Low salinity area in the bottom layer of Jiaozhou Bay mouth

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Abstract: Based on the investigation data of Jiaozhou Bay in May and October of 1979, the content and distribution of salinity in bottom layer in Jiaozhou Bay were studied. The results showed that in May and October, the variation range of salinity in Jiaozhou Bay water was 31.09-31.55 ‰, and the salinity of sea water was over 31.09 ‰. This showed that in the aspect of salinity change, in May and October, in the whole bottom layer of Jiaozhou Bay, the salinity of water body was relatively high. In May, in the bottom, the variation range of salinity in Jiaozhou Bay was 31.49-31.55 ‰, and the salinity of sea water was relatively high. There was a low salinity area in the bottom of Jiaozhou Bay mouth. In the inner and outer waters of the bay mouth, the salinity was higher. The results showed that the salinity in Jiaozhou Bay was high and the salinity of the water outside the bay was high. In October, in the bottom layer, the variation range of salinity in Jiaozhou Bay was 31.09-31.21 ‰, and the salinity of sea water was relatively low. There was a low salinity area in the bottom water outside the mouth of Jiaozhou Bay. Compared with the bay mouth and the water inside the bay mouth, the salinity of the water outside the bay mouth was relatively low, and the interval length of salinity change was 0.12 ‰, and the salinity change from the outside of the bay mouth to the inside of the bay mouth was relatively small. In May, a low salinity area appeared in the bottom of Jiaozhou Bay mouth. In the inner and outer waters, the salinity was higher. In October, a series of decreasing parallel lines with different gradients were formed from the bottom high salinity water area in the inner side of the bay mouth to the bottom low salinity water area in the outer side of the bay mouth.

1. Introduction
The salinity of sea water is the most important and basic element of marine hydro-logical elements[1]. In addition, the salinity of sea water is the main factor affecting the harvest of fishery, and also an important part of the whole marine system [2-3]. Therefore, the study of salinity change and high temperature water area in the coastal area is of great help to protect the marine environment and maintain the sustainable development of ecology. Based on the investigation data in 1979, the salinity of the bottom layer, the distribution of the bottom layer and the source change of salinity in the bottom of Jiaozhou Bay are analyzed. The salinity of the bottom layer, the process of the source change and the amount from sources are studied, which provides a scientific background for the comprehensive analysis of the source and the high temperature area of the bottom layer salinity in Jiaozhou Bay, and provides a theoretical basis for the change of salinity in the bottom layer and its impact on environment.
2. Investigation Waters, Materials 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 horological characteristics of these rivers can alter in different seasons [4,5].

2.2 Materials and Methods. The survey data of salinity in Jiaozhou Bay in May and October, 1979 were provided by the North Sea Monitoring Center of the State Oceanic Administration. 3 stations were set up in Jiaozhou Bay to take water samples: H34、H35、H36 (Figure 1). The samples were taken in May and October, 1979 respectively. According to the water depth, water samples were taken (> 10m, surface layer and bottom layer, and < 10m, only surface layer). The salinity of Jiaozhou Bay water body was investigated according to the national standard method, which was included in the Specification for Marine Monitoring (1991) [6].

![Figure 1 Investigation sites in Jiaozhou Bay](image)

3. Results

3.1 Salinity in bottom layer. In May and October, the variation range of salinity in the bottom layer of Jiaozhou Bay water was 31.09-31.55 ‰, which indicated that the interval length of salinity variation was 0.46 ‰. In May, the variation range of salinity bottom layer in Jiaozhou Bay was 31.49-31.55 ‰, and the salinity of sea water was relatively high. In October, the temperature of salinity in the water decreased obviously. The variation range of salinity in Jiaozhou Bay was 31.09-31.21 ‰. The salinity of seawater was relatively low. Therefore, in May and October, the variation range of salinity in Jiaozhou Bay water body was 31.09-31.55 ‰, and the salinity of sea water was over 31.09 ‰. This showed that in the aspect of salinity change, in May and October, in the whole bottom water area of Jiaozhou Bay, the salinity of water body was relatively high (Table 1).
Table 1. The bottom water temperature in Jiaozhou Bay in May and November

| Time      | May          | October     |
|-----------|--------------|-------------|
| Salinity in seawater / ‰ | 31.49-31.55   | 31.09-31.21 |

3.2 Horizontal distribution of the bottom layer: In May, at station H35 in Jiaozhou Bay mouth, the salinity reached a relatively low level of 31.49 ‰, that was to say, the salinity reached a relatively high level of 31.55 ‰ in Jiaozhou Bay from the bay mouth to the inside of the bay mouth, and also a relatively high level of 31.53 ‰ in Jiaozhou Bay from the bay mouth to the outside of the bay mouth. A series of parallel lines with different gradients were formed from the bay mouth to the inner water area of the bay mouth and to the outer water area of the bay mouth. The salinity decreased from 31.49 ‰ in the center to 31.55 ‰ in the inner water area and 31.53 ‰ in the outer water area (Figure 2).

