Mercury Content and its Distribution in Sea Water of Kagoshima Bay

Rep. Fac. Sci. Kagoshima Univ. (Math., Phys. & Chem.),
No. 26, 75-91, 1993.

Mercury Content and its Distribution in Sea Water of Kagoshima Bay

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(Received Sept. 10, 1993)

Abstract

The mercury content of sea water is ppt levels. A pre-concentration is therefore required for the determination of mercury in sea water.

The recommended procedures for the determination of mercury chemical forms are as follows; (a) A sea water sample is acidified with sulfuric acid and then mercury is reduced with tin(II) chloride. Nitrogen gas is passed through the sample solution and any mercury evolved is trapped on a porous gold collector and determined by cold vapor atomic absorption spectrometry. (b) Sea water samples are treated with sodium hydroxide, copper(II) ions and tin(II) chloride, and the mercury is determined as in (a). (c) Sea water samples are treated with a mixture of sulfuric acid and potassium peroxodisulfate solution and heated on a water bath, followed by (a).

Dissolved inorganic mercury, dissolved inorganic mercury plus a part of the organic mercury and suspended mercury, and the total mercury can be determined by procedures (a), (b) and (c), respectively.

Sea water samples were collected from Kagoshima Bay and from the open ocean (East China Sea) during the period 1983~1991 and the content, the distribution of mercury and its chemical forms were investigated.

Levels of mercury determined by procedures (a), (b) and (c) were found to be in the range of 0.7~7.0 (mean 2.3_8), 0.9~10.2 (mean 3.0_8) and 1.9~14.2 ng/l (mean 5.4_0 ng/l) for 53 samples taken from Kagoshima Bay and 0.5~6.5 (mean 2.2_1), 0.6~5.1 (mean 2.1_0) and 0.9~7.8 ng/l (mean 3.9_3 ng/l) for 45~52 samples taken from the East China Sea, respectively.

Mean levels of mercury [(a), (b), (c)] for Kagoshima Bay were 1.0_8, 1.4_7 and 1.3_7 times higher than those for the East China Sea. From these results, it is considered that factors such as urbanization activies around Kagoshima City, geological circumstances and submarine volcanic activities of Northern Kagoshima Bay have produced

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significant changes in the sea waters of Kagoshima Bay.

Key words: Mercury content, Distribution, Chemical forms, Sea water, Submarine fumarole

Introduction

In recent years, attention has been paid to the mercury content, its distribution and chemical forms in sea water due to the marine environmental problem. There have been many reports concernig the mercury content of sea water at various areas.[1)-7)]

The content of mercury in sea water is usually very low; as little as ppt level[8), 9)]. Thus, it is very difficult to obtain the presise and reliable results by direct method without pre-concentration.

Matunaga et al.[10)] had been reported that the mercury content in open sea was about 5ng/*l*. The Hydrographic Department of Maritime Safety Agency[11)] had been reported the mercury content in sea water around Japan. This research was made for a cause investigation of the mercury pollution fish that was found in the Ushine area of Northern Kagoshima Bay in November, 1973. Mercury content, distribution and chemical forms were compared to Kagosima Bay and open sea water (East China Sea).[12)-22)]

In this study, we determined the mercury content in sea water sampled at various areas. We discuss their content, distribution and chemical forms in sea water.

Experimental

General Circumstances of Kagoshima Bay.

Kagoshima Bay is a narrow inner bay (about 75 km long and about 25 km wide)-an arm of the sea penetrating far into the land from south to north. Its bottom has unique topographic features, as may be seen from the vertical section shown in Fig. 1. Sakurajima Volcano, standing between the central and northern parts of the bay, separates the two sea areas, which communicate with each other only through Nishi Sakurajima Suidou, a shallow area about 40 m deep. Thus, sea water exchange is not easy between the northern part (140 to 200 m deep) and the open ocean.

Reagents and Apparatus.

All reagents were analytical grade of marketing and parts of its were prepared in mercury free by heating (heated at about 700℃).

Porous Gold Agents: trapping agents of mercury vapor sintered chloroauric acid on the surface of chromosorb and its used. This trapping agents contains about 11% gold and is packed into quartz tube.

Atomic Absorption Spectrometer Equipment: A Mercury Auto Monitor of Nippon Instruments Corporation was used. Schematic diagram of appratus for determination of mercury is shown in Fig. 2.

