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The Water Quality and Settlement Areas of Pb Content in the Bottom Water of Jiaozhou Bay

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ABSTRACT. *This paper studies the content of Pb in the bottom water of Jiaozhou Bay and its horizontal distribution according to the investigation materials in the year 1991. The results show that the content of Pb in the water of Jiaozhou Bay, in May, August and October, ranges from 5.51 to 38.32ug/L, confirming to the third- and the fourth-class water quality standards. It indicates that in May, August and October, the water quality in the bottom water of Jiaozhou Bay from the central area to the south bay mouth is moderately or severely polluted by the Pb content. Following on, it reveals that the bottom water from the centre of bay to the east, and to the south bay mouth has been polluted seriously by the human emissions of Pb content under the effect of vertical water body. In May, August and October, the bottom water of Jiaozhou Bay in the east part, and the north and south bay mouth all reflects heavy settlement in Pb content.*

KEYWORDS: *Pb content, water quality in the bottom, horizontal transfer, heavy settlement area, Jiaozhou Bay*

As human beings largely use the products and supplies containing Pb element and in the process of manufacturing and usage, a large number of effluent, exhaust gas and waste materials have been discharged into atmosphere, ocean and land, the Pb content has continuously migrated in the environment, resulting in the change of water quality of the sea [1-6]. Pb content comes to the bottom through the appearance of water body. It reflects the changes of Pb content in the bottom of Jiaozhou Bay under the effect of vertical water body. Based on the investigate materials about the Pb content in Jiaozhou Bay in 1991, this study researches the Pb

content, distribution and settlement process in the bottom water of areas- center area, east area and bay mouth, and displays the current condition and distribution characteristics of Pb content in the above areas, in order to providing scientific basis of its' existence and migration.

1. Waters investigated, resources and methods

1.1 Natural environment in Jioaozhou Bay

Jiaozhou Bay is located in the south of Shandong Peninsula, ranging in 120°04′-120°23′E, 35°58′-36°18′N. Bounded by Tuan Island and Xuejiao Island, connecting to the Yellow Sea. With the area of 446km^2 and average depth of 7m, it is a typical semi-enclosed bay. There are more than 10 rivers flow to the sea, of which the Dagu River, the Yang River, and some rivers in the urban of Qingdao such as Haipo River, Licun River and Loushan River, are the rivers with large runoff and sediment concentration. These rivers are ephemeral streams with obviously seasonal hydrological characteristics [10, 11].

1.2 Resources and methods

The investigation resources used in this paper are the PHC in the water body of Jiaozhou Bay in May, August and October of 1991, offered by the North China Sea Environmental Monitoring Center of State Oceanic Administration. Four stations for water samples in May: Station 52, 55, 60 and 61; four stations in August: Station 55, 60, 61 and 2106; thirteen stations in October: Station 60, as shown in figure 1. Take samples respectively based on the depth:

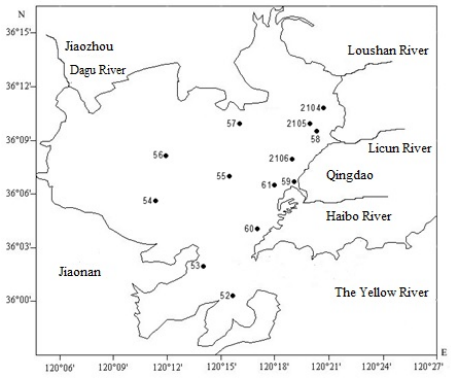

Fig.1 Investigation sites in Jiaozhou Bay

From surface layer and bottom layer, where the depth >10m; from surface layer only, where the depth < 10m. This investigation or survey method used about the

PHC in the water body of Jiaozhou Bay confirms to the national standard methods, and is recorded in *The Specification for Marine Monitoring(1991)* [12].

2. Results

2.1 Content size in bottom

In May, August and October, the changes of Pb content from the bottom of central zone to the north bay mouth are 5.51-38.32ug/L, which conforms to the third and the fourth water class in national standards, 10.00ug/L and 50.00ug/L respectively. In May, the Pb content in Jiaozhou Bay ranges in 5.51-9.64ug/L, conforming to the third-class water quality standard. In August, the Pb content ranges in 10.97-38.32ug/L, conforming to the fourth-class water quality standard. In October, the Pb content is around 7.33ug/L, which conforms to the third-class water quality standard. Therefore, the Pb content in the water body of Jiaozhou Bay in May, August and October are ranging in 5.51-38.32ug/L, conforming to the third and the fourth class water quality standards. It indicates that in May, August and October, viewing from the perspective of Pb content in the bottom water from the bay center to the south bay mouth, the water quality has been polluted in the moderate and severe level respectively (Table 1).

Tab.1 The surface water quality in Jiaozhou bay in May and August

	May	August	October
Pb content /μg·L^{-1}	5.51-9.64	10.97-38.32	7.33
National water quality standards	Third-class	Fourth-class	Third-class

2.2 Horizontal distribution in bottom

In May and in the bottom water from the south bay mouth to the bay center, the Pb content in station 52 located in the south bay mouth reaches a higher level of 9.64ug/L, forming a high content area around the south bay mouth and a series of parallel lines in different gradient. Pb content decreased from 9.64ug/L in the south of the bay mouth to 5.57ug/L in the central area of the bay (Figure 2).

In August and in the bottom water from the bay east to the north bay mouth, the Pb content in station 2106 located in the bay east reaches a high level of 38.32ug/L, forming a high content area around the bay east and a series of parallel lines in different gradient. Pb content decreased from 38.32ug/L in the bay east to 27.22ug/L in the north bay mouth along the gradient (Figure 3).

