

Background level of Cu in Jiaozhou Bay and open sea

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Keywords: Cu, Distribution, Source, Background level, Jiaozhou Bay.

Abstract. This paper analyzed the content, distribution, source and background level of Cu in Jiaozhou Bay and the open sea based on investigation data in 1985. Results showed that the Cu contents in surface waters ranged from 0.10-0.43 $\mu\text{g L}^{-1}$, and were meeting Grade I in Chinese Sea Water Quality Standard, indicated that Jiaozhou Bay and the open sea had not been polluted by Cu in 1985. Stream flow and marine current were the two major Cu sources, whose source strengths were 0.37-0.43 $\mu\text{g L}^{-1}$ and 0.39 $\mu\text{g L}^{-1}$, respectively. The level of Cu contents in the sea waters were mainly impacted by Cu flux of the inflow streams. The background value of Cu in open sea waters was 0.39 $\mu\text{g L}^{-1}$, while for bay waters was 0.10-0.22 $\mu\text{g L}^{-1}$. We hold the opinion that Cu in sea is existing form of matter.

Introduction

Cu is mainly in forms of sulfide ore and oxidized ore, and is one of the wide distribution elements in the nature world. However, a large amount of Cu-contained waste water was discharged along with the rapid development economic, and was finally discharged into the marine environment [1-5]. Cu is one of the necessary elements for the growth and reproduction of organism, yet the excess intake of Cu is harmful to organism. Hence, understanding the background level of Cu in sea waters is essential to marine environmental protection. Jiaozhou Bay is a semi-closed bay located in south of Shandong Peninsula, eastern Chin. The purpose of this paper was to analyzed the content, distribution, source and background level in Cu in Jiaozhou Bay and the open sea, and to provide scientific basis for the research on the source, pollution level and transfer process of Cu in sea waters.

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 km², 7 m and 3 km, respectively. There are more than ten inflow rivers such as Haibo River, Licun River, Dagu River, and Loushan River etc., most of which have seasonal features [6, 7]. The data was provided by North China Sea Environmental Monitoring Center. The survey was conducted in April, July and October 1985. 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 [8].

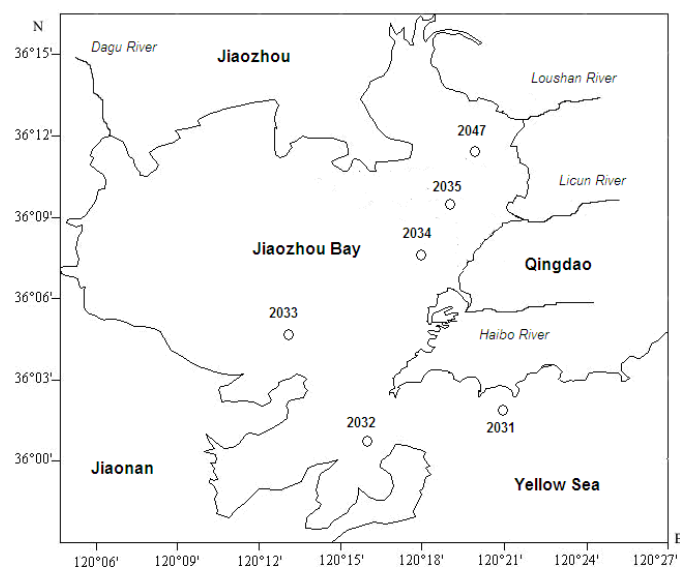


Fig.1 Geographic location and monitoring sites in Jiaozhou Bay

Results and discussion

Distribution and source of Cu. In April, high value region occurred in Site 2035 in the estuary of Licun River in the northeast of the bay, and there were a series of semi-concentric circles, which were decreasing from the northeast ($0.43 \mu\text{g L}^{-1}$) to the coastal waters in the southwest of the bay ($0.11 \mu\text{g L}^{-1}$) (Fig. 2). There was another high value occurred in Site 2031 in open waters in April, and there were a series of semi-concentric circles, which were decreasing from the open waters ($0.39 \mu\text{g L}^{-1}$) to the coastal waters in the southwest of the bay ($0.11 \mu\text{g L}^{-1}$) (Fig. 2). In July, high value region occurred in Site 2034 in the estuary of Haibo River in the northeast of the bay, and there were a series of parallel lines, which were decreasing from the bay mouth ($0.38 \mu\text{g L}^{-1}$) to the bay mouth ($0.22 \mu\text{g L}^{-1}$) and the open waters ($0.10 \mu\text{g L}^{-1}$) (Fig. 3). In October, high value region occurred in Site 2031 in coastal waters in the open sea, and there were a series of parallel lines, which were decreasing from the open sea ($0.39 \mu\text{g L}^{-1}$) to the bay mouth ($0.18 \mu\text{g L}^{-1}$) (Fig. 4). The different distributions of Cu indicated that there might be different pollution sources in different seasons. In according to the horizontal distribution of Cu, we found that high value regions were occurring in estuaries of Licun River and Haibo River ($0.37\text{--}0.43 \mu\text{g L}^{-1}$), and Cu contents were decreasing along with the flow directions of the rivers. Hence, it could be concluded that inflow stream was one of the major Cu source, whose source strength was $0.37\text{--}0.43 \mu\text{g L}^{-1}$. We also found that high value regions were occurring in the open sea in April ($0.39 \mu\text{g L}^{-1}$) and October ($0.39 \mu\text{g L}^{-1}$), and Cu contents were decreasing along with the flow directions of the marine current, indicating that marine current from the open sea is another major Cu source, whose source strength was $0.39 \mu\text{g L}^{-1}$.

