

Different stages of Cd's transporting process in waters in Jiaozhou Bay

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Abstract. Cd pollution in marine bays is one of the critical environmental issues, and understanding the stages of transporting process of Cd in marine bays is essential to pollution control. This paper analyzed the stages of Cd's transporting process in waters in Jiaozhou Bay during 1979–1983. Results showed that the transporting process in waters in Jiaozhou Bay included seven different stages of 1) the sedimentation of Cd content was beginning, 2) the sedimentation of Cd content was increasing, 3) the sedimentation of Cd content was increasing greatly, 4) the sedimentation of Cd content was beginning to decrease, 5) the sedimentation of Cd content was decreasing stably, 6) the sedimentation of Cd content was beginning to stop, and 7) the sedimentation of Cd content was beginning to fully stop. In according to the different stages of Cd's transporting process in waters, the changing trends of Cd contents in surface and bottom waters and their relationships could be defined and predicted.

1. Introduction

Cd has been widely used in industries, and Cd pollution in marine bays is one of the critical environmental issues due to the time-lag of waste treatment to the development of industries. Hence, understanding the stages of transporting process of Cd in marine bays is essential to pollution control [1-6]. Jiaozhou Bay is a semi-closed bay located in Shandong Province, eastern China, and had been polluted by various pollutants including Cd [7-12]. This paper analyzed the different stages of Cd's transporting process in waters in Jiaozhou Bay during 1979–1983, analyzed the changing trends of Cd contents in surface and bottom waters and their relationships, and provided basis information to scientific research and pollution control practice.

2. 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, average water depth and bay mouth width are 446 km², 7 m and 3 km, respectively. This bay is connected to the Yellow Sea in the south. There are a dozen of rivers, and the majors are Dagu River, Haibo River, Licun River, and Loushan River etc., all of which are seasonal rivers [13-14].



The investigation on Cd content in surface and bottom waters in Jiaozhou Bay was conducted in May, August, and November 1979, June, July and September 1980, April, August and November 1981, April, June, July and October 1982, and, May, September and November 1983, respectively [1-10]. Cd in surface waters was sampled and monitored follow by National Specification for Marine Monitoring (Fig. 1)[15].

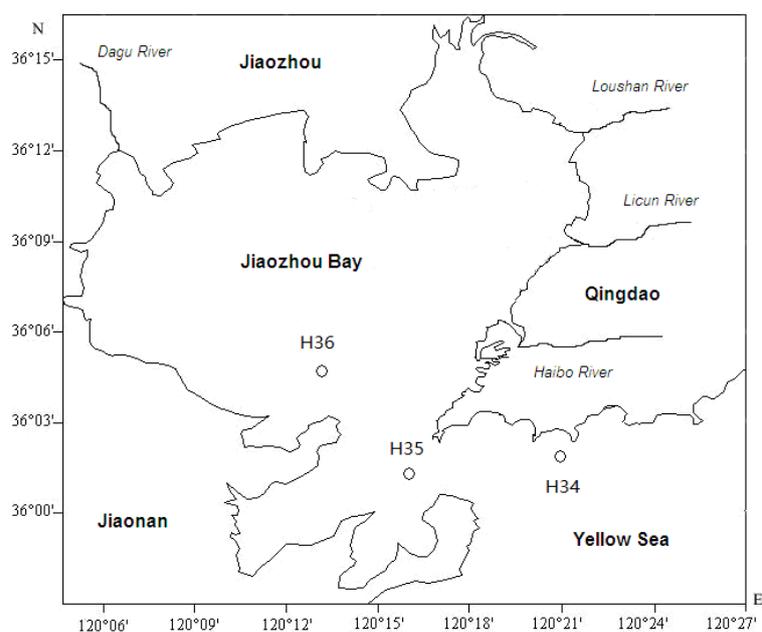


Fig. 1 Geographic location and sampling sites in Jiaozhou Bay

3. Results and discussion

3.1 Horizontal distribution trends of Cd.

In according to the geographic locations, the sampling sites of H36, H35 and H34 were located in the inner of the bay mouth, the bay mouth and the outside of the bay mouth, respectively. In order to facilitate the comparison of the horizontal distributions trends of Cd contents in surface and bottom waters, we took a uniform direction of H36 to H35 and H34 as the representation of the direction, and defined that weather the horizontal change trends from the bay to the open waters were consistent, reverse or different.

