Pb pollution from land-based sources in adjacent region of Jiaozhou Bay

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Abstract. Based on investigation dada on lead (Pb) in July, August and October 1984 in Jiaozhou Bay waters, we analyzed the content, pollution level and distribution of Pb, and defined the major sources of Pb. Results showed that Pb contents in 1984 in surface waters were 0.72-36.00 μg L^{-1} and were meeting Grade I to Grade IV in National Sea Water Quality Standard (GB 3097-1997). We found that river flow and overland runoff were the major sources of Pb. The Pb pollution level in river flow was light and moderate polluted, while in ovrland runoff was heavy polluted. In generatlly, land-based sources in adjacent region were the major sources of Pb in Jiaozhou Bay in 1984, and the source-control/reduction of Pb was necessary.

Introduction

A large amount of Pb-containing waste waters were generated and discharged to rivers and marine bays along with the rapid increase of industry and agriculture [1-6]. The Pb pollution in the environment could be harmful to human being itself finally due to the high toxicity of Pb. Hence,understanding the contents, pollution levels and sources of Pb in marine bay was essential to protect the marine environment and to maintain the harmonious development of society economy and ecological environment [1-6].

Jiaozhou Bay is a semi-closed bay located in Shandong province, eastern China, and had been polluted by various pollutants including Pb [1-6]. This paper analyzed the contents, pollution levels and sources of Pb based on investigation dada on Pb in July, August and October 1984 in Jiaozhou Bay, and tried to provide scientific background and basis for provide basis for Pb pollution control and environmental remediation.

Material and method

Jiaozhou Bay (35°55′-36°18′ N, 120°04′-120°23′ E) is a semi-closed bay located in the south of Shandong Province, eastern China (Fig. 1). The total area and bay mouth depth 446 km^2 and 3 km, respectively. This bay was arounded by Qingdao City, Jiaozhou City and Jiaonan City in the east, north and west, respecitively, and was connected to Yellow Sea in the south. The bay has more than ten inflow rivers, including Haibo Rriver, Licun Rriver and Loushan Rriver etc., all of which have seasonal features [7-8].

The data was provided by North China Sea Environmental Monitoring Center. The survey was conducted in July August and October 1984. Pb in surface waters in six sampling sties (Site 2047, Site 2035, Site 2034, Site 2033, Site 2032 and Site 2031) (Fig. 1) were sampled and monitored follow by National Specification for Marine Monitoring [9].

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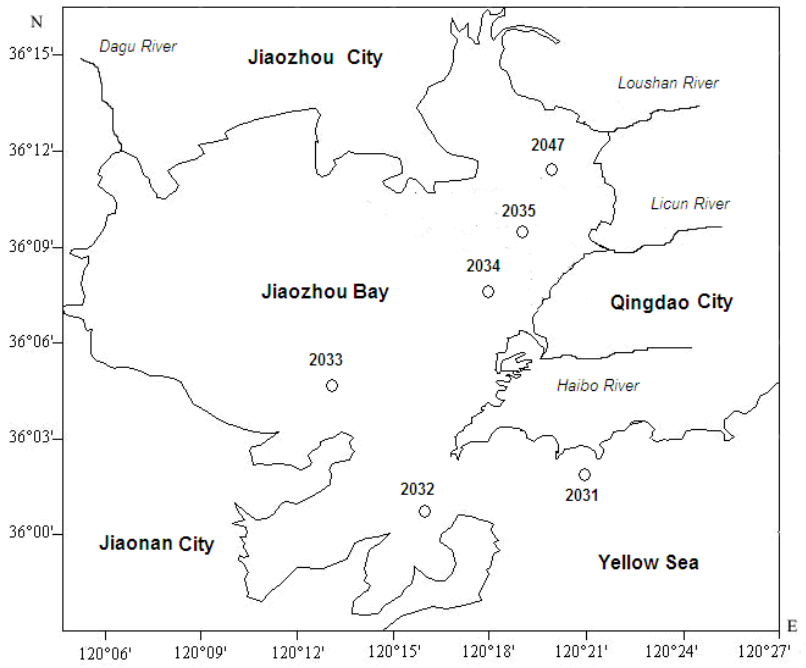

