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Mercury Content Transported from Atmosphere and Land to Jiaozhou Bay

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Abstract: According to the data of May, August and October 1992, the range of Hg content in Jiaozhou Bay waters was 0.009-0.050 μg /L, which met the water quality standard of class I sea water. This showed that in terms of Hg content, in May, August and October, the water of Jiaozhou Bay was clean and free from any Hg pollution. In May, the range of Hg content in Jiaozhou Bay waters was 0.009-0.038 μg /L. In August, the range of Hg content in Jiaozhou Bay waters was 0.021-0.050 μg/L. In October, the range of Hg content in Jiaozhou Bay waters was 0.011-0.040 μg /L. There were two sources of Hg content in Jiaozhou Bay waters, surface runoff and atmospheric deposition. The Hg content from surface runoffwas 0.038-0.040 μg /L, and that from atmospheric deposition was 0.050 μg /L. The model diagram was established to show the different paths and contents of Hg content in the process of input into Jiaozhou Bay. In May and October, the surface runoff was not polluted by any Hg content. In August, atmospheric deposition was not contaminated by any Hg content. That revealed that Hg, humans issued to land and atmosphere, finally got to the ocean. There were two paths. One is that human beings discharge Hg into the atmosphere, and the Hg content reached into the ocean through atmospheric sedimentation. The Hg content from atmospheric sedimentation was relatively high, but the transportation time was relatively short. The other is that human beings discharge Hg content to the land. Through surface runoff, the Hg content reached into the ocean, and the Hg content from surface runoff was relatively low, but the transportation time was relatively short. With more and more paths, Hg content was decreasing.

1 Introduction

In modern times, with the development of industry, many industries released a lot of mercury (Hg) to the environment in the process of production. In this way, human beings continuously discharge Hg content to land, atmosphere and ocean [1-14]. Therefore, the study on the pollution degree and source [1-14] of Hg content in offshore waters will help protect the marine environment and maintain ecological sustainable development. Based on the survey data in 1992, the content, horizontal distribution and source of Hg in Jiaozhou Bay water were analyzed. The water quality, source background and source quantity of Hg in Jiaozhou Bay water were studied for the study of the source, pollution degree and migration process of Hg in Jiaozhou Bay water.

2 Investigation Waters and Methods

2.1 Natural Environments of Jiaozhou Bay

Jiaozhou Bay is located in the south of Shandong Peninsula. Its geographical location is 120 ° 04 ′ - 120 ° 23 ′ E, 35 ° 58 ′ - 36 ° 18 ′ N. It is bounded by the line between Tuan island and Xuejia island and connected with the Yellow Sea, covering an area of about 446km2, with an average water depth of about 7m. It is a typical semi closed Bay. There are more than ten rivers flowing into the sea in Jiaozhou Bay, among which Dagu River, Yang River and Haibo River, Licun River and Loushan River are the ones with large runoff and sediment concentration. These are all seasonal rivers. The hydrological characteristics of these rivers can alter in different seasons [15, 16].

2.2 Materials and Methods

The survey data of Hg in Jiaozhou Bay in May, August and October 1992 were provided by the North Sea Monitoring Center of The State Oceanic Administration. 13 stations were set up in Jiaozhou Bay to take water samples: 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 2104, 2105 and 2106 stations (Figure 1). The samples were taken in May, August and October of 1992 respectively. According to the water depth, water samples were taken (> 10m, surface layer and bottom layer, and < 10m, only surface layer). The Hg content of Jiaozhou Bay water body was investigated according to the national standard

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method, which was included in the National Marine Monitoring Code (1991) [17].

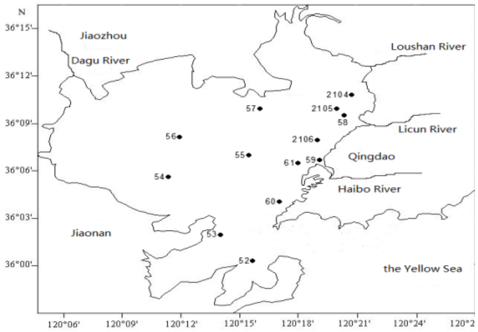

Fig.1 Investigation sites in Jiaozhou Bay

3 Results

3.1 Content

The quality standards for class I sea water (0.05 μg /L), class II sea water (0.20 μ g / L) and class IV sea water (0.50 μg /L) were regulated by the administration. In May, August and October, the range of Hg content in Jiaozhou Bay waters were 0.009-0.050 μg /L, which met the water quality standards of class I and class II seawater.

