Seasonal variations of Pb contents and pollution levels in Jiaozhou Bay in the early stage of reform and opening-up

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Abstract. This paper analyzed the contents, pollution levels and their seasonal variations of Pb in the early stage of the reform and opening-up in Jiaozhou Bay, China. Results showed that Pb contents in surface waters in spring, summer and autumn in 1979 were 0.37−0.99 μg L^{-1}, 0.25−1.52 μg L^{-1} and 0.29−0.75 μg L^{-1}, in 1980 were 0.26−0.88 μg L^{-1}, 0.16−2.71 μg L^{-1} and 0.07−1.59 μg L^{-1}, in 1981 were 0.20−2.65 μg L^{-1}, 0.79−3.34 μg L^{-1} and 0.00−3.30 μg L^{-1}, in 1982 were 0.45−3.35 μg L^{-1}, 0.30−2.67 μg L^{-1} and 0.33−0.67 μg L^{-1}, and in 1983 were 0.75−1.67 μg L^{-1}, 0.58−2.33 μg L^{-1} and 0.59−2.34 μg L^{-1}, respectively. In generally, the maximum values were showing significant seasonal variations that were increasing from spring to summer, and were decreasing from summer to autumn in all of the study years. The pollution levels of Pb in surface waters in Jiaozhou Bay were all Grade I or II, and were worse in summer, best in spring and moderate in autumn. This bay had been slightly of moderated polluted by Pb, and the water quality of Pb in spring and autumn were deteriorating in in 1979 to 1983.

Introduction

Along with the rapid development of industry, population, industrialization and urbanization, the environmental pollution has been a world wide issue. Pb is one of the most critical heavy metals due to the high toxicity and persistence in the environment. Since the since the reform and opening-up, a large amount of Pb−containing waste water, gas and residue were generated and discharged to the environment by industrial and agricultural activities, automobile exhaust, coal electricity plant etc. However, the waste treatment and environmental protection were always far lagging behind the emission of various pollutants. Hence, the air, water and soil were polluted, as well as marine bay since marine is the sink of the pollutants [1−6].

The pollution in the ocean could be harmful to the health of ecologic system and human beings, and the understanding the contents, pollution levels and their seasonal variations in marine environment is essential to marine environmental protection. This aim of this paper is to analyze the contents, pollution levels and their seasonal variations of Pb in the early stage of the reform and opening−up in Jiaozhou Bay, in Shandong Province, China, and to provide basic information to both scientific research and pollution control protection in this bay.

Material and method

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, average water depth and bay mouth width of 446 km^2, 7 m and 3 km, respectively, and is surrounded by Qingdao City, Jiaozhou City and Jiaonan City in the east, north and west, respectively. The bay mouth is located between Tuandao Island and Xuejiadao Island, and is connect to Yellow Sea in the south. There are

more than ten inflow rivers (e.g., Haibo Rriver, Licun Rriver, Dagu Rriver, and Loushan Rriver), most of which have seasonal features [7, 9].

The data was provided by North China Sea Environmental Monitoring Center. The investigations of Pb contents in surface waters were conducted 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]. Surface water samples were collected and measured followed by National Specification for Marine Monitoring [9]. In study area, April, May and June belong to spring; July, August and September belong to summer; October, November and December belong to autumn.

