

The most serious problem facing mankind on Pb pollution

Dongfang Yang^{1, 2, a}, Zhenqing Miao^{3, b, c}, Haixia Li¹, Xiaolong Zhang¹, Qi Wang¹

¹Accountancy School, Xijing University, Xian 710123, China;

²North China Sea Environmental Monitoring Center, SOA, Qingdao 266033, China;

³College of Fisheries, Zhejiang Ocean University, Zhoushan, 316022, China.

^adfyang_dfyang@126.com, ^bcorresponding author, ^cmzq@zjou.edu.cn.

Abstract. Pb pollution is one of the most critical environmental issues in the world. This paper analyzed the content, pollution level and pollution source of Pb in Jiaozhou Bay based on investigation data in surface waters in 1987. Results showed that Pb contents in surface waters in May, July and November 1987 were 1.95-7.96 $\mu\text{g L}^{-1}$, 5.02-61.61 $\mu\text{g L}^{-1}$ and 3.98-24.64 $\mu\text{g L}^{-1}$, respectively, and the pollution levels were moderate, heavy and relative heavy, respectively. The major Pb sources in this bay were river flow and marine current, whose source strengths could be as high as 61.61 $\mu\text{g L}^{-1}$ and 24.64 $\mu\text{g L}^{-1}$, respectively. The pollution level of Pb in Jiaozhou Bay was serious enough in 1987, and the pollution control and environmental remediation were necessary.

1. Introduction

Jiaozhou Bay is a semi-closed bay located in Shandong Province, China. This bay is surrounded by cities of Qingdao, Jiaozhou and Jiaonan, and has been polluted by various pollutants along with the rapid development of economic after China's reform and opening-up since ocean is the sink of various pollutants [1-6]. Therefore, understanding the pollution level and pollution source of Pb in marine bay is essential to environmental protection. Based on investigation data in surface waters in May, July and November 1987 in Jiaozhou Bay, the aim of this paper is to analyze the pollution level and pollution source of Pb, and to provide basic information for scientific research and pollution control.

2. Study area and data collection

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 km² and 7 m, respectively. The bay mouth is very narrow (3 km), and is connected to the Yellow Sea. There are a dozen of rivers including Dagu River, Haibo River, Licun River, and Loushan River etc., all of which are seasonal rivers [7-8]. The investigation on Pb 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].



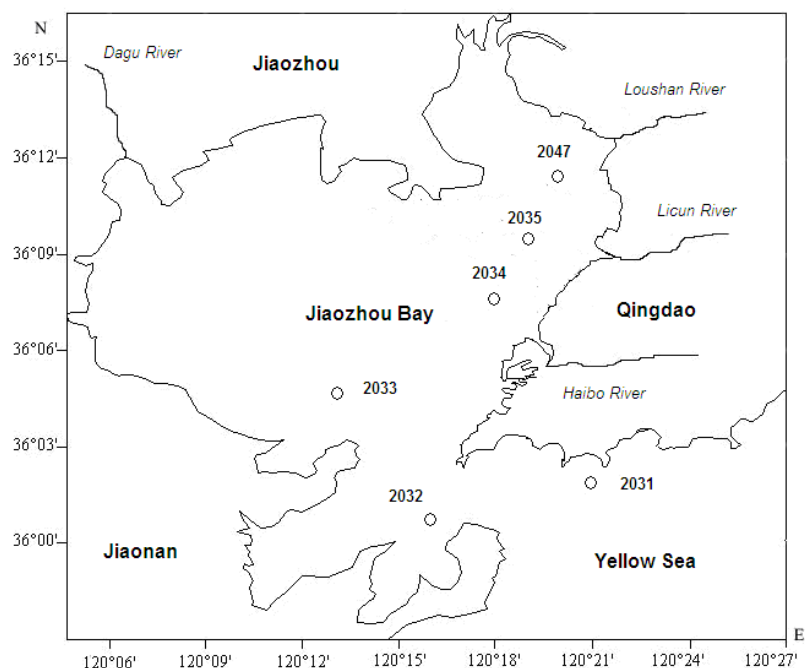


Fig.1 Geographic location and sampling sites of Jiaozhou Bay

3. Results

Content and pollution level of Pb. Pb contents in surface waters in Jiaozhou Bay in May, July and November 1987 were $1.95\text{--}7.96\ \mu\text{g L}^{-1}$, $5.02\text{--}61.61\ \mu\text{g L}^{-1}$ and $3.98\text{--}24.64\ \mu\text{g L}^{-1}$, respectively (Table 1), and were ranging from $1.95\text{--}61.61\ \mu\text{g L}^{-1}$ in the whole year. In according Sea Water Quality Standard (GB3097-1997) (Table 2), the pollution levels of Pb in May, July and November 1987 were moderate (Class II, III and IV), heavy (Class IV, Worse than IV) and relative heavy (Class II, III, IV), respectively (Table 2).