In May, the range of Hg content in Jiaozhou Bay waters was 0.009-0.038 μg /L (Table 1). The high value area was the coastal waters in the southwest of Jiaozhou Bay. In the coastal waters in the southwest of Jiaozhou Bay, the 54 station, the content of Hg in the water was 0.038 μg/L, which meets the water quality standard of class I sea water (0.05μg/L). In addition to the waters in the southwest of the Bay, other waters in Jiaozhou Bay, such as the waters in the northeast, North and center of the Bay, the Hg content is relatively low, less than 0.023μg/L. This shows that the water quality in the northeast, north and central waters of the bay is clean in terms of Hg content, which has reached the water quality standard of class I sea water.

In August, the range of Hg content in Jiaozhou Bay waters was 0.021-0.050 μg/L (Table 1). The high value area was the coastal waters in the east of Jiaozhou Bay. In the coastal waters in the east of Jiaozhou Bay, the 2106 station, the Hg content was higher than 0.050μg/L, which met the water quality standard of class I sea water (0.05μg/L). In addition to the coastal waters in the east of the Bay, in other waters of Jiaozhou Bay, such as the waters in the northeast, north and center of the Bay, the content of Hg is relatively low, less than 0.037μg/L. It is in line with the national water quality standard of class I seawater (0.05μg/L). In terms of Hg content, the waters was clean and met the water quality standard of class I seawater.

In October, the range of Hg content in Jiaozhou Bay waters was 0.011-0.040 μg/L (Table 1), and the high value areas appeared in the northwest, southwest, mouth and center of Jiaozhou Bay. In 56, 54, 53 and 55 Stations that were respectively in the northwest, southwest, mouth and center of Jiaozhou Bay, the content of Hg in the waters was higher than 0.040 μg/L, which met the water quality standard of class I sea water (0.05μg/L). Except the waters in the northwest, southwest, estuary and center of Jiaozhou Bay, the Hg content in other waters of Jiaozhou Bay, such as the waters in the northeast, north and east of Jiaozhou Bay, was relatively low, less than 0.029 μg/L. This showed that the water quality in the northeast, north and east of the Bay, in terms of Hg content, was clean and met the water quality standard of class I sea water.

Therefore, in May, August and October, the range of Hg content in Jiaozhou Bay was 0.009-0.050 μg/L, which conformed to the water quality standard of class I sea water. This showed that in the aspect of Hg content, in May, August and October, the water quality of Jiaozhou Bay reached the water quality standard of class I seawater. The water quality is clean and free from any Hg pollution (Table 1).

Table 1 The quality of water surface in Jiaozhou bay in May, August and October

	May	August	October
Hg content in seawater /μg·L-1	0.009-0.038	0.021-0.050	0.011-0.040
seawater standard of China	first-class	first-class	first-class

3.2 Horizontal Distribution in Surface Layer

In May, at 54 station in the coastal waters in the southwest of Jiaozhou Bay, the Hg content reached a high level of 0.038μg/L, and a series of parallel lines with different gradients were formed with the southwest waters as the center. The Hg content decreased from 0.038 μg/L in the center to 0.015 μg/L in the eastern part of the Bay and 0.009 μ g / L in the northern part of the Bay (Fig. 2).

