The Distribution of Copper and Zinc in the Indian and the Southern Ocean Waters*

Tetsuya Torii** and Sadao Murata**

Abstract: The content of copper and zinc in sea waters collected on the route from Japan to Antarctica during the fourth and the sixth cruises of the Japanese Antarctic Research Expedition (1959–1960, 1961–1962) on board M. S. SOYA was determined. Copper and zinc were analyzed by the colorimetric method using sodium diethylthiocarbamate and dithizone respectively. The analytical results showed that the average contents of reactive copper and zinc in the waters of the Southern Ocean was 1.6 μg/l and 7.5 μg/l respectively. As to the Indian Ocean waters, the average values of 1.4 μg/l for copper and 5.5 μg/l for zinc were obtained.

1. Introduction

Of the trace elements in sea water, copper and zinc have been most extensively investigated during the last three decades. Reviews on these elements in sea water were given by Chow and Thompson (1952), Morita (1955) and Hood (1963). The data of recent works indicate little or no difference between the Pacific and the Atlantic Ocean in the copper and zinc contents in sea water. However a number of data for these elements in the Antarctic and the Indian Ocean waters is limited.

It is of interest to see if contents of copper and zinc in the southern ocean waters differ from those of other ocean waters or not. The present report will give the results of determination of copper and zinc content in the Indian Ocean and the Indian sector of the Antarctic Ocean waters.

2. Collection of samples and methods of analysis

Water samples were collected during the fourth and the sixth cruises of the Japanese Antarctic Research Expedition (JARE-4, Dec. 1959–April 1960; JARE-6, Nov. 1961–April 1962) on board the M. S. SOYA (3,500 tons) which belongs to the Japan Maritime Safety Agency along the course from Tokyo to the Syowa base at the Antarctica. Locations of sampling are shown in Fig. 1.

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Fig. 1. Location of water samples during the cruise of JARE-4 and JARE-6.

The surface samples were collected with a bucket sampler and filtered through a fine glass filter to remove phytoplankton and other suspended matters. After the addition of nitric acid and water samples were stored in polyethylene bottles which were made free from contaminations. Unfiltered samples were also collected and stored with the addition of nitric acid.

For the determination of copper and zinc content in sea water, a spectrophotometric method with sodium diethylthiocarbamate and a mixed color method with dithizone were employed respectively after separating these
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elements by solvent extraction with dithizone from 500 ml of a sample. (MORITA, 1948; MURAKAMI, 1950; CHOW and THOMPSON, 1952; FRIEDBERG, 1955)

3. Results and discussion

Results of analyses of copper and zinc in the surface waters were given in Tables 1, 2 and 3.

<table>
<thead>
<tr>
<th>Date of Collection</th>
<th>Location</th>
<th>Water temp. (°C)</th>
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<th>Cu (μg/l)</th>
<th>Zn (μg/l)</th>
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Table 1. Copper and zinc content in the Southern Ocean waters.

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Table 2. Copper and zinc in the Indian Ocean waters.
Table 3. Content of Cu and Zn in unfiltered samples from the Southern Ocean.

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Table 1 shows that the copper and zinc in sea waters collected during the sixth cruise of Soya in the Southern Ocean range from 0.9 to 3.5 μg/l with an average of 1.6±0.7 μg/l for copper and from 3.0 to 17.8 μg/l with an average of 7.5 ±4.1 μg/l for zinc.

As shown in Table 2, in the Indian Ocean waters, the concentration of copper range from 0.5 to 3.1 μg/l with an averaged value of 1.4 ±0.6 μg/l and content of zinc was 5.5±1.7 μg/l on an average ranging from 3.0 to 8.5 μg/l. No significant regional distributor was observed.

Results of analyses of unfiltered samples obtained from the fourth cruise of JARE are shown in Table 3. The Antarctic convergence was located along the latitude 50°S on the route from Cape Town to the Antarctica (Fig. 2). Samples obtained from the area between Cape Town and the Antarctic convergence showed a concentration of 5.3±3.9 μg/l for copper and 8.1±3.0 μg/l for zinc on an average. On the other hand, smaller values of 2.4±0.8 μg/l and
5.5±2.5 μg/l respectively for copper and zinc contents were obtained from the waters collected between the Antarctic convergence and the Antarctica.

Generally speaking, results of analyses of unfiltered samples showed higher values both for copper and zinc concentrations when compared with those of the filtered ones. The reasons of the discrepancy have not been well clarified yet, but when we consider that copper and zinc are essential constituents of protoplasm, we can not ignore the dissolution from planktonic tissue during the storage of samples.

In comparing with results previously obtained for the world oceans (3 μg/l for copper and 10 μg/l for zinc, after Goldberg, 1963), it is said that our values in the Southern Ocean and the Indian Ocean waters are slightly less. It is to be noted that there are several kinds of chemical species of copper and zinc in sea water, and as pointed out by Rona et al. (1962), a portion of a reactive zinc or copper varies considerably ranging from 5 to 70% to the total concentration of these elements in the sample.

From this point of view, the presence of complexed forms (probably organic) and non-reactive chemical species of copper and zinc in sea water must be considered.

To clarify this situation, further studies are being planned to investigate the organic compounds of copper and zinc and their horizontal and vertical distributions in the Southern Ocean.

Acknowledgements

The authors express their deep appreciation to Professor Yasuo Miyake, Tokyo Kyoiku University, for his helpful suggestion and encouragement, and also they are very much indebted to Dr. Yukio Sugimura, Meteorological Research Institute, and Dr. Yoshimi Morita, Tokyo University of Fisheries, for giving them many helpful criticism and suggestions. Only through the efforts of the scientific staffs of the JARE-4, and JARE-6 in particular of Drs. S. Fukase and K. Watanuki, the sampling was possible.

References


南極海およびインド洋海域における海水中の銅および亜鉛の含量

鳥居鉄也 村田貞雄

要旨 第4次（1959～1960年）および第6次（1961～1962年）日本南極観測隊により、本州から南極大陸に至る航行中に、観測船敷解船長から採取された表面海水の試料について、銅および亜鉛の含量を測定した。

採取試料は硝酸酸性とし、ポリエチレン瓶に保存した。測定は、アルカリ性でジチゾン四塩化炭素溶液により抽出される部分に対して行ない、銅は、ジチゾンジチオカルバミン酸ナトリウムによる比色法、亜鉛は、ジチゾンによる混合色法によった。

採集後、浮遊物を除いた試料についての測定結果は、南極海域で、平均1.6 μg-Cu/l、および7.5 μg-Zn/lであり、インド洋海域では、平均1.4 μg-Cu/lおよび5.5 μg-Zn/lであった。濾過しなかった試料についての結果は、濾過したものに比べると、一般に、銅および亜鉛含量は高い値が得られた。ケープタウンから南極大陆までの間の海域では、南緯50度の南極経線付近を境にして、その含量に差が見られた。