Different influencing states of the source input on Cd in Jiaozhou Bay

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Abstract. Using investigation on Cd in May and August 1990, this paper analyzed the different influencing states of input source on the changes of Cr contents in Jiaozhou Bay. Results showed that in May and August 1990, Cd contents in bottom waters in Jiaozhou Bay were 0.11-0.35 μg L⁻¹ and 0.18-0.48 μg L⁻¹, respectively. The pollution level of the Cd in bottom waters in Jiaozhou Bay in 1990 was still very slight. There were four different states in the influencing process of source input on Cd: 1) when there is no source input, Cd contents are homogeneous in waters, 2) when the sediment is just beginning, Cd contents are relative high in surface waters yet relative low in bottom waters, 3) when the sediment is ongoing, Cd content are relative high in both surface and bottom waters, and 4) when the sediment is over, Cd contents are homogeneous in waters. The different influencing states of source input on Cd in Jiaozhou Bay were demonstrated by the block diagram model.

1. Introduction

Cd is widely used in various industries such as metallurgy chemical engineering and electroplating [1-6]. Cd pollution has been one of the critical environmental issues since the rapid development of industry and the lagging of waste treatment in many countries in regions [7-15]. Many marine bays have been polluted by Cd since ocean is the sink of pollutants [16-21]. However, Cd is high toxic, and the excess existence of Cd in the environmental could result in health risk [22-28]. Understanding the influences of source input on Cd in marine bay is essential to environmental protection and remediation [29-32]. Jiaozhou Bay is a semi-closed bay located in Shandong Province, China. Using investigation on Cd in May and August 1990, this paper analyzed the different influencing states of input source on the changes 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 km², 7 m and 3 km, respectively. There are more than ten inflow rivers such as Haibo River, Licun River, and Loushan River [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. 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 and August 1990, Cd contents in bottom waters in Jiaozhou Bay were 0.11-0.35 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 May and August 1990, Cd contents in bottom waters in the bay were all lower than 1.0 μg L⁻¹ that were confirm to Grade I. Cd in Jiaozhou Bay was mainly sourced from river discharge and atmosphere deposition. The source input of Cd was firstly arriving at surface waters, and then was passing through water body, and was finally arriving at sea bottom. In general, by means of vertical water’s effect [12-14], the pollution level of the Cd in bottom waters in Jiaozhou Bay in 1990 was still very slight.

| Grade | I  | II  | III and Vᵇ |
|-------|----|-----|-------------|
| Content/μg L⁻¹ | 1.00 | 5.00 | 10.00 |

ᵇGuide lines for Cd of Grade III and V are same.

3.2 Horizontal distribution of Cd. In accordance to the geographical location, Site 55 was closed to the bay center and Site 60 was closed to the bay mouth, respectively. In May 1990, Cd contents in bottom waters were relative high in Site 55 (0.35 μg L⁻¹), and there was a high value region in the bay center, the contour lines of Cd contents were forming a series of parallel lines that decreasing from the bay center.
center to the bay mouth (0.11 μg L⁻¹). In August 1990, Cd contents in bottom waters were also relative high in Site 55 (0.48 μg L⁻¹), and there was a high value region in the bay center, the contour lines of Cd contents were forming a series of parallel lines that decreasing from the bay center to the bay mouth (0.18 μg L⁻¹).

3.3 **Vertical variations of Cd.** In waters in the bay center (Site 55), Cd contents in May 1990 were relative low in surface waters (0.35 μg L⁻¹), as well as in bottom waters (0.35 μg L⁻¹). In the same position (Site 55), Cd contents in August 1990 were relative high in surface waters (1.26 μg L⁻¹), as well as in bottom waters (0.48 μg L⁻¹). This indicated that in the bay center the sediment was weak/strong in case of Cd content in water was low/high. In waters in the bay mouth (Site 60), Cd contents in May 1990 were relative high in surface waters (1.02 μg L⁻¹), yet were relative low in bottom waters (0.11 μg L⁻¹). The reason was that the sediment of Cr was not beginning yet. In the same position (Site 60), Cd contents in August 1990 were relative low in surface waters (0.22 μg L⁻¹), as well as in bottom waters (0.18 μg L⁻¹). This indicated that the sediment was weak in case of low Cd contents in waters.

3.4 **Different influencing states of source input on Cd.** In according to the horizontal distributions and vertical variations of Cd contents, it could be found that there were four different states in the influencing process of source input on Cd. State 1: no source input, Cd contents are homogeneous in waters (Fig. 2a). State 2: the sediment is just beginning, Cd contents are relative high in surface waters yet relative low in bottom waters (Fig. 2b). State 3: the sediment is ongoing, Cd content are relative high in both surface and bottom waters (Fig. 2c). State 4: the sediment is over, Cd contents are homogeneous in waters (Fig. 2d). The different influencing states of source input on Cd in Jiaozhou Bay were demonstrated by the block diagram model (Fig. 2).

![Fig. 2 Block diagram model for the different states in the influencing processes of source input on Cr in Jiaozhou Bay](image)

4. **Conclusion**
In May and August 1990, Cd contents in bottom waters in Jiaozhou Bay were 0.11-0.35 μg L⁻¹ and 0.18-0.48 μg L⁻¹, respectively. The pollution level of the Cd in bottom waters in Jiaozhou Bay in 1990 was still very slight. There were four different states in the influencing process of source input on Cd: 1) when there is no source input, Cd contents are homogeneous in waters, 2) when the sediment is just beginning, Cd contents are relative high in surface waters yet relative low in bottom waters, 3) when
the sediment is ongoing, Cd content are relative high in both surface and bottom waters, and 4) when the sediment is over, Cd contents are homogeneous in waters.

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References
[1] Yang DF and Miao ZQ: Marine Bay Ecology (I): Beijing, Ocean Precess, (2010), p. 1-320.
[2] Yang DF and Gao ZH: Marine Bay Ecology (II): Beijing, Ocean Precess, (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 FY, et al.: Applied Mechanics and Materials, Vol.644-650 (2014), p. 5329-5312.
[7] Yang DF, Chen ST, Li BL, et al.: Proceedings of the 2015 international symposium on computers and informatics, 2015, p. 2667-2674.
[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. 80 (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 GX, 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. 133 (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, Beijing 1991), p.1-300.