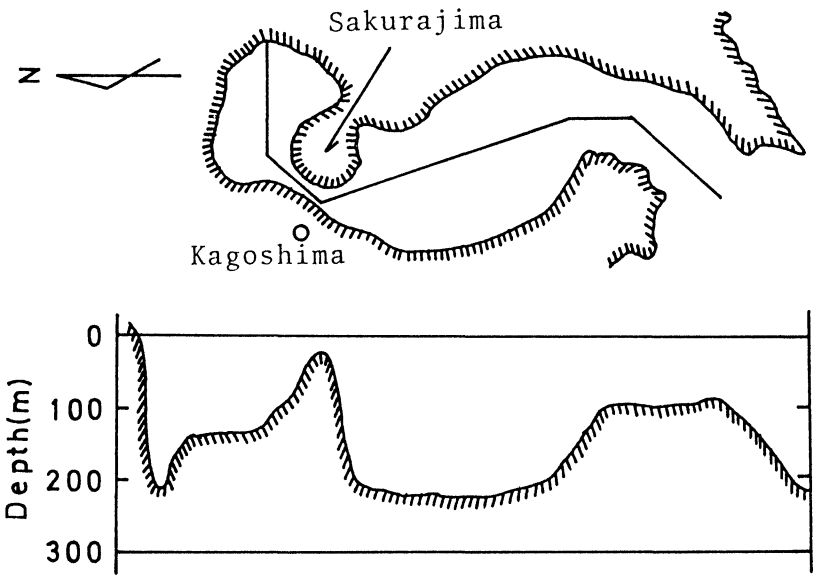

Fig. 1 Vertical section of Kagoshima Bay

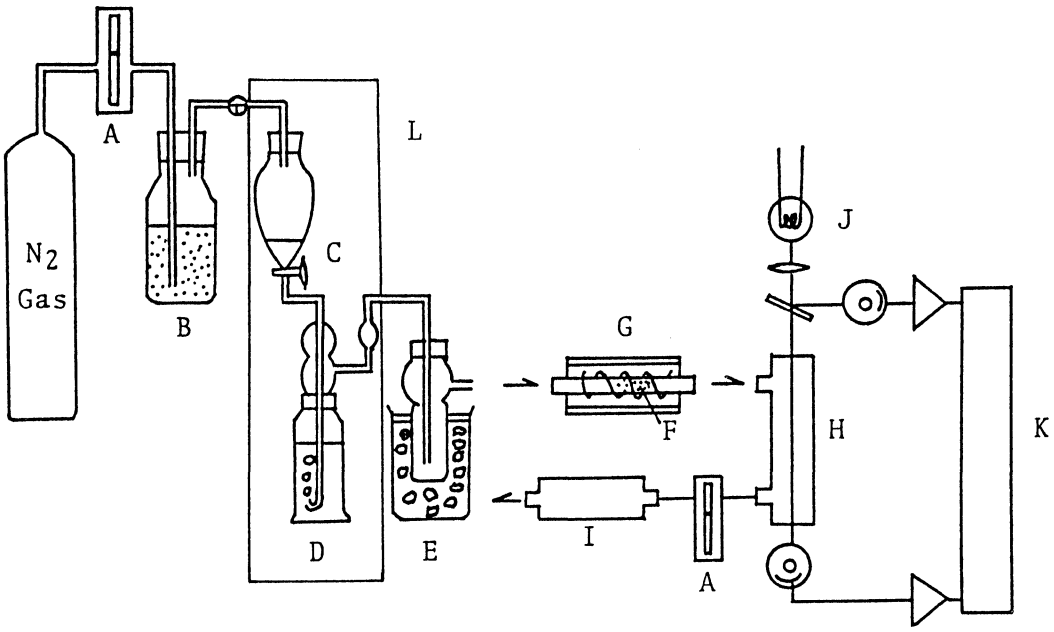

Fig. 2 Schematic diagram of apparatus for the determination of mercury in water sample by cold vapor atomic absorption spectrometry
A: Flow meter, B: H_2SO_4-$KMnO_4$ trapping solution, C: 10% $SnCl_2$ solution, D: Reaction vessel, E: Ice-water(Water trap), F: Mercury trapping room, G: Heater, H: Absorption cell, I: Activated charcoal, J: Hg glow tube, K: Amplifier, L: Plastic desiccator

Sampling and Preservation.

Surface sea water was sampled using a plastic container. Deep sea water samples were obtained by use of the Bandon Sampler (made from polypropylene) hunging on a stenless steel wire. Sea water samples used for mercury determination was kept in hard glass bottles equipped with teflon packing, which were exuded beforehand by approximately 2 mol dm^{-3} nitric acid for two weeks and then washed thoroughly with water. 10 ml of (1:1) sulfuric acid was added to 1 liter of sample. Samples were then brought back to the laboratory and analyzed.

Determination of mercury in sea water.

Mercury content in sea water equals to distilled water usually. Accordingly the contamination of mercury from sampling, container, reagents and atmosphere environment of laboratory are not able to disregard.[9] The procedures that showed in Fig. 3~5 were used for mercury chemical forms of Kagoshima Bay and the open sea water (East China Sea).

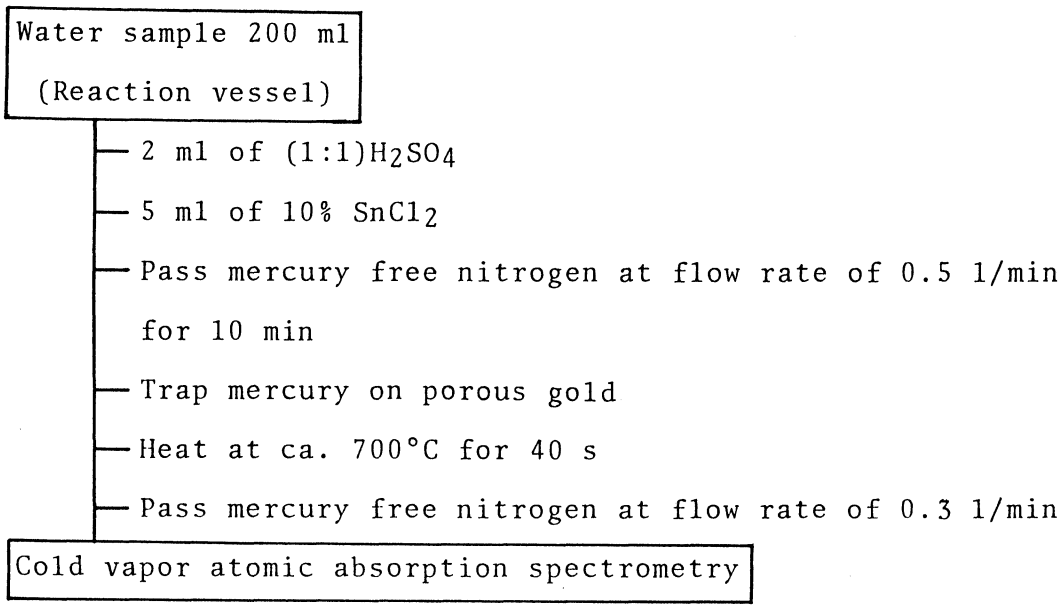

Fig. 3 Analytical procedure of dissolved inorganic mercury in sea water sample. [Procedure(a)]

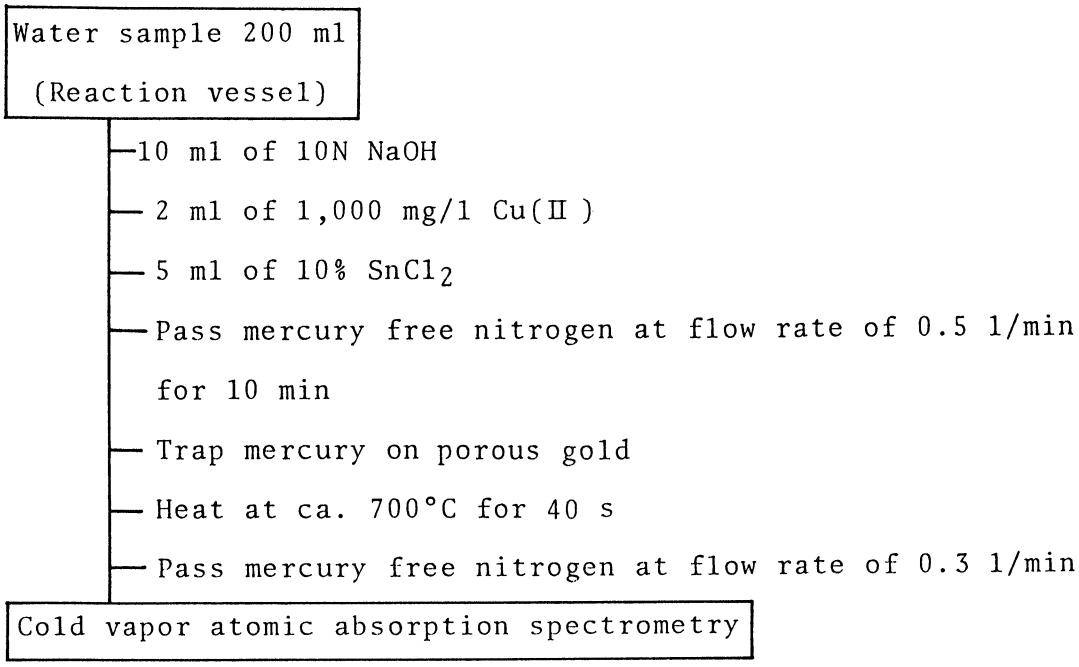

Fig. 4 Analytical procedure of dissolved inoganic mercury plus a part of the organic mercury and suspended mercury in sea water sample. [Procedure(b)]

