Pollution level and source of Hg in Jiaozhou Bay 1987

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Abstract. Hg pollution in marine bays has been one of the most critical environmental issues, and it is necessary to understand the distribution, pollution level and sources of Hg. Based on the investigation data on Hg in Jiaozhou Bay in May, July and November 1987, this paper analyzed the content, pollution level, and sources of Hg. Results showed that Hg contents in surface waters in Jiaozhou Bay in May, July and November 1987 were 0.150—0.264 $\mu$g L\textsuperscript{-1}, 0.088—1.104 $\mu$g L\textsuperscript{-1} and 0.007—0.088 $\mu$g L\textsuperscript{-1}, respectively. The two major Hg sources in Jiaozhou Bay were river flow and marine current, whose source strengths were 0.264—1.104 $\mu$g L\textsuperscript{-1} and 0.088—0.376 $\mu$g L\textsuperscript{-1}, respectively. The source strength of river flow could be worse than Grade IV, while the source strength of marine current was Grade III and IV, indicated that the pollution level of Hg in land river had reached a relative high level in 1987. These findings provided basis for the research and pollution control countermeasures.

1 Introduction

Hg is one of the heavy metal widely used in industry, agriculture and everyday life. A large amount of Hg-containing wastes were generated and discharged to rivers and to marine bays so that ocean became the sink of various pollutants. However, Hg is also one of the critical heavy metal due to the high toxicity, therefore it is necessary to understanding the distribution, pollution level and sources of Hg.

Jiaozhou Bay is a semi-closed bay located in Shandong Province, eastern China, and has been polluted by various pollutants including Hg after China’s Reform and Opening-up [1-6]. Based on the investigation data on Hg in Jiaozhou Bay in May, July and November 1987, the aim of this paper was to analyze the content, pollution level, and sources of Hg, and to provide basis for the research and pollution control countermeasures.

2 Study area and data collection

Study area. Jiaozhou Bay is located in the south of Shandong Province, eastern China (35°55′—36°18′ N, 120°04′—120°23′ E), with the total area and average water depth of 446 km\textsuperscript{2} and 7 m, respectively. This bay is a semi-closed bay connected to the Yellow Sea in the south, with a bay mouth with of 3 km. There are a dozen of rivers including Dagu River, Haibo Rriver, Licun Rriver, and Loushan Rriver etc., all of which are seasonal rivers [7—8].
Data collection. The investigation on Hg in surface waters in Jiaozhou Bay was carried on in May, July and November 1987 in six investigation sites (i.e., 2031, 2032, 2033, 2034, 2035, 2047) (Fig. 1). Hg in waters was sampled and monitored follow by National Specification for Marine Monitoring [9].

![Fig.1 Geographic location and sampling sites of Jiaozhou Bay](image)

3 Results and discussion

Content and pollution of Hg. Hg contents in surface waters in Jiaozhou Bay in May, July and November 1987 were 0.150–0.264 μg L\(^{-1}\), 0.088–1.104 μg L\(^{-1}\) and 0.007–0.088 μg L\(^{-1}\), respectively (Table 1). In generally, Hg’s contents were ranging from 0.007–1.104 μg L\(^{-1}\) in 1987, and Hg’s pollution level were showing significant spatial-temporal variations (Table 1) in according to National Standard of China for Seawater Quality (GB3097-1997) (Table 2).

| Month | May      | July    | November |
|-------|----------|---------|----------|
| Content /μg L\(^{-1}\) | 0.150–0.264 | 0.088–1.104 | 0.007–0.088 |
| Grade | II, III and IV | II, III and IV, worse than IV | I, II |

Table 2 Guidelines for Hg in National Standard of China for Seawater Quality (GB3097 – 1997)

| Grade | | | |
|-------|-------|-------|-------|
| Content /μg L\(^{-1}\) | 0.05 | 0.20 | 0.50 |

