Impacts from human activities and natural background to Zn contents in Jiaozhou Bay

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Abstract. Based on the analysis on the content and spatio-temporal distribution of Zn in surface waters in Jiaozhou Bay in 1983, this paper assessed the pollution level, pollution source and source strength of Zn, and to assess the impacts from human activities and sea water pollutant background in the early stage of the Chinese reform and opening up. Results showed that Zn contents in surface waters in Jiaozhou Bay in May, September and October 1983 were 1.96-117.50 μg L^{-1}, 7.14-42.50 μg L^{-1} and 2.36-14.00 μg L^{-1}, respectively. This bay was heavy polluted by Zn in May, yet in September and October was slightly polluted by Zn. The major sources of Zn in Jiaozhou Bay were marine current, overland runoff, stream flow, marine trafic and small peninsula, whose source strengths were 117.50 μg L^{-1}, 84.62 μg L^{-1}, 13.08-78.84 μg L^{-1}, 42.50 μg L^{-1} and 14.00 μg L^{-1}, and the impacts from human activities were still lower than sea water pollutant background in 1983.

Introduction

A large amount of Zn-containing waste gas, waste water and waste residues generated along with the rapid development of urbanization and industrialization. The marine was polluted as a result and was harmful to human being finally. Zn in the marine bay could be sourced from marine current, overland runoff, marine trafic etc. Marine current was natural source, while the other sources were anthropogenic sources. It is meaningfrul to assess the impacts from human activities and sea water pollutant background in the early stage of the Chinese reform and opening up. Understanding the distributions and pollution sources of Zn are essential and meaningful to assess the pollution level and environmental impact, as well as pollution control [1-2]. Jiaozhou Bay is a semi-closed bay in eastern China. Based on the investigation data on Zn in surface waters in Jiaozhou Bay in different seasons in 1983, the aim of this paper was to analysis the content and spatio-temporal distribution of Zn, to identify the pollution level, pollution source and source strength of Zn, and to to assess the impacts from human activities and natural background in the early stage of Chinese reform and opening up.

Materials and method

Jiaozhou Bay (35°55′-36°18′ N, 120°04′-120°23′ E) is located in the south of Shandong Peninsula, eastern China. The area, bay mouth width and average water depth are 390 km^2, 2.5 km and 7 m, respectively (Fig. 1). This bay is surrounding by cities of Qingdao, Jiaozhou and Jiaonan, respectively. There are more than ten inflow rivers, most of which are seasonal rivers [3-4]. The investigation on in Jiaozhou Bay waters was conducted by North China Sea Environmental Monitoring Center in May, September and October 1983 (Fig. 1). Zn contents in surface waters in nine sampling sites were collected and measured in according to National Specification for Marine Monitoring [5].

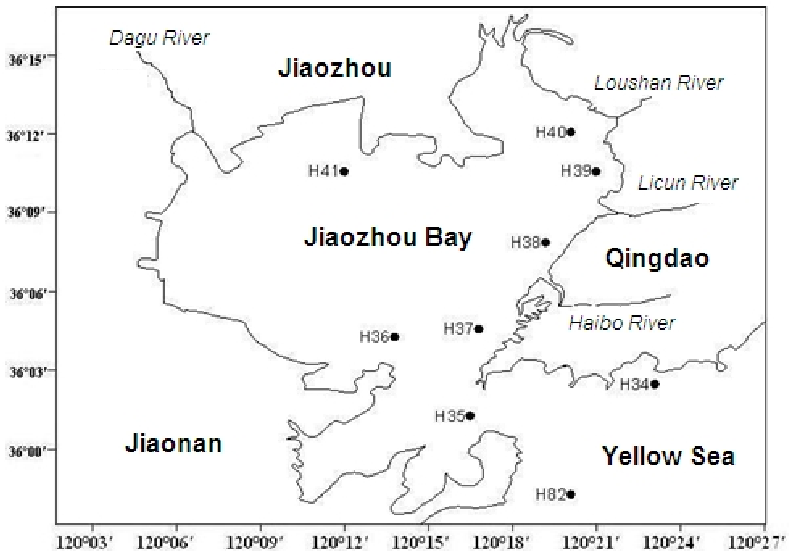

Fig.1 Geography location and sampling sites of Jiaozhou Bay

Results and discussion

Contents and pollution levels of Zn. Zn contents in surface waters in Jiaozhou Bay in May, September and October 1983 were 1.96-117.50 μg L^{-1}, 7.14-42.50 μg L^{-1} and 2.36-14.00 μg L^{-1}, respectively, and were 1.96-117.50 μg L^{-1} in the whole year. In according to National Standard of China for Seawater Quality (GB3097-1997), the water qualities in May, September and October were Class I- IV, Class I- II and Class I, respectively.The highest value of Zn contents in May were higher than 100 μg L^{-1} and the water quality was catagorized as Class IV, indicated that this bay was heavy polluted by Zn in May. However, Zn contents in September and October were very low and this bay was slightly polluted.