Content and water quality of Cu. The contents of Cu in April, July and October in 1985 in surface waters in Jiaozhou Bay and the open sea were $0.11\text{--}0.43 \mu\text{g L}^{-1}$, $0.10\text{--}0.38 \mu\text{g L}^{-1}$ and $0.18\text{--}0.39 \mu\text{g L}^{-1}$, respectively. In comparison with Grade I ($5.00 \mu\text{g L}^{-1}$) of National Sea Water Quality Standard (GB 3097-1997) for Cu, the Cu contents were very low. It could be concluded that Jiaozhou Bay and the open sea had not been by Cu in 1985. The contents of Cu in the bay and the open sea in April were $0.11\text{--}0.43 \mu\text{g L}^{-1}$, in waters between the bay mouth and the open sea were $0.36\text{--}0.39 \mu\text{g L}^{-1}$, in waters in the estuary of Licun River was $0.43 \mu\text{g L}^{-1}$, while in the other areas were $0.11\text{--}0.13 \mu\text{g L}^{-1}$. Hence, Cu contents in April were relative high in estuary of Licun River and the open sea, yet were relative low in the other areas. In July, Cu contents in the bay and the open sea were $0.10\text{--}0.38 \mu\text{g L}^{-1}$, in waters between the coastal waters in the southwest and the open waters were $0.10\text{--}0.22 \mu\text{g L}^{-1}$, while in waters closed to the estuaries of Haibo River, Licun River and Loushan River in the northeast were $0.37\text{--}0.38 \mu\text{g L}^{-1}$. It was clear that Cu contents in the

estuaries of the major inflow rivers were relative high in July, while in the other areas were relative low. In October, Cu contents in the bay and the open sea were 0.18-0.39 $\mu\text{g L}^{-1}$, in waters inside the bay were 0.18-0.20 $\mu\text{g L}^{-1}$, while in waters from the bay mouth to the open sea were 0.25-0.39 $\mu\text{g L}^{-1}$. It was clear that Cu contents in the open sea were relative high in October, while inside the bay were relative low and homogeneous. Although Cu contents were very low and the water quality is good, the spatial-temporal variation of water quality were existing.

