The stable and continuous source of Cr in Jiaozhou Bay

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Keywords: Cr, Content, Distribution, Source, River, Jiaozhou Bay.

Abstract. Cr is one of the critical industrial heavy metal pollutants. Understanding the pollution level and source of Cr in the early stage of the reform is helpful to provide background information to environmental remediation. This paper analyzed the content and distribution of Cr in Jiaozhou Bay waters in 1983. Results showed that Cr contents ranged from 0.13-4.17 μg L^{-1}, and were confirmed with Grade I(50 μg L^{-1}) in according to Chinese Sea Water Quality Standard (GB 3097-1997), indicated that the pollution level of Cr was very low in 1983. In according to the distributions of Cr in surface waters in Jiaozhou Bay, we found that the major inflow rivers such as Loushan River and Licun River were the major input channels of Cr, and industrial point source was the major source of Cr in the early stage of the reform. The source strength was stable all around the year, ranged from 3.78-4.17μg L^{-1}.

Introduction

After the reform and opening-up of China, industries such as metallurgy, electroplating and chemistry industry have been rapidly developing. Meanwhile, industrial pollution has caused many environmental problems. Cr is one of the critical industrial heavy metal pollutants, which could be transported to the marine via overland runoff, stream flow, direct discharging, etc., and could caused serious marine ecological environment essues [1-3]. Hence, understanding the contents, distributions and sources of Cr in in the early stage of the reform is helpful to provide background information to environmental remediation.

Jiaozhou Bay (35°55′-36°18′ N, 120°04′-120°23′ E) is located in Shandong Province, eastern China (Fig. 1). The total area, the width of the bay mouth, and the average water depth are 446 km^2, 2.5 km, and 7m, respectively. This bay is surrounded by economic developed cities of Qingdao, Jiaozhou and Jiaonan. The industrial pollution of these regions had been increasing along with the rapid developing of industries of these cities, and the waters in the bay had been polluted [3-5]. Based on investigation data on Cr contents in surface waters in 9 sampling sites in Jiaozhou Bay in May, September and October 1983, the aim of this paper was to analyze the contents, distributions and pollution sources of Cr, and to provide basis to pollution control and environmental remediation.

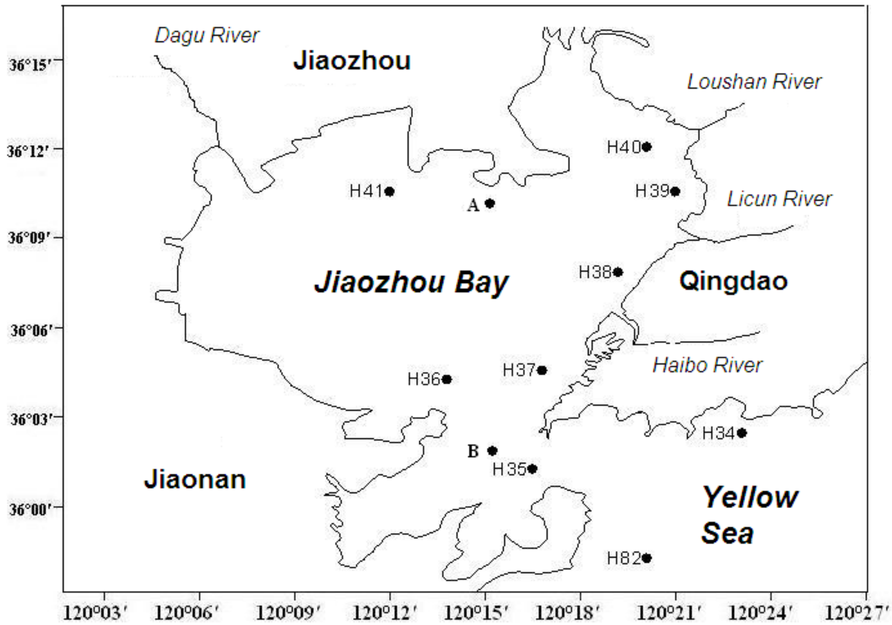

Fig.1 Geographic location and sampling sites of Jiaozhou Bay

Cr content and pollution level in surface waters

Cr contents in surface waters ranged from 0.13-4.17 μg L^{-1}, and were confirmed with Grade I(50 μg L^{-1}) in according to Chinese Sea Water Quality Standard (GB 3097-1997), indicated that the pollution level of Cr was very low in 1983. Meanwhile, the ranges of the Cr contents were very close in different seasons. Hence, it could be concluded that the waters in Jiaozhou Bay had not been significantly polluted by Cr in 1983, and the seasonal variations of Cr was not significant.

