The Interception of the Bay Mouth on the Transport of Hg in Jiaozhou Bay

Dongfang Yang [1, 2, 3, a], Hongmin Suo [1, 2], Sixi Zhu [1, 2], Xiuzhen Tao [1, 2], Ming Wang[1, 2]

[1]Research Center for Karst Wetland Ecology, Guizhou Minzu University, Guizhou Guiyang, Guizhou Guiyang, China;

[2]College of Ecology and Environmental Science, Guizhou Minzu University, Shanghai, 550025, China;

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

[a]dfyang_dfyang@126.com

Abstract

This paper analyzed the horizontal distributions of Hg in bottom waters in the bay mouth of Jiaozhou Bay in 1987 in Shandong Province, China. Results showed that Hg contents in May, July and November 1987 were 0.142-0.254 μg L^{-1}, 0.089-0.404 μg L^{-1}, and 0.000-0.038 μg L^{-1}, respectively. There were high sedimentation processes in bottom waters in the bay mouth in May and July 1987, other high sedimentation processes in bottom waters were occurring in bottom waters outside the bay mouth in July and November 1987. In general, the pollution level of Hg in bottom waters in May and July 1987 were moderate, while in November 1987 were slight. Hg contents were settling rapidly to bottom waters along with the flow direction, and there was interception process in the bay mouth, which was not only intercepting Hg contents inside the bay being transported to open waters, but also intercepting Hg contents in open waters being transported to the bay.

Keywords

Hg; Transport; Interception; Sedimentation; Jiaozhou Bay.

1. Introduction

Hg has been widely in industry, agriculture and people' s daily life. However, a large amount of Hg-containing wastes were generated and discharged to the environment along with the rapid development of economic and population size [1-2]. The excessive existence of Hg content in the environment could cause harm to the ecosystem and to human being finally due to the high toxicity of Hg. Ocean is the sink of various pollutants, and many marine bay have been polluted by Hg in the past several decades [3-7]. Hence, understanding the transport process of Hg is essential to environmental protection.

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 Hg after reform and opening-up [8-11]. This paper analyzed the horizontal distributions of Hg in bottom waters in the bay mouth in 1987, defined the high sedimentation processes in different seasons, and revealed the interception of the bay mouth on the transport processes of Hg. 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.

2. 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 [12-13]. The investigation on Hg in bottom waters in Jiaozhou Bay was carried on in May, July and November 1987, respectively (Fig. 1). Hg samples in bottom waters in three sampling sites (i.e. Site 2031, Site 2032, Site 2033) was sampled and monitored follow by National Specification for Marine Monitoring [14].

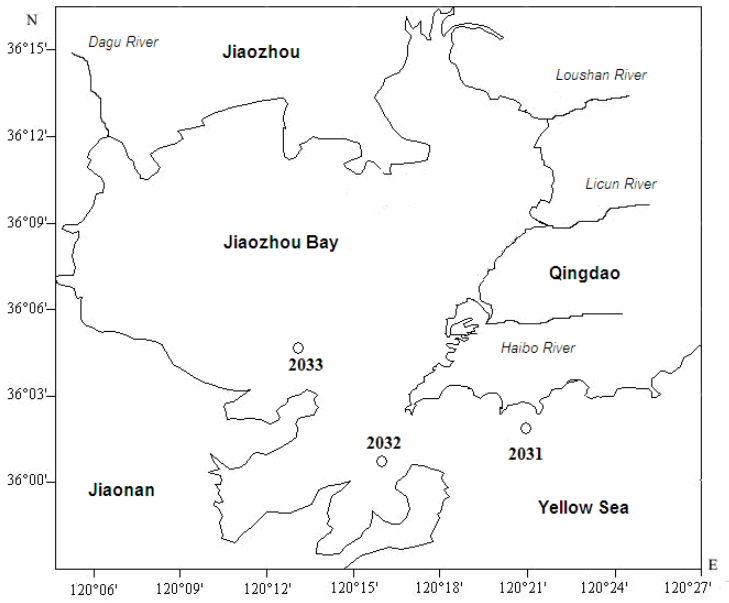

Fig. 1 Geographic location and sampling sites in Jiaozhou Bay

3. Results and Discussion

3.1 Contents and Pollution Levels of Hg.

Hg contents in May, July and November 1987 were 0.142-0.254 μg L^{-1}, 0.089-0.404 μg L^{-1}, and 0.000-0.038 μg L^{-1}, respectively. In according to the guide line of Hg in National Sea Water Quality Standard (GB 3097-1997) (Table 2), Hg contents in May and July 1987 were belonged to Class II to IV, while in November 1987 were belonging to Class I. In general, the pollution level of Hg in bottom waters in May and July 1987 were moderate, while in November 1987 were slight. The seasonal variations of the pollution levels of Hg were significant, which should be taken into consider in decision-making of pollution control and scientific research.

