

## Seasonal variations of Pb in bottom waters in Jiaozhou Bay during 1979-1983

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**Abstract.** Based on investigation data on Pb in bottom waters in Jiaozhou Bay in different months during 1979-1983, we analyzed the seasonal variations of Pb contents and pollution levels. Results showed that the pollution levels during 1979-1983 were light/moderate, and the pollution levels in the bay mouth were seem to be higher than in the other regions. Since stream flow and atmosphere deposition were two of the major sources of Pb in Jiaozhou Bay, whose source strengths of stream flow and atmosphere deposition were highest in August, the pollution levels of Pb in summer were higher than the other seasons. By means of vertical water's effect, the low values in bottom waters were relative stable, and the variations were relative small, and therefore the different of the high values of each month was higher than the different of the low values of each month.

### Introduction

Lead (Pb) is one of the widely used heavy metals in industry and agriculture. However, Pb is high toxic, and the excess Pb in the environment has been a world wide environmental issues since the rapid development of industry and agriculture. Marine bay could be polluted by Pb by various processes such as stream flow and atmosphere deposition, and the ocean could be the sink of Pb and the other pollutants. Hence, understanding the variations of Pb in bottom waters in marine bay is essential to environmental protection.

Jiaozhou Bay is located in Shandong Province, China, and is surrounded by economic and agricultural developed regions of Qingdao, Jiaozhou and Jiaonan. Previous studies showed that this bay had been polluted by various pollutants including Pb [1-6]. This aim of this paper is to analyze the seasonal variations of Pb contents in bottom waters during 1979-1983 in this bay, and to provide scientific basis for pollution control.

### Study area and data collection

Jiaozhou Bay (35°55'-36°18' N, 120°04'-120°23' E) is located in the south of Shandong Province, eastern China (Fig. 1). It is a semi-closed bay with the total area and average water depth are 446 km<sup>2</sup> and 7 m, respectively. The bay mouth is located between Tuandao Island and Xuejiadao Island, and is connect to Yellow Sea in the south. The width of the bay mouth is only 3 km. Most of the rivers have seasonal features [7, 8].

The data was provided by North China Sea Environmental Monitoring Center. Pb contents in bottom waters were investigated in May, August and October 1979, June, July, September and October 1980, April, August and November 1981, April, June, July and October 1982, and May, September and October 1983, respectively [1-6]. Bottom water samples were collected and measured followed by National Specification for Marine Monitoring [9].

