Spatial-temporal changes and the influences of Hg sources in Jiaozhou Bay

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Dongfang Yang[1,2,3,a], Ye Li[4], Bailing Fan [1,2], Chunhua Su [1,2], Sixi Zhu [1,2]

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

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

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

[4] School of Computer Science, Fudan University, 201203, China.

[a]dfyang_dfyang@126.com.

Abstract. Using investigation on Hg in May and August 1990 in Jiaozhou Bay, this paper analyzed the spatial-temporal changes of Hg sources, and the influences on spatial-temporal changes of Hg contents. Results showed that the major Hg sources in May were atmosphere deposition in the center of the bay and the wharf in the north of the bay, whose source strengths were 0.208 μg L^{-1} and 0.194 μg L^{-1}, respectively. Meanwhile, the major Hg sources in August were also atmosphere deposition in the center of the bay and the wharf in the north of the bay, yet whose source strengths were relative low as 0.055 μg L^{-1} and 0.053 μg L^{-1}, respectively. In May, Hg contents in surface waters were higher than in bottom waters. After three months from May to August, a large amount of Hg was accumulated in sea bottom by means of continuous sediment process, resulting in Hg contents in surface waters in the center of the bay were lower than in bottom waters in August, while in the north of the bay mouth Hg contents were homogeneous between surface and bottom waters. At temporal scale, the source input amounts were decreasing from May to August, and Hg contents were decreasing from May to August. However, by means of sediment and accumulation effects, Hg contents in bottom waters were tending to be higher than or closed to what in surface waters. In general, the spatial-temporal changes of Hg contents in marine bay were strongly influenced by the spatial-temporal changes of the Hg sources.

1.Introduction

Many marine bays have been polluted in the past several decades due to the lagging of environmental protection to economic development [1-2]. Ocean is the sink that receives a large amount of pollutants via various sources such as atmosphere deposition, marine traffic, river discharge [3-5]. Understanding the changes of the major sources and their influences on the changes pollutant contents in marine bay is essential to environmental protection [6-8]. Jiaozhou Bay is a semi-closed bay located in Shandong Province, China. This bay is surrounded by cities of Qingdao, Jiaozhou and Jiaonan. This bay has been polluted by various pollutants including Hg since 1980s due to the rapid increase of industry and economic [9-15]. Using investigation on Hg in May and August 1990, this paper analyzed the spatial-temporal changes of Hg sources, and the influences on spatial-temporal changes of Hg. The aim of this paper is to provide scientific basis for pollution control in marine bay.

2.Materials and method

2.1Study area. Jiaozhou Bay (120°04′-120°23′ E, 35°55′-36°18′ N) 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 km^2, 7 m and 3 km, respectively. There are more than ten inflow rivers such as Haibo Rriver, Licun Rriver, and Loushan Rriver [16-17].

2.2Data source. The data was provided by North China Sea Environmental Monitoring Center. The investigations were conducted in May and August 1990, respectively. Surface and bottom water samples in 2 sampling sites (i.e., 55 and 60) were collected and measured followed by National Specification for Marine Monitoring (Fig. 1) [18].

