Transport Trend of Cu in waters and the Mechanism in Jiaozhou Bay

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Abstract: This paper analyzed the horizontal distributions and the trends of Cu contents in surface and bottom waters in Jiaozhou Bay during 1982-1985 in Shandong Province of China, and the mechanism of transport trend in waters were revealed based on this analysis. Results showed that along with the directions of the input sources, the substance contents in surface waters were decreasing, as well as in bottom waters. The substance contents were settling rapidly, and were accumulating in bottom. The directions of the source inputs determined the horizontal distribution trends in both surface and bottom waters, while the substance contents in the source inputs determined the high sedimentation regions of substance contents.

1. Introduction

Jiaozhou Bay is a semi-closed bay in Shandong Province, China. This bay is surrounding by cities of Jiaonan, Qingdao and Jiaozhou, and has been polluted by various pollutants including Cu along with the rapid development of industrialization and urbanization after reform and opening-up [1-6]. Hence, understanding the distributions and the trends of Cu in marine bay is essential to marine environment protection [7-16]. This paper analyzed the horizontal distributions of Cu contents in surface and bottom waters in Jiaozhou Bay in Shandong Province of China based on investigation data on Cu during 1982-1984. Furthermore, the mechanism of transport trend in waters were revealed based on this analysis. The aim of this paper was to provide information for decision-making of pollution control and environmental remediation practice, as well as in scientific research.

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,

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120°04′-120°23′ E). The total area, average water depth and bay mouth width are 446 km2, 7 m and 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 Horizontal distribution trends.

By means of source input of Cu, horizontal water's effect and vertical waters's effect [20-22], the horizontal distribution trends of Cu in surface and bottom waters in Jiaozhou Bay were changing. In 1982, the horizontal distributions of Cu contents in surface and bottom waters in July were consistent, while in October were reverse. In 1983, the horizontal distributions of Cu contents in surface and bottom waters in May and October were consistent, while in September were reverse. In 1984, the horizontal distributions of Cu contents in surface and bottom waters in July were consistent, while in October were reverse. In 1985, the horizontal distributions of Cu contents in surface and bottom waters in April, July and October were consistent. In generally, the horizontal distribution trends of Cu in surface and bottom waters in Jiaozhou Bay in different months could be consistent or reverse (Table 1).

Table 1 The consistency of the horizontal distribution trends of Cu in surface and bottom waters in Jiaozhou Bay in different months

Year	April	May	July	September	October
1982			Reverse		Reverse
1983		Consistent		Reverse	Consistent
1984			Reverse		Consistent
1985	Consistent		Consistent		Consistent

3.2 Mechanism of distribution trend.

In according to the analysis of the horizontal distribution trends of Cu in surface and bottom waters in Jiaozhou Bay during 1982-1985, we proposed the mechanism of transport trend in waters. Along with the directions of the input sources, the substance contents in surface waters were decreasing, as well as in bottom waters. The substance contents were settling rapidly, and were accumulating in bottom. The directions of the source inputs determined the horizontal distribution trends in both surface and bottom waters, while the substance contents in the source inputs determined the high sedimentation regions of substance contents.

During 1982-1985, the horizontal distributions of substance contents in surface and bottom waters in Jiaozhou Bay revealed the high sedimentation regions, and indicated that there were accumulation processes in sea bottom. Therefore, the transport trends of substance contents in waters determined the high sedimentation regions.

3.2.1 Direction of source.

The direction of source input determined the horizontal distribution of substance contents in surface and bottom waters. Substance contents were decreasing along with the direction of the source. This indicated that the substance contents were settling rapidly, and were accumulating in bottom. Hence, the high sedimentation region could be defined.

3.2.2 High sedimentation in case of unique source.

In case of unique source input to the bay, and in according to the mechanism of transport trend of substance content in waters, it could be defined that the substance contents in surface waters were decreasing, as well as in bottom waters. The substance contents were settling rapidly and there were accumulation process in sea bottom, so that the high sedimentation region could be defined, that was in place where the source was input to waters in the bay. For instance, in Jiaozhou Bay, in case of there was only one river was the major Cu source, the high sedimentation region was in the estuary of the river.

3.2.3 High sedimentation in case of two sources.

In case of two sources input to the bay, and in according to the mechanism of transport trend of substance content in waters, it could be defined that the substance contents in surface waters were decreasing, as well as in bottom waters. The substance contents were settling rapidly and there were accumulation process in sea bottom, so that the high sedimentation region could be defined, that was in place where the directions of the two sources were intersecting and the sedimentation was overlaying. For instance, in Jiaozhou Bay, in case of there were two major Cu sources (i.e., river flow and marine current), the high sedimentation region was in the bay mouth in where the directions of the two sources were intersecting.

3.2.4 High sedimentation in case of several sources.

In case of several sources input to the bay, and in according to the mechanism of transport trend of substance content in waters, it could be defined that the substance contents in surface waters were decreasing, as well as in bottom waters. The substance contents were settling rapidly and there were accumulation process in sea bottom, so that the high sedimentation region could be defined. Taken each source input of substance as the center, the substance contents were decreasing along with the directions of the sources. Hence, there would be several decreasing trends in case of several sources, and the trends were intersecting and the sedimentation was overlaying, resulting in the high sedimentation regions. For instance, in Jiaozhou Bay, in case of there were three major Cu sources (i.e., river flow, island top and harbor), the high sedimentation region was in the inside of the bay mouth since the three sources were all inside the bay.

4. Conclusions

Based on the analysis of the horizontal distributions trends of Cu contents in surface and bottom waters in Jiaozhou Bay, the mechanism of transport trend in waters were revealed. Along with the directions of the input sources, the substance contents in surface waters were decreasing, as well as in bottom waters. The substance contents were settling rapidly, and were accumulating in bottom. The directions of the source inputs determined the horizontal distribution trends in both surface and bottom waters, while the substance contents in the source inputs determined the high sedimentation regions of substance contents.

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