suggests that Fe supply by the ashes to sea water is very probable.

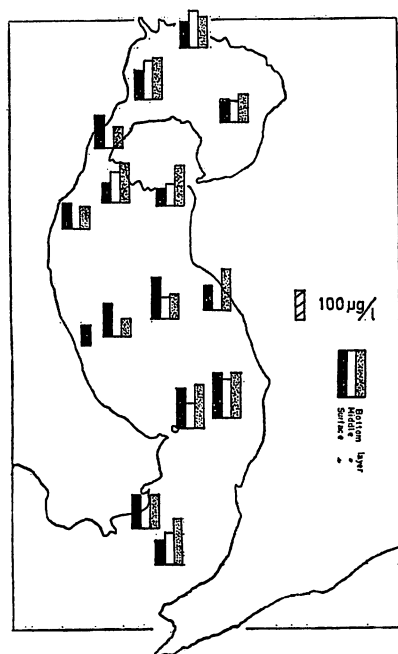


Fig. 2. "Fe" distribution in Kagoshima Bay.

Table 1. Extracted fractions of trace metals in volcanic ashes.

	Fe	Mn	Ni	Cu	Co	Zn	Pb	Cd
Sea water	2.52	0.81	5.38	1.26	—*	2.43	1.09	0.04
0.2 N HCl	366.05	7.81	3.87	3.37	—	3.78	3.78	—

(µg/l)

* not detected

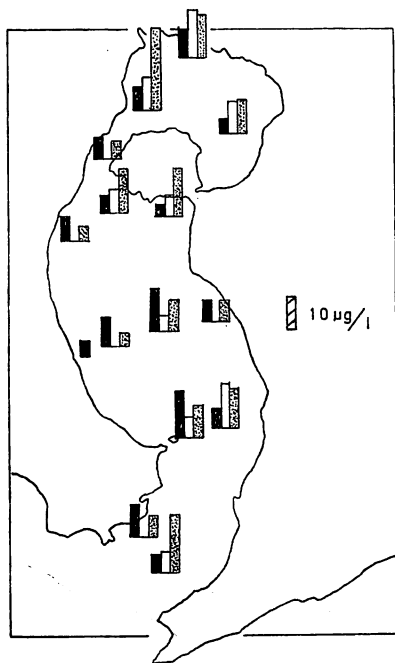


Fig. 3. "Mn" distribution in Kagoshima Bay.

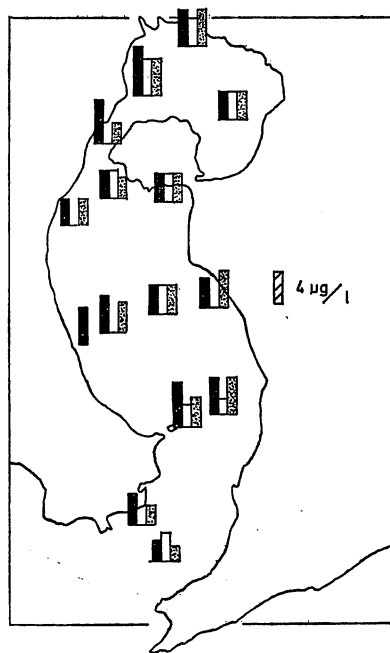


Fig. 4. "Co" distribution in Kagoshima Bay.

Mn and Co concentrations were shown in Fig. 3 and Fig. 4 respectively. Mn were found in higher values in the samples of inner part and deeper layer of the bay. A highest value was obtained in the bottom water at St. 13. Co was found 1.9–6.5 $\mu\text{g/l}$ through the results obtained which were ordinary for the inshore waters.

Ni contents were observed to be a little higher when compared to other published ones on shore waters of Japan⁴⁾. It distributed rather uniformly from surface to bottom and mouth part to bosom part of this bay.

Cu was observed 1.0–4.7 $\mu\text{g/l}$, and showed rather less amount in the samples from innerest station (St. 15). Except this station, it can be said that this metal distributed evenly throughout the bay.