Figure 2 Salinity distribution at the bottom in Jiaozhou Bay in May 1979

In October, at station H36, in the inner water area of Jiaozhou Bay mouth, the salinity in the water area from the inner side of the bay mouth to the bay mouth reached a relatively high level of 31.21 ‰. A high salinity area was formed with the inner water area of the bay mouth as the center, and a series of parallel lines with different gradients were formed from the inner of the bay mouth to the outer side of the bay mouth. The salinity decreased from 31.21 ‰ of high salinity in the center to 31.09 ‰ in waters outside the bay mouth (Figure 3).
4. Discussion

4.1 Regional variation of salinity in the bottom. In May and October, the variation range of salinity in the bottom of Jiaozhou Bay was 31.09-31.55 ‰. From May to October, the salinity of seawater was more than 31.09 ‰. Moreover, the interval length of salinity change was 0.46 ‰. This showed that in May and October, in the bottom waters of Jiaozhou Bay, the salinity of the whole water body was relatively high, and the interval length of salinity change was relatively large.

In May, in the bottom water area, the variation range of salinity in Jiaozhou Bay was 31.49-31.55 ‰, and the salinity of sea water was relatively high. There was a low salinity area in the bottom water of Jiaozhou Bay mouth. In the inner and outer waters, the salinity was higher. The results showed that the salinity of the water in Jiaozhou Bay was high and the salinity of the water outside the bay was high. When sea currents passed through the bay mouth, it did not bring high salinity to the bay mouth waters.

In October, in the bottom water area, the variation range of salinity in Jiaozhou Bay was 31.09-31.21 ‰, and the salinity of sea water was relatively low. There was a low salinity area in the bottom water outside the mouth of Jiaozhou Bay. In the inner and outer waters, the salinity was higher. The results showed that the salinity of the water in the surface waters of the open sea brought the high salinity to Jiaozhou Bay, making the surface waters and outer waters of the bay reach the highest value of 31.58-31.60 ‰. Therefore, from the bottom water outside the bay mouth to the bottom water of the bay mouth, there was a relatively high salinity water area. In this way, a low salinity area appeared in the bottom water of Jiaozhou Bay mouth. In the inner and outer waters, the salinity was higher.

4.2 Source of bottom salinity in May. In May, a large amount of evaporation in the surface waters of the North Coast resulted in a relatively high salinity of 31.55 ‰ in the surface waters of the north coast. Therefore, from the bottom water inside the bay mouth to the bottom water of the bay mouth, there was a relatively high salinity water area. In the surface waters and outer waters of the bay mouth, in May, the surface currents with high salinity in the open sea brought the high salinity to Jiaozhou Bay, making the surface waters and outer waters of the bay mouth reach the highest value of 31.58-31.60 ‰. Therefore, from the bottom water outside the bay mouth to the bottom water of the bay mouth, there was a relatively high salinity water area. In this way, a low salinity area appeared in the bottom water of Jiaozhou Bay mouth. In the inner and outer waters, the salinity was higher.
4.3 Source of bottom salinity in October. In October, a large amount of evaporation in the northern coastal waters resulted in a relatively high salinity of 31.80 ‰. In October, in the water area of Loushan River estuary, because the rainy season has ended, the river brought only a small amount of fresh water to the offshore, resulting in the high salinity of Loushan River estuary of 31.53-31.53 ‰. Therefore, from the bottom water inside the bay mouth to the bottom water of the bay mouth, there was a relatively high salinity water area. In October, the surface currents with low salinity in the open sea brought the low salinity to Jiaozhou Bay, making the water area of the bay mouth and the water area outside the Bay reach the lowest value of 31.12-31.18 ‰. Therefore, from the bottom water outside the bay mouth to the bottom water of the bay mouth, there was a relatively low salinity water area. A series of parallel lines with different gradients were formed from the inner bottom water to the outer bottom water. The salinity decreased from high salinity of 31.21 ‰ in the inner bottom water to 31.09 ‰ in the outer bottom water.

5. Conclusions
In May and October, the variation range of salinity in Jiaozhou Bay water was 31.09-31.55 ‰, and the salinity of sea water was over 31.09 ‰. This showed that in the aspect of salinity change, in May and October, in the whole bottom water area of Jiaozhou Bay, the salinity of water body was relatively high.

In May, in the bottom water area, the variation range of salinity in Jiaozhou Bay was 31.49-31.55 ‰, and the salinity of sea water was relatively high. There was a low salinity area in the bottom water of Jiaozhou Bay mouth. In the inner and outer waters, the salinity was higher. The results showed that the salinity of the water in Jiaozhou Bay was high and the salinity of the water outside the bay was high.

In October, in the bottom water area, the variation range of salinity in Jiaozhou Bay was 31.09-31.21 ‰, and the salinity of sea water was relatively low. There was a low salinity area in the bottom water outside the mouth of Jiaozhou Bay. Compared with the bay mouth and the water inside the bay mouth, the salinity of the water outside the bay mouth was relatively low, and the interval length of salinity change was 0.12 ‰, and the salinity change from the outside of the bay mouth to the inside of the bay mouth was relatively small.

In May, from the inner bottom water area to the bottom water area of the bay mouth, there was a relatively high salinity water area. From the bottom water outside the bay mouth to the bottom water of the bay mouth, there was a relatively high salinity water area. In this way, a low salinity area appeared in the bottom water of Jiaozhou Bay mouth. In the inner and outer waters, the salinity was relatively high.

In October, from the bottom water inside the estuary to the bottom water of the estuary, a relatively high salinity water area appeared. From the bottom water outside the bay mouth to the bottom water of the bay mouth, there were low salinity waters. A series of decreasing parallel lines with different gradients were formed from the high salinity water area at the inner bottom to the low salinity water area at the outer bottom.

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). Thanks Prof. Qiang Shi for ardent help and nice suggestion.

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