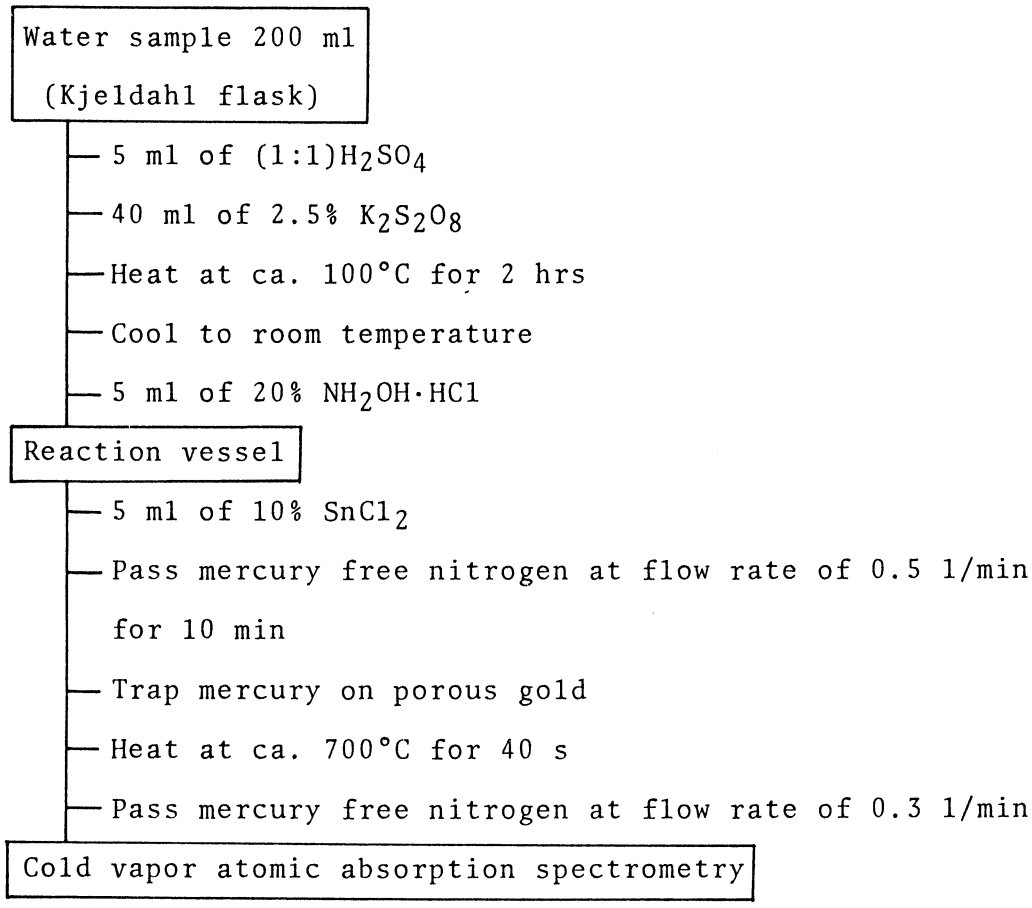

Fig. 5 Analytical procedure of total mercury in sea water sample. [Procedure(c)]

Mercury Content in sea water of Kagoshima Bay and the Open Sea Water (East China Sea).

The content, distribution and chemical forms of mercury in sea water samples taken from various areas were investigated.

Sea water samples were collected from Kagoshima Bay and from the open ocean (East China Sea) during the period 1983~1991. Sampling stations of Kagoshima Bay and the open sea (East China Sea) are shown in Fig. 6~7. The analytical results of mercury content by procedures (a), (b) and (c) are shown in Table 1~2.

