Horizontal Distribution Trends of Hg in Marine Bay 1989

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Horizontal Distribution Trends of Hg in Marine Bay 1989

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Abstract. This paper analyzed the contents and distribution trends of Hg in surface and bottom waters in April and July 1989. Results showed that Hg contents in surface and bottom waters were 0.066-0.146 μg L⁻¹ and 0.064-0.109 μg L⁻¹, respectively. In July 1989, Hg contents in surface and bottom waters were 0.005-0.046 μg L⁻¹ and 0.012-0.017 μg L⁻¹, respectively. The pollution level of Hg in Jiaozhou Bay 1989 was still slight. The seasonal variations of Hg in both surface and bottom waters were spring > summer. The seasonal variations of Hg contents in surface waters were determined by the changes of the major Hg sources, while the corresponding seasonal variations of Hg contents in bottom waters were results of accumulation effect and dilution effect of waters. There was about a period of six months between the end of the rainy season to the beginning of the rainy season in the flowing year, in which a big part of Hg was accumulated in land surface and river bed. By means of vertical water’s effect, the horizontal distribution trends of Hg in surface and bottom waters were consistent no matter in different seasons.

1. Introduction
Hg has been widely used in various industries, and a large amount of Hg-containing wastes were generated and discharged to the environment along with the rapid development of industries[1-2]. However, industrial waste treatment in many countries and regions is always lagging, resulting in many marine bays were polluted by Hg since ocean is the sink of pollutants [5-6]. Furthermore, Hg is high toxic and the excessive existence of Hg in the environment is harmful to organism and ecosystem [3-4].

Jiaozhou Bay is a semi-closed bay located in Shandong Province China, and has been polluted by various pollutants including Hg after the rapid increasing of industry since Reform and Opening-up [10-14]. Using investigation data on Hg in surface and bottom waters in Jiaozhou Bay in April and July 1989, this paper analyzed the contents and distributions of Hg. The aim of this paper was to better understand the transporting processes of Hg in marine bay, and provide basis for scientific research and environment remediation.

2. Materials and method
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 are 446 km² and 7 m, respectively. The bay mouth is very narrow (3 km), and is connected to the Yellow Sea in the south. There are a dozen of rivers including Dagu River, Haibo River, Licun River, and Loushan River etc., all of which are seasonal rivers [15-16].
The investigation on Hg in surface and bottom waters in Jiaozhou Bay was carried on by North China Sea Environmental Monitoring Center. In April and July 1989, Hg contents in bottom waters were measured in Site 85 and Site 90 in the bay center and the bay mouth, respectively (Fig. 1). Hg in waters was sampled and monitored follow by National Specification for Marine Monitoring [17].

![Fig. 1 Geographic location and monitoring sites in Jiaozhou Bay](image_url)

3. Results

3.1 Pollution level of Hg contents in surface and bottom waters. In April 1989, Hg contents in surface and bottom waters were 0.066-0.146 μg L⁻¹ and 0.064-0.109 μg L⁻¹, respectively. These contents were higher than Grade I (0.05 μg L⁻¹) and up to Grade II (0.20 μg L⁻¹) for Hg in Sea Water Quality Standard (GB 3097-1997). In July 1989, Hg contents in surface and bottom waters were 0.005-0.046 μg L⁻¹ and 0.012-0.017 μg L⁻¹, respectively. These contents were up to than Grade I (0.05 μg L⁻¹) for Hg in Sea Water Quality Standard (GB 3097-1997). In general, the pollution level of Hg in Jiaozhou Bay 1989 was still slight.

3.2 Seasonal variations of Hg in surface and bottom waters. In study area, April and July are spring and summer, respectively. In according to Hg contents in April and July 1989, the seasonal variations of Hg in both surface and bottom waters were spring > summer. Hence, the seasonal variations of Hg in both surface and bottom waters are same. Meanwhile, Hg contents in surface waters in April were relatively high, as well as in bottom waters. Furthermore, Hg contents in surface waters in July were relatively low, as well as in bottom waters. There were displaying the vertical waters’s effect and horizontal waters’s effect [12-14].

3.3 Horizontal distributions of Hg in surface and bottom waters. In April 1989, Hg contents in surface and bottom waters were relatively high in Site 90 in the bay mouth, and the contour lines of Hg contents were forming a series of parallel lines decreasing from the bay mouth to the bay center. In July 1989, Hg contents were relative high in Site 85 in the bay center, and the contour lines of Hg contents in surface and bottom waters were forming a series of parallel lines decreasing from the bay center to the bay mouth. Hence, the horizontal distribution trends of Hg contents in surface and bottom waters were consistent no matter in spring or in summer.
4. Discussion

4.1 Vertical migrating process. Hg contents in waters were changing a lot while transporting through the waters by means of vertical waters’s effect [12-14]. The growth and reproduction of marine zooplankton and phytoplankton were increasing from spring to summer [16], resulting a great deal of colloid which was able to enhance the absorption capacity of suspending particular matters. Hence, a big part of Hg was absorbed to the suspending particular matters and transported to sea bottom continuously by means of gravity force and marine current [11]. That was the vertical sedimentation process of Hg.