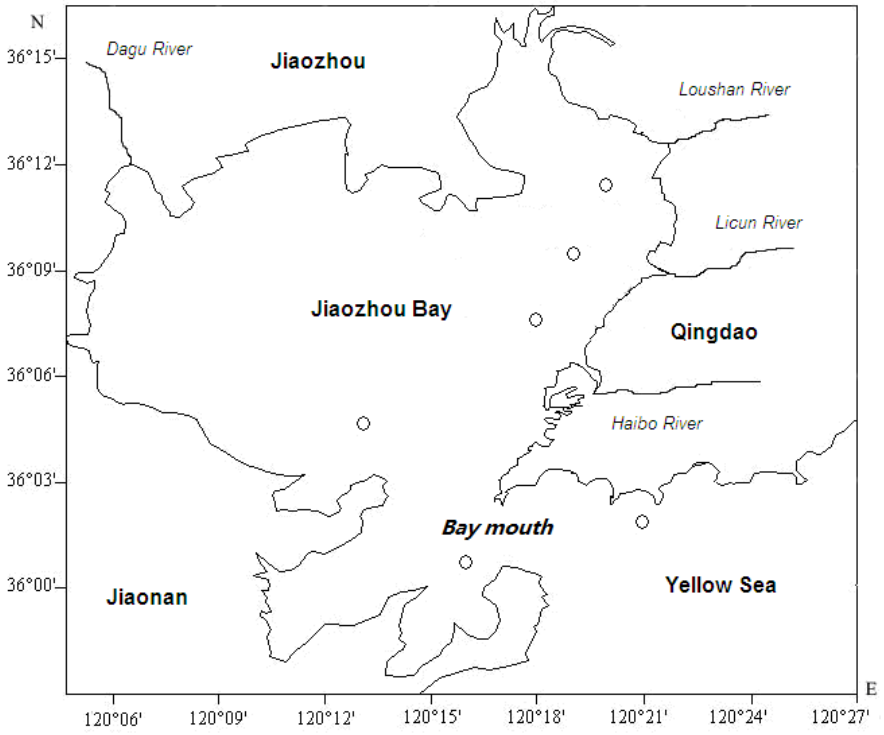

Fig. 1 Geographic location and sampling sites in Jiaozhou Bay

Seasonal variation of Pb contents

Pb contents in surface waters in Jiaozhou Bay in spring, summer and autumn in 1979 to 1983 were listed in Fig. 2. Pb contents in surface waters in Jiaozhou Bay in spring, summer and autumn in 1979 were 0.37−0.99 μg L^{-1}, 0.25−1.52 μg L^{-1} and 0.29−0.75 μg L^{-1}, respectively; in 1980 were 0.26−0.88 μg L^{-1}, 0.16−2.71 μg L^{-1} and 0.07−1.59 μg L^{-1}, respectively; in 1981 were 0.20−2.65 μg L^{-1}, 0.79−3.34 μg L^{-1} and 0.00−3.30 μg L^{-1}, respectively; in 1982 were 0.45−3.35 μg L^{-1}, 0.30−2.67 μg L^{-1} and 0.33−0.67 μg L^{-1}, respectively; in 1983 were 0.75−1.67 μg L^{-1}, 0.58−2.33 μg L^{-1} and 0.59−2.34 μg L^{-1}, respectively (Fig. 2). During 1979 to 1983, the minimum values of Pb contents were showing little seasonal variations, yet the maximum values were showing significant seasonal variations that were increasing from spring to summer except in 1982, and were decreasing from summer to autumn in all of the study years (Fig. 2). The sources of Pb to Jiaozhou Bay were stream flow discharge, atmosphere dry/wet deposition etc., and were strongly dependent of rainfall−runoff. The wet season in study area was beginning in spring, reaching the climax in summer, and decreasing in autumn. Hence, Pb contents in summer were higher than in spring, and were decreasing from summer to autumn due to the decreasing of stream flow and atmosphere deposition.