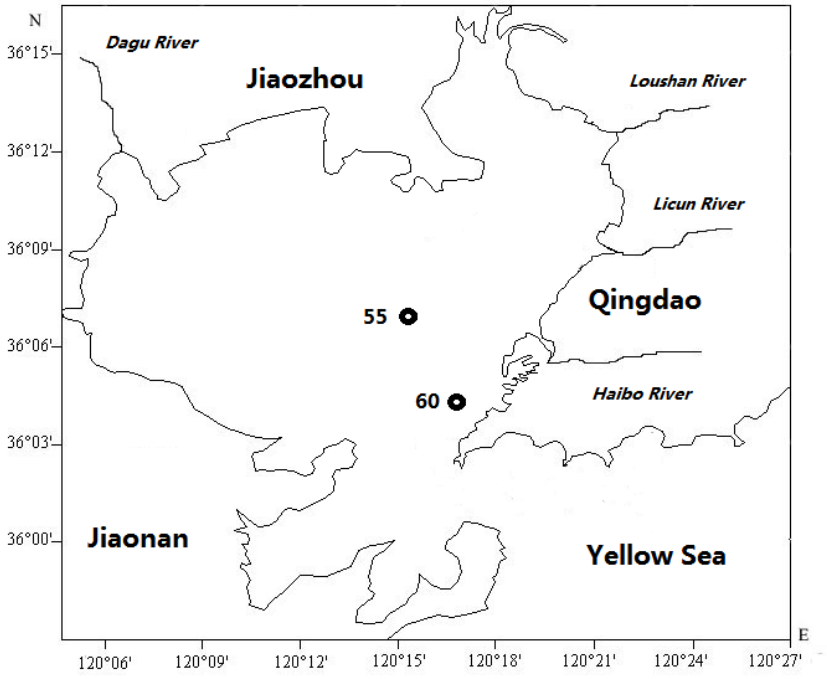

Fig. 1 Geographic location and monitoring sites in Jiaozhou Bay

3.Results and discussion

3.1Sources of Hg in May 1990. Hg contents in surface waters could be impacted by source input directly, and therefore the major source could be defined in according to the horizontal distribution of Hg in surface waters. In May 1990, there was a high value center of Hg contents in Site 55 in the center of the bay, and the contour lines of Hg contents were forming a series of concentric circles that decreasing from the center of the bay (0.208 μg L^{-1}) to the north of the bay (0.039 μg L^{-1}). Meanwhile, there was another high value center of Hg contents in Site 60in the north of the bay mouth, and the contour lines of Hg contents were forming a series of semi-circles that decreasing from the north of the bay (0.194 μg L^{-1}) to the northwest of the bay (0.024 μg L^{-1}). This indicated that the major Hg sources in May 1990 were atmosphere deposition in the center of the bay and the wharf in the north of the bay mouth, whose source strengths were 0.208 μg L^{-1} and 0.194, respectively.

3.2Sources of Hg in August 1990. In August 1990, there was a high value center of Hg contents in Site 55 in the center of the bay, and the contour lines of Hg contents were forming a series of concentric circles that decreasing from the center of the bay (0.055 μg L^{-1}) to the north of the bay (0.027 μg L^{-1}). Meanwhile, there was another high value center of Hg contents in Site 60 in the north of the bay

mouth, and the contour lines of Hg contents were forming a series of semi-circles that decreasing from the north of the bay (0.053 μg L^{-1}) to the northwest of the bay (0.034 μg L^{-1}). This indicated that the major Hg sources in May 1990 were atmosphere deposition in the center of the bay and the wharf in the north of the bay mouth, whose source strengths were 0.208 μg L^{-1} and 0.194 μg L^{-1}, respectively. This indicated that the major Hg sources in August 1990 were also atmosphere deposition in the center of the bay and the wharf in the north of the bay mouth, yet whose source strengths were relative low as 0.055 μg L^{-1} and 0.053 μg L^{-1}, respectively.