Higher contents of Zn (Fig. 7) and Pb (Fig. 8) were found in the water samples from inner part of the bay. This can be ascribed partly to the transport of municipal drainages and industrial wastes by several rivers which pour into sea near around St. 14 and St. 15, and partly to the replenishments from the volcanic ashes as described previously.

Cd was below detection limit of our method employed here in most samples except those of five stations. Biggest concentration of 0.05 $\mu\text{g/l}$ was found on surface water at St. 9.

To compare the distributional pattern of each metal in Kagoshima Bay, the correlation coefficients between any two metals except Cd were calculated on the surface water samples. The results in Table 2 indicated high correlation were found among

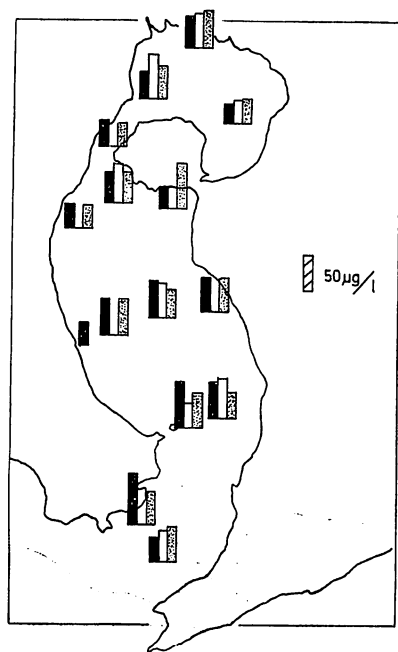


Fig. 5. "Ni" distribution in Kagoshima Bay.

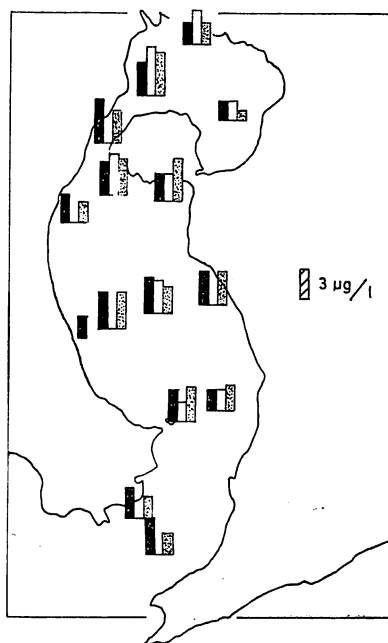


Fig. 6. "Cu" distribution in Kagoshima Bay.

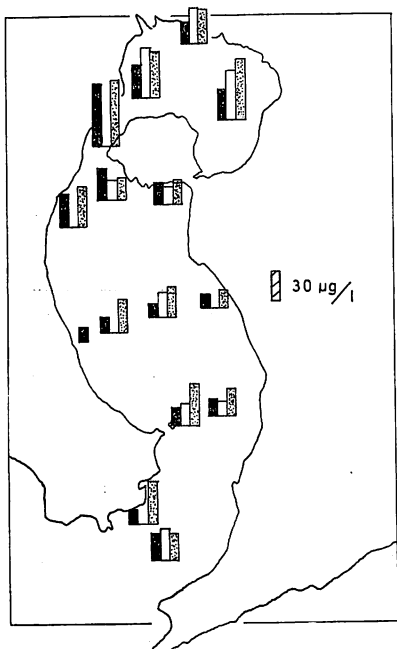


Fig. 7. "Zn" distribution in Kagoshima Bay.

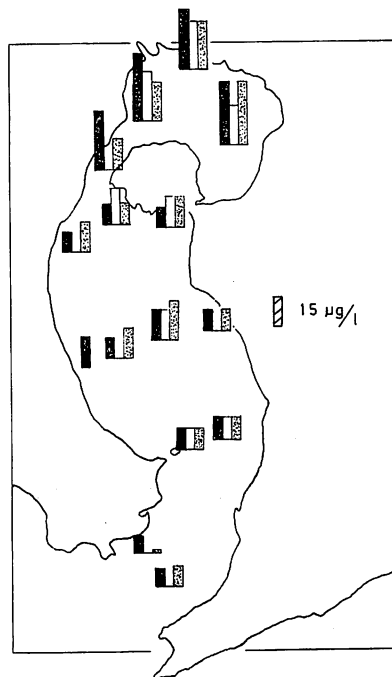


Fig. 8. "Pb" distribution in Kagoshima Bay.