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

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

3. Discussion

3.1 Water quality

In Jiaozhou Bay, Pb content comes from the transportation of ship terminals, surface runoff and the flow of rivers. Pb goes to the surface of the water, and then through the water body to the bottom. Under the effect of vertical water body, Pb content varies from 5.51 to 38.32 ug /L in the bottom waters from the center of bay to the south of bay mouth, which conforms to the third and the fourth-class water quality standards. This indicates that in May, August and October, the water quality in the bottom waters of Jiaozhou Bay from the center of the bay to the south of the bay mouth was moderately or severely polluted by Pb content.

In May, Pb content in the bottom water of Jiaozhou Bay varies from 5.51 to 9.64ug/L, which is moderately polluted. Pb content which is higher than 5.00ug/L and at the same time lower than 10.00ug/L indicates that the water quality reaches the third-class standard and is moderately polluted in the area from the center of bay to the south bay mouth.

In August, Pb content in the bottom waters of Jiaozhou Bay ranges from 10.97 to 38.32 ug /L, indicating severely polluted in the water quality. In the bottom waters of Jiaozhou Bay, Pb content from the eastern part of the bay to the northern part of the bay is higher than 10.00 ug /L, but lower than 50.00 ug /L, conforming to the fourth-class water standard.

In October, the content range of Pb in the bottom water of jiaozhou bay is 7.33ug /L, which means moderately polluted of the water quality by Pb. In the bottom waters of Jiaozhou Bay and the northern waters of the bay mouth, Pb content is higher than 5.00ug /L, but lower than 10.00mug /L, indicating that the quality of water in the north of the bay mouth reached the third-class quality standard and the water quality is moderately polluted.

In May, Pb content are high in the bottom water of Jiaozhou Bay and the water is moderately polluted by Pb, especially in the bottom water of south bay mouth. In August, the higher Pb content indicates the water quality is severely polluted, especially in the bottom water of bay east. In October, Pb content reaches the level of moderately pollution, especially in the bottom water of the north bay mouth.

3.2 Settlement Areas

In Jiaozhou Bay, the water in the bay exchanges with the outer water through the bay mouth, and the concentration of substances decreases continuously [13].

Pb content ranges from 5.51 to 9.64 ug /L in the bottom of Jiaozhou Bay from bay center to the south bay mouth in May. From the south bay mouth to the center of the bay, Pb content decreases along the gradient from the south bay mouth to the center of the bay. The results have shown that the Pb content in the southern waters of the bay mouth has a relatively high sedimentation rate. In the central waters, Pb content has a relatively low sedimentation rate.

In August, Pb content ranges from 10.97 to 38.32 ug /L in the bottom waters of Jiaozhou Bay from the bay east to the north bay mouth. Pb content decreases along the gradient from the bay east to the north bay mouth. The results show that Pb content in the eastern waters has a relatively high sedimentation rate. In the northern waters of bay mouth, Pb content has a relatively low sedimentation rate.

3.3 Horizontal migration process

In May, the Pb content in the waters of Jiaozhou Bay comes from the ship terminals, which is 16.00ug/L. In this way, under the effect of vertical water body, a high Pb content deposition of 9.64 ug /L appeared in the bottom water of the

southern bay mouth. In the central surface waters, there is no source of shipping. So there is a low deposition of Pb content of 5.57ug/L in the bottom water of bay center under the effect of vertical water body.

In August, the Pb content in the northern of bay comes from the surface runoff, around 30.47ug/L. Therefore, under the effect of vertical water body, there is a high settlement of Pb content, 38.32ug/L, in the bottom of bay east. In the surface of north bay mouth, there is a source of shipping terminal around 31.66ug/L, which results in the high settlement of Pb content, 27.22ug/L[7-9].

In the bottom waters of Jiaozhou Bay from the center of the bay to the south of the bay mouth, Pb content in the southern waters of the bay mouth showed a high settlement in May. In August, Pb content in the eastern waters shows a high settlement. Meanwhile, the Pb content in the northern waters of the bay mouth also shows a high settlement. Therefore, Pb content in the bottom waters in the east of the bay, the north and the south shows a high settlement in May and August.

4. Conclusion

In May, August and October, Pb content in Jiaozhou Bay water body ranges from 5.51 to 38.32 ug /L, which is in line with the national quality standards for the third and the fourth class water quality. This indicates that in May, August and October, the water quality in the bottom waters of Jiaozhou Bay from the center of the bay to the south of the bay mouth is moderately or severely polluted by Pb content. This also indicates that the bottom waters from the center of the bay to the east and to the south bay mouth have been seriously polluted by human emissions of Pb content under the effect of vertical water bodies.

In May, Pb content is very high in the bottom waters of Jiaozhou Bay, and the water quality is moderately polluted, especially in the bottom waters in the south bay mouth. In August and in the bottom waters of Jiaozhou Bay, Pb content is relatively high, and the water quality is seriously polluted by Pb content, especially in the bottom waters in the bay east. In October and in the bottom waters of Jiaozhou Bay, Pb content is very high, and the water quality is moderately polluted, especially in the northern bottom waters of the bay mouth.

In the bottom waters of Jiaozhou Bay from the bay center to the south of the bay mouth, Pb content in the southern bay mouth shows a high settlement in May. In August, Pb content in the eastern waters also shows a high settlement. Meanwhile, the Pb content in the northern waters of the bay mouth shows a high settlement as well. Simply speaking, the Pb content in the bottom waters of Jiaozhou Bay, in the east, north and south of the bay, all displays a high settlement or settlement in May and August.

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