Table 1 Cr contents and pollution levels in surface water in Jiaozhou Bay in 1983

Time	May	September	October
Concentration/μg L^{-1}	0.13 to 3.96	0.70 to 3.78	0.44 to 4.17
Grade	I	I	I

Horizontal distributions of Cr in surface waters

The horizontal distributions of Cr in surface waters in Jiaozhou Bay in May, September and October 1983 were showed in Fig. 2, Fig. 3 and Fig. 4, respectively. In May, the highest value of Cr contents was occurred in Site H40 (3.96 μg L^{-1}) closed to the estuary of Loushan River in the northeast of the bay, while low values were occurred in Site H37 (0.24 μg L^{-1}) and H35 (0.24 μg L^{-1}) in the bay mouth. Cr contents in Site H34 and H82 outside the bay mouth were very low (0.29-0.65 μg L^{-1}). The contour lines were forming a series of semi-concentric circles, which were decreasing from the estuaries of the major inflow rivers in the northeast of the bay to the bay mouth (Fig. 2). In September, the highest value was occurred in Site H39 (3.78 μg L^{-1}) between the estuaries of Loushan River and Licun River. Site H34 and H82 was closed to and located in the bay mouth, whose Cr contents were 1.17 μg $L^{-1}$and 0.70 μg L^{-1}, respectively. As showed in Fig. 3, there were a series of semi-concentric circles, which were decreasing from the high value center in the estuaries of the major river in the northeast to the bay mouth in the south. Similarly, Cr contents in Site H34 and Site H82 were as low as 1.17 μg L^{-1} and 0.70 μg L^{-1}, respectively. In October, high value center was also occurred in the estuaries of the major rivers in the northeast of the bay, and were also decreasing from the high value center in the estuaries of the major river in the northeast to the bay mouth in the south (Fig. 4). The highest and lowest values of Cr contents in the bay were occurred in Site 39 and Site H35, which were 4.17 μg $L^{-1}$and 1.44 μg L^{-1}, respectively. Without exception, Cr contents in Site H34 and Site H82 were as low as0.44 μg L^{-1} and 0.60 μg L^{-1}, respectively. In generally, the horizontal distributions of Cr contents in Jiaozhou Bay in May, September and October were similar, implying that the source of Cr may be same in different seasons.

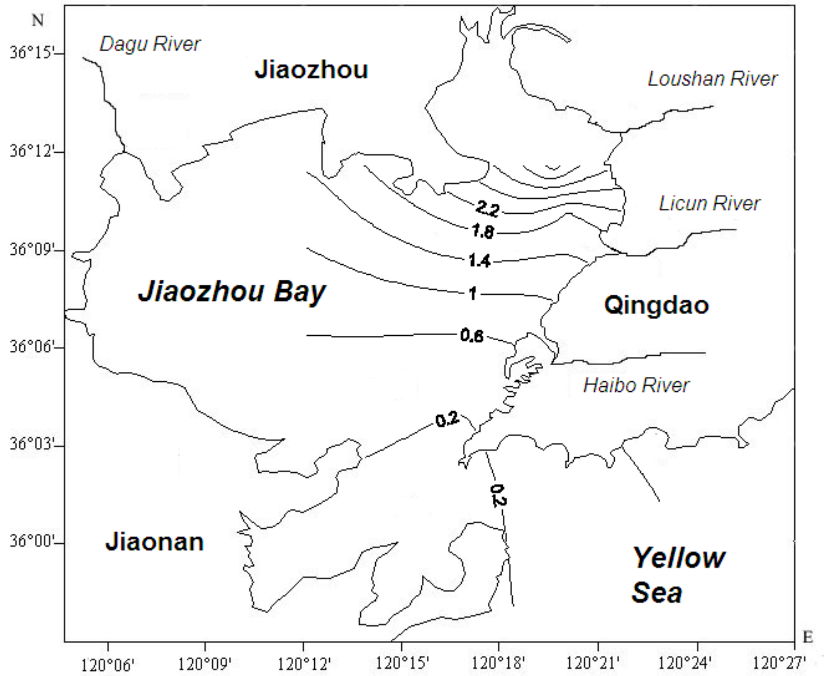

Fig. 2 Cr distributions in surface waters in Jiaozhou Bay in May (μg L^{-1})