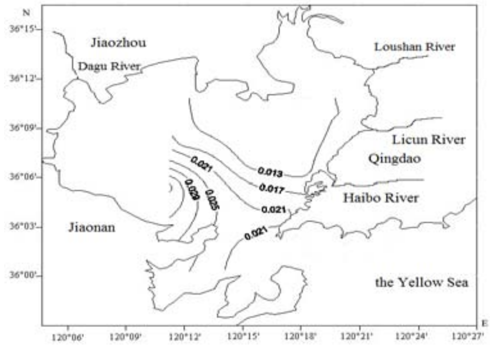

Fig.2 Hg content distribution at the surface in Jiaozhou Bay in May(μg/L)

In August, at the 2106 station in the eastern waters of Jiaozhou Bay, the Hg content reached a high level of 0.050 μg/L, and a high Hg content area was formed with the eastern waters as the center, forming a series of semi concentric circles with different gradients. The Hg content decreased from 0.050 μg/L in the center to 0.021 μg/L in the center of the Bay (Fig. 3).

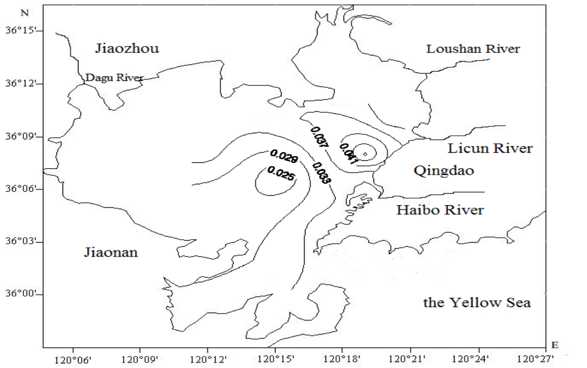

Fig.3 Hg content distribution at the surface in Jiaozhou Bay in August(μg/L)

In October, at the 56 station in the northwest of Jiaozhou Bay, 54 station in the southwest, 53 station at Wankou and 55 station in the center of Jiaozhou Bay, the Hg content reached 0.040 μg/L, a high Hg content area was formed with the water area in the southwest of Jiaozhou Bay as the center, forming a series of parallel lines with different gradients. The Hg content decreased from 0.040 μg/L in the center to 0.011 μ g/L in the north of the Bay, 0.015 μg/L in the east of the Bay and 0.011 μg/L in the southeast of the Bay (Figure 4).

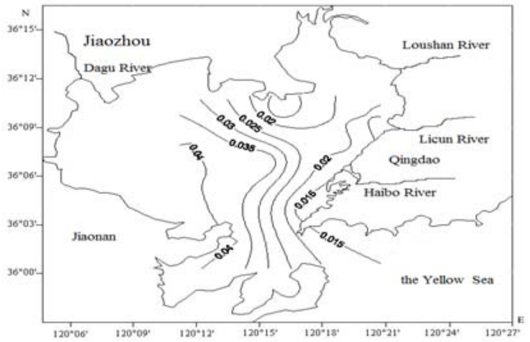

Fig.4 Hg content distribution at the surface in Jiaozhou Bay in October (μg/L)

4 Discussion

4.1 Water Quality

In May, August and October, the range of Hg content in Jiaozhou Bay waters was 0.009-0.050 μg/L, which met the water quality standard of class I seawater. This showed that in terms of Hg content, in May, August and October, the water of Jiaozhou Bay was clean and free from any Hg pollution.

In May, the range of Hg content in Jiaozhou Bay water was 0.009-0.038 μg/L, and the water area of Jiaozhou Bay was not polluted by Hg. In the coastal waters in the southwest of Jiaozhou Bay, the Hg content reached a relatively high level of 0.038 μg /L, which showed that the seawater quality has reached the water quality standard of a class of seawater, and the waters was not polluted by Hg. Except the water area in the southwest of Jiaozhou Bay, the content of Hg was relatively low in other waters of Jiaozhou Bay, which met the national water quality standard of class I sea water. The water was clean and not polluted by Hg.

In August, the range of Hg content in Jiaozhou Bay waters was 0.021-0.050 μg/L, and the water area of Jiaozhou Bay was not polluted by Hg. In the coastal waters in the east of Jiaozhou Bay, the content of Hg has reached a relatively high level of 0.050 μg/L, which showed that the water quality of seawater has reached the water quality standard of a class of seawater, and the waters was not been polluted by Hg. Except the coastal waters in the east of Jiaozhou Bay, the content of Hg is relatively low in other waters of Jiaozhou Bay, which met the water quality standard of national class I seawater. The water was clean and has not been polluted by Hg.

