

## Identification of the stages of migrating process of Cr in Jiaozhou Bay

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**Abstract:** Understanding the transfer process of Cr in marine bay is essential to pollution control and environmental remediation. Jiaozhou Bay is a semi-closed bay located in Shandong Province, China. This paper analyzed the transfer trends of Cr in surface and bottom waters in Jiaozhou Bay, and identified the different stages of transfer process. Results showed that the transfer process of Cr in this bay could be divided into three stages, i.e., 1) the settlement of Cr was beginning, 2) the settlement of Cr was going on, and 3) the settlement of Cr was stopping. Furthermore, we provided a block model to describe the transfer process of Cr in Jiaozhou Bay. In according to the block model, the migrating paths and the traces of Cr could be defined intuitively, and the distribution trends of Cr could also be predicted.

### 1. Introduction

Cr is one of the widely used heavy metal elements in various industries, and Cr pollution has been one of the critical environmental issues in the world. Marine is the sink of pollutants, and many marine waters have been polluted by various pollutants due to the rapid increase of industry [1-4]. Hence, understanding the migrating process of pollutants in maine bay is essential to pollution control and environmental remediation.

Jiaozhou Bay is a semi-closed bay located in Shandong Province, eastern China, and has been polluted by various pollutants [5-8]. This paper analyzed the migration trends of Cr in surface and bottom waters in Jiaozhou Bay, and identified the different stages of migrating process. Furthermore, a block model was provided to describe the transfer process of Cr in Jiaozhou Bay. In according to the block model, the migrating paths and the traces of Cr could be defined intuitively, and the distribution trends of Cr could also be predicted.

### 2. Materials and method

Jiaozhou Bay (35°55'-36°18' N, 120°04'-120°23' E) is located in the south of Shandong Peninsula, eastern China. The area, bay mouth width and average water depth and average water depth are 390 km<sup>2</sup>, 2.5 km and 7.0 m, respectively (Fig. 1). This bay is surrounding by cities of Qingdao, Jiaozhou and Jiaonan in the east, north and south, respectively. The bay mouth is located in the south of the bay, and is connected with the Yellow Sea. There are more than ten inflow rivers such as Loushan River, Licun River and Haibo River [9-10].

The investigation on Cr in surface waters in Jiaozhou Bay was conducted by North China Sea Environmental Monitoring Center. The investigation times were in August 1979, April and August 1981, April, July and October 1982, and May, September and October 1983, respectively [3-8], and the sampling sites were showed in Fig. 1. The investigation and measurement of Cr were following by National Specification for Marine Monitoring [11].

