Transport trend of Cu in surface and bottom waters in Jiaozhou Bay

Dongfang Yang[1, 2, 3, a], Qiang Wang[1, 2], Chunhua Su[1, 2], Xiuqin Yang [1, 2], Wei Zhou[1, 2]
[1]Research Center for Karst Wetland Ecology, Guizhou Minzu University, Guiyang 550025, China;
[2]College of Chemistry and Environmental Science, Guizhou Minzu University, Guiyang 550025, China;
[3]North China Sea Environmental Monitoring Center, SOA, Qingdao 266033, China
[a]dfyang_dfyang@126.com

Key words: Cu; Mechanism; Transport; Horizontal distribution; Jiaozhou Bay.
Abstract. This paper analyzed the horizontal distributions and the trends of Cu contents in surface and bottom waters in Jiaozhou Bay during 1982-1985 in Shandong Province of China. Results showed that the distribution trends of Cu contents in surface and bottom waters could be consistent of reverse, and there were high sedimentation and accumulation processes in bottom waters. These were the results of the combine effect of Cu’s source input (i.e., marine current, river flow, island top, overland runoff and marine traffic), horizontal water’s effect and vertical waters’s effect. Furthermore, this paper analyzed the mechanisms for the horizontal distribution trends. These findings were helpful information in decision-making of pollution control and environmental remediation practice, as well as in scientific research.

Introduction

Jiaozhou Bay is a semi-closed bay in Shandong Province, China. This bay is surrounding by cities of Jiaonan, Qingdao and Jiaozhou, and has been polluted by various pollutants including Cu along with the rapid development of industrialization and urbanization after reform and opening-up [1-6]. Hence, understanding the transport process and the mechanism of Cu in marine bay is essential to marine environment protection [7-16]. This paper analyzed the horizontal distributions of Cu contents in surface and bottom waters in Jiaozhou Bay based on investigation data on Cu during 1982-1985. The aim of this paper was to provide information for decision-making of pollution control and environmental remediation practice, as well as in scientific research.

Study area and data collection

Jiaozhou Bay is located in the south of Shandong Province, eastern China (35°55′-36°18′ N, 120°04′-120°23′ E). The total area, average water depth and bay mouth width are 446 km^2, 7 m and 3 km, respectively. This bay is a typical of semi-closed bay which is connected to the Yellow Sea in the south. There are a dozen of rivers, and the majors are Dagu River, Haibo Rriver, Licun Rriver, and Loushan Rriver etc., all of which are seasonal rivers [17-18].

The investigation on Cd in surface waters in Jiaozhou Bay was carried on in July and October 1982, May, September and October 1983, July and October 1984, and April, July and October 1985, respectively [13-16] (Fig. 1). Cu in waters was sampled and monitored follow by National Specification for Marine Monitoring [19].

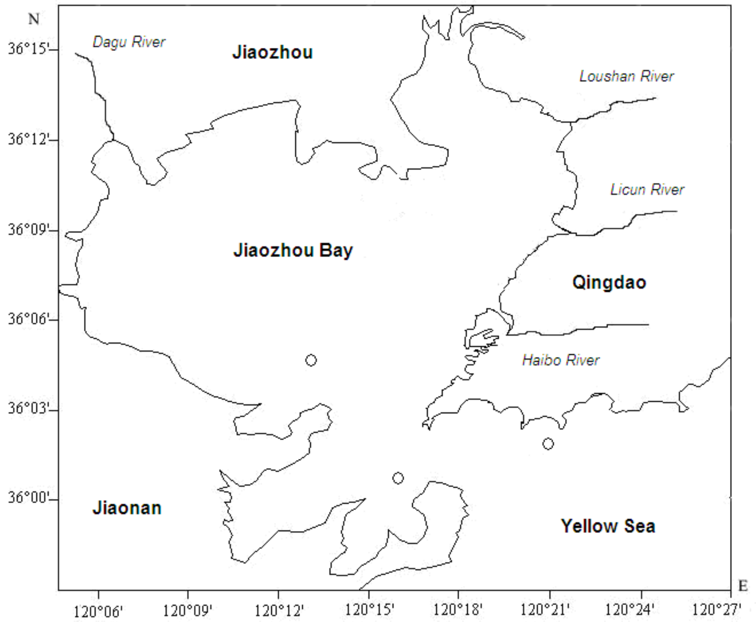

Fig. 1 Geographic location and sampling sites in Jiaozhou Bay

Results

In 1982. In July 1982, Cu contents in surface waters were increasing from coastal waters in the southwest of the bay (0.50 μg L^{-1}) to the northeast of the bay (0.53 μg L^{-1}) , while in bottom waters were decreasing from coastal waters in the southwest of the bay (1.46 μg L^{-1}) to the northeast of the bay (0.29 μg L^{-1}). In October 1982, Cu contents in surface waters were decreasing from coastal waters in the southwest of the bay (3.56 μg L^{-1}) to the northeast of the bay (2.55 μg L^{-1}) , while in bottom waters were increasing from coastal waters in the southwest of the bay (1.78 μg L^{-1}) to the northeast of the bay (2.78 μg L^{-1}).

