Research on the distributions and migrations of Zn in marine bay

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Abstract. This paper analyzed the vertical distribution and seasonal variations of Zn in waters of Jiaozhou Bay, Shandong Province, eastern China. Results showed that the Zn contents in Jiaozhou Bay waters were highest in spring and then decreasing from summer to autumn. There was an accumulation process of Zn in land surface in winter, and the ice and snow thaw as well as in increasing of rainfall runoff in spring leading to the increasing of the input of Zn to the bay. By processes of sedimentation and diffusion, Zn was continually depositing to the sea bottoms, and was decreasing from the pollution sources. Finally, we conclude that the Zn contents in the bay waters were mainly determined by the accumulation of Zn in land surface in winter, and the migration of Zn in bay waters were mainly determined by vertical sedimentation and water exchange.

Introduction

Zn was one of the materials for industries of pesticide, pharmaceutical, alloying etc. Although Zn was one of the essential elements for both plants and animals, the excessive intake of Zn could be harmful to organisms [1]. In recent years, the ecological hazard of Zn had drawn increasing attention [2]. Moreover, heavy metals such as Zn could be accumulated in biological tissues, and the biological magnification of Zn was more serious. For instance, Zn pollution in the marine waters could be poisonous to marine organism, and finally to human by means of food chain if sea foods contaminate by Zn were edibled.

Jiaozhou Bay is a semi-closed bay located in Shandong Province, eastern China (35°55′-36°18′ N, 120°04′-120°23′ E). The total water area was 390 km^2, yet the width of the bay mouth was only 3 km [2]. The pollution of Zn in this bay was increasing after 1980s due to the development of industries. Being a semi-closed bay, the water exchange capacity of Jiaozhou Bay was relative weak, which enhanced the significance of the understanding of the migrations of the pollutants.

Hence, understanding the Zn pollution and migration of Zn was one of the basis efforts for environmental protection. Based on investigation data of Zn in waters in Jiaozhou Bay in five sampling sites (084, 121, 122, 083 and 123) in April, July and October 1982 (Fig. 1), the major aims of this paper were to analysis the seasonal variations and migrations of Zn, and to provide basis for pollution control of Zn.

Seasonal variations of Zn

In April, July and October in surface waters, Zn contents were 37.90-167.71 $\mu g.L^{-1}$, 7.05-12.18 $\mu g.L^{-1}$ and 2.22-5.36 $\mu g.L^{-1}$, respectively. Accordingly, the Zn contents were 39.07-137.34 $\mu g.L^{-1}$, 6.00-13.40 $\mu g.L^{-1}$ and 2.13-5.63 $\mu g.L^{-1}$ respectively in bottom waters. It could be concluded that Zn contents in both surface and bottom waters in Jiaozhou Bay showed significant seasonal variations, whose contents were in order of spring > summer > autumn (Fig. 2). Zn in Jiaozhou Bay was mainly inputted by stream flow, which was mainly determined by rainfall runoff. In winter, a large

amount of Zn was accumulated in land surface. Subsequently, the rainfall was increasing in the next spring, in addition with the ice and snow thaw, and the input of Zn to the bay was rapidly increasing in the spring.

