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Vertical Water's Effect on Pb Contents in Jiaozhou Bay 1987

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Abstract: This paper analyzed the seasonal variation, vertical change, and horizontal distributions of Pb contents in Jiaozhou Bay, China. Results showed that Pb contents in surface waters in May, July and November in Jiaozhou Bay 1987 were 1.95-3.02 μg L^{-1}, 18.76-22.02 μg L^{-1} and 3.98-24.64 μg L^{-1}, respectively, while in bottom waters were 1.87-2.60 μg L^{-1}, 15.11-19.68 μg L^{-1} and 11.08-15.18 μg L^{-1}, respectively. The pollution levels of Pb in May, July and November 1987 in Jiaozhou Bay were slight, moderate and heavy, respectively. Pb contents in surface waters were in order of autumn>summer>spring, while in bottom waters were in order of summer>autumn>spring. Pb contents in bottom waters would be relative low/high if Pb contents in surface waters were relative low/high. The seasonal variations of Pb contents in surface waters were mainly determined by the seasonal changes of Pb sources, while in bottom waters were mainly determined by the changes of vertical water's accumulation and dilution effects. The horizontal distributions of Pb contents in surface and bottom waters were consistent in case of only one major Pb source, while were reverse in case of two different major Pb sources.

1. Introduction

A large amount of Pb-containing wastes was generated and discharged to the environment with the rapid development of industry and the lagging of waste treatment. Marine is the sink of pollutants, and many marine bays have been polluted by Pb by means of point and diffuse sources of Pb [1-2]. Previous studies showed that vertical water's effect on pollutant in marine bay is one of the key factors in transporting processes [3-8], which was useful in research on environmental behaviors of pollutants in marine bay. Jiaozhou Bay is a semi-closed bay in Shandong Province, China. This paper analyzed the seasonal variation, vertical change, and horizontal distributions of Pb contents in Jiaozhou Bay, and revealed the vertical water's effect on Pb. The aim of this paper was to provide scientific basis for better understanding the transporting processes of pollutants in marine bay.

2. Study area and data collection

Jiaozhou Bay (120°04′-120°23′ East, 35°55′-36°18′ North) is located in 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 River, Licun River, Dagu River, and Loushan River. The data were provided by North China Sea Environmental Monitoring Center. The survey on Pb was conducted in May, July and November 1987. Surface and bottom water samples in three stations (i.e. 2031, 2032 and 2033) were collected and measured followed by National Specification for Marine Monitoring [9].

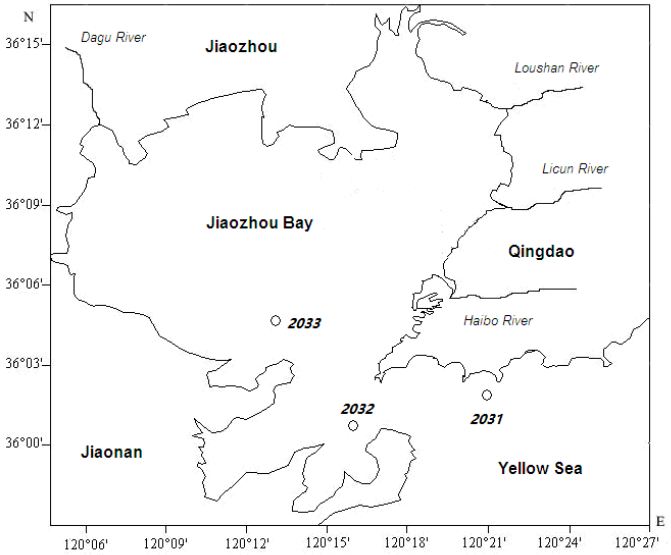

Fig.1 Geographic location and monitoring sites in Jiaozhou Bay

3. Results

3.1 Seasonal variation of Pb.

Pb contents in surface waters in May, July and November, 1987 in Jiaozhou Bay, were 1.95-3.02 μg L-1, 18.76-22.02 μg L-1 and 3.98-24.64 μg L-1, respectively, while in bottom waters were 1.87-2.60 μg L-1, 15.11-19.68 μg L-1 and 11.08-15.18 μg L-1, respectively. According to Sea water quality standard (GB 3097-1997), the pollution levels of Pb in May, July and November, 1987 in Jiaozhou Bay were slight, moderate and heavy, respectively.