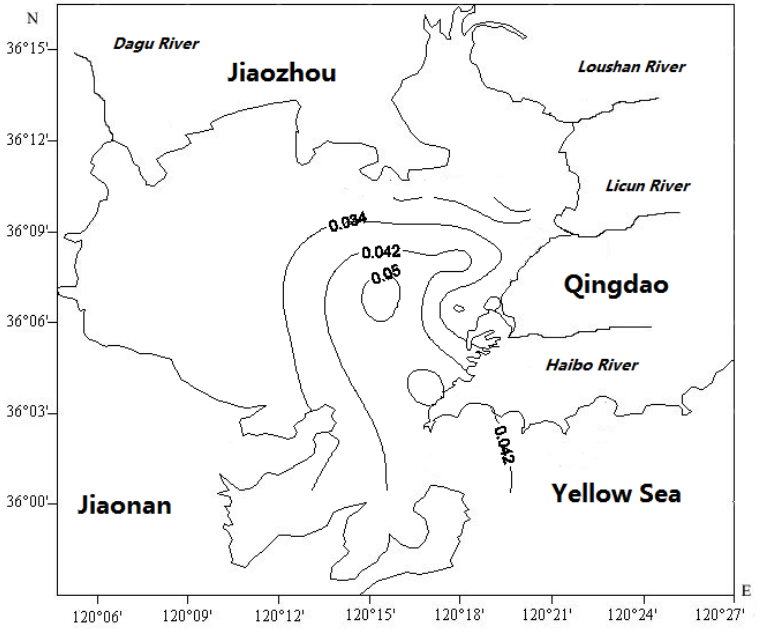

Fig. 2 Horizontal distribution in of Hg contents in surface waters in August 1990 in Jiaozhou Bay

3.3Spatial-temporal changes of Hg sources and contents. In May 1990, in waters in the centers of the bay, the major Hg source was atmosphere deposition whose source input was 0.208 μg L^{-1}. In this region, Hg contents in surface waters were higher than in bottom waters, and were decreasing from the center of the bay to the north of the bay. Meanwhile, in waters in the north of the bay, the major Hg sources was the wharf in the north of the bay mouth whose source input was 0.194 μg L^{-1}. In this region, Hg contents in surface waters were also higher than in bottom waters, and were decreasing from the north of the bay mouth to the northwest of the bay. In August 1990, in waters in the centers of the bay, the major Hg source was atmosphere deposition whose source input was 0.055μg L^{-1}. In this region, Hg contents in surface waters were lower than in bottom waters, and were decreasing from the center of the bay to the southwest of the bay. Meanwhile, in waters in the north of the bay, the major Hg sources was the wharf in the north of the bay mouth whose source input was 0.053 μg L^{-1}. In this region, Hg contents in surface waters were same with in bottom waters, and were decreasing from the north of the bay mouth to the northwest of the bay.

The spatial changes of Hg contents in May and August were different. In waters in the center of the bay, the source input of atmosphere was relative strong, by means of the three month continuous sediment, the accumulation of Hg in sea bottom was huge, resulted in Hg contents in surface waters in August were lower than in bottom waters. In waters in the north of the bay mouth, the source input of the wharf was relative weak, by means of the three month continuous sediment, the accumulation of Hg in sea bottom was huge, resulted in Hg contents were homogeneous between surface waters and bottom waters. At temporal scale, the source input amounts were decreasing from May to August, and Hg contents were decreasing from May to August. However, by means of sediment and accumulation effects, Hg contents in bottom waters were tending to be higher than or closed to what in surface

waters. In general, the spatial-temporal changes of Hg contents in marine bay were strongly influenced by the spatial-temporal changes of the Hg sources.

4.Conclusion

The major Hg sources in May were atmosphere deposition in the center of the bay and the wharf in the north of the bay, whose source strengths were 0.208 μg L^{-1} and 0.194 μg L^{-1}, respectively. The major Hg sources in August were also atmosphere deposition in the center of the bay and the wharf in the north of the bay, yet whose source strengths were relative low as 0.055 μg L^{-1} and 0.053 μg L^{-1}, respectively.

At spatial scale, Hg contents in surface waters in May were higher than in bottom waters. After three months from May to August, a large amount of Hg was accumulated in sea bottom by means of continuous sediment process, resulting in the fact that Hg contents in surface waters in the center of the bay were lower than in bottom waters in August, while in the north of the bay mouth Hg contents were homogeneous between surface and bottom waters.

At temporal scale, the source input amounts were decreasing from May to August, and Hg contents were decreasing from May to August. However, by means of sediment and accumulation effects, Hg contents in bottom waters were tending to be higher than or closed to what in surface waters. In general, the spatial-temporal changes of Hg contents in marine bay were strongly influenced by the spatial-temporal changes of the Hg sources.

Acknowledgement

This research was sponsored by Doctoral Degree Construction Library of Guizhou Nationalities University, 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).

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