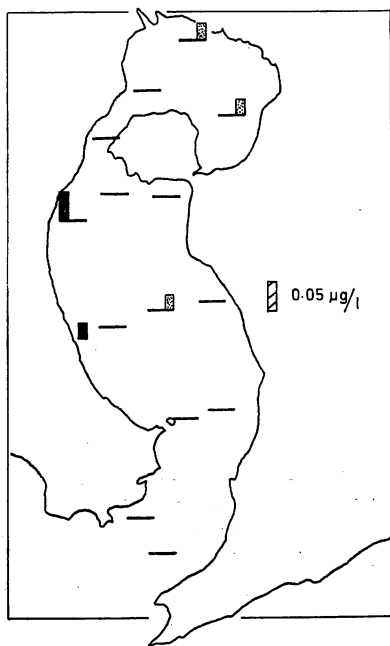


Fig. 9. "Cd" distribution in Kagoshima Bay.

Table 2. Correlation coefficients between two metals in sea water of Kagoshima Bay.

Metal	Metal	Coeff.	Metal	Metal	Coeff.
Fe	Mn	0.74	Co	Ni	0.07
	Co	0.33		Cu	0.05
	Ni	0.71		Zn	0.27
	Cu	0.37		Pb	0.53
	Zn	-0.16	Ni	Cu	0.40
	Pb	-0.05		Zn	-0.42
Mn	Co	0.22	Pb	-0.30	
	Ni	0.91	Cu	Zn	0.18
	Cu	0.40		Pb	-0.19
	Zn	-0.33	Zn	Pb	0.62
	Pb	-0.13			

Fe, Mn and Ni, and between Pb and Zn. We cannot conclude these correlations are always kept in this bay, but it provides some indications in distributions of trace metals here.

Kagoshima Bay can generally be said not to have been polluted profoundly as far as trace metal contents concern, however, we must be very careful before obtaining conclusion concerning with the present situation of the bay, because it has peculiar character of slow water exchange with oceanic water owing to narrow entrance for its vast area.

Acknowledgements

The authors gratefully acknowledge Mr. Takahashi, K., a retired captain of Nansei Maru, a research vessel of Kagoshima University and her crews for their help in collecting samples. Thanks also go to Mr. Minowa, M. and Mr. Ito, H., Technical Institute, Kagoshima Prefecture, on their kind lending of Atomic absorption spectrophotometer and pertinent advices in its manipulation.

References

- 1) SAISHO, T. (1976): Eutrophication and changes of plankton species in Kagoshima Bay. Jap. Soc. Sci. Fish., Kyushu Branch Meeting, Kagoshima.
- 2) KAMATA, M., ONISHI, T., YONEHARA, N., SAKAMOTO, H., and KAWASHIMA, T. (1974): The supply of polluted substances to Kagoshima Bay and its present situation in water quality. Report on the environmental investigation of Kagoshima Bay (in Japanese).
- 3) BIECHLER, D. G. (1965): Determination of trace copper, lead, zinc, cadmium, nickel and iron in industrial waste waters by atomic absorption spectrometry after ion exchange concentration on Dowex A-1. Anal. Chem., **37**, 1054-1055.
- 4) INOUE, A., KAIBARA, R., and ASAKAWA, S. (1974): The heavy metal concentrations in the waters along the coast of Fukuyama. This Bull., **23**, 209-219. (in Japanese).
- 5) KURENKOV, I. I. (1966): The influence of volcanic ashfall on biological processes in a lake. Limnol. Oceanog., **11**, 426-429.