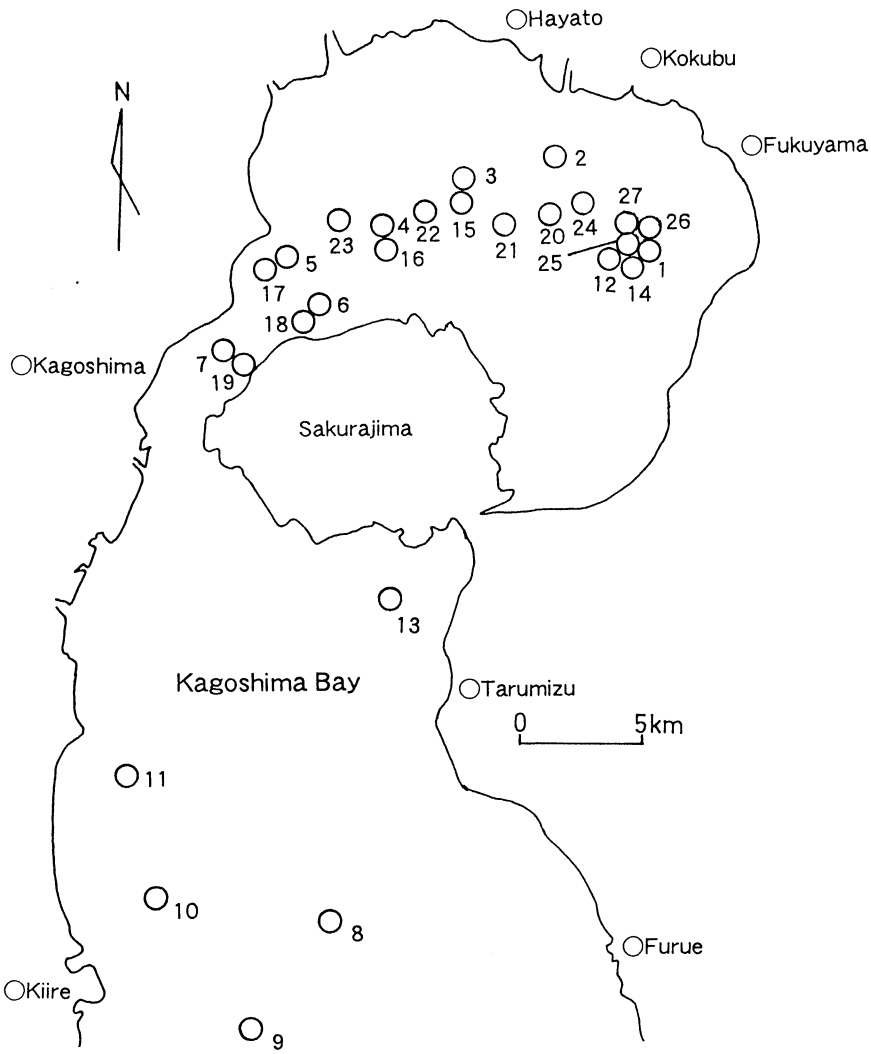

Fig. 6 Stations of sampling in Kagoshima Bay

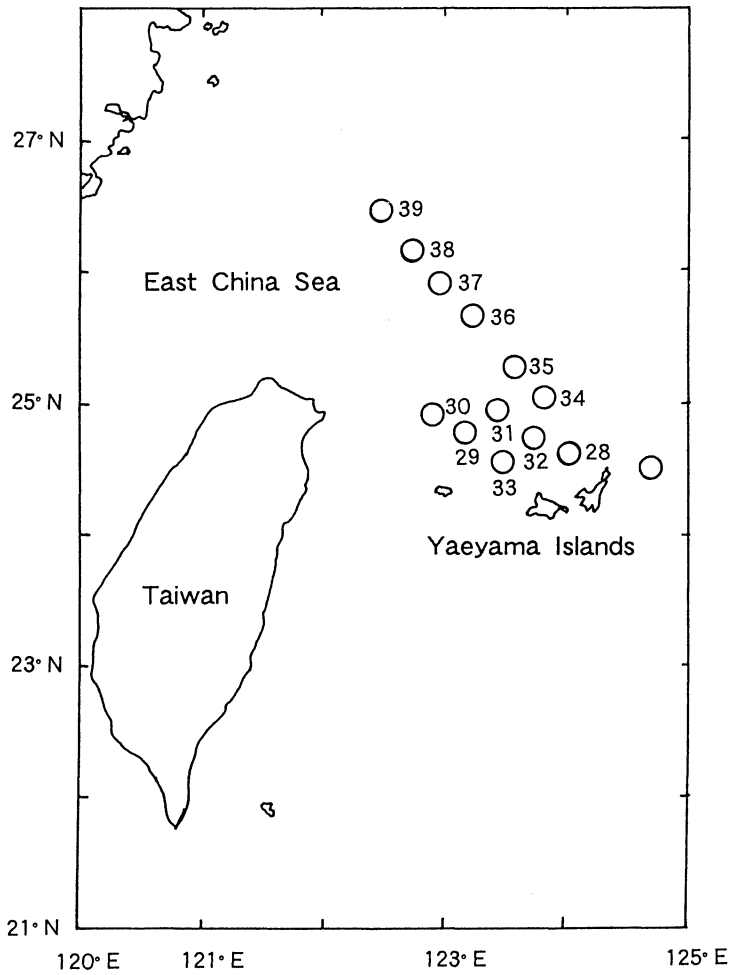

Fig. 7 Stations of sampling in the East China Sea

Table 3 shows organizing data of mercury content of Kagoshima Bay and the open sea (East China Sea).

Levels of mercury determined by procedures (a), (b) and (c) were found to be in the range of 0.7～7.0 (mean 2.3_8), 0.9～10.2 (mean 3.0_8) and 1.9～14.2 ng/*l* (mean 5.4_0 ng/*l*) for 53 samples taken from Kagoshima Bay and 0.5～6.5 (mean 2.2_1), 0.6～5.1 (mean 2.1_0) and 0.9～7.8 ng/*l* (mean 3.9_3 ng/*l*) for 45～52 samples taken from the East China Sea, respectively.

Mean levels of mercury [(a), (b), (c)] for Kagoshima Bay were 1.0_8, 1.4_7 and 1.3_7 times higher than those for the East China Sea.

Distribution of Mercury Content in Surface Water of Kagoshima Bay.

Dissolved inorganic mercury, dissolved inorganic mercury plus a part of the organic mercury and suspended mercury, and the total mercury content for 27 surface water samples taken from Kagoshima Bay are shown in Figs. 8～10.

In the surface sea water of Kagoshima Bay, the range of content of dissolved inorganic mercury is 0.7～7.0 ng/*l*. The arithmetic mean and geometric mean are 2.9_7, 2.7_0 ng/*l*, respectively. The range of content of dissolved inorganic mercury plus a part of the organic

Table 1 Mercury content in sea water samples of Kagoshima Bay

Station No.	Station	Date	Depth (m)	Temp. (°C)	pH	Hg content (ng/l) (a)	(b)	(c)
1	31°39.3'N, 130°46.1'E	Dec.02.'83	0	19.6	8.24	1.0	1.9	14.2
1	" " " " " "	Dec.02.'83	50	19.1	8.13	2.3	2.4	9.4
1	" " " " " "	Dec.02.'83	100	16.9	7.72	1.8	2.7	8.6
1	" " " " " "	Dec.02.'83	150	16.0	7.32	1.0	2.0	9.6
2	31°41.0'N, 130°44.3'E	Dec.02.'83	0	19.1	8.28	2.0	2.1	7.7
3	31°40.5'N, 130°42.1'E	Dec.02.'83	0	18.9	8.25	1.7	1.2	12.1
4	31°39.5'N, 130°40.1'E	Dec.02.'83	0	19.2	8.26	1.7	2.1	3.4
5	31°38.7'N, 130°37.6'E	Dec.02.'83	0	19.4	8.17	1.8	1.9	2.9
6	31°37.7'N, 130°38.5'E	Dec.02.'83	0	19.6	8.13	3.3	13.4	13.4
7	31°36.5'N, 130°36.2'E	Dec.02.'83	0	19.7	8.16	1.3	1.9	5.8
8	31°24.4'N, 130°39.1'E	Dec.06.'85	0	18.6	8.19	5.0	5.4	5.6
8	" " " " " "	Dec.06.'85	20	18.7	8.17	1.4	1.5	4.1
8	" " " " " "	Dec.06.'85	60	18.7	8.08	1.4	1.9	5.0
8	" " " " " "	Dec.06.'85	100	16.3	7.98	2.2	1.9	5.7
8	" " " " " "	Dec.06.'85	150	15.4	7.91	1.4	1.9	2.4
8	" " " " " "	Dec.06.'85	200	15.2	7.89	2.2	2.6	3.8
9	31°22.1'N, 130°37.2'E	Dec.07.'85	0	19.3	8.15	4.1	3.5	7.4
10	31°24.9'N, 130°34.9'E	Dec.07.'85	0	19.3	8.13	2.8	2.2	4.6
11	31°27.6'N, 130°33.9'E	Dec.07.'85	0	18.9	8.13	3.2	2.6	5.0
12	31°38.9'N, 130°46.2'E	Dec.08.'85	0	18.7	8.06	3.9	3.9	10.6
12	" " " " " "	Dec.08.'85	30	19.1	8.01	1.2	1.2	1.9
12	" " " " " "	Dec.08.'85	70	18.5	7.87	1.3	1.4	2.6
12	" " " " " "	Dec.08.'85	110	16.9	7.47	1.5	1.8	2.8
12	" " " " " "	Dec.08.'85	150	16.3	7.00	2.3	2.6	4.1
12	" " " " " "	Dec.08.'85	190	16.2	6.79	4.5	4.9	7.4
13	31°31.5'N, 130°40.5'E	Dec.08.'85	0	17.5	8.24	3.2	3.7	4.1
13	" " " " " "	Dec.08.'85	30	17.4	8.22	0.7	0.9	2.0
13	" " " " " "	Dec.08.'85	60	17.1	8.12	1.2	1.3	2.6
13	" " " " " "	Dec.08.'85	90	16.5	8.05	0.9	1.3	2.0
13	" " " " " "	Dec.08.'85	130	14.7	7.96	1.2	1.8	2.0
13	" " " " " "	Dec.08.'85	160	14.8	7.86	1.2	1.4	2.6
14	31°38.9'N, 130°46.2'E	Feb.05.'86	0	13.9	7.84	4.8	9.2	10.7
15	31°40.3'N, 130°42.0'E	Feb.05.'86	0	13.7	7.92	2.8	5.3	5.9
16	31°39.0'N, 130.40.2'E	Feb.05.'86	0	13.8	7.90	2.4	9.7	12.9
17	31°38.5'N, 130°37.2'E	Feb.05.'86	0	13.5	7.92	3.4	7.3	8.7
18	31°37.4'N, 130°38.3'E	Feb.05.'86	0	13.7	7.96	1.7	3.8	4.9
19	31°36.2'N, 130°36.7'E	Feb.05.'86	0	13.6	7.95	3.8	3.6	4.9