Table 1 Guidelines for Pb in Sea Water Quality Standard (GB3097-1997)

Class	I	II	III	IV
Pb content/ $\mu\text{g L}^{-1}$	1.0	5.0	10.0	50.0

Table 2 Water quality class of Pb in surface waters in May, July and November in Jiaozhou Bay 1987

	May	July	November
Pb content/	1.96-7.96	15.02-61.61	3.98-24.64
Class	II, III	IV, Worse than IV	II, III, IV

Horizontal distribution and source of Pb. In May 1987, high value ($7.96\ \mu\text{g L}^{-1}$) of Pb contents in surface waters was occurring in estuary of Licun River in the northeast of the bay, and Pb contents were decreasing from the high value to the bay mouth ($2.60\ \mu\text{g L}^{-1}$) and the open waters ($1.95\ \mu\text{g L}^{-1}$) (Fig. 2). In July 1987, high value ($61.61\ \mu\text{g L}^{-1}$) of Pb contents in surface waters was also occurring in estuary of Licun River in the northeast of the bay, and Pb contents were decreasing from the high value to the bay mouth ($20.02\ \mu\text{g L}^{-1}$) and the open waters ($15.02\ \mu\text{g L}^{-1}$) (Fig. 3). In November 1987, a high value ($15.95\ \mu\text{g L}^{-1}$) of Pb contents in surface waters was occurring in estuary of Loushan River in the northeast of the bay, and Pb contents were decreasing from the high value to the bay mouth ($9.08\ \mu\text{g L}^{-1}$) (Fig. 4). Another high value ($24.64\ \mu\text{g L}^{-1}$) of Pb contents in surface waters in November 1987 was occurring in the open water, and Pb contents were decreasing from the high value to the bay mouth ($3.98\ \mu\text{g L}^{-1}$) (Fig. 4).

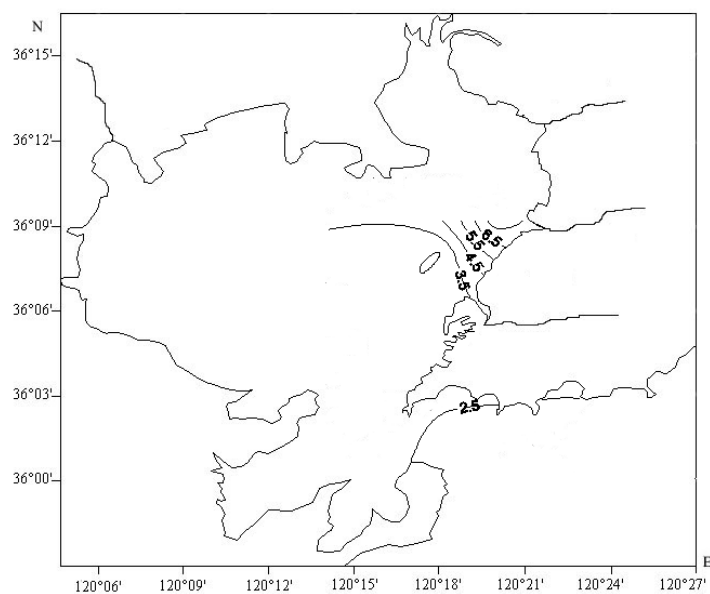


Fig. 2 Horizontal distribution of Pb contents in surface waters in Jiaozhou Bay in May 1987 / $\mu\text{g L}^{-1}$

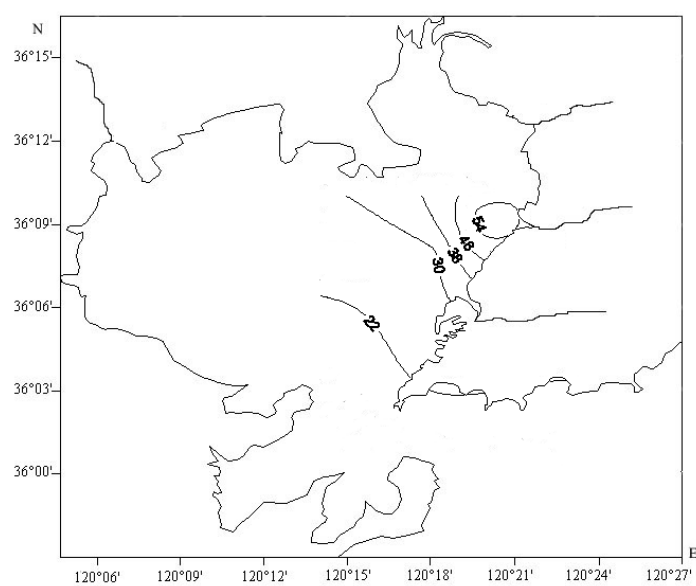


Fig. 3 Horizontal distribution of Pb contents in surface waters in Jiaozhou Bay in July 1987 / $\mu\text{g L}^{-1}$