Table 1 Guide line of Zn in National Standard of China for Seawater Quality (GB3097-1997

Class	I	II	III	IV
Guide line	20.00	50.00	100.00	500.00

Table 2 Pollution level of Zn in May, September and October in Jiaozhou bay

Time	May	September	October
Content/μg L^{-1}	1.96-117.50	7.14-42.50	2.36-14.00
Class	I, II, III, IV	I, II	I

Spatial distributions of Zn. In May, a high value region was formed around Site H34 (117.50 μg L^{-1}) with a series of different gradient parallel lines (Fig. 2). It was clear that Zn contents were decreasing from the open waters to the center of the bay (3.06 μg L^{-1}) along with the flow direction of the marine current (Fig. 2). The was also a high value region around Site H34 in coastal waters in the north of the bay (84.62 μg L^{-1}), and were also a series of different gradient parallel lines (Fig. 2). Zn contents were decreasing from the north of the bay to the bay mouth in the south (3.06 μg L^{-1}). A high value region was formed around Site H40 (78.84 μg L^{-1}) in the estuaries of the major rivers in the northeast of the bay (Fig. 2), as well as a serious of different gradient parallel lines. Zn contents were decreasing from the estuaries to the bay mouth (3.06 μg L^{-1}) along with the direction of the stream flow. In September, a high value region was formed around Site H37 (42.50 μg L^{-1}) in the coastal waters in the east of the bay with a series of semi-concentric circles (Fig. 3). It was clear that Zn contents were decreasing from the east of the bay to the bay mouth (15.63 μg L^{-1}). However, there was a low value regions (7.14-7.21 μg L^{-1}) around Site H38 and H39 in the estuaries of the major rivers in the northeast of the bay (Fig. 3). In October, a high value region (14.00 μg L^{-1}) was formed around Site H35 in the bay mouth, and there were a serios of semi-concentric circles which were decreasing from the bay mouth to the center of the bay (2.36 μg L^{-1}). Another high value regions (13.08-13.82 μg L^{-1}) around Site H38 and H39 in the estuaries of the major rivers in the northeast of the bay (Fig. 4).

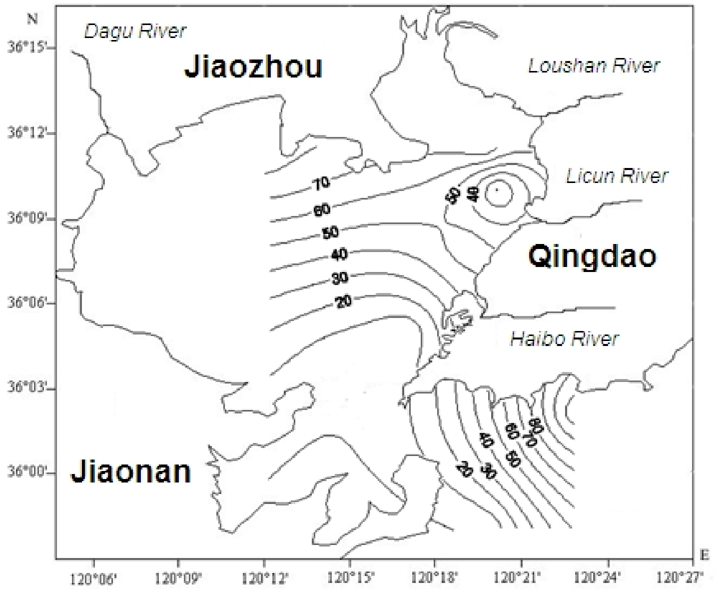

Fig. 2 Spatial distribution of Zn in surface waters in Jiaozhou Bay in May 1983/μg L^{-1}