Table 1 Mercury content in sea water samples of Kagoshima Bay(Continued)

Station No.	Station	Date	Depth (m)	Temp. (°C)	pH	Hg content(ng/l) (a)	(b)	(c)
20	31°39.7'N, 130°44.2'E	Oct.28.'87	0	23.0	8.17	4.1	4.4	6.1
20	" " " " " "	Oct.28.'87	50	21.9	8.05	3.1	4.2	4.8
20	" " " " " "	Oct.28.'87	100	16.6	7.57	4.1	4.5	6.6
20	" " " " " "	Oct.28.'87	150	16.0	7.17	4.4	4.2	6.2
20	" " " " " "	Oct.28.'87	170	15.9	6.83	4.3	5.8	9.1
20	" " " " " "	Oct.28.'87	190	15.8	6.74	7.5	10.2	14.2
21	31°39.5'N, 130°43.1'E	Oct.28.'87	0	23.0	8.15	2.2	6.9	7.2
22	31°39.7'N, 130°41.2'E	Oct.28.'87	0	23.0	8.16	2.2	2.6	3.9
23	31°39.6'N, 130°39.0'E	Oct.28.'87	0	23.1	8.16	2.8	2.9	3.5
24	31°40.0'N, 130°45.0'E	Feb.10.'91	0	16.0	8.01	2.1	3.4	5.6
25	31°39.6'N, 130°46.1'E	May.04.'91	0	19.5	8.30	4.2	4.5	6.2
25	" " " " " "	May.04.'91	200	17.8	5.47	4.1	4.7	5.8
26	" " " " " "	May.05.'91	0	19.4	8.27	1.7	3.4	5.3
26	" " " " " "	May.05.'91	200	18.5	6.26	4.1	3.5	5.5
27	31°40.1'N, 130°46.3'E	May.06.'91	0	18.8	8.27	7.0	7.9	8.2
27	" " " " " "	May.06.'91	200	17.6	7.34	5.1	6.2	6.5

Table 2 Mercury content in sea water samples of the open ocean(East China Sea)

Station No.	Station	Date	Depth (m)	Temp. (°C)	pH	Hg content(ng/l) (a)	(b)	(c)
28	24°44'N, 124°02'E	Oct.07.'83	0	29.5	8.32	1.8	1.4	3.3
28	" " " " " "	Oct.07.'83	50	30.1	8.28	1.4	1.7	4.7
28	" " " " " "	Oct.07.'83	100	28.0	8.22	1.4	1.5	6.8
28	" " " " " "	Oct.07.'83	500	18.0	7.93	2.4	1.8	5.8
28	" " " " " "	Oct.07.'83	1000	10.2	7.42	6.5	6.3	7.2
29	24°54'N, 123°22'E	Oct.07.'83	0	30.0	8.22	0.7	4.2	4.3
29	" " " " " "	Oct.07.'83	50	28.5	8.21	1.7	1.1	1.5
29	" " " " " "	Oct.07.'83	100	25.0	8.14	0.6	1.4	3.6
29	" " " " " "	Oct.07.'83	500	18.1	7.62	1.8	1.0	4.6
29	" " " " " "	Oct.07.'83	1000	11.0	7.51	0.6	2.0	1.7
30	24°54'N, 123°22'E	Oct.07.'83	0	29.6	8.31	1.0	2.0	4.3
30	" " " " " "	Oct.07.'83	50	29.0	8.30	0.8	1.2	1.8
30	" " " " " "	Oct.07.'83	100	24.5	8.25	0.5	1.0	0.9
30	" " " " " "	Oct.07.'83	500	14.5	7.58	1.0	1.0	1.2
30	" " " " " "	Oct.07.'83	1000	9.5	7.44	2.8	2.4	7.4

Table 2 Mercury content in sea water samples of the open ocean(East China Sea)(Continued)