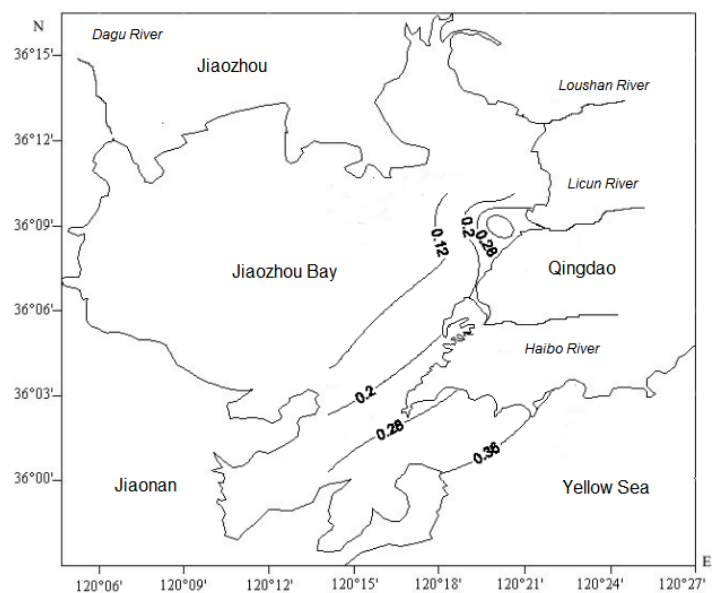


Fig. 2 Distributions of Cu in surface waters in Jiaozhou Bay in April 1985

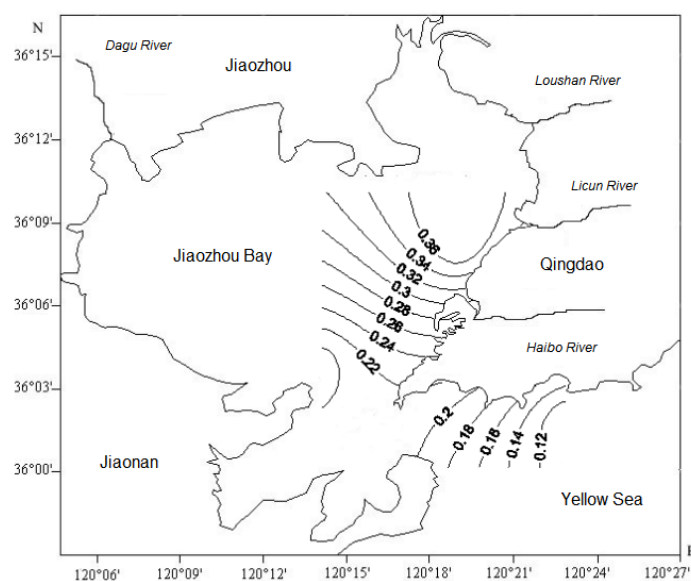


Fig. 3 Distributions of Cu in surface waters in Jiaozhou Bay in July 1985

Background level of Cu. As described above, stream flow and marine current were two major source of Cu in Jiaozhou Bay. In April and July, the source strengths of stream flow was 0.37-0.43 $\mu\text{g L}^{-1}$; while in April and October, the source strengths of marine current was 0.39 $\mu\text{g L}^{-1}$. It could be found that and range of the source strength of stream flow was covering which of the marine current. Hence, the impact of the Cu flux from the streams were strong to Cu contents in sea waters. The Cu source strengths of marine current were same in April and October, indicated the Cu source strength of marine current were not changing with seasons, and the background level of Cu in open waters was 0.39 $\mu\text{g L}^{-1}$. In case of no pollution source, Cu contents in waters between the coastal waters in the southwest and the open waters in July were relative low and homogeneous (0.10-0.22 $\mu\text{g L}^{-1}$). Moreover, there was also a low value and homogeneous region of Cu contents inside the

bay in October ($0.18\text{--}0.20\ \mu\text{g L}^{-1}$) in case of no pollution source. Hence, it could be found that the background level of Cu in bay waters was $0.10\text{--}0.22\ \mu\text{g L}^{-1}$.

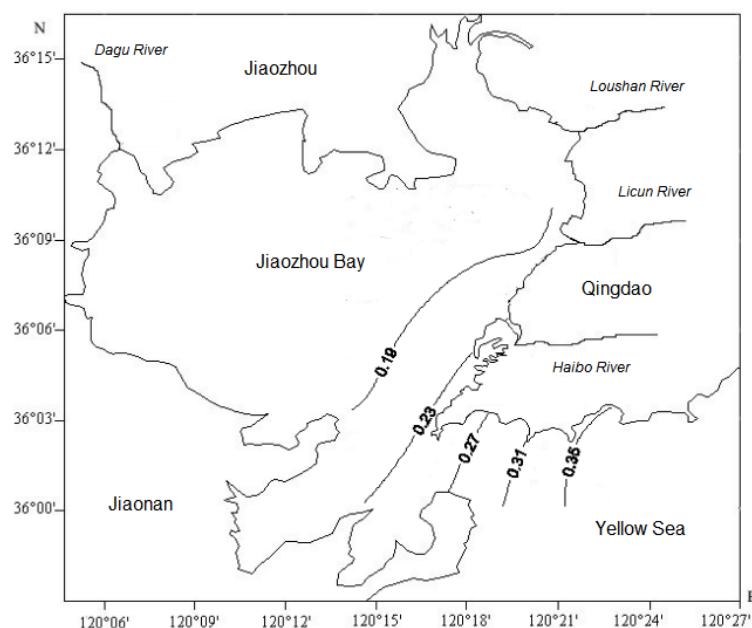


Fig. 4 Distributions of Cu in surface waters in Jiaozhou Bay in October 1985

Conclusions

The contents of Cu in April, July and October in 1985 in surface waters in Jiaozhou Bay and the open sea were $0.11\text{--}0.43\ \mu\text{g L}^{-1}$, $0.10\text{--}0.38\ \mu\text{g L}^{-1}$ and $0.18\text{--}0.39\ \mu\text{g L}^{-1}$, respectively, and this bay had not been by Cu in 1985. Stream flow and marine current were the two major Cu sources, whose source strengths were $0.37\text{--}0.43\ \mu\text{g L}^{-1}$ and $0.39\ \mu\text{g L}^{-1}$, respectively. The background value of Cu in open sea waters was $0.39\ \mu\text{g L}^{-1}$, while for bay waters was $0.10\text{--}0.22\ \mu\text{g L}^{-1}$. We hold the opinion that Cu in sea is existing form of matter.

Acknowledgment

This research was sponsored by Doctoral Degree Construction Library of Guizhou Nationalities University, Education Ministry's New Century Excellent Talents Supporting Plan (NCET-12-0659), the China National Natural Science Foundation (31560107), Major Project of Science and Technology of Guizhou Provincial ([2004]6007-01), Guizhou R&D Program for Social Development ([2014] 3036) and Research Projects of Guizhou Nationalities University ([2014]02), Research Projects of Guizhou Province Ministry of Education (KY [2014] 266), Research Projects of Guizhou Province Ministry of Science and Technology (LH [2014] 7376), and Comprehensive Reform Pilot Project of Environmental Science Specialty ([2013]446).

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