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To cite this article: Dongfang Yang et al 2018 IOP Conf. Ser.: Mater. Sci. Eng. 392 042049

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Influence of Cd contents on the vertical migration process in marine bay

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Abstract. This paper analyzed the contents and distributions of Cadmium (Cd) in Jiaozhou Bay 1989. Results showed that Cd contents in bottom waters in Jiaozhou Bay in April and July 1989 were 0.05-0.06 μg L-1 and 0.06 μg L-1, respectively. The water quality of Cd was meeting Grade I, and the pollution level of Cd was very slight in 1989. The vertical water’s effect was very weak in case of Cd contents in waters were very low, resulting in the vertical migration strength of Cd was very weak, and Cd contents in waters were changing along with the moving of marine current. The vertical water’s effect was strong in case of Cd contents in waters were relative high, resulting in the vertical migration strength of Cd was very strong, and big part of Cd in waters were transporting to sea bottom.

1. Introduction
Cd is widely used in many industries such as metallurgy, chemical engineering and electroplating [1–5]. A large amount of Cd-containing wastes are generating and discharging to the environmental along with the rapid increasing of industry and economic [6–10]. As a result, many marine bays have been polluted by Cd since the waste treatment in many countries and regions is always lagging [11–15]. By means of vertical water’s effect [16–18], Cd contents in waters in marine bay were changing continuously. Hence, understanding the vertical migration processes of Cd in marine bay is essential to environmental protection and remediation [19–20].

Jiaozhou Bay is a semi-closed bay located in Shandong Province, China [21–25]. This bay had been polluted by various pollutants including Cd since 1980s due to the rapid development of industry [26–32]. Using investigation on Cd in surface and bottom waters in 1989 in Jiaozhou Bay, this paper researched the vertical distributions, and analyzed the influencing factors on the migration processes. The aim of this paper is to provide basis for research on the vertical migration of Cd in marine bay.

2. Materials and method

Study area and data collection. 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 [33–34].

The investigation on Cd in Jiaozhou Bay was carried on by North China Sea Environmental Monitoring Center. In April 1989, Cd contents in bottom waters were measured in Site 85 and Site 90 in the bay center and the bay mouth, while in July 1989 Cd contents in bottom waters were measured in Site 85 (Fig 1). Cd in waters was sampled and monitored follow by National Specification for Marine Monitoring [35].

Fig 1 Geographic location and monitoring sites in Jiaozhou Bay

3. Results and discussion

Contents and horizontal distributions of Cd. Cd contents in bottom waters in Jiaozhou Bay in April and July 1989 were 0.05–0.06 μg L\(^{-1}\) and 0.06 μg L\(^{-1}\), respectively. In April 1989, high value of Cd contents was in Site 85 in the bay center, and the contour lines of Cd contents were forming a series parallel lines that decreasing from the bay center to the bay mouth in the south of the bay. However, the horizontal distribution of Cd in July 1989 was unclear since there was only one sampling site.

Pollution level of Cd. Cd from the source inputs was firstly arrived at surface waters in marine bay, and then was transporting vertically through water body by means of vertical water’s effect, and was arriving sea bottom finally, resulting in the changing of Cd contents in surface and waters [12–14]. The China Sea Water Quality Standard (GB 3097-1997) establishes guide lines for Cd (Table 1). Obviously, Cd contents in bottom waters in April and July 1989 were lower than 1.00 μg L\(^{-1}\), and were indicating that the water quality of Cd was meeting Grade I, and the pollution level of Cd was very slight in 1989.

| Grade | I | II | III and V |
|-------|---|----|-----------|
| Content/μg L\(^{-1}\) | 1.00 | 5.00 | 10.00 |

Vertical migration of Cd. In April 1989, Cd contents in surface waters in the bay center was relative low (0.05 μg L\(^{-1}\)), while in bottom waters in this location was relative high (0.06 μg L\(^{-1}\)). Meanwhile, Cd contents in surface waters in the bay mouth was relative high (0.08 μg L\(^{-1}\)), while in bottom waters
in this location was relative low (0.05 μg L\(^{-1}\)), which indicated that the vertical water’s effect was very weak in case of Cd contents in waters were very low, resulting in the vertical migration strength of Cd was very weak, and Cd contents in waters were changing along with the moving of marine current. In July 1989, Cd contents in surface waters in the bay center was relative high (0.12 μg L\(^{-1}\)), while in bottom waters in this location was also relative high (0.06 μg L\(^{-1}\)), which indicated that the vertical water’s effect was strong in case of Cd contents in waters were relative high, resulting in the vertical migration strength of Cd was very strong, and big part of Cd in waters were transporting to sea bottom.

4. Conclusions
Cd contents in bottom waters in Jiaozhou Bay in April and July 1989 were 0.05–0.06 μg L\(^{-1}\) and 0.06 μg L\(^{-1}\), respectively. The water quality of Cd was meeting Grade I, and the pollution level of Cd was very slight in 1989.

The vertical water’s effect was very weak in case of Cd contents in waters were very low, resulting in the vertical migration strength of Cd was very weak, and Cd contents in waters were changing along with the moving of marine current.

The vertical water’s effect was strong in case of Cd contents in waters were relative high, resulting in the vertical migration strength of Cd was very strong, and big part of Cd in waters were transporting to sea bottom.

Acknowledgement
This research was sponsored by Doctoral Degree Construction Library of Guizhou Nationalities University and 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).

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