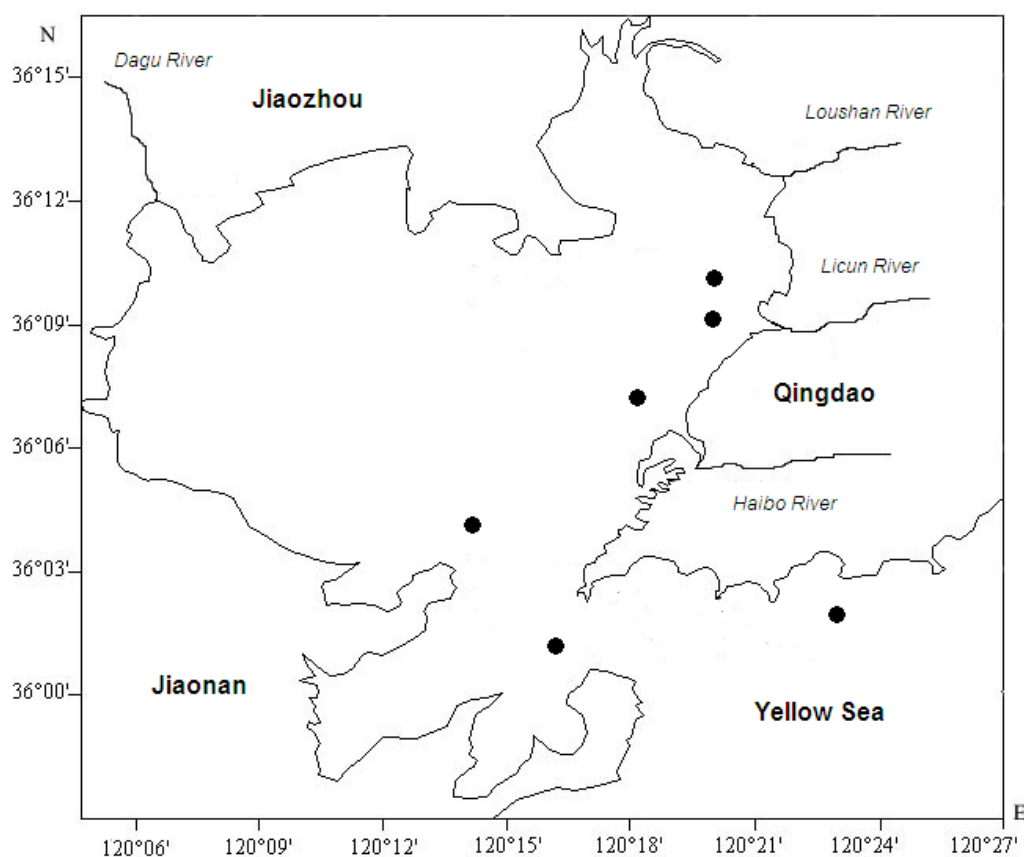


Fig.1 Geographic location and monitoring sites in Jiaozhou Bay

## Results and discussion

**Pollution levels of Pb.** Pb contents in bottom waters in different months during 1979-1983 Jiaozhou Bay were listed in Table 1. The pollution levels of Pb in bottom waters in Jiaozhou Bay were assessed in according to Chinese Sea Water Quality Standard (GB 3097-1997). In 1979, Pb contents in all of the sampling sites in May and October were Grade I. However, in August 1979, Pb contents in the bay mouth were as high as  $7.00 \mu\text{g L}^{-1}$  and were meeting Grade III, and in other positions were Grade I/II. It could be found that the pollution levels of Pb in May and October 1979 were light, yet in the bay mouth in August were moderate. In July and September 1980, Pb contents in all of the sampling sites were Grade I. However, in June and October 1980, Pb contents in the south of the bay mouth were Grade II, yet in other positions were Grade I. In generally, the pollution levels in 1980 were light. In August 1981, Pb contents in the bay mouth were as high as  $5.16 \mu\text{g L}^{-1}$ , and were meeting Grade III, while in the other sampling sites in different months were meeting Grade I/II. Hence, it could be conclude that the pollution levels in the Bay mouth in August 1981 were moderate, and in the other cases were light. In July and October 1982, Pb contents in all of the sampling sites were meeting Grade I, while in April and June were meeting Grade I/II, indicated that the pollution levels of Pb in 1982 were light. In different months in 1983, the Pb contents were meeting grade Grade I/II, indicated that the pollution levels of Pb in 1983 were also light. In generally, the pollution levels during 1979-1983 were light/moderate, and the pollution levels in the bay mouth were seem to be higher than in the other regions.

**Seasonal variations of Pb.** Pb contents in bottom waters in different months were ranging from  $0.01\text{-}7.00 \mu\text{g L}^{-1}$ , and the high and low values of each month were ranging from  $0.55\text{-}7.00 \mu\text{g L}^{-1}$ , and  $0.01\text{-}1.26 \mu\text{g L}^{-1}$ , respectively. The different of the high values of each month was  $7.00\text{-}0.55=6.45 \mu\text{g L}^{-1}$ , and for low values was  $1.26\text{-}0.01=1.25 \mu\text{g L}^{-1}$ . It could be found that the different of the high values of each month was higher than the different of the low values of each month. The reason was that by means of vertical water's effect [10], the low values in bottom waters were relative stable, and the variations were relative small. It was found that the low value of

Pb contents in August was higher than  $1.00 \mu\text{g L}^{-1}$ , while in other months was lower than  $1.00 \mu\text{g L}^{-1}$ . Hence, it could be concluded that the pollution levels in most of the months could be reduced from light pollution to no pollution, except in August. In study area, April, May and June belong to spring; July, August and September belong to summer; October, November and December belong to autumn. During 1979-1983, Pb contents in spring, summer and autumn were ranging from  $0.01\text{-}2.41 \mu\text{g L}^{-1}$ ,  $0.24\text{-}7.00 \mu\text{g L}^{-1}$  and  $0.13\text{-}2.40 \mu\text{g L}^{-1}$ , respectively. Obviously, the pollution levels of Pb in summer were higher than the other seasons. The reason was that stream flow and atmosphere deposition were two of the major sources of Pb in Jiaozhou Bay, and the source strengths of stream flow and atmosphere deposition were highest in August.

Table 1 Pb contents in bottom waters during 1979-1983 Jiaozhou Bay/ $\mu\text{g L}^{-1}$ .

Year	1979	1980	1981	1982	1983	Overall
April			0.01-2.41	0.52-1.03		0.01-2.41
May	0.45-0.72				0.95-1.15	0.45-1.15
June		0.12-1.49		1.08		0.12-1.49
July		0.24-0.85		0.30-1.00		0.24-1.00
August	0.45-7.00		1.26-5.16			0.45-7.00
September		0.26-0.75			1.06-1.56	0.26-1.56
October	0.46-0.55	0.07-1.60		0.13-1.00	0.46-2.40	0.07-2.40
November			0.93-1.95			0.93-1.95

## Conclusions

The pollution levels during 1979-1983 were light/moderate, and the pollution levels in the bay mouth were seem to be higher than in the other regions. The pollution levels of Pb in summer were higher than the other seasons. The reason was that stream flow and atmosphere deposition were two of the major sources of Pb in Jiaozhou Bay, and the source strengths of stream flow and atmosphere deposition were highest in August. By means of vertical water's effect, the low values in bottom waters were relative stable, and the variations were relative small, and therefore the different of the high values of each month was higher than the different of the low values of each month.

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