3.2 Seasonal variation and vertical change of Pb.

According to seasonal division in studied area, May, July and November were spring, summer and autumn, respectively. For seasonal variation, Pb contents in surface waters were in order of autumn>summer>spring, while in bottom waters were in order of summer>autumn>spring. In general, Pb contents in bottom waters would be relative low/high in case of Pb contents in surface waters were relative low/high.

3.3 Horizontal distributions of Pb.

In accordance with the geographic location of the monitoring sites, Sites of 2033, 2032 and 2031 were located in the inside, middle and outside of the bay mouth, respectively. In May 1987, Pb contents in surface and bottom waters were both decreasing from the middle of the bay mouth to the open waters. In July 1987, Pb contents in surface waters were decreasing from the open waters to the middle of the bay mouth, while in bottom waters were reverse.

4. Discussion

4.1 Settling process of Pb.

Due to vertical water's effect, Pb contents in waters were changing while passing water body from surface waters to bottom waters [10-12]. The growth and reproduction of marine phytoplankton were increasing rapidly in summer, resulting in a lot of colloids in waters, thus, enhancing the absorption ability of suspended particular matters in waters [1-6]. Hence, a big part of Pb contents was absorbed to the suspended particular matters and transported to sea bottom. Hence, Pb contents were settling to sea bottom continuously.

4.2 Seasonal variation process of Pb.

The major Pb source in spring was river flow, whose source strength was relative low, resulting in low Pb contents in surface waters in spring. The major Pb sources in summer were river flow, and the source strength was increasing since in increasing of rainfall, resulting in relative high Pb contents in surface waters in summer. The major Pb sources in autumn were river and marine current, and overlay source strengths were highest, causing the highest Pb contents in surface waters in autumn. By means of vertical water's effect [10-12], Pb contents were settling to sea bottom waters rapidly and continuously. Hence, Pb contents in bottom waters were increasing from spring, and reaching the highest in summer. Pb contents in bottom waters in autumn was lower than that in summer due to the decreasing of the growth and reproduction of marine phytoplankton. It could be found that there was accumulation effect of Pb contents during spring to summer, indicating that, there was dilution effect of Pb contents from summer to autumn. Generally, the seasonal variations of Pb contents in surface waters were mainly determined by the seasonal changes of Pb sources, while in bottom waters were mainly determined by the changes of vertical water's accumulation and dilution effects.

4.3 Spatial variation process of Pb.

The change ranges of Pb contents in May, July and November 1987 in surface and bottom waters were closed. In light of vertical water's effect and horizontal water's effect [10-12], the accumulation effect was performing in case of low Pb contents in surface waters to bottom waters, and the dilution effect was performing in case of high Pb contents in surface waters to bottom waters. Hence, the variation range of Pb contents in surface waters were 1.95-24.64 μg L-1, which were higher than those in bottom waters (1.78-19.68 μg L-1). There was only one major Pb source (i.e., river flow) in May, leading to consistent horizontal distributions of Pb contents in surface and bottom waters. There were two major Pb sources (i.e., river flow and marine current), whose input directions were different, resulting in reverse horizontal distributions of Pb contents in surface and bottom waters by means of the overlay effect of the major Pb sources and the vertical settling process of Pb from surface waters to bottom waters [10-12].

5. Conclusion

The pollution levels of Pb in May, July and November 1987 in Jiaozhou Bay were slight, moderate and heavy, respectively. Pb contents in surface waters were in order of autumn>summer>spring, while in bottom waters were in order of summer>autumn>spring. In a word, Pb contents in bottom waters would be relative low/high in case of Pb contents in surface waters were relative low/high.

The seasonal variations of Pb contents in surface waters were mainly determined by the seasonal changes of Pb sources, while in bottom waters were mainly determined by the changes of vertical water's accumulation and dilution effects. The horizontal distributions of Pb contents in surface and bottom waters were consistent in case of only one major Pb source, while were reverse in case of two different major Pb sources.

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