In 1983. In May 1983, Cu contents in surface waters were decreasing from the inside of the bay (9.48 μg L^{-1}) to the outside of the bay (2.94 μg L^{-1}), in bottom waters were also decreasing from the inside of the bay (3.88 μg L^{-1}) to the outside of the bay (2.33 μg L^{-1}). In September 1983, Cu contents in surface waters were increasing from the inside of the bay (1.28 μg L^{-1}) to the outside of the bay (4.86 μg L^{-1}), while in bottom waters were decreasing from the inside of the bay (1.90 μg L^{-1}) to the outside of the bay (1.59 μg L^{-1}). In October 1983, Cu contents in surface waters were increasing from the inside of the bay (1.40 μg L^{-1}) to the outside of the bay (2.00 μg L^{-1}), in bottom waters were also increasing from the inside of the bay (1.45 μg L^{-1}) to the outside of the bay (1.78 μg L^{-1}).

In 1984. In July 1984, Cu contents in surface waters were decreasing from the inside of the bay (1.83 μg L^{-1}) to the outside of the bay (0.28 μg L^{-1}), while in bottom waters were increasing from the inside of the bay (0.36 μg L^{-1}) to the outside of the bay (2.97 μg L^{-1}). In October 1984, Cu contents in surface waters were decreasing from the inside of the bay (2.00 μg L^{-1}) to the outside of the bay (0.90 μg L^{-1}), in bottom waters were also decreasing from the inside of the bay (0.61 μg L^{-1}) to the outside of the bay (0.40 μg L^{-1}).

In 1985. In April 1985, Cu contents in surface waters were increasing from the inside of the bay (0.36 μg L^{-1}) to the outside of the bay (0.39 μg L^{-1}), in bottom waters were also increasing from the inside of the bay (0.10 μg L^{-1}) to the outside of the bay (0.12 μg L^{-1}). In July 1985, Cu contents in surface waters were increasing from the inside of the bay (0.22 μg L^{-1}) to the outside of the bay (0.10 μg L^{-1}), in bottom waters were also decreasing from the inside of the bay (0.42 μg L^{-1}) to the outside of the bay (0.19 μg L^{-1}). In October 1985, Cu contents in surface waters were increasing from the inside of the bay (0.25 μg L^{-1}) to the outside of the bay (0.39 μg L^{-1}), in bottom waters were also increasing from the inside of the bay (0.19 μg L^{-1}) to the outside of the bay (0.30 μg L^{-1}).

Discussion

In 1982. In July 1982, a big part of Cu in surface waters was settling to bottom waters in summer season, while this part of Cu was accumulating in bottom waters, resulting in the horizontal distributions of Cu contents in surface and bottom waters were reverse. In October 1982, the sedimentation of Cu was decreasing yet was going on, resulting in the horizontal distributions of Cu contents in surface and bottom waters were reverse. Hence, the horizontal distributions of Cu contents in surface and bottom waters in July and October 1982 were reverse.
In 1983. In May 1983, the major source input of Cu was relative strong, and the sedimentation of Cu was rapid, resulting in the horizontal distributions of Cu contents in surface and bottom waters were consistent. In September 1983, the sedimentation of Cu was decreasing yet was going on, resulting in the decreasing of Cu in surface waters and the increasing of Cu in bottom waters, and the horizontal distributions of Cu contents in surface and bottom waters were reverse. In October 1983, the sedimentation of Cu was decreasing, resulting in the increasing of Cu in surface waters and the increasing of Cu in bottom waters, and the horizontal distributions of Cu contents in surface and bottom waters were consistent. Hence, the horizontal distributions of Cu contents in surface and bottom waters in May and October 1983 were consistent, while in September 1983 were reverse.
In 1984. In July 1984, the major source of Cu was river flow, and the source strength was relative strong. Cu contents in surface waters were decreasing since the sedimentation of Cu was rapid, while in bottom waters were increasing due to the accumulation of Cu in bottom waters, resulting in the horizontal distributions of Cu contents in surface and bottom waters were reverse. In October 1984, the source of Cu was marine current, and the source strength was relative weak. Cu contents in surface waters were decreasing, and in bottom waters were also increasing due to the sedimentation and accumulation of Cu in bottom waters were decreasing, resulting in the horizontal distributions of Cu contents in surface and bottom waters were consistent. Hence, the horizontal distributions of Cu contents in surface and bottom waters in July 1984 were reverse, while in October 1984 were consistent.
In 1985. In April 1985, the major source of Cu was marine current, and the source strength was relative weak, resulted in the increasing or Cu contents in both surface and bottom waters against with the flow direction of marine current, resulting in the horizontal distributions of Cu contents in surface and bottom waters were consistent. In July 1985, the major source of Cu was river flow, yet the source strength was relative weak. Cu contents in surface waters were decreasing by means of the sedimentation of Cu, and in bottom waters were increasing since the sedimentation of Cu was weak, resulting in the horizontal distributions of Cu contents in surface and bottom waters were consistent. In October 1984, the major source of Cu was marine current, and the source strength was relative weak, resulting in the horizontal distributions of Cu contents in surface and bottom waters were consistent. Cu contents in surface waters were decreasing by means of the sedimentation of Cu, and in bottom waters were increasing since the sedimentation of Cu was weak. Hence, the horizontal distributions of Cu contents in surface and bottom waters in April, July and October 1985 were consistent.

