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Vertical Distribution of Cu in Waters in the Bay Mouth of Jiaozhou Bay

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Abstract: We analyzed the horizontal, vertical and seasonal variations of Cu in waters in the bay mouth of Jiaozhou Bay, eastern China in 1985. Results showed that, the seasonal distributions of Cu in surface and bottom waters were different that Cu contents in surface waters were in order of autumn > summer > spring, while in bottom waters were in order of summer > autumn > spring. The distributions Cu contents in surface and bottom waters were same in different seasons, the variation ranges of Cu contents in surface and bottom waters were closed no matter Cu contents were high or low. The Cu contents in surface and bottom waters were consist and the loss of Cu was little no matter Cu contents were high or low. The spatial variation of Cu was mainly determined by pollution sources and the vertical sedimentation. Both the temporal and spatial variations of Cu in waters were revealing the horizontal sedimentation process that Cu would be settling to the sea bottom rapidly by means of gravity and current.
Keywords: Cu, Spatial variation, Temporal variation, Transfer process, Jiaozhou Bay

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1. INTRODUCTION

Cu is one of the necessary elements for organism, and is widely distributed in the nature world, yet the excessive intake is harmful to organism. The excess anthropogenic Cu-containing waste gas and waste water had been one of the critical environmental issues in mangy countries and regions, as well as in many marine bays [1-5]. Hence, understanding the seasonal variation, spatial distributions and transfer processes of Cu is essential to environmental protection and pollution control. Based on investigation data on Cu in waters in 1985, we analyzed the content, pollution level and transport feature of Cu in Jiaozhou Bay, eastern China, and to provide scientific basis for researching on the existence and transfer of Cu in marine bay.

2. MATERIAL AND METHOD

Jiaozhou Bay (35°55′-36°18′ N, 120°04′-120°23′ E) is located in the south of Shandong Province, eastern China (Fig. 1). It is a semi-closed bay with the total area, average water depth and bay mouth width of 446 km^2, 7 m and 3 km, respectively, and is connect to Yellow Sea in the south. There are more than ten inflow rivers (e.g., Haibo Rriver, Licun Rriver, Dagu Rriver, and Loushan Rriver), most of which have seasonal features [6, 7]. The data was provided by North China Sea Environmental Monitoring Center. The survey was conducted in April, July and October 1985. Bottom water samples in three stations (i.e. 2031, 2032 and 2033) were collected and measured followed by National Specification for Marine Monitoring [8].

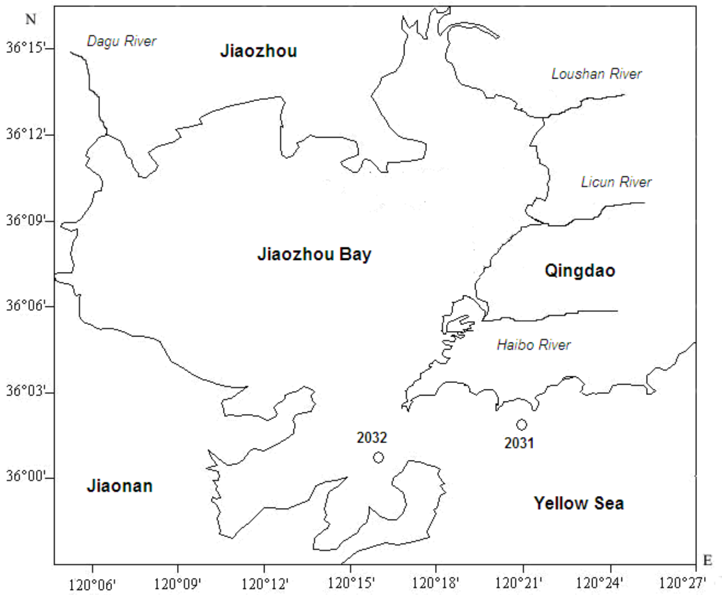

Fig. 1 Geographic location and sampling sites in Jiaozhou Bay

3. RESULTS

3.1 Seasonal variations of Cu

Cu contents in surface waters in April, July and October in Jiaozhou Bay in 1985 were 0.11-0.43 μg L^{-1}, 0.10-0.38 μg L^{-1} and 0.18-0.39 μg L^{-1}, respectively, while in bottom waters were 0.10-0.12 μg L^{-1}, 0.19-0.42 μg L^{-1} and 0.19-0.30 μg L^{-1}, respectively. April, July and October were spring, summer and autumn in study area. Cu contents in surface waters were in order of autumn > summer > spring, while in bottom waters were also in order of summer > autumn > spring. The range of Cu contents in surface and bottom waters were 0.10-0.43 μg L^{-1} and 0.10-0.42 μg L^{-1}, and were very closed.

3.2 Horizontal variations of Cu

The three sampling Sites of 2031, 2032 and 2033 were located in the open sea, the bay mouth and the inside of the bay mouth, respectively. In April and October, Cu in both surface and bottom waters were both increasing from the bay mouth to the open sea. In July, Cu contents in surface waters were decreasing from bay mouth to the open sea, yet in bottom waters were reverse. Hence, the horizontal distributions of Cd contents in surface and bottom waters in spring and autumn were same, while for summer were reverse.

