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Different statuses for the sediment process of Cr in Jiaozhou Bay

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Abstract. Using investigation data on chromium (Cr) in surface and bottom waters in Jiaozhou Bay in April, July and October 1982, this paper analyzed the sediment processes of Cr. Results showed that the horizontal distributions and vertical variations of Cr in waters were strongly impacted by overland runoff. The sediment process of Cr in Jiaozhou Bay within year could be divided into three statuses. Status 1: little source input from overland runoff. In April the wet season was not coming yet, and the source input of Cr from overland runoff was little, and there was little influence on Cr contents in waters far away from the coast in the southwest, and there was sediment process in coastal waters in the southwest of the bay. Status 2: strong source input from overland runoff. In July the wet season was coming, and the source input of Cr from overland runoff was strong, and there was strong influence on Cr contents in waters near the coast in the southwest, and there was sediment process in waters far away from the coast in the southwest of the bay since the continuous input of Cr from overland runoff. Status 3: the source input from overland runoff was over. In October the wet season was over, and the source input of Cr from overland runoff was weak, and there was little influence on Cr contents in waters, and in the coastal waters in the southwest of the bay the vertical variations were returning to the status before the source input since the continuous sediment of Cr in the past wet season.

1. Introduction

A large amount of Cr-containing wastes have been discharged to the environment due to the rapid increasing of industry and the lagging of waste treatment [1-2]. Many marine bays have been polluted by Cr since ocean is the sink of various pollutants [3-4]. Understanding the environmental behavior of Cr in marine bay is essential to environmental protection and remediation [3-4]. This paper analyzed the sediment processes of Cr in Jiaozhou Bay, using investigation data on Cr in April, July and October 1982. It was found that during the sediment process of Cr, there were three different stages. Furthermore, block diagram models were provided to demonstrate the different stages. The aim of this paper was to provide scientific basis for better understand the environmental behavior of Cr in marine bay.



2. Materials and method

2.1. Study area. Jiaozhou Bay is located in the south of Shandong Province, eastern China ($35^{\circ}55'-36^{\circ}18' \text{ N}$, $120^{\circ}04'-120^{\circ}23' \text{ E}$). The total area and average water depth are 446 km^2 and 7 m , respectively (Fig. 1). 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 [7-8].

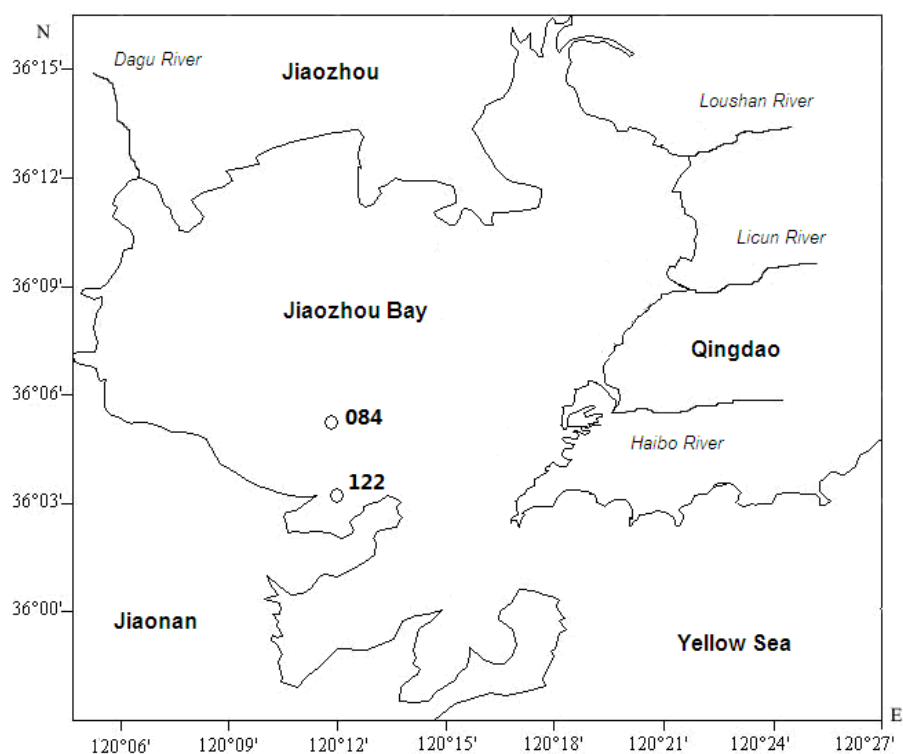


Fig. 1 Geographic location and sampling sites of Jiaozhou Bay

2.2. Data collection. Dataset on Cr in Jiaozhou Bay was provided by North China Sea Environmental Monitoring Center. The investigations were carried on in April, July and October 1982. Cr in surface and bottom waters was monitored follow by National Specification for Marine Monitoring [9]. The sampling Sites were Site 122 in the coastal waters in the southwest and Site 084 in far away from the southwest, respectively (Fig. 1).

