Spatial and temporal sedimentation processes of Cu in Jiaozhou Bay

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Abstract

Cu pollution in marine bays has been one of the critical environmental issues, and understanding the spatial-temporal sedimentation process is essential to pollution control. This paper analyzed the spatial-temporal sedimentation processes of Cu in Jiaozhou Bay based on investigation data in 1985. Results showed that at temporal scale the sedimentation progress contained four status of 1) no Cu input, 2) the rapid increase of Cu input, 3) the rapid decrease of Cu input, and 4) the recover of Cu input. At spatial scale, Cu contents were tending to be homogeneous in locations with little Cu input, yet Cu content in surface waters were high than which in bottom waters in locations with Cu input. The Spatial-temporal sedimentation law for Cd was defined that, Cu contents in surface and bottom waters were determined by the spatial-temporal variation of Cu sources and the distances of the transporting processes away from the sources.

Keywords

Cu; Spatial; Temporal; Sedimentation; Jiaozhou Bay.

1. Introduction

A large amount of Cu was used in industry and agriculture, and a large amount of Cu-containing waste was generated and discharged to the environment. Many marine bays were polluted by Cu since ocean was the sink of pollutants [1-5]. Sedimentation is one of the key migration processed of Cu in marine bay, and understanding the spatial and temporal sedimentation process is essential to pollution control. Jiaozhou Bay is a semi-closed bay located in Shandong Province, eastern China. This paper analyzed the spatial and temporal sedimentation process of in Jiaozhou Bay based on investigation data in 1985, and provided important basis information to scientific research and pollution control practice.

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 km2, 7 m and 3 km, respectively. There are more than ten inflow rivers such as Haibo Rriver, Licun Rriver, Dagu Rriver, and Loushan Rriver etc., most of which have seasonal features [6-9].

The data was provided by North China Sea Environmental Monitoring Center. The survey was conducted in April, July and October, respectively. Surface water samples in three stations (i.e. 2031, 2032, 2033) were collected and measured followed by National Specification for Marine Monitoring [8].

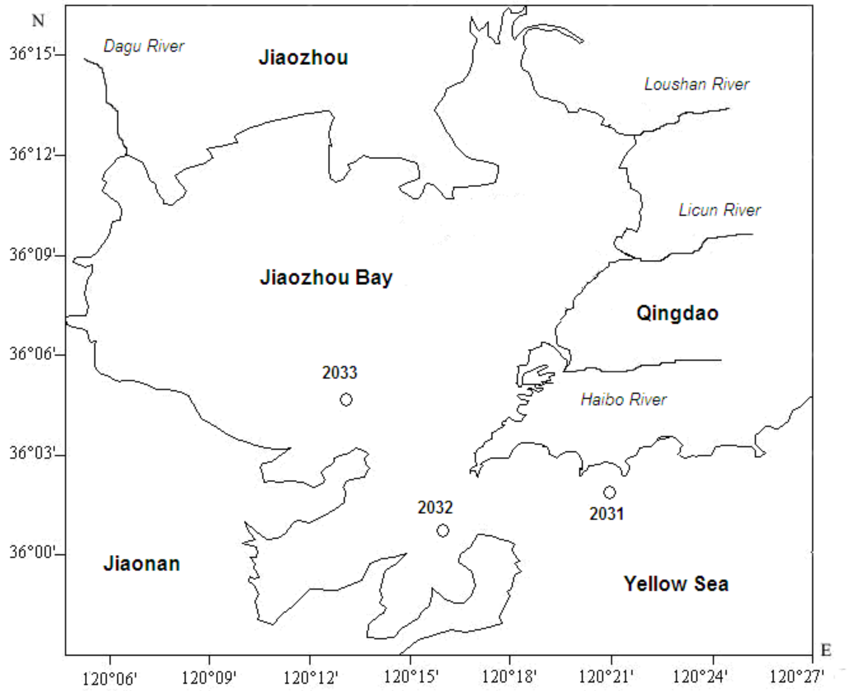

Fig.1 Geographic location and monitoring sites in Jiaozhou Bay

3. Results and Discussion

3.1 Vertical Variation of Cu.

In order to defined the vertical variations, Cu contents in surface waters in each sampling sites in each month were subtracted by which in bottom waters, which were indicating that weather Cu in surface waters were higher or lower than in bottom waters. The ranges of the subtractions of Cu contents between surface waters and bottom waters in April, July and October 1979 were 0.00—0.27 μg L-1, -0.20—0.00 μg L-1 and -0.03—0.09 μg L-1, respectively, and in the whole year were -0.20—0.27 μg L-1. In general, the vertical variations of Cu in Jiaozhou Bay were showing spatial-temporal variations (Table 1), which were analyzed in the flowing section.