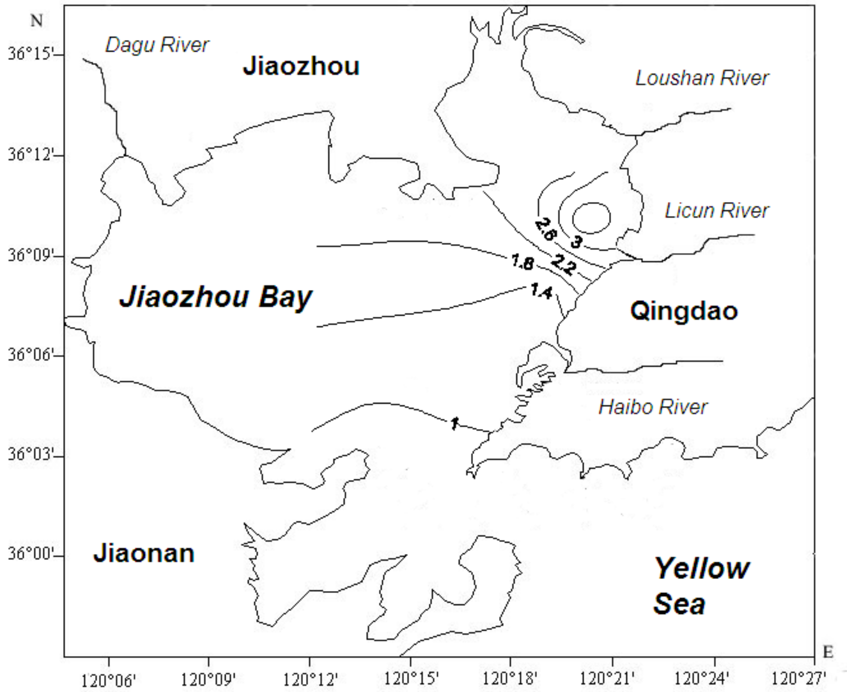

Fig. 3 Cr distributions in surface waters in Jiaozhou Bay in September (μg L^{-1})

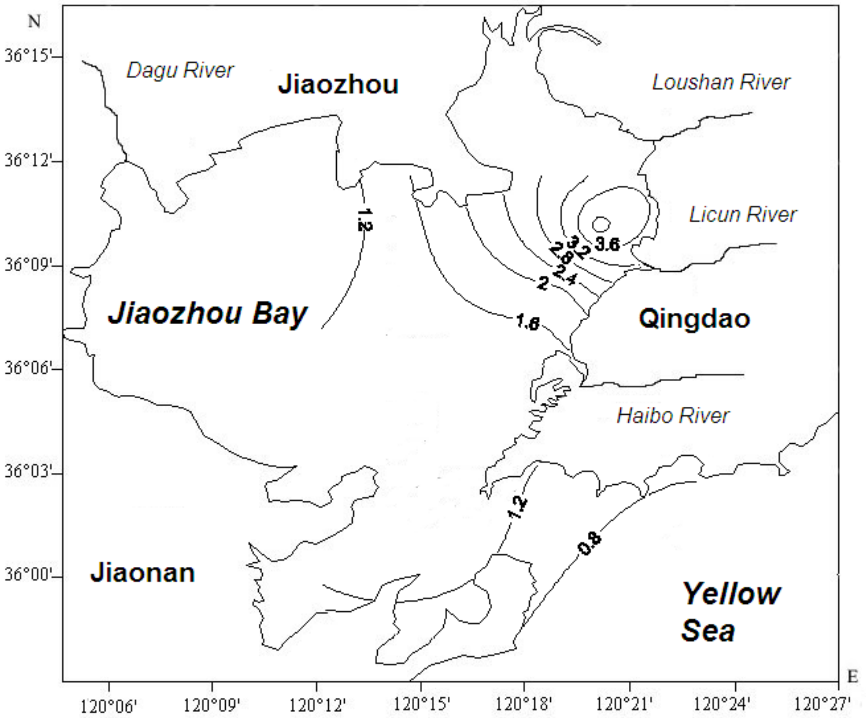

Fig. 4 Cr distributions in surface waters in Jiaozhou Bay in October (μg L^{-1})

Sources of Cr

In according to the distributions of Cr contents, we found that high value centers were all occurred in the estuaries of the major rivers, low value centers were all occurred in the bay mouth, and contents in waters outside the bay mouth were lowest. Furthermore, Cr contents were all decreasing from the estuaries of the major rivers in the northeast of the bay to the bay mouth in the south. Hence, it could be concluded that the major rivers such as Loushan River and Licun River were the major input channels of Cr to Jiaozhou Bay. Obviously, industrial point source was the major source of Cr in this bay in 1983, and the source strength ranged from 3.78-4.17μg L^{-1}, which was stable all around the year.

Conclusions

Cr contents in surface waters ranged from 0.13-4.17 μg L^{-1}, and were confirmed with Grade I (50 μg L^{-1}) in according to Chinese Sea Water Quality Standard (GB 3097-1997), indicated that the pollution level of Cr was very low in 1983. The major inflow rivers such as Loushan River and Licun River were the major input channels of Cr, and industrial point source was the major source of Cr in the early stage of the reform. The source strength was stable all around the year, ranged from 3.78-4.17μg L^{-1}. These information was helpful to provide background information to environmental remediation.

Acknowledgement

This research was sponsored by Education Ministry's New Century Excellent Talents Supporting Plan (NCET-12-0659), Project of Outstanding Technological Educators of Governor of Guizhou ([2012]71), Project of Low Carbon Technology Plan of Guiyang (2012205]), Project of Science and Technology Foundation of Guiyang (LKM[2012]05), Special Research Projects of High Level Talents of Guizhou Province (TZJF-2011-44), and Research Projects of Guizhou Nationalities University ([2014]02).

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