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Spatial and temporal variations of Cr in Jiaozhou Bay 1990

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Abstract. Using investigation on Cd in May and August, 1990, this paper analyzed the spatial and temporal variations of Cd contents in Jiaozhou Bay. Results showed that in May, 1990, Cd contents in surface waters and bottom waters were 0.35-1.02 μg L^{-1} and 0.11-0.35 μg L^{-1}, compared to 0.22-1.26 μg L^{-1} and 0.18-0.48 μg L^{-1} in August, 1990. The pollution level of Cd in this bay in 1990 was still slight. Cd contents were confirmed to Grade I and Grade II, and the pollution level of Cd in this bay in 1990 was still slight. Cd contents in both surface and bottom waters were in order of spring < summer. By means of vertical water's effect and horizontal water's effect, the sediment of Cd was rapid and continuous, resulting in accumulation effect or dilution effect in bottom waters. Cd contents in bottom waters were relatively high/low in case of Cd contents in surface waters were relatively high/low. Ocean is a large solution, all of the substances to be homogeneous no matter the source input is strong or weak. Ocean has the feature of homogeneity, which was demonstrated by a block diagram model.

1. Introduction

Jiaozhou Bay is a semi−closed bay located in Shandong Province, China. This bay is surrounded by cities of Qingdao, Jiaozhou and Jiaonan. The industry and economic were developing rapidly since 1980s [1−5]. However, the environmental pollution problem was rising due to the lagging of waste treatment from waste generating [6−8], resulting in this bay being polluted by various pollutants [9−16]. Cd is widely used in various industries, yet Cd is high toxic and the excess existence of Cd in the environmental could result in health risk [16−28]. Understanding the spatial and temporal variations of Cd in marine bay is essential to environmental protection and remediation [29−32]. Using investigation on Cd in May and August 1990, this paper analyzed the spatial and temporal variations of Cr contents. The aim of this paper is to provide basis for research on the migration of Cd in marine bay.

2. Study area and data source

2.1 Study area. Jiaozhou Bay (120°04′-120°23′ E, 35°55′-36°18′ N) is located in the south of Shandong Province, eastern China (Fig. 1). It is a semi-closed bay with the total area, average water depth and bay mouth width of 446 km^2, 7 m and 3 km, respectively. There are more than ten inflow rivers such as Haibo Rriver, Licun Rriver, and Loushan Rriver [33−34].

2.2 Data source. The data was provided by North China Sea Environmental Monitoring Center. The investigations were conducted in May and August 1990, respectively. Surface and bottom water samples in 2 sampling sites (i.e., 55 and 60) were collected and measured followed by National Specification for Marine Monitoring (Fig. 1) [35].

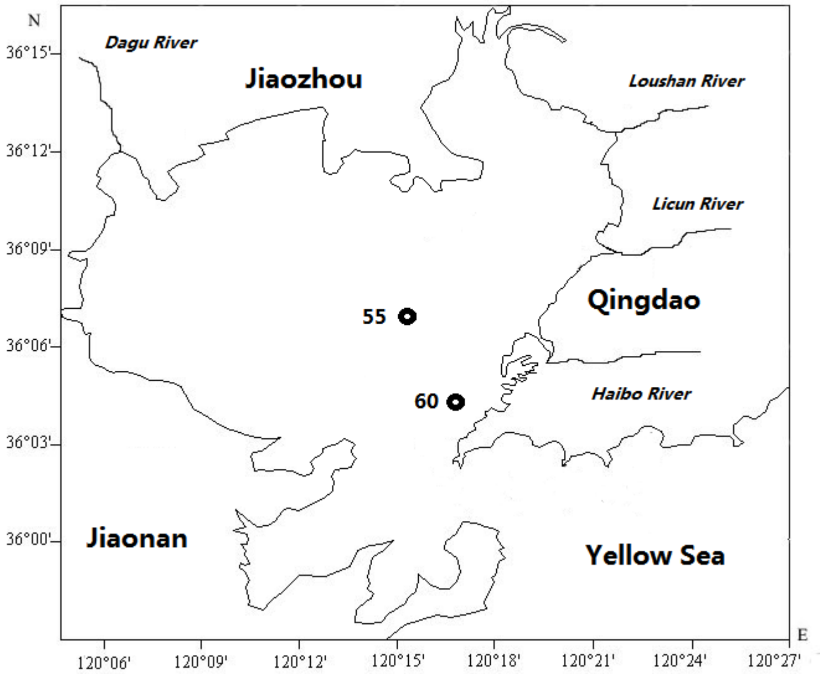

Fig. 1 Geographic location and monitoring sites in Jiaozhou Bay

3. Results and discussion

3.1 Pollution level of Cd. In May 1990, Cd contents in surface waters and bottom waters were 0.35-1.02 μg L^{-1} and 0.11-0.35 μg L^{-1}, respectively. In August 1990, Cd contents in surface waters and bottom waters were 0.22-1.26 μg L^{-1} and 0.18-0.48 μg L^{-1}, respectively. The China Sea Water Quality Standard (GB 3097−1997) establishes guide lines for Cd (Table 1). In general, Cd contents were confirmed to Grade I and Grade II, and the pollution level of Cd in this bay in 1990 was still slight.