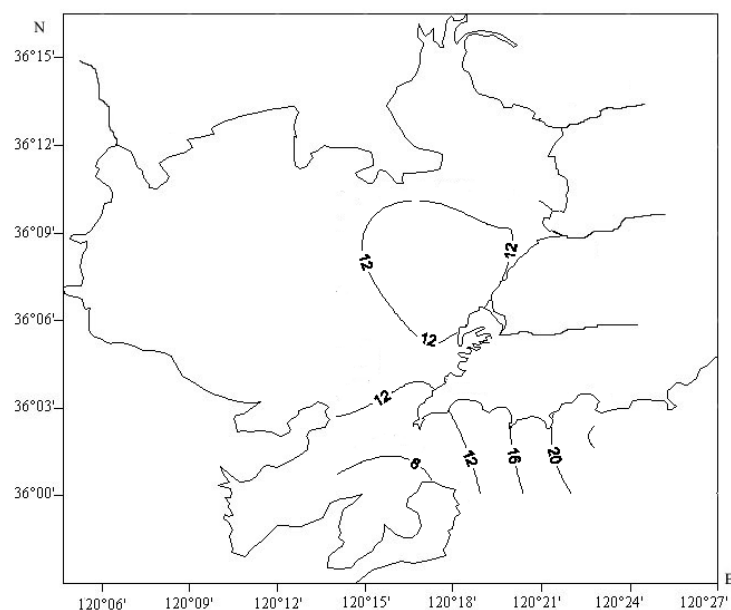


Fig. 4 Horizontal distribution of Pb contents in surface waters in Jiaozhou Bay in November 1987 / $\mu\text{g L}^{-1}$

4. Discussion

Pollution level of Pb. At temporal scale, it was found that the pollution levels of Pb in May, July and November 1987 were moderate, heavy and relative heavy, respectively (Table 1). However, the pollution levels of Pb were showing spatial variations. In May 1987, Pb contents in the estuaries of the major rivers in the northeast of the bay could be as high as $7.96 \mu\text{g L}^{-1}$ and were Class III to IV, while in other locations were Class II. In July 1987, Pb contents in the estuaries of the major rivers in the northeast of the bay could be as high as $61.61 \mu\text{g L}^{-1}$ and were worse than Class IV, while in other positions were all higher than $10 \mu\text{g L}^{-1}$ and were Class IV. In November 1987, Pb contents in the open waters could be as high as $24.64 \mu\text{g L}^{-1}$ and were Class IV, in the center of the bay were ranging from 1.0 – $5.0 \mu\text{g L}^{-1}$ and were Class III, while in the estuaries of the rivers in the northeast were as high as $15.95 \mu\text{g L}^{-1}$ and were Class IV. In generally, the pollution level of Pb in Jiaozhou Bay in 1987 was serious enough, and the seasonal and spatial variations of the pollution level should be taken into considered in scientific research and pollution control practice.

Pollution source of Pb. The source of Pb could be defined in according to the horizontal distribution of Pb contents in surface waters. In May 1987, Pb contents in surface waters were decreasing from the estuary of Licun River to the bay mouth and the open waters, indicated that river flow was the major source. In July 1987, Pb contents in surface waters were decreasing from the estuary of Licun River to the bay mouth and the open waters, indicated that river flow was the major source. In November 1987, Pb contents in surface waters was occurring in estuary of Loushan River in the northeast of the bay, and Pb contents were decreasing from the estuary of Loushan River and the open waters to the bay mouth, indicated that river flow and marine current the major sources (Fig. 3). For the whole year, the Pb sources were river flow and marine, whose source strengths could be as high as $61.61 \mu\text{g L}^{-1}$ and $24.64 \mu\text{g L}^{-1}$, respectively. In according Sea Water Quality Standard (GB3097-1997) (Table 2), the pollution level of Pb's in river flow and marine current could be worse than Class IV and Class IV, respectively. Obviously, the pollution level of Pb in surface waters in Jiaozhou Bay indicated that this bay had been heavy polluted in 1987 due to human activities. Furthermore, the pollution level of Pb in the marine current indicated that the background level of Pb in the ocean had been serious enough since 1987. It was necessary to make efforts to control the pollution sources.

5. Conclusions

Pb contents in surface waters in Jiaozhou Bay in May, July and November 1987 were $1.95\text{--}7.96\ \mu\text{g L}^{-1}$, $5.02\text{--}61.61\ \mu\text{g L}^{-1}$ and $3.98\text{--}24.64\ \mu\text{g L}^{-1}$, respectively, and the pollution levels were moderate (Class II, III and IV), heavy (Class IV, Worse than IV) and relative heavy (Class II, III, IV), respectively. The pollution level of Pb in Jiaozhou Bay in 1987 was serious enough, and the seasonal and spatial variations of the pollution level were significant. It was necessary to make efforts to control the pollution sources.

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