Station No.	Station	Date	Depth (m)	Temp. (°C)	pH	Hg content(ng/l) (a)	(b)	(c)
31	25°09'N, 123°30'E	Oct.07.'83	0	29.2	8.29	0.5	0.6	3.2
31	" " " " " "	Oct.07.'83	50	28.8	8.28	1.3	1.2	3.1
31	" " " " " "	Oct.07.'83	100	24.9	8.22	3.2	3.3	3.7
31	" " " " " "	Oct.07.'83	500	14.3	7.71	2.4	3.8	5.4
31	" " " " " "	Oct.07.'83	1000	9.0	7.50	1.3	1.4	3.4
32	24°52.6'N, 123°45.2'E	Jul.28.'84	0	31.0	8.39	2.3	2.3	5.1
32	" " " " " "	Jul.28.'84	50	28.4	8.35	2.1	1.1	6.0
32	" " " " " "	Jul.28.'84	100	24.0	8.20	3.7	2.6	5.6
32	" " " " " "	Jul.28.'84	200	21.0	8.21	4.0	2.8	7.8
32	" " " " " "	Jul.28.'84	500	14.3	8.00	3.3	2.8	4.8
32	" " " " " "	Jul.28.'84	1000	10.0	7.75	4.3	2.1	4.5
33	24°40.1'N, 123°30.1'E	Jul.28.'84	0	30.4	8.30	2.3	-	4.4
33	" " " " " "	Jul.28.'84	50	26.9	8.30	1.7	-	6.0
33	" " " " " "	Jul.28.'84	100	23.2	8.23	2.9	-	4.0
33	" " " " " "	Jul.28.'84	200	20.4	8.20	3.4	-	5.0
33	" " " " " "	Jul.28.'84	500	14.5	7.98	5.0	5.1	9.1
33	" " " " " "	Jul.28.'84	1000	9.6	7.75	3.9	4.2	6.6
34	25°09.9'N, 123°51.8'E	Aug.03.'84	0	30.1	8.39	2.8	3.4	4.4
34	" " " " " "	Aug.03.'84	50	26.6	8.34	3.2	-	3.3
34	" " " " " "	Aug.03.'84	100	24.1	8.28	1.7	-	3.8
34	" " " " " "	Aug.03.'84	200	20.9	8.22	2.5	4.4	3.3
34	" " " " " "	Aug.04.'84	500	15.0	8.05	2.3	3.6	3.3
34	" " " " " "	Aug.04.'84	1000	9.7	7.72	4.1	-	3.7
35	25°23.6'N, 123°35.5'E	Aug.04.'84	0	30.2	8.37	3.8	3.7	5.3
35	" " " " " "	Aug.04.'84	50	27.0	8.28	2.7	2.9	3.3
35	" " " " " "	Aug.04.'84	100	23.7	8.21	2.8	2.0	4.3
35	" " " " " "	Aug.04.'84	500	14.2	8.00	3.1	3.0	3.5
35	" " " " " "	Aug.04.'84	1000	10.0	7.80	4.7	3.1	3.5
36	25°46.5'N, 123°15.6'E	Aug.04.'84	0	30.4	8.30	2.7	1.6	3.4
36	" " " " " "	Aug.04.'84	50	28.3	8.33	3.0	1.5	5.6
36	" " " " " "	Aug.04.'84	100	23.0	8.22	3.6	1.8	3.6
37	26°00.0'N, 123°00.0'E	Aug.04.'84	0	30.0	8.28	2.4	1.5	3.2
37	" " " " " "	Aug.04.'84	50	25.4	8.26	3.8	3.3	3.9
38	26°13.4'N, 122°45.4'E	Aug.04.'84	0	28.6	8.31	2.7	1.6	3.2
38	" " " " " "	Aug.04.'84	50	23.2	8.23	2.5	2.6	3.4
39	26°31.0'N, 122°30.0'E	Aug.04.'84	0	29.8	8.32	3.6	2.4	4.2
39	" " " " " "	Aug.04.'84	50	25.6	8.39	3.2	1.5	3.2

Table 3 Average values of mercury content in sea waters of Kagoshima Bay and the open ocean(East China Sea)

Locality		Mercury content(ng/l) (a)	(b)	(c)
Kagoshima Bay	X_A	$2.9_7(2.7_7)$	$4.4_7(3.7_6)$	$7.0_7(6.1_9)$
	X_G	$2.7_0(2.3_8)$	$3.7_6(3.0_8)$	$6.4_2(5.4_0)$
	n	27 (53)	27 (53)	27 (53)
Open Ocean (East China Sea)	X_A	$2.2_2(2.5_7)$	$2.2_5(2.3_8)$	$4.0_3(4.2_7)$
	X_G	$1.9_0(2.2_1)$	$1.9_8(2.1_0)$	$3.9_6(3.9_3)$
	n	12 (52)	11 (45)	12 (52)

X_A:Arithmetic mean, X_G:Geometric mean, n:No. of samples
Without( ):Surface sea water, ( ):Include each class of depth

mercury and suspended mercury is 0.9~10.2 ng/*l*. The arithmetic mean and geometric mean are 4.4_7, 3.7_6 ng/*l*, respectively. The range of content of tatal mercury is 1.9~14.2 ng/*l*. The arithmetic mean and geometric mean are 7.0_7, 6.4_2 ng/*l*, respectively. Dissolved inorganic mercury content is not difference between Kagoshima Bay and the open sea (East China Sea). But, mercury content of dissolved inorganic mercury plus a part of the organic mercury and suspended mercury and total mercury are high in comparison with the open sea water. However, there is not high mercury content abnormally.

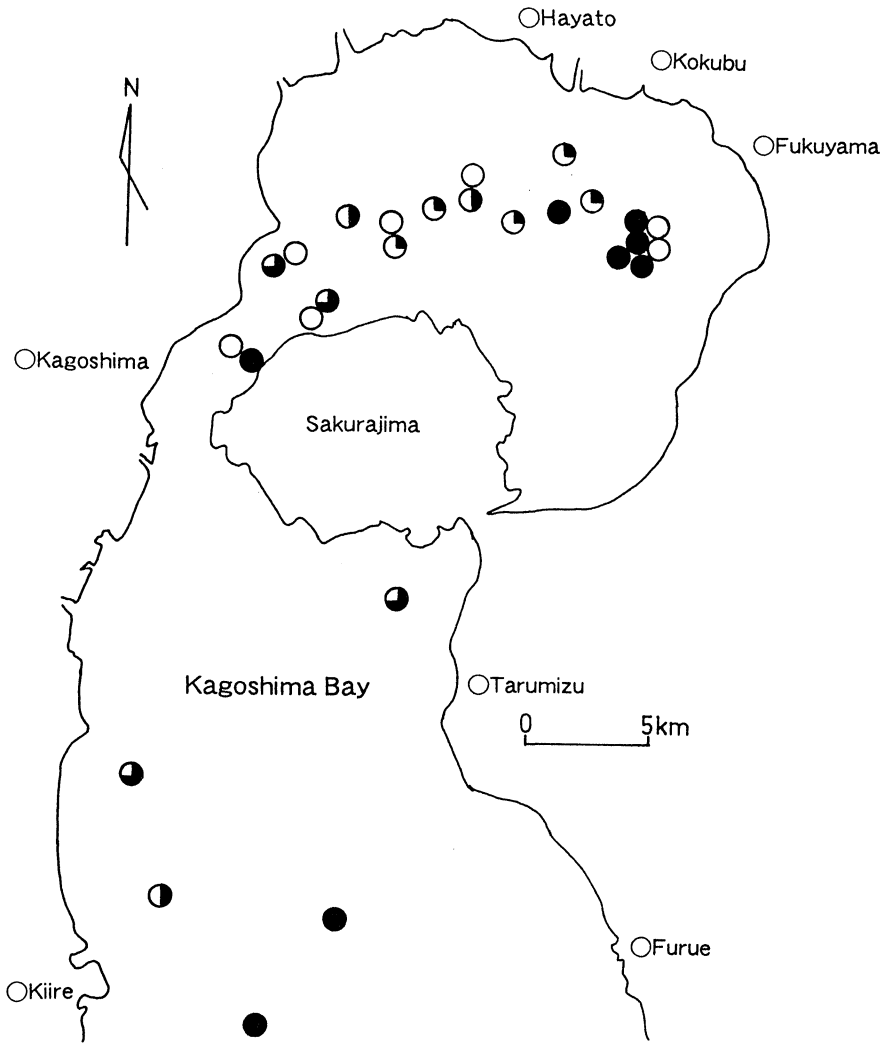

Fig. 8 Distribution of dissolved inorganic mercury in surface sea water of Kagoshima Bay

