The land-ocean transfer process of Pb

Dongfang Yang[1, 4, a], Yinjiang Zhang[1, b,c], Xiancheng Qu[1], Danfeng Yang[2] and Yu Chen [3]

[1]China College of Life Science, Shanghai Ocean University, Shanghai, 201306, China

[2] College of Information Science and Engineering, Fudan University, Shanghai, 200433, China

[3] College of Information, Shanghai Ocean University, Shanghai, 201306, China

[4]North China Sea Environmental Monitoring Center, SOA, Qingdao 266033, China.

[a]dfyang_dfyang@126.com; [b]Corresponding author; [c]yjzhang@shou.edu.cn.

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Abstract. This paper analyzed the seasonal variations and land-ocean transfer process of Pb in Jiaozhou Bay based on investigation data in surface waters in different seasons during 1979-1983. Results showed that during 1979-1983, both stream flow and marine current were the major Pb sources in Jiaozhou Bay. However, the inputs of Pb from atmosphere deposition and the top of the island were not beginning until 1981, and the inputs of Pb from marine traffic was not beginning until 1983.The seasonal variations of Pb contents in this bay were mainly determined by the inputs of Pb by anthropogenic activities, particularly the variations of the sources strengths. The land-ocean transfer of Pb could be expressed by a block diagram model, which indicated that Pb contents in the marine bay were mainly determined by the strength and frequency of Pb inputs from anthropogenic activities, and meanwhile, Pb was moving from high content areas to low content areas in the ocean interior.

Introduction

The Pb pollution has been one of the critical environmental issues on a worldwide scale due to the large amount of the use of Pb in industries along with the rapid development of economic and population. For instance, the annual output of Pb was 3.1×10^6 ton in 1971. Hence the excessive Pb in the environment in the continent was transported to the ocean by stream flow, atmosphere deposition, etc. Understanding the land-ocean transfer process was essential to marine environmental protection[1-6].

Jiaozhou Bay is a semi-closed bay located in south of Shandong Peninsula, eastern Chin. The aim of this paper was to analyze the seasonal variations and land-ocean transfer process of Pb in Jiaozhou Bay based on investigation data in surface waters in different seasons during 1979-1983, and to provide scientific basis for the research on the source, pollution level and transfer process, and for the sustainable development of study area.

Material and method

Jiaozhou Bay (120°04′-120°23′ E, 35°55′-36°18′ N) 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. There are more than ten inflow rivers such as Haibo Rriver, Licun Rriver, Dagu Rriver, and Loushan Rriver etc., most of which have seasonal features [7-8].

The data was provided by North China Sea Environmental Monitoring Center. The survey was conducted in May, August and October 1979; June, July, September and October 1980; April, August and November 1981; April, July and October 1982; and May, September and October 1983 [1-6]. Surface water samples in six stations (i.e. 2031, 2032, 2033, 2034, 2035 and 2047) were collected and measured followed by National Specification for Marine Monitoring [9].

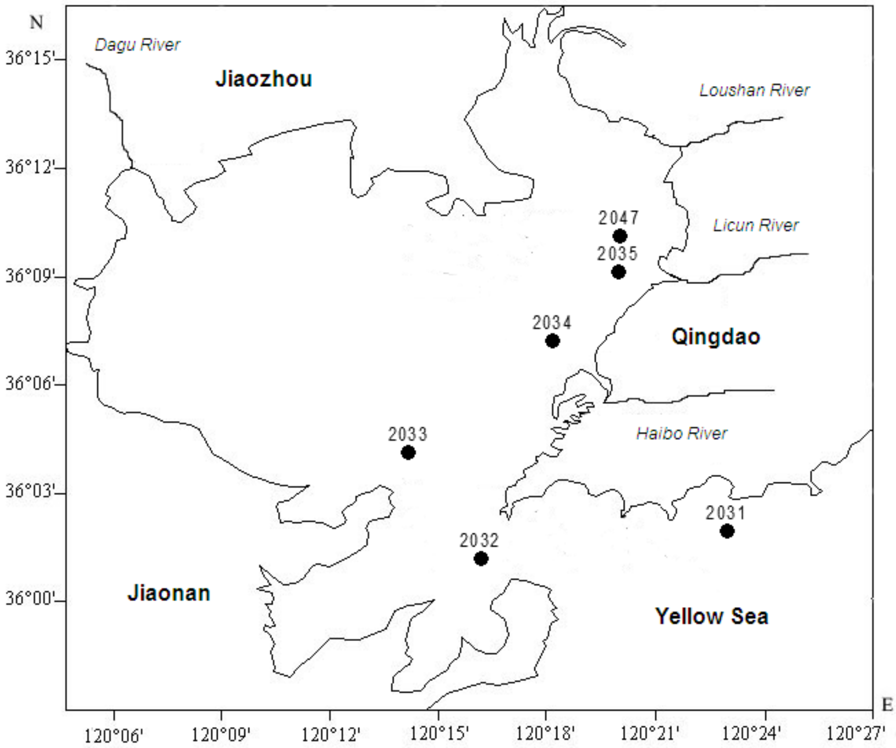

Fig.1 Geographic location and monitoring sites in Jiaozhou Bay

Results

For seasonal division in study area, April, May and June were spring; July, August and September were summer; and October, November and December were autumn. Pb contents in different seasons during 1979-1983 were listed in Table 1.