3. Results and discussion

3.1. Horizontal distribution and source input of Cr. The source input of Cr could be identified according to the horizontal distributions. In April 1982, the high value of Cr in surface waters was occurring in Site 122 in the coastal waters in the southwest of the bay, and Cr contents were decreasing from Site 122 ($0.83 \mu\text{g L}^{-1}$) to Site 84 ($0.81 \mu\text{g L}^{-1}$) far away from the coastal waters in the southwest of the bay. However, the difference was small. This indicated that the source input of Cr in April was little. In July 1982, the high value of Cr in surface waters was occurring in Site 122 in the coastal waters in the southwest of the bay, and Cr contents were decreasing from Site 122 ($1.37 \mu\text{g L}^{-1}$) to Site 84 ($1.02 \mu\text{g L}^{-1}$) far away from the coastal waters in the southwest of the bay (Fig. 2). The difference was relative big. The reason was that July was the wet season and the source input of Cr from overland runoff was huge. In October 1982, the low value of Cr in surface waters was occurring in Site 122 in the coastal waters in the southwest of the bay, and Cr contents were increasing from Site

122 ($0.24 \mu\text{g L}^{-1}$) to Site 84 ($0.51 \mu\text{g L}^{-1}$) far away from the coastal waters in the southwest of the bay. The reason was that there was little source input from overland runoff in October since the wet season was over. In general, the horizontal distributions of Cr in surface waters were strongly impacted by overland runoff.

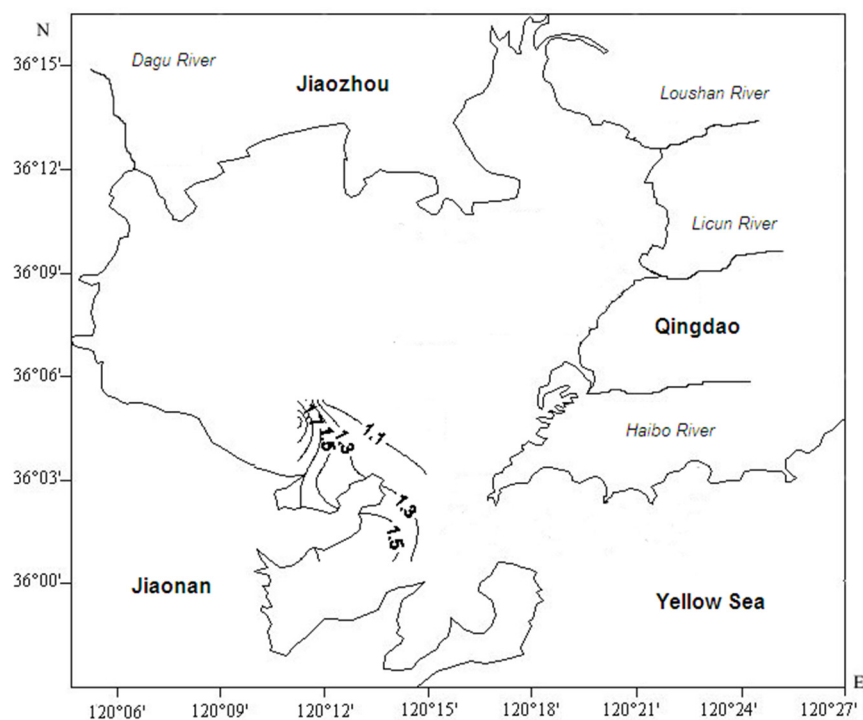


Fig. 2 Horizontal distribution of Cr in surface waters in Jiaozhou Bay in July 1982/ $\mu\text{g L}^{-1}$

3.2. Vertical variation and sediment of Cr. In order to define the vertical variations, for each sampling site, Cr contents in surface waters was subtracted from which in bottom waters. Difference > 0 , difference < 0 and difference $= 0$ indicate Cr contents in surface waters are higher, lower or equal to which in bottom waters (Table 1). In April, July and October 1982, the differences were -0.12 to $0 \mu\text{g L}^{-1}$, -1.09 to $0.17 \mu\text{g L}^{-1}$ and -0.07 to $0 \mu\text{g L}^{-1}$, respectively. It could be found that the differences were relative big in July which was the wet season. Therefore, the source input of Cr from overland runoff in the wet season was also influencing the vertical variations of Cr strongly.