Table 1 China Sea Water Quality Standard (GB 3097-1997) guide lines for Cd

Grade	I	II	III and V[b]
Content/μg L^{-1}	1.00	5.00	10.00

[b]Guide lines for Cd of Grade III and V are same.

3.2 Vertical water's effect. The source input of Cd is firstly reaching surface waters, and then is moving through water body, and is finally reaching sea bottom. The growth and reproduction of marine plankton are increasing from spring and reaching the climax in summer. The growth and reproduction of marine plankton are resulting in a large amount of colloids, which are able to enhancing the absorption ability of suspended particle matters [23]. As a result, a great deal of Cd is absorbed by the suspended particle matters and then is moving from surface water to bottom waters continuously by means of gravity and marine current. Therefore, by means of vertical water's effect, Cd could be transported to sea bottom along with the continuous sediment process [25−27].

3.3 Seasonal variation process. In study area, May and August belongs to spring and summer, respectively. For temporal variation, Cd contents in surface waters were in order of spring < summer, and in bottom waters were also in order of spring < summer. The seasonal variation of Cd is influenced by source input, as well as vertical water's effect and horizontal water's effect [25−27]. The major Cd source in spring was marine traffic whose source strength was relative low (1.02 μg L^{-1}). In summer, the major Cd source was atmosphere deposition whose source strength was relative high (1.26 μg L^{-1}). Cd contents in surface waters were in order of spring < summer. By means of vertical water's effect and horizontal water's effect [25−27], Cd contents in bottom waters were in order of spring < summer.

3.4 Spatial variation process. In May 1990, Cd contents in surface waters were increasing from the bay center to the bay mouth, while in bottom waters were decreasing from the bay center to the bay mouth. In August 1990, Cd contents in both surface and bottom waters were decreasing from the bay center to the bay mouth. Therefore, the horizontal distributions of Cd in surface and bottom waters were reverse in spring, yet were consistent in summer. By means of vertical water's effect and horizontal water's effect [25−27], the sediment of Cd was rapid and continuous, resulting in accumulation effect or dilution effect in bottom waters. The horizontal distributions of Cd in surface and bottom waters were reverse in spring. The reason was that there was dilution effect in the bay mouth in spring. The horizontal distributions of Cd in surface and bottom waters were consistent in summer. The reason was that there were dilution effects in the bay center and the bay mouth in summer.

3.5 Homogeneity feature. In May 1990, Cd contents in surface waters were relatively low (0.35-1.02 μg L^{-1}), and in bottom waters were also relatively low (0.11-0.35 μg L^{-1}). In August 1990, Cd contents in surface waters were relatively high (0.22-1.26 μg L^{-1}), and in bottom waters were also relatively high (0.18-0.48 μg L^{-1}). Cd contents in bottom waters were relatively high/low in case of Cd contents in surface waters were relatively high/low. The variation ranges in surface waters (0.67-1.04 μg L^{-1}) were higher than in bottom waters (0.24-0.30 μg L^{-1}). Ocean is a large solution, and by means of water's effect [25-27], all of the substances to be homogeneous no matter the source input is strong or weak. Therefore, ocean has the feature of homogeneity (Fig .2).

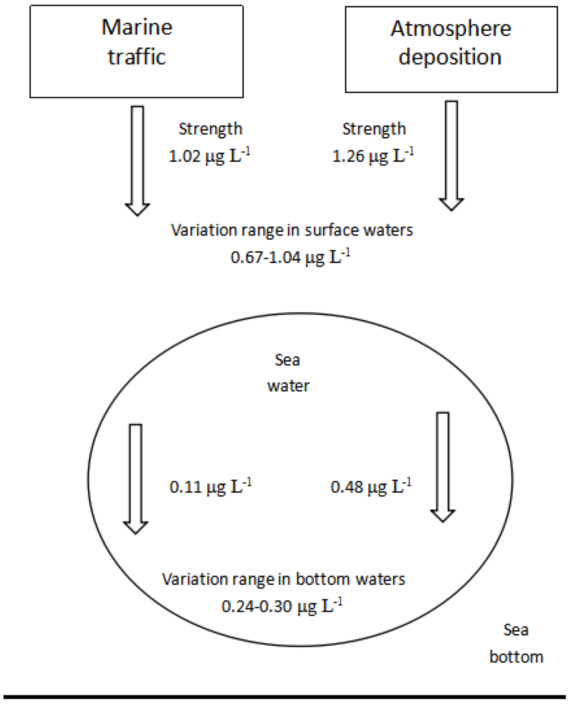

Fig. 2 Block diagram model for ocean's feature of homogeneity

4. Conclusion

Cd contents were confirm to Grade I and Grade II, and the pollution level of Cd in this bay in 1990 was still slight. Cd contents in surface waters were in order of spring < summer, and in bottom waters were also in order of spring < summer. By means of vertical water's effect and horizontal water's effect, the sediment of Cd was rapid and continuous, resulting in accumulation effect or dilution effect in bottom waters. Cd contents in bottom waters were relatively high/low in case of Cd contents in surface waters were relatively high/low. Ocean is a large solution, all of the substances to be homogeneous no matter the source input is strong or weak. Ocean has the feature of homogeneity.

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