Easonal variations of contents and distribution trends of Hg in Jiaozhou Bay 1987

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Abstract

This paper analyzed the seasonal variations of contents and distribution trends of Hg in different seasons in 1987, and revealed the vertical settling processes and their mechanism. Results showed that Hg contents in surface waters in Jiaozhou Bay in May, July and November 1987 were 0.150-0.264 μg L-1, 0.088-1.104 μg L-1 and 0.007-0.088 μg L-1, respectively, while in bottom waters were 0.142-0.254 μg L-1, 0.089-0.404 μg L-1 and 0.000-0.038 μg L-1, respectively. Hg contents in both surface and bottom waters were in order of summer >spring > autumn, and the seasonal variation of Hg contents in surface and bottom waters in this bay were consistent. The sedimentation of Hg to bottom waters were in order of summer > spring > autumn. The major sources could also be identified in according to the horizontal distributions of Hg contents in surface and bottom waters.

Keywords

Hg; Content; Distribution; Seasonal; Source; Sedimentation.

1. Introduction

Hg is one of the heavy metal elements widely used in industry, agriculture and everyday life, and is also one of the critical high toxicity heavy metal elements [1-2]. A large amount of Hg-containing wastes were generated and discharged to the environment, and the excessive Hg contents in the environment is harmful to organism and the ecosystem. Ocean is the sink of pollutants, and Hg pollution in marine bays has been one of the critical environmental issues [3-13].

Jiaozhou Bay is a semi-closed bay located in Shandong Province, eastern China, and has been polluted by various pollutants including Hg after Reform and Opening-up [1-6]. This paper analyzed the seasonal variations of contents and distribution trends of Hg in different seasons in 1987, and revealed the vertical settling processes and their mechanism. The aim of this paper was to provide basis for the research and pollution control countermeasures.

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 and average water depth of this bay are 446 km2 and 7 m, respectively, and connected to the Yellow Sea in the south. This bay is a semi-closed bay whose bay mouth is only 3 km width. There are a dozen of rivers including Dagu River, Haibo Rriver, Licun Rriver, and Loushan Rriver etc., all of which are seasonal rivers [14-15].

The investigation on Hg in surface waters in Jiaozhou Bay was carried on in May, July and November 1987 in six investigation sites (i.e., 2031, 2032, 2033) (Fig. 1). Hg in waters was sampled and monitored follow by National Specification for Marine Monitoring [16].

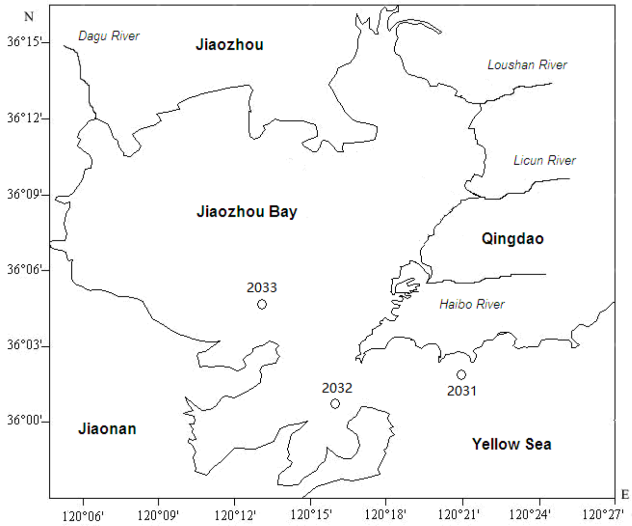

Fig.1 Geographic location and sampling sites of Jiaozhou Bay

3. Results and discussion

Seasonal variations of Hg. River flow and marine current were the two major Hg sources in Jiaozhou Bay. By means of vertical water's effect [17-19], Hg contents were changing along with the transporting process through water body. Hg contents in surface waters in Jiaozhou Bay in May, July and November 1987 were 0.150-0.264 μg L-1, 0.088-1.104 μg L-1 and 0.007-0.088 μg L-1, respectively, while in bottom waters 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 study area, May, July and November belong to spring, summer and autumn, respectively. It could be found that Hg contents in both surface and bottom waters were in order of summer >spring > autumn. This indicated that the seasonal variation of Hg contents in surface and bottom waters in this bay were consistent.

