Homogenous process Cd contents in marine bay

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Abstract. Using investigation data on Cadmium (Cd) in waters in Jiaozhou Bay 1989, we analyzed the spatial and temporal distributions of Cd, and identified the homogenous process of Cd contents. Results showed that by means of vertical water’s effect Cd contents in both surface and bottom waters were showing seasonal variations of spring > summer. High Cd contents in surface waters could result in dilution effect in bottom waters, while low Cd contents in surface waters could result in accumulation effect in bottom waters. That was the homogenous process of Cd contents in marine bay. Ocean is a large container in where every substances discharged into would be homogeneous distributed finally no matter the contents are high or low.

1. Introduction
Cd is one of the widely used heavy metal elements in many industries [1–5]. A large amount of Cd-containing wastes are generating and discharging to the ocean since the waste treatment in many countries and regions is always lagging [6–10]. Many marine bays have been polluted by Cd and ecological risks are remaining [11–15]. By means of vertical water’s effect, Cd contents in waters in marine bay were changing continuously, and were tending to be homogenous distributed [16–18]. Hence, understanding this homogenous process 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 China’s Reform and Opening-up [26–32]. By using investigation on Cd in in Jiaozhou Bay 1989, this paper researched the horizontal distributions and seasonal variations, and analyzed the homogenous process. The aim of this paper is to provide basis for research on migration process 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 surface and bottom waters were measured in Site 85 and Sit 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

Contents of Cd. In April 1989, Cd contents in surface and bottom waters in Jiaozhou Bay were 0.05–0.08 μg L⁻¹ and 0.05–0.06 μg L⁻¹, respectively. In July 1989, Cd contents in surface and bottom waters in Jiaozhou Bay were 0.12 μg L⁻¹ and 0.06 μg L⁻¹, respectively. In according to the China Sea Water Quality Standard (GB 3097-1997) guide lines for Cd (Table 1), Cd contents in surface and bottom waters in April and July 1989 were lower than 1.00 μg L⁻¹, and 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 |

Seasonal variations of Cd. April and July in study area are spring and summer, respectively. For seasonal variation, Cd contents in surface and bottom waters were in order of spring < summer. In April 1989, Cd contents in surface waters were relative low, and in bottom waters were also relative low. In July 1989, Cd contents in surface waters were relative high, and in bottom waters were still relative low. This indicated that Cd contents in bottom would be relative low no matter Cd contents in surface waters were relative high or relative low.

Horizontal distributions of Cd. In April 1989, high value of Cd contents in surface was in Site 90 in the bay mouth, Cd contents were decreasing from the bay mouth in the south of the bay to the bay center. Meanwhile, high value of Cd contents in bottom waters was in Site 85 in the bay center, and Cd contents decreasing from the bay center to the bay mouth in the south of the bay. Hence, the horizontal distributions of Cd contents in surface and bottom waters in April 1989 were opposite. However, the horizontal distribution of Cd in July 1989 was unclear since there was only one sampling site.
4. Discussion

**Vertical migration process of Cd.** Cd contents in waters were changing a lot during the transporting process through the waters by means of vertical waters’s effect [25–27]. The growth and reproduction of marine zooplankton and phytoplankton were increasing from spring to summer [23], and a great deal of colloid which was able to enhance the absorption capacity of suspending particular matters. Hence, a big part of Cd was absorbed to the suspending particular matters and transported to sea bottom continuously by means of gravity force and marine current [23–24].

**Seasonal changing process of Cd.** In April and July 1989, the seasonal variations of Cd in both surface and bottom waters were spring < summer. In spring, the major Cd sources in Jiaozhou Bay was river flow, whose source strengths were relative weak, and Cd contents in surface waters were relative low. In summer, the major Cd source were river flow and atmosphere deposition, and the source strength was relative strong, and therefore Cd contents in surface waters were relative high. Hence, the seasonal variations of Cd in surface waters were spring < summer. By means of vertical water’s effect [25–27], Cd was transporting and accumulating in bottom waters along with time continuously, resulting in Cd contents in bottom waters were also in order of spring < summer. The seasonal variations of Cd contents in surface waters were determined by the changes of the major Cd sources, while in bottom waters were determined by both the source input and vertical water’s effect.

**Homogenous process of Cd.** Cd contents in surface waters in April and July 1989 were relative low and relative high, respectively. However, Cd content in bottom waters in both April and July were relative low, which indicated low Cd contents in surface waters in April resulted in accumulation process in bottom waters, while high Cd contents in surface waters in July resulted in dilution process in bottom waters. By this way, Cd contents in bottom would be relative low no matter Cd contents in surface waters were relative high or relative low (Fig 2). That was the homogenous process of Cd contents in marine bay. Ocean is a large container in where every substances discharged into would be homogeneous distributed finally no matter the contents are high or low.

![Homogenous process of Cd contents in Jiaozhou Bay](image-url)
5. Conclusions
In April 1989, Cd contents in surface and bottom waters in Jiaozhou Bay were 0.05–0.08 μg L⁻¹ and 0.05–0.06 μg L⁻¹, respectively. In July 1989, Cd contents in surface and bottom waters in Jiaozhou Bay were 0.12 μg L⁻¹ and 0.06 μg L⁻¹, respectively. The pollution level of Cd was very slight in 1989.