In October, the range of Hg content in Jiaozhou Bay waters was 0.011-0.040 μg/L, and the water area of Jiaozhou Bay was not polluted by Hg. In the waters of the northwest, southwest, mouth and center of Jiaozhou Bay, the Hg content has reached a relatively high level of 0.040 μg/L, which showed that the sea water quality has reached the water quality standard of class I sea water, and the water was not been polluted by Hg. Except the water areas in the northwest, southwest, Wankou and the center of the Bay, the Hg content was relatively low, which met the water quality standard of the national class I seawater. The water was clean and not polluted by Hg.

4.2 Source

In May, a high Hg content area was formed in the southwest water area of Jiaozhou Bay, which indicated that the source of Hg was the surface runoff. The content of Hg in transportation was 0.038 μg/L, which was relatively high.

In August, a high content area of Hg was formed in the eastern waters of Jiaozhou Bay, which indicated that the source of Hg was atmospheric deposition. The Hg content in transportation was 0.050 μg/L, which was very high.

In October, a high content area of Hg was formed in the southwest water area of Jiaozhou Bay, which indicated that the source of Hg was surface runoff. The content of Hg in transportation was 0.040 μg/L, which was relatively high.

Therefore, in May, the Hg content transported by surface runoff to Jiaozhou Bay was 0.038 μg/L, which was in line with the national class I sea water quality standard of 0.05 μg/L. This indicated that the surface runoff was not contaminated by any Hg content (Table 2). In August, the Hg content transported to Jiaozhou Bay from atmospheric subsidence was 0.050 μg/L, which was in line with the national class I sea water quality standard of 0.05 μg/L. This indicated that the atmospheric deposition was not contaminated by any Hg content (Table2). In October, the content of Hg transported by surface runoff to Jiaozhou Bay was 0.040 μg/L, which was in line with the national class I sea water quality standard of 0.05 μg/L. This indicated that the surface runoff was not contaminated by any Hg content (Table2).

Table.2 The Hg contents from the different sources in Jiaozhou bay

Time	May	August	October
Sources	Surface runoff	atmospheric deposition	Surface runoff
Hg content/μg·L1	0. 038	0.050	0.040

4.3 Model Diagram of Transportation

There are two sources of Hg content in Jiaozhou Bay waters, surface runoff and atmospheric deposition. The Hg content from surface runoff was between 0.038-0.040 μg/L, and that from atmospheric deposition was 0.050 μg/L. The model diagram was established to show the different paths and contents of Hg content in the process of entering Jiaozhou Bay (Fig. 5). In this way, the migration process of Hg content from human emission to atmosphere and ocean was quantitatively revealed.

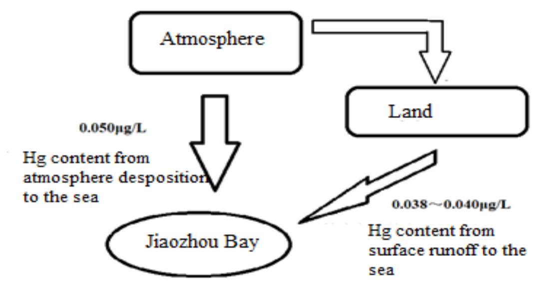

Fig.5 the main source of the Hg content into the Jiaozhou bay (μg/L)

In May, the Hg content in transportation from surface runoff to Jiaozhou Bay was 0.038 μg/L, a relatively low level. This showed that the surface runoff was not polluted by any Hg content.

In August, the Hg content in transportation from atmospheric deposition to Jiaozhou Bay was 0.050 μg/L Hg, a relatively high level. And the atmospheric deposition was not polluted by any Hg content.

In October, the Hg content in transportation from surface runoff to Jiaozhou Bay was 0.040 μg/L, a relatively low level. And the surface runoff was not polluted by any Hg content.