3.3 Vertical variations of Cu

In April, Cu contents in surface waters were highest (0.11-0.43 μg L^{-1}), yet in bottom waters were lowest (0.10-0.12 μg L^{-1}). In July, Cu contents in surface waters were relative high (0.10-0.38 μg L^{-1}), yet in bottom waters were highest (0.19-0.42 μg L^{-1}). In October, Cu contents in surface waters were relative high (0.18-0.39 μg L^{-1}), and in bottom waters were also relative high (0.19-0.30 μg L^{-1}).

Table 1 The ranges of Cu contents in surface and bottom waters in different seasons

Month	April	July	October
Surface waters	Highest	Relative high	Relative high
Bottom waters	Lowest	Highest	Relative high

4. DISCUSSION

4.1 Sedimentation process of Cu

Cu contents were changing greatly while transferring through the water body by means of vertical water's effect [9]. In summer, the activities of zooplankton and phytoplankton were increasing, and the adsorption capacities of suspended particulate matters were enhancing due to the large production of colloid [7]. Hence, a large amount of Cu in waters was absorbing and settling to the sea bottom under the force of gravity and current. That was the horizontal settling process of Cu [1-5].

4.2 Seasonal variations process of Cu

The major Cu sources in Jiaozhou Bay in spring were stream flow and marine current. Although Cu contents were relative high in surface waters, most of Cu had not been settled to bottom waters, hence Cu contents in bottom waters were still very low. In summer, due to the enhance of sedimentation, most of Cu were settled to bottom waters, and Cu contents in bottom waters were relative high. In Autumn, Cu contents in surface waters had been reduced to a low level due to the continuous sedimentation, and Cu contents in bottom waters were reaching a high level due to the continuous accumulation [9]. By means of vertical water's effect [6], Cu contents in bottom waters were mainly determined by which in surface waters and the accumulation of Cu in bottom waters, leading to the difference of the seasonal variations of Cu contents in surface and bottom waters.

4.3 Spatial sedimentation process of Cu

The horizontal distributions of Cu in surface and bottom waters were determined by Cu sources and the source strengths. In April, Cu was mainly sourced from stream flow and marine current, whose source strengths were relative high. Cu contents in both surface and bottom waters were decreasing from the open sea to the bay mouth, indicating the influence of marine current. In July, Cu was mainly sourced from stream flow, whose source strengths were relative high. Cu contents in both surface and bottom waters were decreasing from the bay mouth to open sea, indicating the influence of stream flow. In October, Cu was mainly sourced from marine current, whose source strengths were relative high. Cu contents in both surface and bottom waters were decreasing from the open sea to the bay mouth, indicating the influence of marine current. For spatial scale, the horizontal distributions of Cu in surface and bottom waters were consist. The reason was that a large amount of Cu was settling to the bottom waters rapidly by gravity and current. That was the spatial sedimentation process of Cu.

4.4 Variation sedimentation of Cu

In April, July and October, the ranges of Cu contents in surface and bottom waters were 0.10-0.43 μg L^{-1} and 0.10-0.42 μg L^{-1}, respectively, which were very close. These ranges were showing the effects of sedimentation, leading to the rapid transport of Cu from surface waters to bottom waters, and the consist of the variation of Cu contents in surface and bottom waters.

4.5 Vertical sedimentation of Cu

Cu contents in April, July and October were different, yet the loss ranges were (0.10-0.10 μg L^{-1}) to (0.43-0.42 μg L^{-1}), i.e., 0.00-0.01μg L^{-1}, indicating that there was little loss by means of vertical water's effect [6]. Hence, no matter Cu contents in were high or low, they were closed in both surface and bottom waters. In case of Cu contents were high or low, most of Cu were setting to bottom waters, yet little Cu were removed by water flow. Hence, Cu contents in surface and bottom waters were consist.

5. CONCLUSION

Cu contents in surface waters were in order of autumn > summer > spring, while in bottom waters were also in order of summer > autumn > spring. Cu in bottom waters were mainly determined by which in surface waters and the accumulation of Cu in bottom waters, leading to the difference of the seasonal variations of Cu contents in surface and bottom waters.

For spatial scale, the horizontal distributions of Cu in surface and bottom waters were consist. The reason was that a large amount of Cu was settling to the bottom waters rapidly by gravity and current. That was the spatial sedimentation process of Cu.

These ranges were showing the effects of sedimentation, leading to the rapid transport of Cu from surface waters to bottom waters, and the consist of the variation of Cu contents in surface and bottom waters.

No matter Cu contents in were high or low, they were closed and consist in surface and bottom waters, because most of Cu were setting to bottom waters, yet little Cu were removed by water flow. Hence, Cu contents in surface and bottom waters were consist.

These seasonal variations and spatial distributions of Cu confirmed the horizontal settling process of Cu that a large amount of Cu in waters was absorbing and settling to the sea bottom under the force of gravity and current.

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