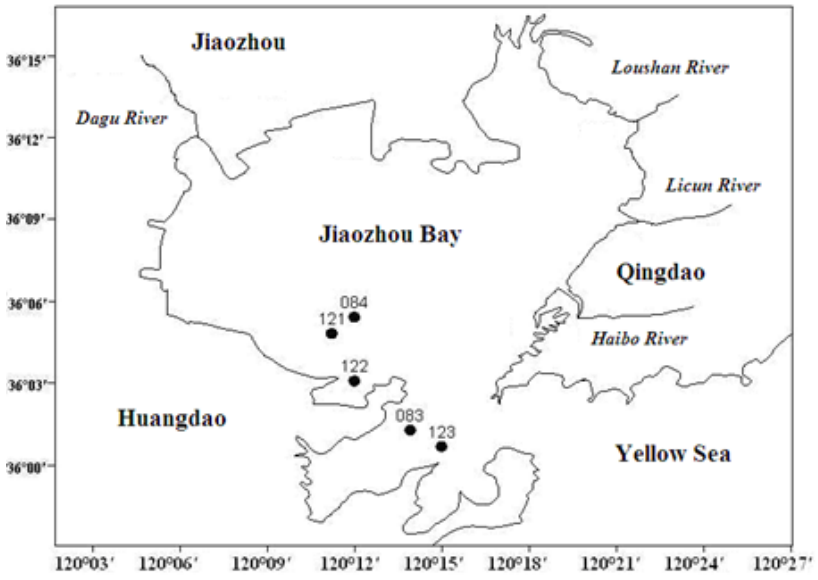

Fig.1 Sampling sites of Zn in Jiaozhou Bay

Vertical distributions of Zn

Zn contents in surface waters were higher than in bottom waters in different seasons (Fig. 2). Zn irons in sea waters had strong capacity to be combined with suspended particles and phytoplankton, same as many other metal irons such as Cu. The feature could strongly influence the vertical migration of Zn in sea waters. The growth and reproduction of phytoplankton were increasing in warm season especially in summer [4], as well as the absorption of Zn, resulting in the increasing of the sedimentation of Zn in summer and autumn. During spring, most of the accumulated Zn in land surface had been transferred to the bay, leaving few Zn in land surface in summer and autumn even if the rainfall in summer and autumn was generally more abundant than in spring. Hence, Zn in bottom waters in summer and autumn would not be increasing even the sedimentation was constant.

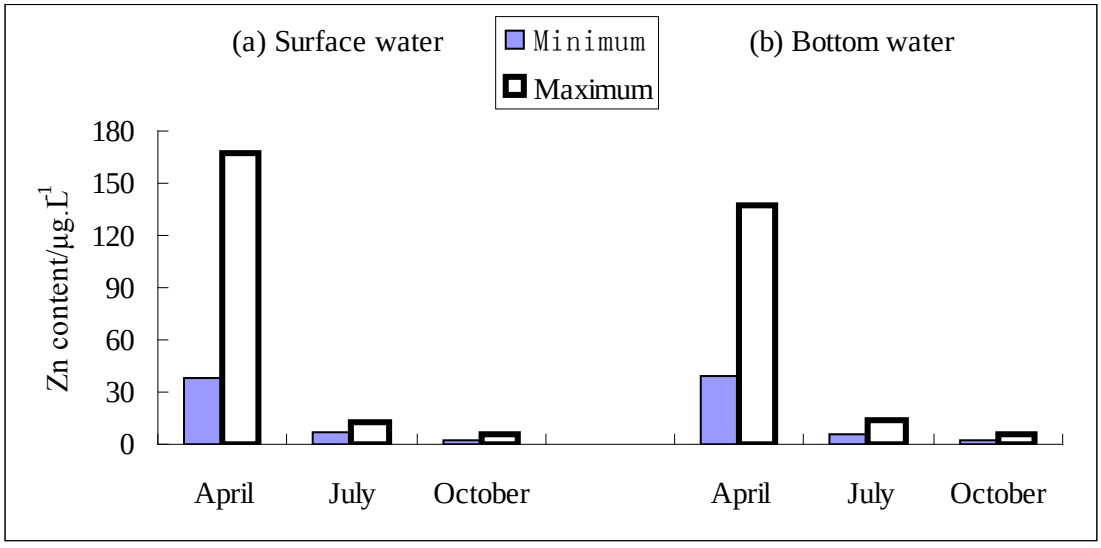

Fig. 2 The minimum and maximum of Zn contents in a) surface waters and b) bottom waters in April, July and October 1982 in Jiaozhou Bay

Horizontal diffusion of Zn

The horizontal distributions of Zn in bottom waters in Jiaozhou Bay in April, July and October were showing inverse trends (Fig. 3). In April, Zn contents were decreasing from the inshore waters to the center of the bay, confirming that the accumulated Zn in land surface was transferred to the bay by overland runoff and stream flow. In July, the Zn contents were decreasing from the bay mouth to the center of the bay, along with the flow direction of the ocean current, indicating the diffusion effect of water exchange. In October, the Zn contents were decreasing from center of the bay to the inshore waters, indicating that atmospheric deposition was one of the major sources of Zn in wet season. In generally, Zn contents were decreasing form the pollution sources to the around areas by means of water exchange.