4.2 Seasonal changing process. In spring, the major Hg sources in Jiaozhou Bay was river flow, whose source strengths were relatively strong, and Hg contents in waters were relatively high. In summer, the major Hg source was river flow yet the source strength was relatively weak, and Hg contents in waters were relatively low. Hg contents in surface waters in Jiaozhou Bay were increasing from a relatively high level in April, and then decreasing and reaching a relatively low level in July. By means of vertical water’s effect and horizontal water’s effect [12-14], Hg contents were settling to sea bottom rapidly and continuously. The relatively high Hg contents were diluted when arrived at sea bottom, while the relatively low Hg contents were accumulated when arrived at sea bottom [12-14], resulted in Hg contents in surface and bottom waters were in order of spring >summer. Hence, the sedimentation process of Hg in waters in April and July 1989 revealed the accumulation effect and dilution effect. The seasonal variations of Hg contents in surface waters were determined by the changes of the major Hg sources, while the corresponding seasonal variations of Hg contents in bottom waters were results of accumulation effect and dilution effect of waters.

4.3 Mechanism of Hg’s seasonal changing process. Jiaozhou Bay is a semi-closed bay (Fig. 1), which is surrounded by land in the east, north and west, and is connected with open waters via a narrow bay mouth in the south. Hg contents in waters were decreasing vertically, and were showing the gravity settling of Hg. The horizontal distributions of Hg contents in surface and bottom waters were confirming the migration process and mechanism in waters [1-11]. The settling process of Hg indicated that Hg was low soluble in waters and could be absorbed to suspending particular matters and transported from surface waters to bottom waters, and fixed to sedimentation in sea bottom finally. The anthropogenic Hg discharged to the environment could be finally transported to waters via water cycle, and to sea bottom finally by means of water’s effect. Once the rainy season has ended, a big part of anthropogenic Hg discharged to air and soil was remained in land surface, and a big part of anthropogenic Hg discharged to rivers was remained in the river bed. There was about a period of six months between the end of the rainy season to the beginning of the rainy season in the flowing year, in which a big part of Hg was accumulated in land surface and river bed. When the rainy season was coming again in the flowing year, a lot of Hg was washing from land surface and transporting from river, and was discharging to ocean. Hence, Hg contents in April 1989 were higher. As the rainy season was going on, the remaining Hg in land surface and river bed was decreasing, and the content and flux of Hg to waters and ocean were also decreasing in July 1989. The seasonal variations of Hg contents in 1988 were consistent with other years of 1979, 1980, 1981, 1985, 1986 and 1988 [9-11]. That was the seasonal variation’s mechanism of Hg, and was also the terrestrial migration mechanism.

4.4 Mechanism of Hg’s spatial changing process. The input of Hg to Jiaozhou Bay in April 1989 was relatively high, and the horizontal distributions of Hg contents in surface and bottom waters were reverse. Hg contents in surface waters were decreasing from the bay center to the bay mouth in April 1989, and a big part of Hg was settling rapidly to bottom waters by means of gravity and current. However, the relatively high Hg contents were just arriving at the bay mouth, in which the sedimentation of Hg was just beginning. Hence, Hg contents in bottom waters in the bay center were still relatively low, resulted in an increasing trend from the bay center to the bay mouth. The input of
Hg to Jiaozhou Bay in July 1989 was relatively low, and the horizontal distributions of Hg contents in surface and bottom waters were consistent. Hg contents in surface waters were also decreasing from the bay center to the bay mouth in July 1989, and a big part of Hg was settling rapidly to bottom waters by means of gravity and current. Since the sedimentation of Hg was on-going from spring to summer, a lot of Hg was accumulating in the inner side of the bay mouth, resulted in a decreasing trend from the inner side of the bay mouth to the outer side of the bay mouth. In general, the spatial changing trends of Hg in surface and bottom waters were consist by means of vertical water’s effect [12-14].

5. Conclusions
The pollution level of Hg in Jiaozhou Bay 1989 was still slight. The seasonal variations of Hg in both surface and bottom waters were spring > summer. The seasonal variations of Hg contents in surface waters were determined by the changes of the major Hg sources, while the corresponding seasonal variations of Hg contents in bottom waters were results of accumulation effect and dilution effect of waters. There was about a period of six months between the end of the rainy season to the beginning of the rainy season in the flowing year, in which a big part of Hg was accumulated in land surface and river bed. By means of vertical water’s effect, the horizontal distribution trends of Hg contents in surface and bottom waters were consistent no matter in spring or in summer.

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