Table 1 Differences of Cr contents between surface waters and bottom waters in Jiaozhou Bay

Month	122	84
April	Negative	0
July	Positive	Negative
October	Negative	0

3.3. Sediment process of Cr. By means of the variation of source input, the sediment processes of Cr within year were showing different stages. In April, Cr contents in surface waters ranged from 0.81 to $0.83 \mu\text{g L}^{-1}$, and the differences of Cr contents between surface waters and bottom waters were -0.12 to $0 \mu\text{g L}^{-1}$. These indicated that Cr contents in bottom waters were higher than in surface waters. These indicated that in April the wet season was not coming yet, and the source input of Cr from overland runoff was little, and there was little influence on Cr contents in waters far away from the coast in the southwest, and there was sediment process in coastal waters in the southwest of the bay (Fig. 3). In July, Cr contents in surface waters ranged from 1.02 to $1.37 \mu\text{g L}^{-1}$, and the differences of Cr contents between surface waters and bottom waters were -1.09 to $0.17 \mu\text{g L}^{-1}$. In coastal waters in the southwest

of the bay, Cr contents in surface waters were higher than in bottom waters. These indicated that in July the wet season was coming, and the source input of Cr from overland runoff was strong, and there was strong influence on Cr contents in waters near the coast in the southwest, and there was sediment process in waters far away from the coast in the southwest of the bay since the continuous input of Cr from overland runoff (Fig. 4). In October, Cr contents in surface waters ranged from 0.24 to 0.51 $\mu\text{g L}^{-1}$. In coastal waters in the southwest of the bay Cr contents in bottom waters were higher than in surface waters, while in waters far away from the coast in the southwest of the bay the vertical variations of Cr contents were very small. These indicated that in October the wet season was over, and the source input of Cr from overland runoff was weak, and there was little influence on Cr contents in waters, and in the coastal waters in the southwest of the bay the vertical variations were returning to the status before the source input since the continuous sediment of Cr in the past wet season (Fig. 5).