Table 2. Guide line of Hg in National Sea Water Quality Standard (GB 3097-1997)

Class	I	II and III	IV
Content/μg L^{-1}	0.05	0.2	0.5

3.2 Horizontal Distributions of Hg.

In according to the geographic location, the three sampling sites of Site 2033, Site 2032 and Site 2031 were located in the inside of the bay mouth, middle of the bay mouth and outside of the bay mouth, respectively (Fig. 1). In May 1987, the high value (0.254 μg L^{-1}) of Hg contents was occurring in Site 2032 in the middle of the bay mouth, and Hg contents were decreasing from the high value center to the inside of the bay mouth (0.174 μg L^{-1}), and to the open waters (0.142 μg L^{-1}), respectively (Fig. 2).

In July 1987, high value of Hg contents (0.404 μg L^{-1}) were occurring in Site 2031 in the open waters, and Hg contents were decreasing from the high value center to the bay mouth (0.089 μg L^{-1}) (Fig. 3). In November 1987, high value of Hg contents (0.038 μg L^{-1}) were also occurring in Site 2031 in the open waters, and Hg contents were decreasing from the high value center to the bay mouth (0.000 μg L^{-1}), which were similar to Fig. 3. In general, the horizontal distributions of Hg contents were showing seasonal and spatial variations.

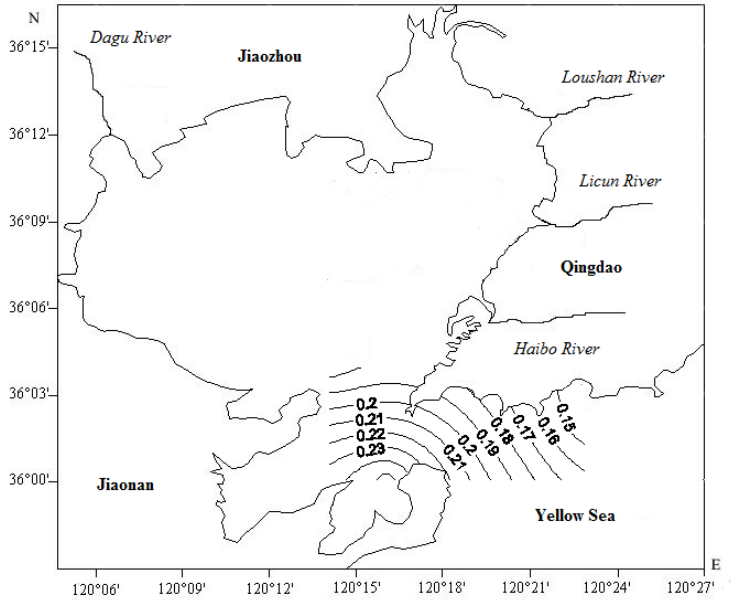

Fig. 2 Horizontal distributions of Hg in bottom waters in Jiaozhou Bay in May 1987

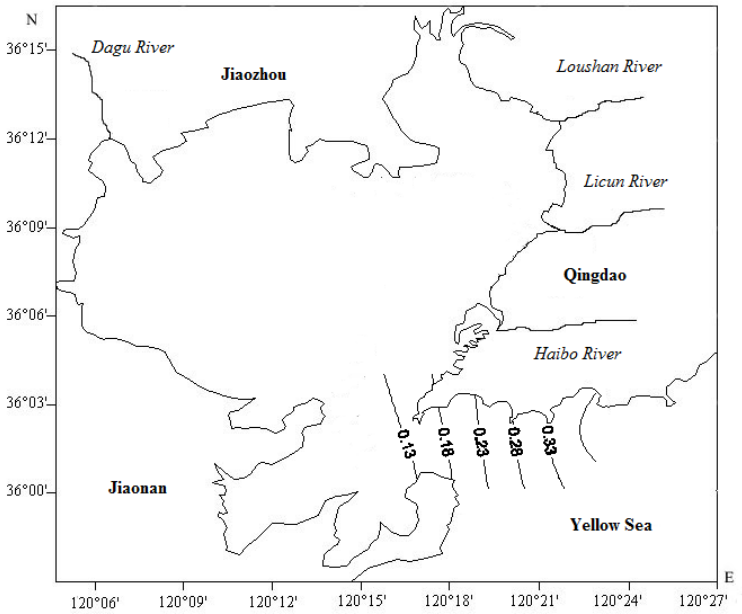

Fig. 3 Horizontal distributions of Hg in bottom waters in Jiaozhou Bay in July 1987