Conclusions

In Jiaozhou Bay, these were five major Cu sources, i.e., marine current, river flow, island top, overland runoff and marine traffic, respectively. The source input of Cu had features of seasonal and spatial variations, and by means of horizontal water's effect and vertical waters's effect, the horizontal distribution processes of Cu in surface and bottom waters in Jiaozhou Bay were varying in different months. In general, the distribution trends of Cu contents in surface and bottom waters could be consistent or reverse.

Acknowledgment

This research was sponsored by the China National Natural Science Foundation (31560107), Doctoral Degree Construction Library of Guizhou Nationalities University 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).

References

[1] Yang DF and Miao ZQ: Marine Bay Ecology (I): Beijing, Ocean Precess, (2010), p. 1-320. (in Chinese)

[2] Yang DF and Gao ZH: Marine Bay Ecology (II): Beijing, Ocean Precess, (2010), p. 1-330. (in Chinese)

[3] Yang DF, Miao ZQ, Song WP, et al.: Advanced Materials Research, Vol.1092-1093 (2015), p. 1013-1016.

[4] Yang DF, Miao ZQ, Cui WL, et al.: Advances in intelligent systems research, (2015), p. 17-20.

[5] Yang DF, Wang FY, Zhu SX, et al.:Advances in Engineering Research, Vol. 31(2015): p. 1284-1287.

[6] Yang DF, Zhu SX, Wu YJ, et al.:Advances in Engineering Research, Vol. 31(2015): p. 1288-1291.

[7] Yang DF, Wang FY, Zhu SX, et al.: Materials Engineering and Information Technology Apllication, Vol. 2015, p. 554-557.

[8] Yang DF, Zhu SX, Zhao XL, et al.: Advances in Engineering Research, Vol. 40 (2015), p. 770-775.

[9] Yang DF, Zhu SX, Wang FY, et al.:Advances in Computer Science Research, Vol. (2015), p. 1765-1769.

[10] Yang DF, Zhu SX, Wang FY, et al.: Advances in Engineering Research, Vol. 60(2016), p. 408-411.

[11] Yang DF, Zhu SX, Wang M, et al.: Advances in Engineering Research, Vol. 67(2016), p. 1311-1314.

[12] Yang DF, Yang DF, Wang M, et al.: Advances in Engineering Research, Vol. (2016), Part G, p. 1917-1920.

[13] Yang DF, Yang DF, He HZ, et al.: Advances in Engineering Research, Vol. 84 (2016), p. 852-856.

[14] Yang DF, He HZ, Wang FY, et al.: Advances in Materials Science,Energy Technology and Environmental Engineering, Vol. (2017), p. 291-294.

[15] Yang DF, Zhu SX, Yang DF, et al.: Computer Life, Vol. 4 (2016), p. 579-584.

[16] Yang DF, Yang DF, Tao XZ, et al.: World Scientific Research Journal, Vol. 22 (2016), p. 69-73.

[17] Yang DF, Chen Y, Gao ZH, et al.: Chinese Journal of Oceanology and Limnology, Vol. 23(2005), p. 72-90. (in Chinese)

[18] Yang DF, Wang FY, Gao ZH, et al. Marine Science, Vol. 28 (2004), p. 71-74. (in Chinese)

[19] China's State Oceanic Administration: The specification for marine monitoring (Ocean Press, Beijiang 1991), p.1-300. (in Chinese)

[20] Yang DF, Wang FY, He HZ, et al.: Proceedings of the 2015 international symposium on computers and informatics, 2015, p. 2655-2660.

[21] Yang DF, Wang FY, Zhao XL, et al.: Sustainable Energy and Enviroment Protection. 2015, p. 191-195.

[22] Yang DF, Wang FY, Yang XQ, et al.:Advances in Computer Science Research, Vol. 2352 (2015), p. 198-204.