Fig.1 Investigation sites in Jiaozhou Bay

Results and discussion

Contents of Pb in surface waters. Pb contents in surface waters in July, August and October 1984 in Jiaozhou Bay were 0.72-36.00 μg L^{-1} (Table 1), and were meeting Grade I to Grade IV in National Sea Water Quality Standard (GB 3097-1997) (Table 2). In July, Pb contents were ranging from 9.34-36.00 μg L^{-1}, and were meeting Grade III to Grade IV (Table 1). Pb contents in the inside of the bay, the middle of the bay mouth and the outside of the bay were all higher than 9 μg L^{-1}, yet in the coastal region in the southwest of the bay were higher than 30 μg L^{-1}. It could be defined that a big part of Jiaozhou bay was moderate polluted by Pb in July, and the coastal region in the southwest was heavy polluted. In August, Pb contents were ranging from 5.65-8.92 μg L^{-1} (Table 1), and were meeting Grade III, indicated that Jiaozhou bay was moderate polluted by Pb in August. In October, Pb contents were ranging from 0.72-2.57 μg L^{-1} (Table 1), and contents in estuaries of the major river in the northeast of the bay were meeting Grade II, while in other regions were meeting Grade I, indicated that Jiaozhou bay was slightly polluted by Pb in October.

Table1 Pollution level of Pb in surface water in July, August and October 1984

Month	July	August	October
Content/μg L^{-1}	9.34-36.00	5.65-8.92	0.72-2.57
Water quality grade	III and IV	III	I and II

Table 2 Guideline of Pb in National Sea Water Quality Standard (GB 3097-1997)

Grade	I	II	III	IV
Content/μg L^{-1}	1.00	5.00	10.00	50.00

Horizontal distributions of Pb in surface waters. In July, there was a high value (36.00 μg L^{-1}) in Site 2033 and a high value region in the coastal waters in the southwest of the bay, and there were a series of semi-concentric circles, which were decreasing from the high value center to the bay mouth (10.00 μg L^{-1}), as well as the outside of the bay mouth (9.34 μg L^{-1}) (Fig. 2). In August, there was a high value (8.92 μg L^{-1}) in Site 2047 and a high value region in the estuary of Loushan River, and there were a series of semi-concentric circles, which were decreasing from the high value center to the estuary of Licun River (5.65 μg L^{-1}). In October, there was a high value (2.57 μg L^{-1}) in Site 2035 and a high value region in the estuary of Licun River in the northeast of the bay,

and there were a series of semi-concentric circles, which were decreasing from the high value center to the bay mouth in the south (0.08 μg L^{-1}) (Fig. 3). The distributions of Pb indicated that there were different sources.

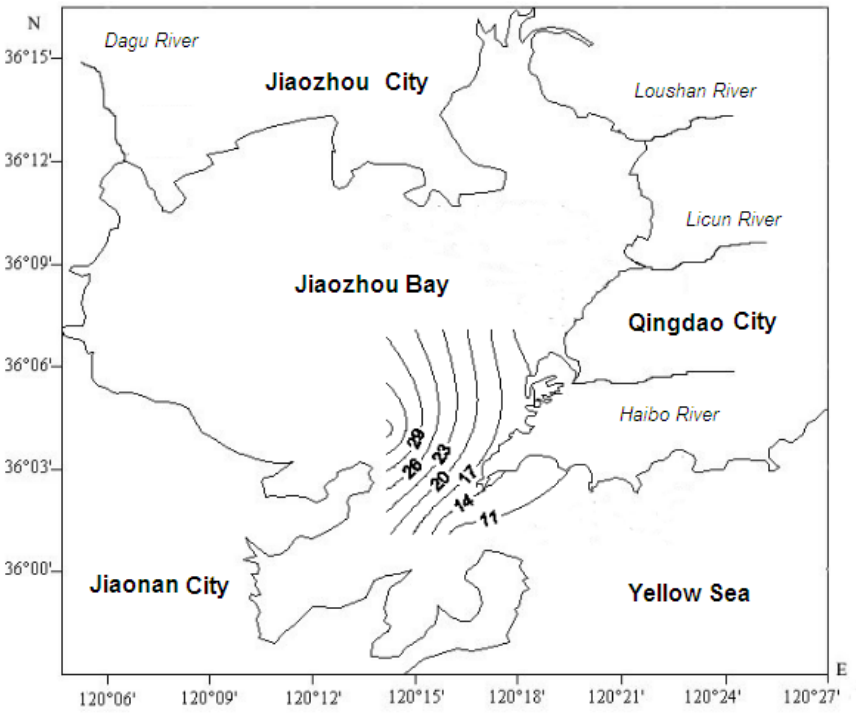

Fig. 2 Horizontal distributions of Pb in surface waters of Jiaozhou Bay in July 1984/μg L^{-1}