3.3 Transport Processes of Hg.

Once Hg was transported to the bay via the major pollution sources, Hg was originally arriving at surface waters, and was transported via water body to bottom waters. The horizontal distributions of Hg in bottom waters in May 1987 indicated that there was high sedimentation process in the bay mouth, while were low sedimentation processed in waters inside the bay mouth and outside the bay mouth (Fig. 2). The horizontal distributions of Hg in bottom waters in May and November 1987 indicated that there was high sedimentation process in waters outside the bay mouth, while was low sedimentation

processed in waters inside the bay mouth (Fig. 3). By means of vertical water's effect [15], and the water exchange between waters in the bay and the open waters, Hg contents were changing continuously [16].

3.4 The Interception of the Bay Mouth on the Transport Processes of Hg.

The major Hg source in May 1987 was river flow, whose source strength was relative high, and there was high sedimentation of Hg in the bay mouth. The major Hg source in July and November 1987 was marine current, whose source strength was relative high in July yet was relative low in November. It could be found that no matter the source strengths of marine current were high or low, there were high sedimentation processes in waters outside the bay mouth (Fig. 3). Hg contents were settling rapidly to bottom waters along with the flow direction, and there was interception process in the bay mouth. The narrow bay mouth of Jiaozhou Bay was playing a role as a barrier, which was intercepting the Hg contents inside the bay being transported to open waters, and was also intercepting the Hg contents in the open waters being transported to the inside of bay.

4. Conclusion

The horizontal distributions of Hg in bottom waters in the bay mouth of Jiaozhou Bay in 1987 were analyzed. The pollution level of Hg in bottom waters in May and July 1987 were moderate, while in November 1987 were slight. Both seasonal and spatial variations of Hg contents in this bay were significant. Hg contents were settling rapidly to bottom waters along with the flow direction. The narrow bay mouth of Jiaozhou Bay was playing a role as a barrier, resulting in the interception process in the bay mouth.

Acknowledgments

This research was sponsored by Doctoral Degree Construction Library of Guizhou Nationalities University, the China National Natural Science Foundation (31560107) 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] Chen Y, Gao ZH, Qu YH, et al.: Chinese Journal of Oceanology Limnology, Vol. 25(2007), p. 455-458. (in Chinese)
[4] Yang DF, Cao HR, Gao ZH, et al.: Ocean Environmental Science, Vol. 27 (2008), p. 37-39.
[5] Yang DF, Wang LL, Gao ZH, et al.: Ocean Environmental Science, Vol. 28 (2009), p. 501-505 .
[6] Chen Y, Zhang YJ, Gao JH, et al.: Ocean Development and Management, Vol. 30 (2013), p. 81-83.
[7] Yang DF, Sun PY, Ju L, et al: Coastal Engineering, Vol. 32(2013), p.65-76.
[8] Yang DF, Xu ZJ Qu YF, et al.:Coastal Engineering, Vol. 33(2014), p. 67-78.
[9] Chen Y, Qu YF, Pei RL, et al.:Advanced Materials Research, Vol.955-959 (2014), p. 2491-2495.
[10] Yang DF, Zhu SX, Wang FY, et al.:Advanced Materials Research, Vol.955-959(2014), p. 2496-2500.
[11] Yang DF, Zhu SX, Wang FY, et al.: Applied Mechanics and Materials, Vol.556-562 (2014), p. 633-636.

[12] Yang DF, Wang FY, He HZ, et al.: Advanced Materials Research, Vols.955-959(2014),p. 1443-1447.
[13] Yang DF, Geng X, Qu YF, et al.: Ocean Development and Management, Vol. 31 (2014), p. 112-118. (in Chinese)
[14] Yang DF, Chen Y, Gao ZH, et al.: Chinese Journal of Oceanology and Limnology, Vol. 23(2005), p. 72-90. (in Chinese)
[15] Yang DF, Wang F, Gao ZH, et al. Marine Science, Vol. 28 (2004), p. 71-74. (in Chinese)
[16] China's State Oceanic Administration: The specification for marine monitoring (Ocean Press, Beijiang 1991), p.1-300. (in Chinese)
[17] Yang DF, Wang FY, He HZ, et al.:Proceedings of the 2015 international symposium on computers and informatics, Vol. (2015), p. 2655-2660.
[18] Yang DF, Miao ZQ, Xu HZ et al.: Marine Environmental Science, Vol. 32 (2013), p. 373-380.