Mechanism of Cu's High Settling Process in Jiaozhou Bay

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Abstract: Ocean is the sink of various pollutants by means of the settling process. Understanding the mechanism of settling process of pollutants is essential to environmental protection and scientific research. This paper analyzed the high settling regions of Cu in bottom waters in Jiaozhou Bay, and revealed the mechanism the high settling process based on investigation data on Cu during 1982-1985. Results showed that there were five mechanisms for Cu's high settling processes. These findings were helpful information in decision-making of pollution control and environmental remediation practice.

1. Introduction

Ocean is the sink of various pollutants by means of the settling process. Many marine bays have been polluted by various pollutants including Cu along with the rapid development of industrialization and urbanization [1-6]. Hence, understanding the settling process and the mechanism of Cu in marine bay is essential to marine environment protection. Jiaozhou Bay is a semi-closed marine bay in Shandong Province China. This bay has been polluted by various pollutants including Cu after the reform and opening-up [7-16]. Based on investigation data on Cu during 1982-1985, this paper analyzed the high settling regions of Cu in bottom waters in Jiaozhou Bay, and revealed the mechanism the high settling process.

Fig. 1 Geographic location and sampling sites in Jiaozhou Bay

2. Study area and data collection

Jiaozhou Bay is located in the south of Shandong Province, eastern China (35°55′-36°18′ N, 120°04′-120°23′ E). The total area, average water depth and bay mouth width are 446 km2, 7 m and

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3 km, respectively. This bay is a typical of semi-closed bay which is connected to the Yellow Sea in the south. There are a dozen of rivers, and the majors are Dagu River, Haibo Rriver, Licun Rriver, and Loushan Rriver etc., all of which are seasonal rivers [17-18]. The investigation on Cd in surface waters in Jiaozhou Bay was carried on in July and October 1982, May, September and October 1983, July and October 1984, and April, July and October 1985, respectively [13-16] (Fig. 1). Cu in waters was sampled and monitored follow by National Specification for Marine Monitoring [19].

3. Results and discussion

3.1 Distributions and high settling regions.

In accoring to the horizontal distributions of Cu contents in bottom waters in Jiaozhou Bay in different months during 1982-1985, the high settling regions could be defined and were listed in Table 1 to Table 4. In July 1982, there was a high value region in the coastal waters in the southwest of the bay, and Cu contents were decreasing from the high value region to the center of the bay (Table 1). In October 1982, there was a high value region in the bay mouth in the southwest of the bay, and Cu contents were decreasing from the high value region to the center of the bay (Table 1). It could be found that, there were two high settling regions in 1982, and there was one high value region in each month (Table 1).

Table 1 Source and high settling regions of Cu in Jiaozhou Bay 1982-1985

Source and high settling region	July	October
High settling region	Coastal waters in the southwest	The bay mouth in the southwest

In May 1983, there was a high value region in the coastal waters in the east of the bay, and Cu contents were decreasing from the high value region to the open waters (Table 2). In September 1983, there was a high value region in the coastal waters in the east of the bay, and Cu contents were decreasing from the high value region to the open waters (Table 2). In October 1983, there was a high value regions in coastal waters in the southwest of the bay, and Cu contents were decreasing from the high value region to the open waters (Table 2). It could be seen from Table 2 that there was one high value region in each month in 1983, and the high settling region in May and September 1983 was same.

Table 2 Source and high settling regions of Cu in Jiaozhou Bay 1983

Source and high settling region	May	September	October
High settling region	Coastal waters in the east of the bay	Coastal waters in the east of the bay	Coastal waters in the southwest of the bay

In May 1984, there was a high value region in the bay mouth, and Cu contents were decreasing from the high value region to the open waters (Table 3). In October 1984, there was a high value regions in the open waters, and Cu contents were decreasing from the high value region to the bay mouth (Table 3). Hence, There was one high value region in each month in 1984 (Table 3).

Table 3 Source and high settling regions of Cu in Jiaozhou Bay 1984

Source and high settling region	July	October
High settling region	The bay mouth	Open waters outside the bay mouth

In April 1984, there was a high value region in the coastal waters in the bay mouth, and Cu contents were decreasing from the high value region to the open waters (Table 4). In July 1984, there was a also high value region in the coastal waters in the bay mouth, and Cu contents were decreasing from the high value region to the open waters (Table 4). In October 1983, there was a high value regions in the open waters, and Cu contents were decreasing from the high value region to the bay mouth (Table 2). Hence, there was one high value region in each month in 1984, and the

high settling region in April and July 1984 was same.

Table 4 Source and high settling regions of Cu in Jiaozhou Bay 1985

Source and high settling region	April	July	October
High settling region	Open waters outside the bay mouth	The bay mouth	The bay mouth

3.2 Mechanism of the high settling region.

The high settling regions were the combined effects of source input, horizontal water's effect and vertical water's effect [20-22]. The sources and high settling regions of Cu in Jiaozhou Bay 1982-1985 were listed in Table 5. The horizontal distributions of Cu contents in bottom waters in Jiaozhou Bay during 1982-1985 indicated that there were rapid settling process and accumulation process in this bay.

In 1982, there were two major Cu sources and two high settling processes (Table 5). In 1983, there were four major Cu sources, yet there were also two high settling processes (Table 5). In 1984, there were also two major Cu sources and two high settling processes (Table 5). In 1985, there were also two major Cu sources and two high settling processes (Table 5). In general, there was one high value region in each month in 1982-1985, and the high settling regions in different months could be same or different (Table 1 to Table 4).

The high settling processes and high value regions were revealing that, 1) there could be a unique high settling region of Cu contents in case of several major Cu sources, 2) the number of high settling regions of Cu contents must be smaller than the number of major Cu sources, 3) the high settling regions of Cu contents in different monitoring times as long as the major Cu sources were same, 4) the locations of major Cu sources and high settling regions were in the same side of the bay mouth, and 5) Cu contents in surface waters were higher than or equal to which in bottom waters in the rapid settling process of Cu (Table 5).

Table 5 Sources and high settling regions of Cu in Jiaozhou Bay 1982-1985

Source and high settling region	1982	1983	1984	1985
Source	Overland runoff, marine current	River flow, marine traffic, island top, overland runoff	River flow, marine	River flow, marine current
Source strength/μg L^{-1}	3.56, 2.33	2.20-10.57, 9.48, 4.86, 2.28	1.88-4.00, 2.00	0.37~0.43, 0.39
High settling process	Coastal waters in the southwest, the bay mouth	Coastal waters in the east of the bay, Coastal waters in the southwest of the bay	The bay mouth, open waters outside the bay mouth	The bay mouth, open waters outside the bay mouth
High value/μg L^{-1}	1.46-3.22	1.90-3.95	0.61-2.97	0.12-0.42

4. Conclusions

The high settling process of Cu in Jiaozhou Bay were analyzed, and the mechanisms were, 1) there could be a unique high settling region of Cu contents in case of several major Cu sources, 2) the number of high settling regions of Cu contents must be smaller than the number of major Cu sources, 3) the high settling regions of Cu contents in different monitoring times as long as the major Cu sources were same, 4) the locations of major Cu sources and high settling regions were in the same side of the bay mouth, and 5) Cu contents in surface waters were higher or equal to which in bottom waters in the rapid settling process.

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