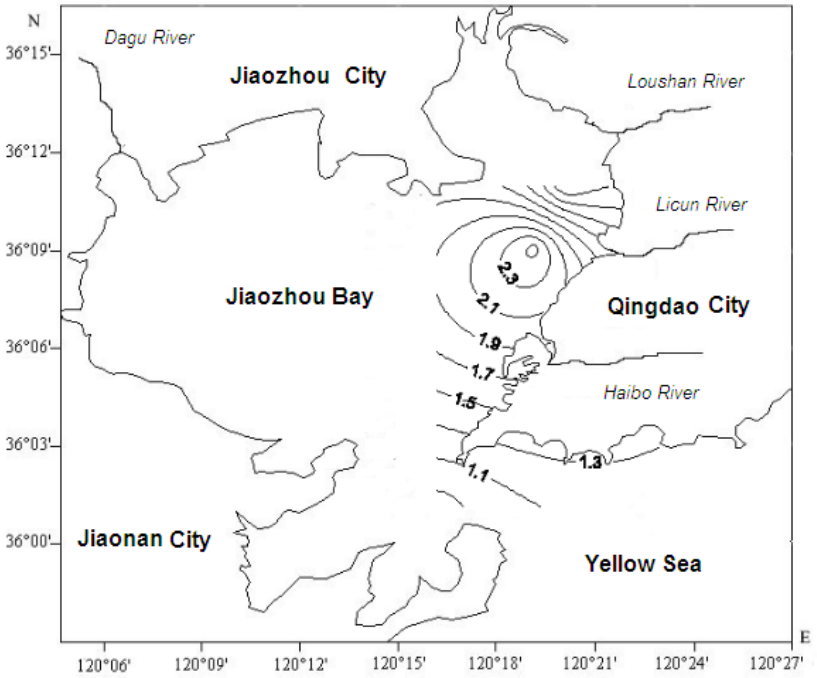

Fig. 3 Horizontal distributions of Pb in surface waters of Jiaozhou Bay in October 1984/μg L^{-1}

Sources of Pb. There were high value region in the cosatal regions in the southwest of the bay, indicated that the major source of Pb in July was overland runoff, whose source strength was 36.00 μg L^{-1}, which were meeting Grand III (Table 3). There were high value regions in the estuaries of Loushan River and Licun River in August and October, indicated river flow was the major Pb source in August and October. The source strengths Loushan River and Licun River were 8.92 μg L^{-1} and 2.57 μg L^{-1}, respectively (Table 3), and were meeting Grade III and II, respectively. In generally, river flow and overland runoff were the major sources of Pb. The Pb pollution level in

river flow was light and moderate polluted, while in ovrland runoff was heavy polluted. In order to reduce the contents and pollution levels of Pb in Jiaozhou Bay, the source-control/reduction of Pb from land-based sources in adjacent region was necessary.

Table 3 Source and source strengths of Pb in Jiaozhou Bay in 1984

Source	River flow	Overland runoff
Source strength/μg L^{-1}	2.57-8.92	36.00
Water quality grade	II and III	III

Conclusion

Pb contents in surface waters in July, August and October 1984 in Jiaozhou Bay were 0.72-36.00 mg L^{-1}, and were meeting Grade I to Grade IV. River flow and overland runoff were the major sources of Pb, whose source strengths were 2.57-8.92 μg L^{-1} and 36.00 μg L^{-1}, respectively. The Pb pollution level in river flow was light and moderate polluted, while in ovrland runoff was heavy polluted. In order to reduce the contents and pollution levels of Pb , the source-control/reduction of Pb from land-based sources in adjacent region was necessary.

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