In May, August and October 1979, Pb contents in surface waters were 0.37- 0.99 μg L^{-1}, 0.25-1.52 μg L^{-1} and 0.29-0.75 μg L^{-1}, respectively, indicated that Pb contents in surface waters in 1979 were in order of summer > spring > autumn (Table 1). In June, July, September and October 1980, Pb contents in surface waters were 0.26-0.88 μg L^{-1}, 0.16-2.71 μg L^{-1}, 0.20-1.59 μg L^{-1} and 0.07-0.89 μg L^{-1}, respectively, indicated that Pb contents in surface waters in 1980 were in order of summer > spring > autumn (Table 1). In April, August and November 1981, Pb contents in surface waters were 0.20-2.65 μg L^{-1}, 0.79-3.34 μg L^{-1} and 0.00-3.30 μg L^{-1}, respectively, indicated that Pb contents in surface waters in 1981 were in order of summer > spring > autumn (Table 1). In April, July and October 1982, Pb contents in surface waters were 0.49-3.25 μg L^{-1}, 0.30-2.67 μg L^{-1} and 0.33-0.67 μg L^{-1}, respectively, indicated that Pb contents in surface waters in 1982 were in order of spring > summer > autumn (Table 1). In May, September and October 1983, Pb contents in surface waters were 0.75-1.47 μg L^{-1}, 0.67-2.33 μg L^{-1} and 1.00-2.22 μg L^{-1}, respectively, indicated that Pb contents in surface waters in 1982 were in order of summer > autumn > spring (Table 1).

Table 1 Pb contents in different seasons during 1979-1983/μg L^{-1}

Year	Spring	Summer	Autumn
1979	0.37- 0.99	0.25-1.52	0.29-0.75
1980	0.26-0.88	0.16-2.71	0.07-0.89
1981	0.20-2.65	0.79-3.34	0.00-3.30
1982	0.49-3.25	0.30-2.67	0.33-0.67
1983	0.75-1.47	0.67-2.33	1.00-2.22

Discussions

During 1979-1983, there were five major sources of Pb in Jiaozhou Bay, i.e., stream flow, atmosphere deposition, marine current, the top of the island and marine traffic. In generally, the seasonal variations of Pb contents in this bay were mainly determined by the inputs of Pb by anthropogenic activities, particularly the variations of the sources strengths. During 1979-1983, both stream flow and marine current were the major Pb sources in Jiaozhou Bay. However, the inputs of Pb from atmosphere deposition and the top of the island were not beginning until 1981, and the inputs of Pb from marine traffic was not beginning until 1983.

The utility of Pb by human activities could product Pb pollution to the environment including soil, water and atmosphere, and the excessive Pb in the continent could be transported to the marine environment since ocean was the sink of various pollutants. Once Pb was input to the ocean, Pb was delivered from high contents areas to low content areas by means of marine current. In generally, the land-ocean transfer of Pb could be expressed by a block diagram model (Fig. 2). It could be seen from the block diagram model that Pb contents in the marine bay were mainly determined by the strength and frequency of Pb inputs from anthropogenic activities, and meanwhile, Pb was moving from high content areas to low content areas in the ocean interior.

This block diagram model was based on the ocean had the characteristic of homogeneity[10], that was the substances in the ocean were continually stirred and transported by tide and current, leading to the homogeneity of the substances. The tide was playing the dominant role in coastal waters, while in the deep sea the main role was marine current, as well as storm tide and submarine earthquake.

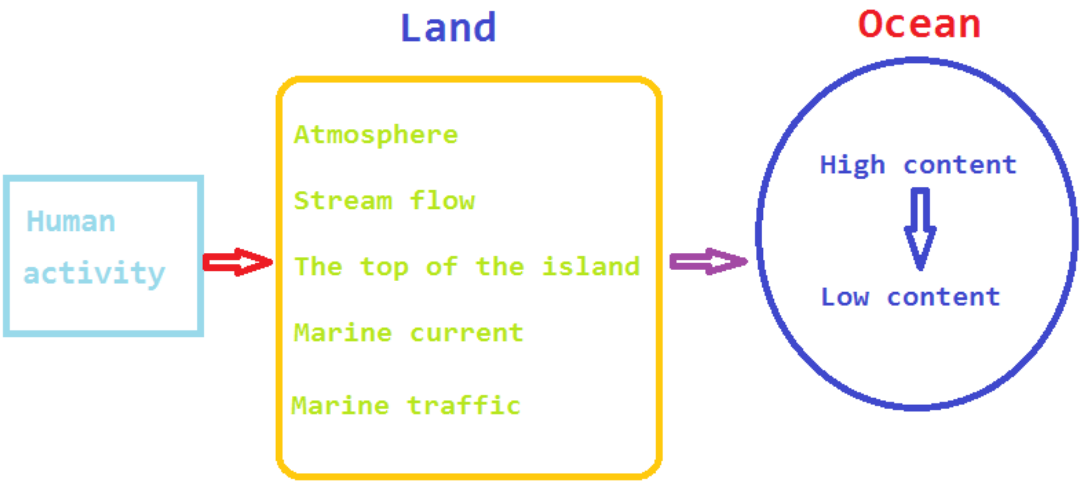

Fig.2 The block diagram model of the land-ocean transfer process of Pb

Conclusions

During 1979-1983, the five major sources of Pb in Jiaozhou Bay were stream flow, atmosphere deposition, marine current, the top of the island and marine traffic. During 1979-1983, both stream flow and marine current were the major Pb sources in Jiaozhou Bay. However, the inputs of Pb from atmosphere deposition and the top of the island were not beginning until 1981, and the inputs of Pb from marine traffic was not beginning until 1983.

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