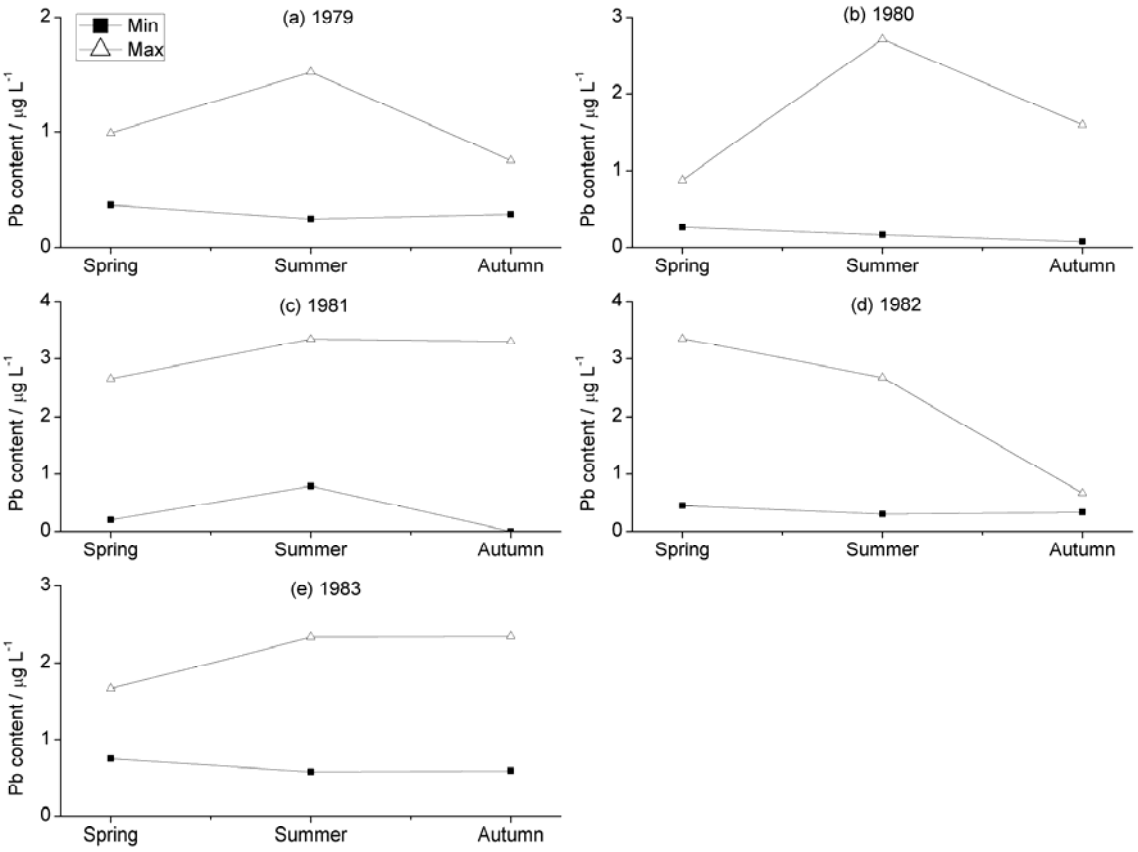

Fig. 2 Seasonal variation of Pb contents in surface waters in Jiaozhou Bay during 1979−1983

Seasonal variation of the pollution levels of Pb

In according to National Sea Water Quality Standard (GB 3097−1997) for Pb (Table 1), the pollution levels of Pb in different seasons in surface waters in Jiaozhou Bay during 1979 to 1983 were listed in Table 2. It could be seen that for individual years, the pollution levels of Pb in surface waters in Jiaozhou Bay were all Grade I or II, indicated that this bay had been slightly of moderated polluted by Pb in 1979 to 1983. For spring, Pb contents were Grand I in 1979 and 1980, yet were increasing to Grade I−II in 1981 to 1983. For summer, Pb contents were Grade I−II in 1979 to 1983. For autumn, Pb contents were Grand I in 1979, 1980 and 1982, yet were Grade I−II in 1981 and 1984. In generally, the pollution levels of Pb were worse in summer, best in spring and moderate in autumn. In consideration that the rainfall-runoff was still lack in spring, in when point source was the major pollution source. Obviously, in spring and autumn, water quality of Pb were deteriorating from 1979 to 1983, indicating that point source of Pb in study area was increasing from 1979 to 1983. Hence, the control of Pb pollution from both point and non-point sources were necessary.

Table 1 Guideline of Pb contents in National Sea Water Quality Standard (GB 3097−1997)

Grade	I	II	III	IV
Guideline/μg L^{-1}	1.0	2.0	5.0	50.0

Table 2 Water quality Grades of Pb in surface waters in Jiaozhou Bay during 1979−1983

Year	Spring	Summer	Autumn
1979	I	I−II	I
1980	I	I−II	I
1981	I−II	I−II	I−II
1982	I−II	I−II	I
1983	I−II	I−II	I−II

Conclusion

During 1979 to 1983, the minimum values of Pb contents were showing little seasonal variations, yet the maximum values were showing significant seasonal variations that were increasing from spring to summer except in 1982, and were decreasing from summer to autumn in all of the study years. The pollution levels of Pb in surface waters in Jiaozhou Bay were all Grade I or II. This bay had been slightly of moderated polluted by Pb in 1979 to 1983, and the water quality of Pb in spring and autumn were deteriorating from 1979 to 1983. The pollution levels of Pb were worse in summer, best in spring and moderate in autumn.

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