4.4 Change of Content in Transportation

In May, the Hg content transported from surface runoff to Jiaozhou Bay was 0.038 μg/L, and the surface runoff was not polluted by any Hg content. This showed that the Hg content of human emissions to land was relatively low, and the Hg content of direct emissions to the ocean through surface runoff was also relatively low. In this way, there is no pollution of Hg content on land.

In August, the Hg content transported to Jiaozhou Bay by atmospheric deposition was 0.050 μg/L, and the atmospheric deposition was not polluted by any Hg content, which revealed that the Hg content of human emissions to the atmosphere was relatively high, which brought about the increase of the migration paths of the Hg content, so that the area of human emissions through the atmosphere was expanding. On the other hand, after a long time of human input to the ocean, the Hg content of the ocean has increased, and the ocean was polluted lightly.

In October, the Hg content transported from the surface runoff to Jiaozhou Bay was 0.040 μg/L, and the surface runoff was not polluted by any Hg content. This showed that from May to October, human issued Hg content to land continuously, and the Hg content of human emission to land is relatively low. However, the duration of emission was relatively long, and the Hg content of human emission to land was relatively stable: 0.038-0.040 μg/L. The content of Hg discharged directly to the ocean through surface runoff was also relatively low. In this way, there is no pollution of Hg content on land.

That revealed that Hg content, humans issued to land and atmosphere, finally got to the ocean. There were two paths. One is that human beings discharge Hg into the atmosphere, and the Hg content reached into the ocean through atmospheric sedimentation. The Hg content from atmospheric sedimentation was relatively high, but the transportation time was relatively short. The other is that human beings discharge Hg content to the land. Through surface runoff, the Hg content reached into the ocean, and the Hg content from surface runoff was relatively low, but the transportation time was relatively short. With more and more paths, Hg content was decreasing.

5 Conclusion

In May, August and October, the range of Hg content in Jiaozhou Bay waters was 0.009-0.050 μg/L, which met the water quality standard of class I seawater. This showed that in terms of Hg content, in May, August and October, the water of Jiaozhou Bay was clean and free from any Hg pollution.

In May, the range of Hg content in Jiaozhou Bay water was 0.009-0.038 μg/L, and the water area of Jiaozhou Bay was not polluted by Hg. In the coastal waters in the southwest of Jiaozhou Bay, the content of Hg reached a relatively high level of 0.038 μg/L. In other waters of Jiaozhou Bay, the content of Hg was relatively low.

In August, the range of Hg content in Jiaozhou Bay water was 0.021-0.050 μg/L, and the water area of Jiaozhou Bay was not polluted by Hg. In the coastal waters in the east of Jiaozhou Bay, the content of Hg was 0.050 μg/L, a relatively high level, and in other waters of Jiaozhou Bay, the content of Hg was relatively low.

In October, the range of Hg content in Jiaozhou Bay water was 0.011-0.040 μ g / L, and the water area of Jiaozhou Bay was not polluted by Hg. In the northwest, southwest, mouth and center of Jiaozhou Bay, the content of Hg was 0.040 μg/L, higher than that in other waters.

There are two sources of Hg content in Jiaozhou Bay waters, surface runoff and atmospheric deposition. The Hg content from surface runoff was 0.038-0.040 μg /L, and that from atmospheric deposition was 0.050 μg /L. The model diagram was established to show the different paths and contents of Hg content in the process of input into Jiaozhou Bay. This quantitatively revealed the migration process of Hg content from human emissions to the atmosphere and land.

Therefore, in May and October, the surface runoff was not polluted by any Hg content. In August, atmospheric deposition was not contaminated by any Hg content.

Hg content that humans issued to land and atmosphere, finally got to the ocean. There were two paths. One is that human beings discharge Hg into the atmosphere, and the Hg content reached into the ocean through atmospheric sedimentation. The Hg content from atmospheric sedimentation was relatively high, but the transportation time was relatively short. The other is that human beings discharge Hg content to the land. Through surface runoff, the Hg content reached into the ocean, and the Hg content from surface runoff was relatively low, but the transportation time was relatively short. With more and more paths, Hg content was decreasing.

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