The seasonal variation of the growth and reproduction of plankton was impacting the seasonal variation of pollutants in marine bay. The growth and reproduction of plankton were increasing in spring, and were very rapid in summer, and then were decreasing in autumn [15]. The increasing or decrease of the growth and reproduction of plankton could result in the increasing or decrease of the absorption ability of suspended particular matters, as well as the increasing or decrease of sedimentation of Hg to sea bottom [13]. Hence, the sedimentation of Hg to bottom waters were in order of summer > spring > autumn.

In spring 1987, the major Hg source was river flow, and Hg content in surface water was relative high as 0.264 μg L-1, and Hg content in bottom waters was also relative high (0.254 μg L-1) by means of vertical water's effect. In summer 1987, one of the major Hg sources was river flow yet the source strength was higher (1.104 μg L-1), another major Hg source was marine current. Hence, the source input of Hg to this bay was increase in summer, and a large amount of Hg was transported to bottom water since the sedimentation of Hg was highest summer. Therefore, Hg contents in bottom waters in summer 1987 could be as high as 0.404 μg L-1. There were little river flow source input to the bay in autumn, and the source strength of marine current was very weak (0.088 μg L-1), resulted in Hg contents in both surface and bottom waters were lowest within year.

Distribution trends of Hg. In according to the geographic location, sampling sites of 2033, 2023 and 2031 were located in the inside of the bay mouth, middle of the bay mouth and outside of the bay mouth, respectively. In May 1987, Hg contents and surface and bottom waters were decreasing from the inside of the bay mouth to the outside of the bay mouth. In July and November 1987, Hg contents and surface and bottom waters were increasing from the inside of the bay mouth to the outside of the bay mouth. Hence, it could be found that the horizontal distributions of Hg contents in surface and bottom waters were consistent in different seasons. The reason was that Hg contents could be transported to sea bottom rapidly by means of vertical water's effect, no matter Hg contents were high or low in waters. That was the spatial sedimentation processes of Hg contents.

In general, st spatial scale, a big part of Hg was absorbed to suspended particular matters, and could be transported to sea bottom rapidly by means of vertical water's effect, no matter Hg contents were high or low in waters. Meanwhile, the source of Hg determined the horizontal distributions of Hg contents in surface and bottom waters. Horizontal distribution trends of Hg contents in surface and bottom waters were decreasing from the high value center (the location of source input) to locations far away along with the distance. Hence, once the horizontal distributions of Hg contents in surface and bottom water were identified, the major sources could also be identified.

4. Conclusion

Hg contents in surface waters in Jiaozhou Bay in May, July and November 1987 were 0.150-0.264 μg L-1, 0.088-1.104 μg L-1 and 0.007-0.088 μg L-1, respectively, while in bottom waters were 0.142-0.254 μg L-1, 0.089-0.404 μg L-1 and 0.000-0.038 μg L-1, respectively. Hg contents in both surface and bottom waters were in order of summer >spring > autumn.

The seasonal variation of Hg contents in surface and bottom waters in this bay were consistent. The seasonal variation of the growth and reproduction of plankton was impacting the seasonal variation of pollutants in marine bay. The sedimentation of Hg to bottom waters were in order of summer > spring > autumn. The major sources could also be identified in according to the horizontal distributions of Hg contents in surface and bottom waters.

Acknowledgments

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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] Yand 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, Guo 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 D F, Chen Y, Gao Z H, et al.: Chinese Journal of Oceanology and Limnology, Vol. 23(2005),p. 72-90.
[15] Yang DF, Wang FY, 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, Beijing 1991), p.205-282. (in Chinese)
[17] Yang DF, Wang FY, He HZ, et al.: Proceedings of the 2015 international symposium on computers and informatics, 2015, p.2655-2660.
[18] Yang DF, Wang,FY, Zhao XL, et al.: Sustainable Energy and Environment Protection, 2015, p. 191-195.
[19] Yang DF, Wang FY, Yang XQ, et al.:Advances in Computer Science Research, Vol. 2352 (2015), p.198-204.