Hg ng/l	No. of samples
○ ≦2.0	7
◔ 2.1～2.5	5
◑ 2.6～3.0	3
◕ 3.1～3.5	4
● 3.6≦	8

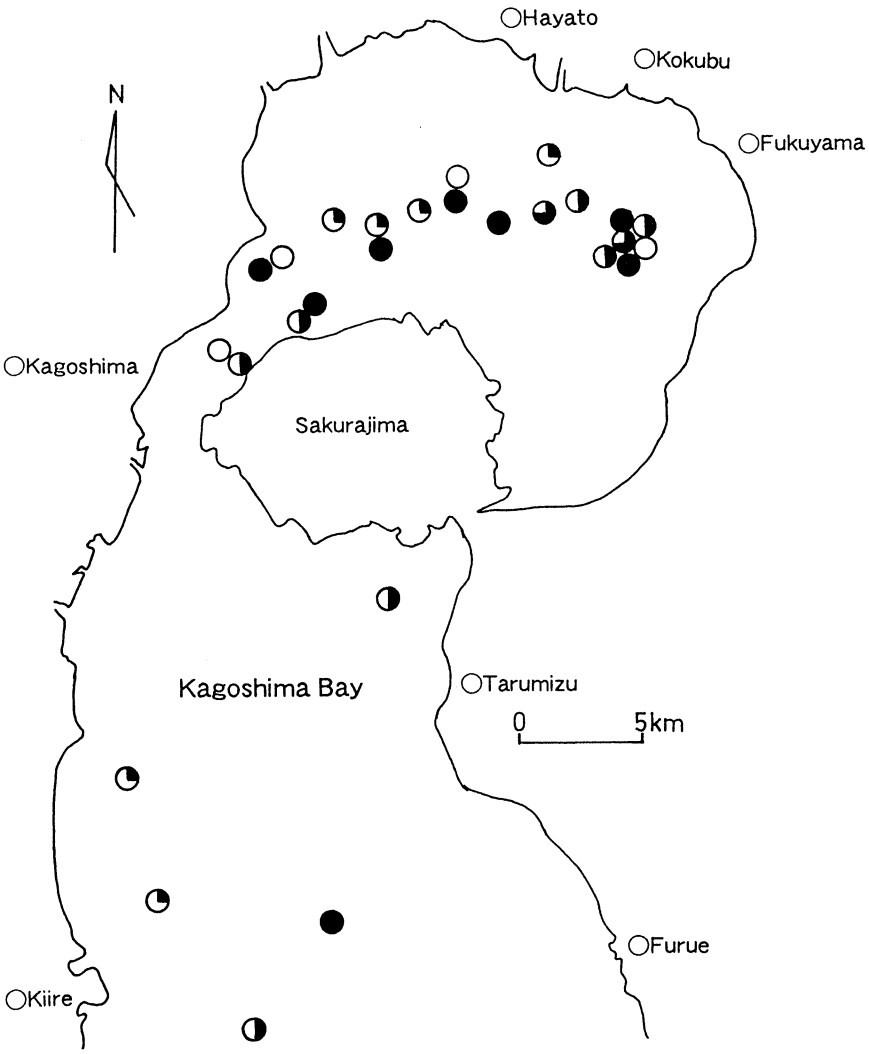

Fig. 9 Distribution of dissolved inorganic mercury plus a part of organic mercury and suspended mercury in surface sea water of Kagoshima Bay

Hg ng/l	No. of samples
○ ≦2.0	4
◔ 2.1～3.0	6
◑ 3.1～4.0	7
◕ 4.1～5.0	2
● 5.1≦	8

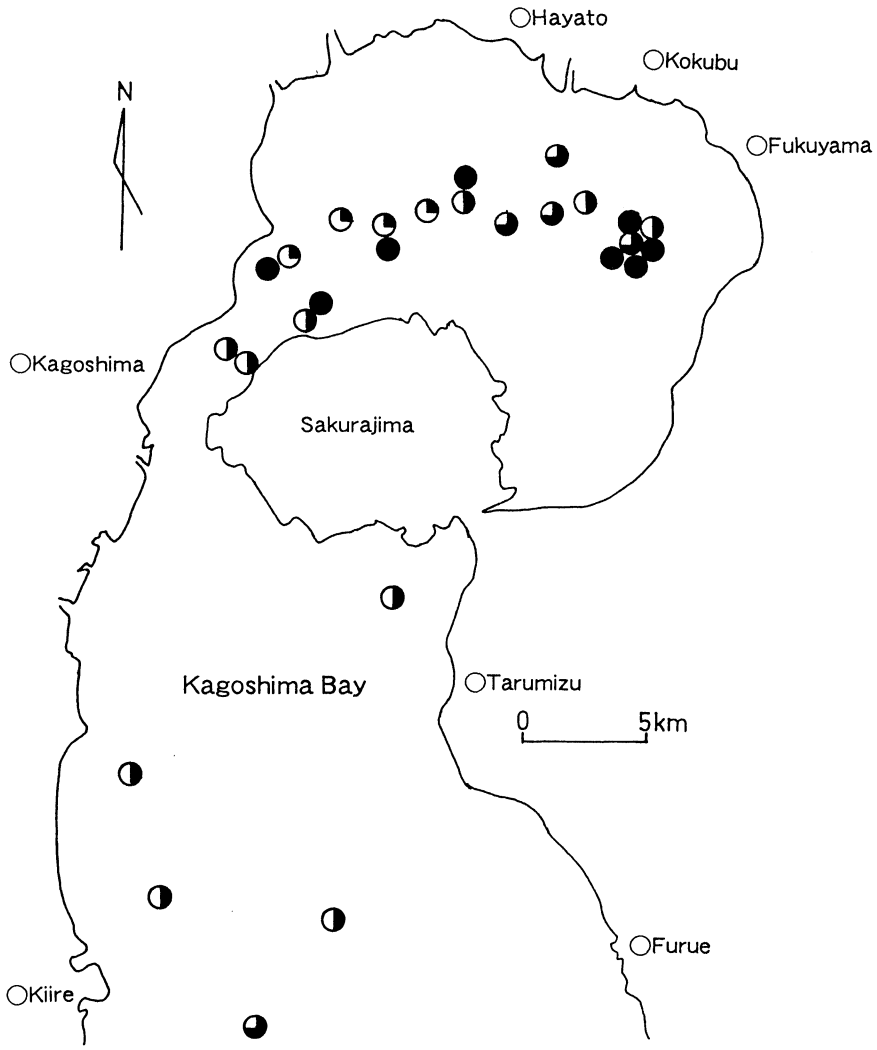

Fig. 10 Distribution of total mercury in surface sea water of Kagoshima Bay

Hg ng/l	No. of samples
○ ≦2.0	0
◔ 2.1～4.0	4
◑ 4.1～6.0	10
◕ 6.1～8.0	5
● 8.1≦	8

Vertical Distribution of Mercury in Sea Water of Kagoshima Bay.