For seasonal variation, Cd contents in surface and bottom waters were in order of spring < summer. The seasonal variations of Cd contents in surface waters were determined by the changes of the major Cd sources, while in bottom waters were determined by both the source input and vertical water’s effect.

Low Cd contents in surface waters resulted in accumulation process in bottom waters, while high Cd contents in surface waters resulted in dilution process in bottom waters. By this way, Cd contents in bottom would be relative low no matter Cd contents in surface waters were relative high or relative low. Ocean is a large container in where every substances discharged into would be homogeneous distributed finally no matter the contents are high or low.

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References
[1] Yang DF and Miao ZQ: Marine Bay Ecology (I): Beijing, Ocean Press, (2010), p. 1-320.
[2] Yang DF and Gao ZH: Marine Bay Ecology (II): Beijing, Ocean Press, (2010), p. 1-330.
[3] Yang DF, Chen Y, Wang H, et al.: Coastal Engineering, Vol. 29 (2010), p. 73-82.
[4] Yang DF, Chen Y, Liu CX, et al.: Coastal Engineering, Vol. 32(2013), p. 68-78.
[5] Yang DF, Zhu SX, Wu YF, et al.: Applied Mechanics and Materials, Vol.644-650 (2014), p. 5325-5328.
[6] Yang DF, Wang FY, Wu YF, et al.: Applied Mechanics and Materials, Vol.644-650 (2014), p. 5333-5335.
[7] Yang DF, Zhu SX, Wang FY, et al.: 2014 IEEE workshop on advanced research and technology industry applications. Part D, 2014, p. 1012-1014.
[8] Yang DF, Zhu SX, Yang XQ, et al.: Materials Engineering and Information Technology Application, 2015, p. 558-561.
[9] Yang DF, Zhu SX, Wang FY, et al.: Advances in Computer Science Research, 2015, p. 2352: 194-197.
[10] Yang DF, Chen ST, Li BL, et al.: Proceedings of the 2015 international symposium on computers and informatics, 2015, p. 2667-2674.
[11] Yang DF, Wang FY, Sun ZH, et al.: Advances in Engineering Research, Vol. 40 (2015), p. 776-781.
[12] Yang DF, Wang FY, Yang XQ, et al.: Advances in Engineering Research, Vol. 60 (2016), p. 1347-1350.
[13] Yang DF, Yang DF, Zhu SX, et al.: Advances in Engineering Research, Vol. 60 (2016), p. 403-407.
[14] Yang DF,Yang XQ, Wang M, et al.: Advances in Engineering Research, Vol. 60 (2016), p. 412-415.
[15] Yang DF, Wang FY, Zhu SX, et al.: Advances in Engineering Research, Vol. 65 (2016), p. 298-302.
[16] Yang DF, Qu XC, Chen Y, et al.: Advances in Engineering Research, Vol. 60 (2016), p. 993-997.
[17] Yang DF,Yang DF, Zhu SX, et al.: Advances in Engineering Research, Vol. 80 (2016), p. 998-1002.
[18] Yang DF, Zhu SX, Wang ZK, et al.: Computer Life, Vol. 4 (2016), p. 446-450.
[19] Yang DF, Wang FY, Zhu SX, et al.: World Scientific Research Journal, Vol. 2 (2016), p. 38-42.
[20] Yang DF, Zhu SX, Wang M, et al.: International Core Journal of Engineering, Vol. 2 (2016), p. 1-4.
[21] Yang DF, Yang DF, Zhu SX, et al.: Journal of Computing and Electronic Information Management, Vol. 3 (2016), p. 467-474.
[22] Yang DF, Zhu SX, Wang ZK, et al.: Journal of Computing and Electronic Information Management, Vol. 4 (2017), p. 1-9.
[23] Yang DF, Wang FY, Zhu SX, et al.: Computer Life, Vol. 5 (2017), p. 1-7.
[24] Yang DF, Wang ZK, Su CH, et al.: Advances in Engineering Research, Vol. 123 (2017), p. 1477-1480.
[25] Yang DF, Wang FY, Zhu SX, et al.: Computer Life, Vol. 5 (2017), p. 91-95.
[26] Yang DF, Wang FY, Zhu SX, et al.: World Scientific Research Journal, Vol. 3 (2017), p. 1-5.
[27] Yang DF, Li HX, Zhang XL, et al.: Advances in Engineering Research, Vol. 138 (2017), p. 847-850.
[28] Yang DF, Miao ZQ, Li HX, et al.: Earth and Environment Science, Vol. 81 (2017), p. 1-6.
[29] Yang DF, Wang Q, Wang ZK, et al.: Earth and Environment Science, Vol. 81 (2017), p. 1-4.
[30] Yang DF, Wei LZ, Feng M, et al.: Earth and Environment Science, Vol. 81 (2017), p. 1-5.
[31] Yang DF, Wang Q, Wang M, et al.: Advances in Engineering Research, Vol. 141 (2017), p. 1587-1590.
[32] Yang DF, Li HX, Zhang XL, et al.: Earth and Environment Science, Vol. 113 (2018), p. 1-4.
[33] Yang DF, Chen Y, Gao ZH, et al.: Chinese Journal of Oceanology and Limnology, Vol. 23 (2005), p. 72-90.
[34] Yang DF, Wang FY, Gao ZH, et al. Marine Science, Vol. 28 (2004), p. 71-74.
[35] China’s State Oceanic Administration: The specification for marine monitoring (Ocean Press, Beijiang 1991), p. 1-300.