Table 1. Subtraction of Cu contents between the surface and bottom waters in Jiaozhou Bay

Month	Site 2033	Site 2032	Site 2031
April	Zero	Positive	Positive
July	Zero	Negative	Negative
October	Negative	Positive	Positive

3.2 Regional Sedimentation of Cu.

The subtractions of Cu contents between the surface and bottom waters in Jiaozhou Bay were indicating the variations of Cu contents in waters (Table 1). Once Cu was input to the bay, it was firstly entering into surface waters, and was settling to bottom waters rapidly and continuously. River flow and marine current the major Cu sources in April, yet river flow were just beginning to input Cu to the bay in April. Hence, Cu contents in surface waters were higher than in bottom waters in the bay mouth and the open waters. While in waters inside the bay mouth, Cu contents in waters were homogeneous since the Cu input from river flow was also just beginning and the contents were still low. In July, river flow was the major Cu source, and the source strength was relative high. A big part of Cu had been settled to and accumulated in bottom waters during April to July. Hence, Cu contents in bottom water were high than which in surface waters in waters in the bay mouth and outside the bay mouth. In waters inside the bay mouth, Cu contents in waters were homogeneous. In October, Marine current was the major Cu source. Hence, Cu contents in surface waters were higher than in bottom waters in the bay mouth and the open waters, while in waters inside the bay mouth were reverse.

3.3 Temporal Sedimentation of Cu.

In waters inside the bay mouth, Cu contents in April and July were consistent in surface and bottom waters, while in October Cu contents in surface waters were lower than in bottom waters.In waters in the bay mouth, Cu contents in surface waters in April and July were lower than in bottom waters, while in October were reverse. In waters in the outside of the bay mouth, Cu contents in surface waters in April and October were higher than in bottom waters, while in July were reverse. The spatial-temporal variations of Cu contents showed that at temporal scale the sedimentation progress contained four status of 1) no Cu input, 2) the rapid increase of Cu input, 3) the rapid decrease of Cu input, and 4) the recover of Cu input. This indicated that in case of no Cu input (April and July) Cu contents in waters were tending to be homogeneous, and in case of Cu input and by means of sedimentation (October) Cu contents in bottom waters were higher than in surface waters.

3.4 Spatial Sedimentation of Cu.

In April, Cu contents in surface waters and bottom waters were consistent in waters in the bay mouth, while in waters in the bay mouth and outside the bay mouth Cu contents in surface waters were higher than in bottom waters. In July, Cu contents in surface waters and bottom waters were consistent in waters inside the bay mouth, while in waters in the bay mouth and outside the bay mouth Cu content in surface waters were lower than in bottom waters. In October, Cu contents in surface waters were lower than in bottom waters in waters inside the bay mouth, while in waters in the bay mouth and outside the bay mouth Cu contents in surface waters were higher than in bottom waters. At spatial scale, Cu contents were tending to be homogeneous in locations with little Cu input, yet Cu content in surface waters were high than which in bottom waters in locations with Cu input. The Spatial-temporal sedimentation law for Cd was defined that, Cu contents in surface and bottom waters were determined by the spatial-temporal variation of Cu sources and the distances of the transporting processes away from the sources.

4. Conclusion

The ranges of the subtractions of Cu contents between surface waters and bottom waters in April, July and October 1979 were 0.00—0.27 μg L-1, -0.20—0.00 μg L-1 and -0.03—0.09 μg L-1, respectively, and in the whole year were -0.20—0.27 μg L-1. In general, the vertical variations of Cu in Jiaozhou Bay were showing spatial-temporal variations.

At temporal scale, the sedimentation progress contained four status of 1) no Cu input, 2) the rapid increase of Cu input, 3) the rapid decrease of Cu input, and 4) the recover of Cu input.

At spatial scale, Cu contents were tending to be homogeneous in locations with little Cu input, yet Cu content in surface waters were high than which in bottom waters in locations with Cu input.

The Spatial-temporal sedimentation law for Cd was defined that, Cu contents in surface and bottom waters were determined by the spatial-temporal variation of Cu sources and the distances of the transporting processes away from the sources.

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