In 1979, the horizontal distribution trends of Cd contents in surface and bottom waters in May and August were reverse, while in November were different (Table 1). In 1980, the horizontal distribution trends of Cd contents in surface and bottom waters in June and July were reverse, In September were consistent, and in October were different (Table 2). In 1981, the horizontal distribution trends of Cd contents in surface and bottom waters in August and November were consistent, while in April were different (Table 3). In 1982, the horizontal distribution trends of Cd contents in surface and bottom waters in July and October were consistent, while in April were different (Table 4). In 1983, the horizontal distribution trends of Cd contents in surface and bottom waters in May, September and October were all reverse (Table 5). In general, the horizontal distributions of Cd contents in surface waters were determined by the spatial-temporal variations of Cd sources and horizontal water's effect [16], while in bottom waters were determined by the spatial-temporal variations of Cd sources, horizontal water's effect [17-18].

Table 1 Horizontal distribution trends of Cd contents in surface and bottom waters from the bay to the bay mouth in Jiaozhou Bay 1979

Month	Surface water	Bottom waters	Comment
May	Decrease	Increase	Reverse
August	Decrease	Increase	Reverse
November	Decrease	No trend	Different

Table 2 Horizontal distribution trends of Cd in surface and bottom waters from the bay to the bay mouth in Jiaozhou Bay 1980

Month	Surface water	Bottom waters	Comment
June	Increase	Decrease	Reverse
July	Increase	Increase	Reverse
September	Decrease	Decrease	Consistent
October	No trend	Decrease	Different

Table 3 Horizontal distribution trends of Cd contents in surface and bottom waters from the bay to the bay mouth in Jiaozhou Bay 1981

Month	Surface water	Bottom waters	Comment
April	Decrease	No trend	Different
August	Decrease	Decrease	Consistent
November	No trend	No trend	Consistent

Table 4 Horizontal distribution trends of Cd contents in surface and bottom waters from the bay to the bay mouth in Jiaozhou Bay 1982

Month	Surface water	Bottom waters	Comment
April	Increase	No trend	Reverse
July	Decrease	Decrease	Consistent
October	Decrease	Decrease	Consistent

Table 5 Horizontal distribution trends of Cd contents in surface and bottom waters from the bay to the bay mouth in Jiaozhou Bay 1983

Month	Surface water	Bottom waters	Comment
May	Decrease	Increase	Reverse
September	Increase	Decrease	Reverse
November	Decrease	Increase	Reverse

3.2 Different stages of Cd's transporting process.

In according to the spatial-temporal variations of Cd content, it could be identified that the transporting process in waters in Jiaozhou Bay included seven different stages of I) the sedimentation of Cd content was beginning, II) the sedimentation of Cd content was increasing, III) the sedimentation of Cd content was increasing greatly, IV) the sedimentation of Cd content was beginning to decrease, V) the sedimentation of Cd content was decreasing stably, VI) the sedimentation of Cd content was beginning to stop, and VII) the sedimentation of Cd content was beginning to fully stop (Table 6). In according to the different stages of Cd's transporting process in waters, the changing trends of Cd contents in surface and bottom waters and their relationships could be defined and predicted.

The transporting process of Cd in waters in Jiaozhou Bay could be defined by these seven different stages. During the process from the sedimentation of Cd was beginning to the sedimentation of Cd was stopping fully, it could be identified that there were rapid sedimentation process and accumulation process Cd, and Cd content in bottom waters could be disappear in case of Cd content in surface waters was disappear. Furthermore, were provided a block diagram model to show the different stages of Cd's transporting process in waters (Fig. 2). This block diagram model indicated that the changes of Cd contents and distribution trends in surface and bottom waters determined the transporting process of Cd in surface and bottom waters.