Fig. 11 shows the vertical distribution of dissolved inorganic mercury, dissolved inorganic mercury plus a part of the organic mercury and suspended mercury, and the total mercury contained in sea waters of the southern (Stn. 8) and northern (Stn. 12, 20) parts of Kagoshima Bay.

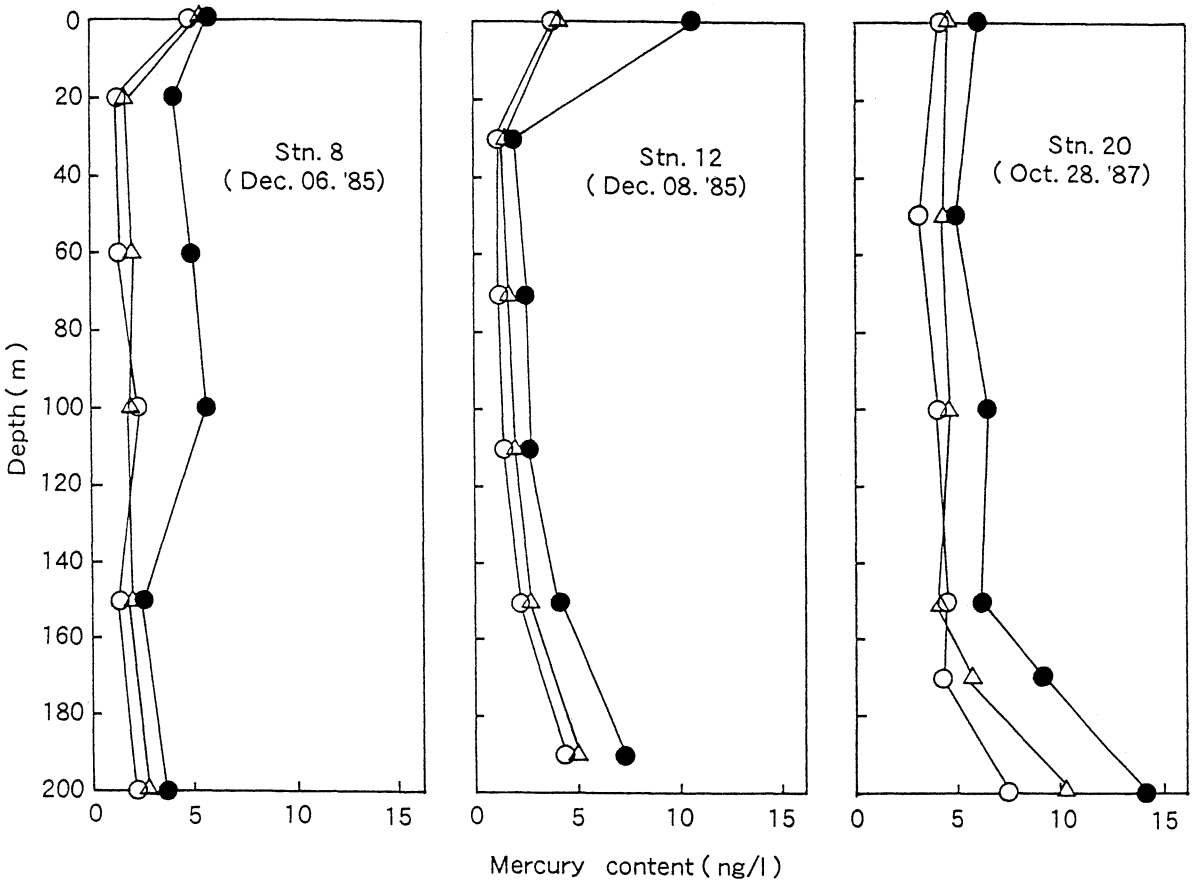

Fig. 11 Vertical profiles of dissolved inorganic mercury, dissolved inorganic mercury plus a part of organic mercury and suspended mercury and total mercury in Kagoshima Bay
○: Dissolved inorganic mercury
△: dissolved inorganic mercury plus a part of organic mercury and suspended mercury
●: Total mercury

Dissolved inorganic mercury and dissolved inorganic mercury plus a part of the organic mercury and suspended mercury and the total mercury content are little different in its depth at Stn. 8. However, dissolved inorganic mercury and dissolved inorganic mercury plus a part of the organic mercury and suspended mercury and the total mercury content are increse in the depth at Stn. 12 and Stn. 20. There is existence of the sea bottom fumarole as

one of the specificity in the marine environment of Kagoshima Bay. Decrease of pH of sea water was investigated conspicuously from April to November in stratification.[23), 24)] As for in this period, the mixing of the top and bottom of sea water is almost nonexistent. It was understandable on the basis of carbon dioxide and hydrogen sulfide that was discharged from submarine fumarole.[25)] Mercury, arsenic and antimony that derive from the submarime fumarolic activity were concentrated remarkably vicinity of sea bottom fumarole at depth 200 m point.[26)] The vertical distribution of mercury content in sea water of vicinity of sea bottom fumarole clearly showed higher concentrations in northern than in southern part.
A survey had been mainly carried out in Nothern Kagoshima Bay. It may be possibillity that submarine fumarole is revealed as a result of these investigations. Becasuse volcanic activity vary with the times and then continual survey is necessary.

Conclusion

The mercury content in sea water samples taken from Kagoshima Bay and the open ocean (East China Sea) was determined by cold vapor atomic absorption spectrometry. Mercury content and its distribution including chemical forms in sea water of Kagoshima Bay and the open ocean were investigated. The results were as follows;

1) Levels of mercury determined by procedures (a), (b) and (c) were found to be in the geometric mean 2.3_8, 3.0_8 and 5.4_0 ng/l for 53 samples taken from Kagoshima Bay and 2.2_1, 2.1_0 and 3.9_3 ng/l for 45～52 samples taken from the open sea (East China Sea), respectively.

2) Dissolved inorganic mercury, dissolved inorganic mercury plus a part of the organic mercury and suspended mercury and the total mercury content in sea water of Kagoshima Bay were 1.0_8, 1.4_7, 1.3_7 times of the open ocean (East China Sea), respectively.

3) The distribution of mercury content in sea water of Kagoshima Bay revealed high concentration in a limited area in the northern part.
Dissolved inorganic mercury content was not difference between Kagoshima Bay and the open sea (East China Sea)

4) Some higher values of mercury were found at a hot position, 200 m deep, near the center of volcanic activity in the northern part of Kagoshima Bay.

Studies of the mechanism of mercury concentration in fishes are under way in various fields of research, but a satisfactory explanation has not yet been reached.

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