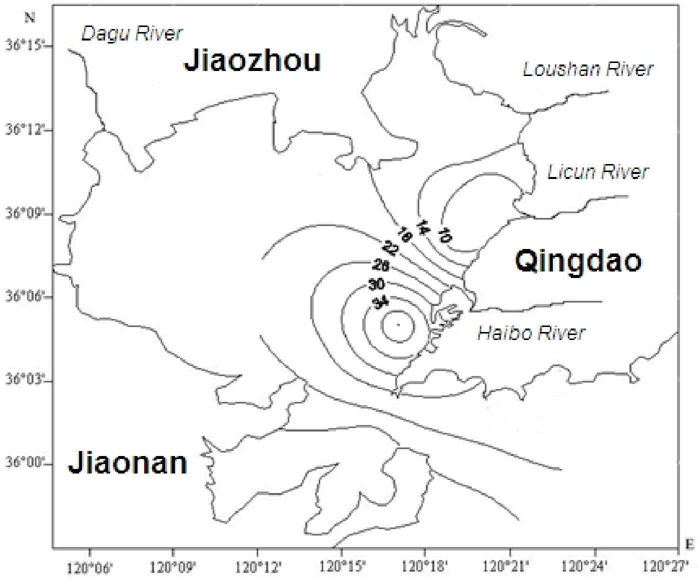

Fig. 3 Spatial distribution of Zn in surface waters in Jiaozhou Bay in September 1983/μg L^{-1}

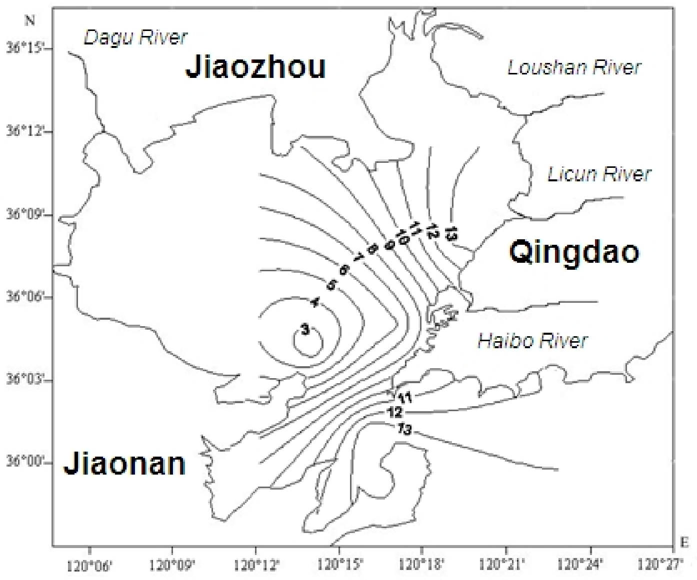

Fig. 4 Spatial distribution of Zn in surface waters in Jiaozhou Bay in October 1983/μg L^{-1}

Pollution sources and source strengths of Zn. Zn contents in May were drcreasing from the open waters to the center of the bay along with the flow direction of the marine current (Fig. 2), indicated that marine current was one of the major sources, whose source strength could be as high as 117.50 μg L^{-1}. High value region of Zn in the north and the northeast of the bay indicated that overland runoff and stream flow were also major sources, whose source strengths were 84.62 μg L^{-1} and 78.84 μg L^{-1}. In Septemer, a high value region was formed in the coastal in the east of the bay in where there were port terminals. Hence, it could found that marine trafic was one of the sources, whose source strength was 42.50 μg L^{-1}. In October, a high value region was formed in the bay mouth, indicated the top of the small peninsula could be source of Zn, whose source strength was 14.00 μg L^{-1}. Meanwhile, another high value region was formed in estuaries of the major rivers in the northeast, indicated flow was one of the major sources, whose source strength was 7.14-7.21 μg L^{-1}. Hence, it could be concluded that the major sources of Zn in Jiaozhou Bay were marine current, overland runoff, stream flow, marine trafic and small peninsula, whose source strengths were 117.50 μg L^{-1}, 84.62 μg L^{-1}, 13.08-78.84 μg L^{-1}, 42.50 μg L^{-1} and 14.00 μg L^{-1}, respectively (Table 3). If defined marine current was natural source, while the other sources were anthropogenic sources, it was clear that the impacts from human activities were still lower than sea water pollutant background in 1983.

Table 3 Source strengths of different pollution sources of Zn in Jiaozhou bay

Source	Marine current	Overland runoff	Stream flow	Marine traffic	Small peninsula
Content/μg L^{-1}	117.50	84.62	13.08-78.84	42.50	14.00

Conclusions

Zn contents in surface waters in Jiaozhou Bay in May, September and October 1983 were 1.96-117.50 μg L^{-1}, 7.14-42.50 μg L^{-1} and 2.36-14.00 μg L^{-1}. This bay was heavy polluted by Zn in May, yet in September and October were very low and the water was slightly polluted by Zn. The major sources of Zn in Jiaozhou Bay were marine current, overland runoff, stream flow, marine trafic and small peninsula, whose source strengths were 117.50 μg L^{-1}, 84.62 μg L^{-1}, 13.08-78.84 μg L^{-1}, 42.50 μg L^{-1} and 14.00 μg L^{-1}, respectively. The impacts from human activities were still lower than sea water pollutant background in 1983.

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