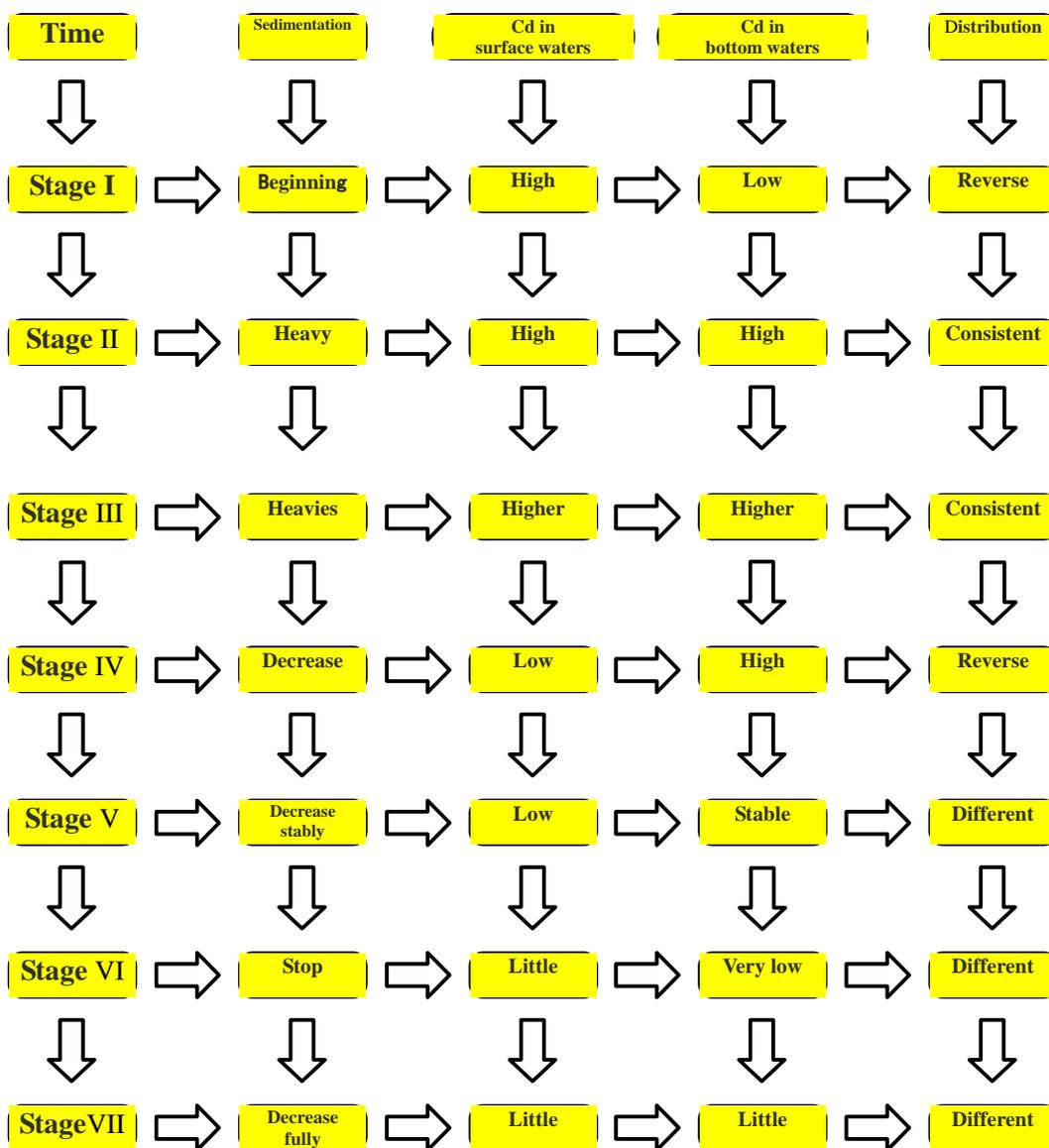


Fig.2 The block diagram model of the stages of Cd's transporting process in Jiaozhou Bay.

Table 6 The different stages of transporting process of Cd in waters in Jiaozhou Bay

Stage	Sedimentation status	Cd contents in Surface waters	Cd contents in Bottom waters	comparison of the concordance
I	Beginning	High	Low	Reverse
II	Increasing	High	High	Consistent
III	Increasing greatly	Higher	Higher	Consistent
IV	Beginning to decrease	Low	High	Reverse
V	Decreasing stably	Low	Stable	Different
VI	Stopping	Little	Very low	Different
VII	Fully stopping	Little	Little	Different

4. Conclusion

The transporting process in waters in Jiaozhou Bay included seven different stages of 1) the sedimentation of Cd content was beginning, 2) the sedimentation of Cd content was increasing, 3) the sedimentation of Cd content was increasing greatly, 4) the sedimentation of Cd content was beginning to decrease, 5) the sedimentation of Cd content was decreasing stably, 6) the sedimentation of Cd content was beginning to stop, and 7) the sedimentation of Cd content was beginning to fully stop. In according to the stages and the block diagram model, the changing trends of Cd in surface and bottom waters and their relationships could be defined and predicted.

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