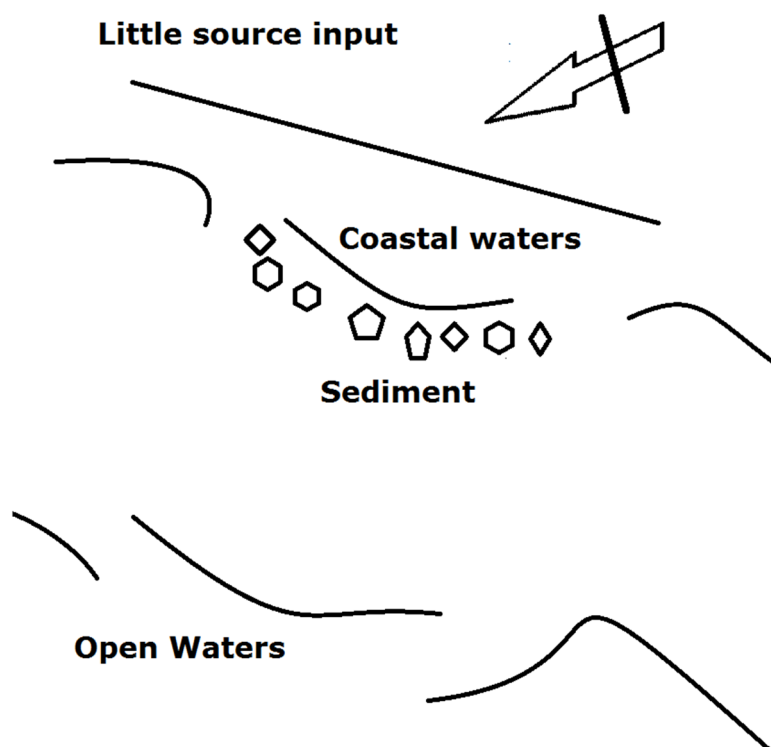


Fig. 3 Block diagram model for the sediment process in status 1

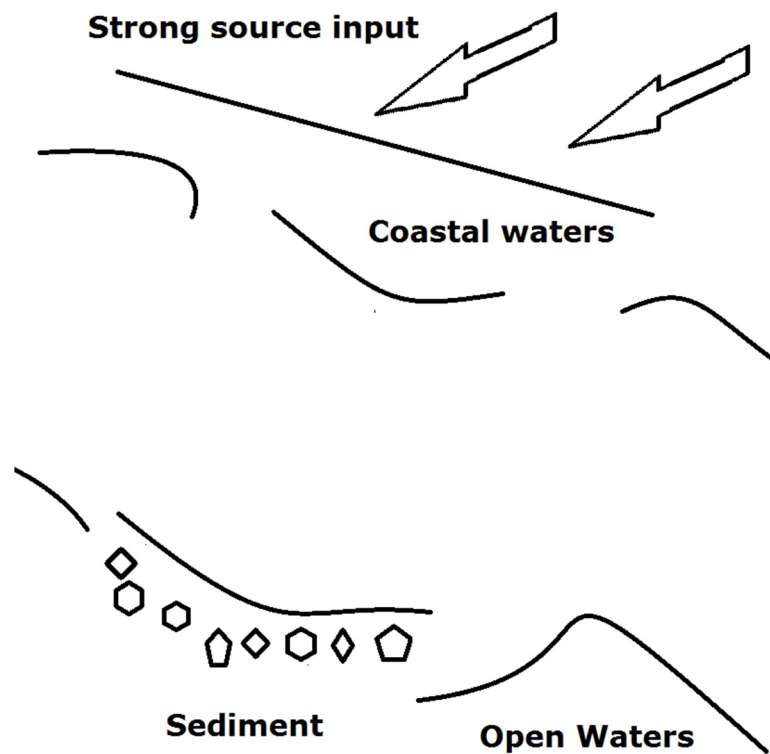


Fig. 4 Block diagram model for the sediment process in status 2

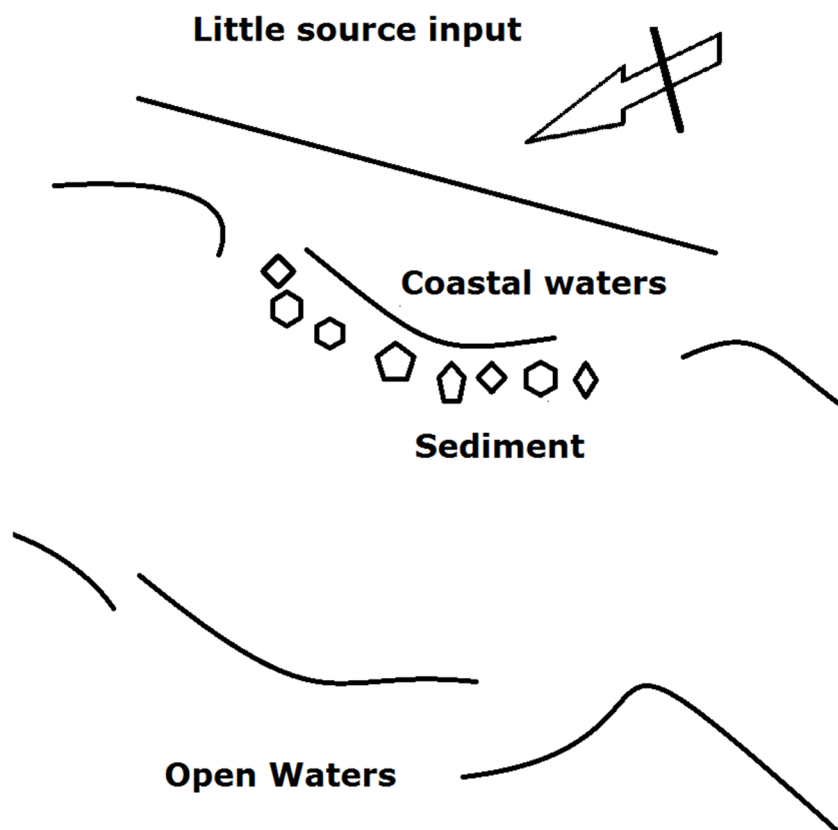


Fig. 5 Block diagram model for the sediment process in status 3

4. Conclusions

The horizontal distributions and vertical variations of Cr in waters were strongly impacted by overland runoff. The sediment process of Cr in Jiaozhou Bay within year could be divided into three statuses. Status 1: little source input from overland runoff. Status 2: strong source input from overland runoff. Status 3: the source input from overland runoff was over. The different statuses were demonstrated by the block diagram models.

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