Conclusion

Zn contents in both surface and bottom waters in Jiaozhou Bay were in order of spring > summer > autumn. Zn in Jiaozhou Bay was mainly inputted by stream flow, as well as atmospheric deposition. There was an accumulation process of Zn in land surface in winter, leading to the increasing of the input of Zn to the bay. By processes of sedimentation and diffusion, Zn was continually depositing to the sea bottoms, and was decreasing from the pollution sources.

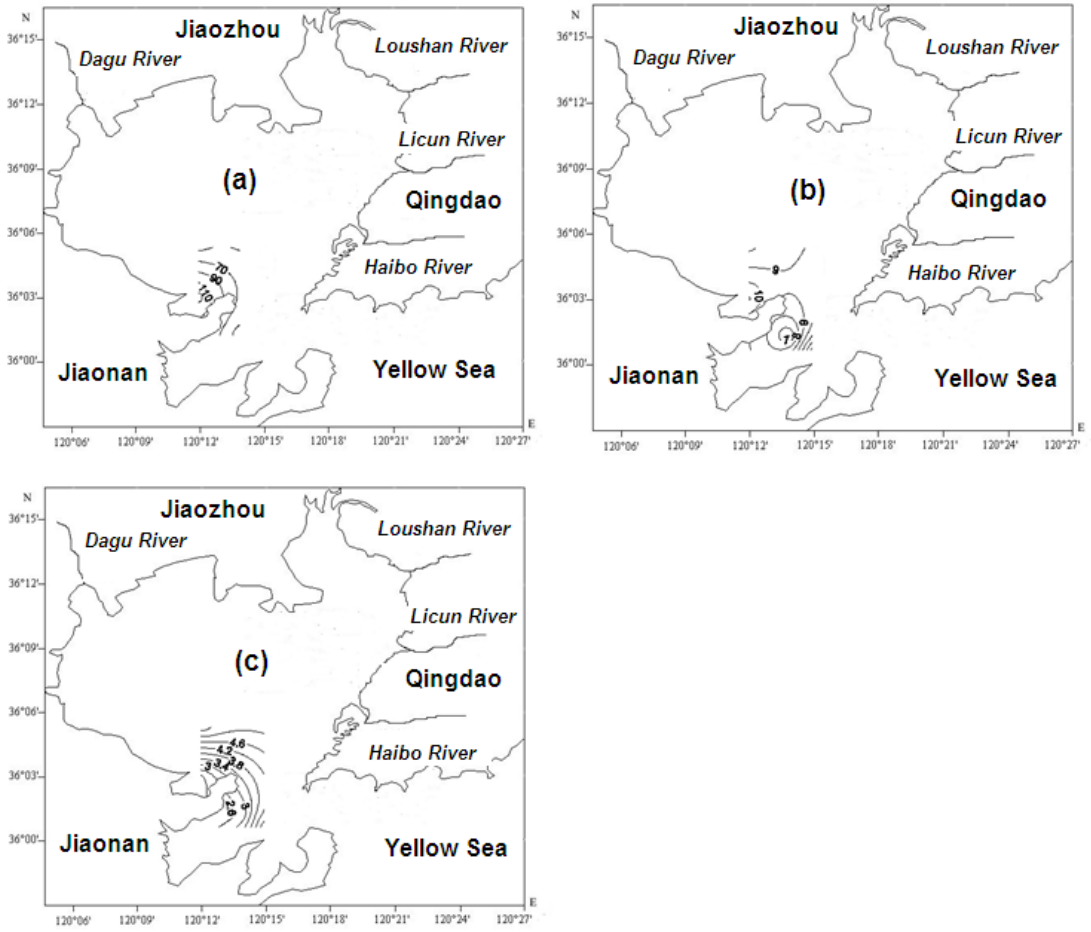

Fig. 3 Distributions of Zn in bottom waters in Jiaozhou Bay in a) April, b) July and c) October 1982/μg.L^{-1}

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