In May 1987, Hg contents in Site 2034, Site 2033 and Site 2032 in coastal waters in the east and south of the bay were ranging from 0.241–0.264 μg L\(^{-1}\), and were belong to Grade III and IV, while in other Sites were ranging from 0.05–0.20 μg L\(^{-1}\), and were relative low and belong to Grade II. In
July 1987, the highest Hg content was in Site 2035 in the east of the bay (1.104 μg L⁻¹), and was much more high than Grade III and IV, indicating that the pollution level in this location was worse than Grade IV. Meanwhile, Hg contents was as high as 0.376 μg L⁻¹ in the open waters, and the pollution level in this location was also worse than Grade IV. However, Hg contents in other Sites were ranging from 0.05 − 0.20 μg L⁻¹, and were relative low and belong to Grade II. In November 1987, the highest Hg content was in the open water (0.088 μg L⁻¹) and was belong to Grade II, while Hg contents in other locations were lower than 0.05 μg L⁻¹ and was belong to Grade I. In generally, Hg’s contents were relative high in coastal waters in the estuaries of the major inflow rivers and in the open waters from spatial aspect, while Hg’s pollution levels were relative high in summer yet relative low in autumn form temporal aspect.

Distribution and source of Hg. The horizontal distribution of Hg contents in marine bays was mainly determined by the spatial variation of source input and water exchange, and was important evidence to identify and source of Hg. In May 1987, the high Hg contents were in the estuary of the major inflow river in the northeast of the bay, and Hg contents were forming a series of parallel lines which were decreasing from the bay to the bay mouthflow direction of the major rivers (Fig. 2a). Hence, it could be defined that river was the major source of Hg in May 1987. In July 1987, the high Hg content was in Site 2035 in the estuary of Licun River in the coastal waters in the northeast of the bay, and Hg contents were forming a series of semi-circles which were decreasing from the northeast of the bay to center of the bay along with the flow direction of Licun River (Fig. 2b). Hence, it could be defined that river was the major source of Hg in July 1987. In November 1987, high value (0.088 μg L⁻¹) was in Site 2031 in the open waters, and Hg contents were forming a series of parallel lines which were decreasing from the open waters to the bay (0.007 μg L⁻¹) along with the flow direction of marine current (Fig. 2c). However, Hg contents were very low in the inside of the bay (0.007 − 0.014 μg L⁻¹). Hence, it could be defined that marine current was the major source of Hg in November 1987.

In generally, the two major Hg sources in Jiaozhou Bay were river flow and marine current, whose source strengths were 0.264 − 1.104 μg L⁻¹ and 0.088 − 0.376 μg L⁻¹, respectively. In according to National Standard of China for Seawater Quality (GB3097-1997) (Table 2), it could be found that the source strength of river flow could be worse than Grade IV, while the source strength of marine current was Grade III and IV. Hence, it could also be found that the pollution level of Hg in land river had reached a relative high level in 1987.
Fig. 2 Horizontal distribution of Hg in in Jiaozhou Bay in a) May, b) July and c) November 1987/μg L$^{-1}$

4 Conclusion
Hg contents in surface waters in Jiaozhou Bay in May, July and November 1987 were 0.150−0.264 μg L$^{-1}$, 0.088−1.104 μg L$^{-1}$ and 0.007−0.088 μg L$^{-1}$, and were showing significant spatial-temporal variations. Hg’s contents were relatively high in coastal water in the estuaries of the major inflow rivers and in the open water from spatial aspect, while Hg’s pollution levels were relatively high in summer yet relatively low in autumn form temporal aspect. The two major Hg sources in Jiaozhou Bay were river flow and marine current, whose source strengths were 0.264−1.104 μg L$^{-1}$ and 0.088−0.376 μg L$^{-1}$, respectively. The source strength of river flow could be worse than Grade IV, while the source strength of marine current was Grade III and IV, indicated that the pollution level of Hg in land river had reached a relative high level in 1987.

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