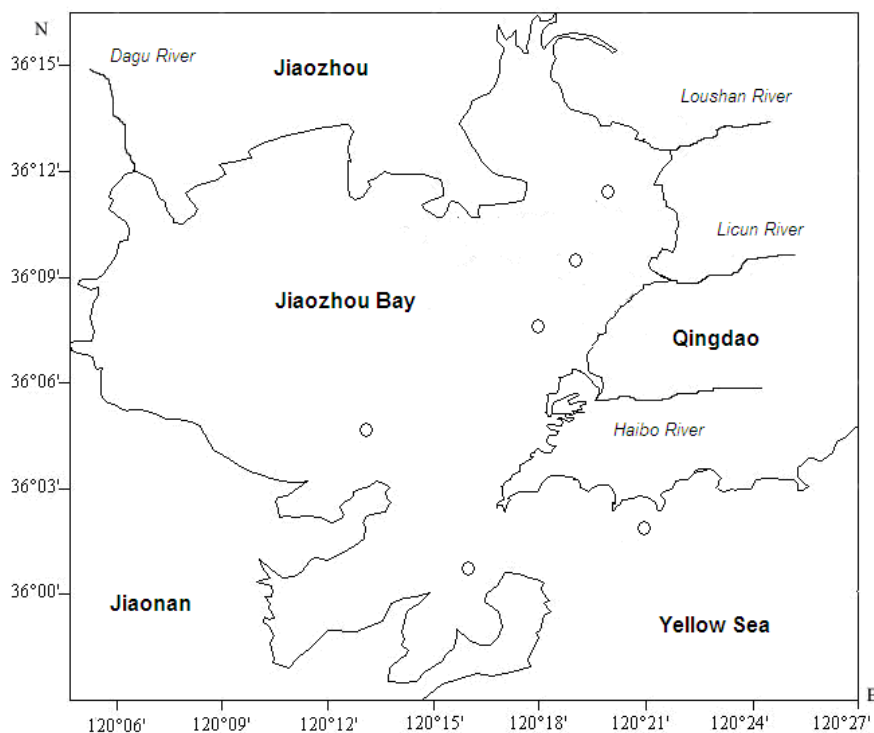


Fig.1 Geographic location and sampling sites of Jiaozhou Bay

### 3. Results and discussion

#### 3.1 Distribution trends of Cr.

The distribution trends of Cr in surface and bottom waters were different in different seasons. Cr contents in surface and bottom waters in August 1979 were  $1.30\text{--}1.40\ \mu\text{g L}^{-1}$  and  $0.03\text{--}0.10\ \mu\text{g L}^{-1}$ , respectively. In August 1979, Cr contents in surface and bottom waters were all decreasing from the open waters to the bay mouth, indicating consistent distribution trends in surface and bottom waters. Cr contents in surface and bottom waters in August 1981 were  $0.28\text{--}0.42\ \mu\text{g L}^{-1}$  and  $0.30\text{--}1.42\ \mu\text{g L}^{-1}$ , respectively. In August 1981, Cr contents in surface waters were decreasing from the estuary of Haibo River in the northeast of the bay to the bay mouth and the open waters, yet in bottom waters were converse. Cr contents in surface and bottom waters in April 1982 were  $0.81\text{--}0.83\ \mu\text{g L}^{-1}$  and  $0.81\text{--}0.95\ \mu\text{g L}^{-1}$ , in October 1982 were  $0.24\text{--}0.51\ \mu\text{g L}^{-1}$  and  $0.31\text{--}0.51\ \mu\text{g L}^{-1}$ , respectively. In April and October 1982, Cr contents in both surface and bottom waters were decreasing from the coastal waters in the southwest to the northeast of the bay. In July 1982 Cr contents in surface waters were decreasing from the coastal waters in the southwest to the northeast of the bay, yet were increasing in bottom waters. Hence, the distribution trends in surface and bottom waters in April and October 1982 were consist, yet in July 1982 were converse. Cr contents in surface and bottom waters in May 1983 were  $0.13\text{--}0.24\ \mu\text{g L}^{-1}$  and  $0.99\text{--}1.08\ \mu\text{g L}^{-1}$ , in September 1983 were  $0.70\text{--}1.17\ \mu\text{g L}^{-1}$  and  $1.12\text{--}1.16\ \mu\text{g L}^{-1}$ , in October 1982 were  $1.31\text{--}1.44\ \mu\text{g L}^{-1}$  and  $0.69\text{--}1.58\ \mu\text{g L}^{-1}$ , respectively. In May, September and October 1983, Cr contents were all decreasing from the coastal waters in east of the bay mouth to the bay mouth, indicating consistent distribution trends in surface and bottom waters.

#### 3.2 Stages of migrating process of Cr.

In generally, the migration processes of Cr were mainly determined by the input of Cr and the water body's effect [12-14]. In Jiaozhou Bay, the migrating process of Cr in this bay could be divided into three stages (Table 1). Stage 1, the settlement of Cr was beginning. At this stage, Cr contents were high in surface waters yet were low in bottom waters, the distribution trends in surface and bottom waters were consist. The reason was that the sedimentation of Cr was beginning

to settle yet Cr contents were still low in bottom waters. Stage 2, the sedimentation of Cr was going on. At this stage, Cr contents in both surface and bottom waters were relative high, a big part of Cr had been settling to bottom waters, and the sedimentation was going on, leading to the distribution trends in surface and bottom waters were converse. Stage 3, the settlement of Cr was stopping. At this stage, Cr contents in both surface and bottom waters were relative low, and the sedimentation of Cr had been stopping, leading to the distribution trends in surface and bottom waters were consist. Furthermore, we provided a block model to describe the transfer process of Cr in Jiaozhou Bay (Fig. 2). In according to the block model, the migrating paths and the traces of Cr could be defined intuitively, and the distribution trends of Cr could also be predicted. This is essential to pollution control and environmental remediation.

Table 1 The horizontal distribution trends and stages of Cr in surface and bottom waters

Stage	Sedimentation	Cr content in surface waters	Cr content in bottom waters	Distribution trends in surface and bottom waters
1	Beginning	High	Low	Consist
2	Going on	High	High	Converse
3	Stopping	Low	Low	Consist

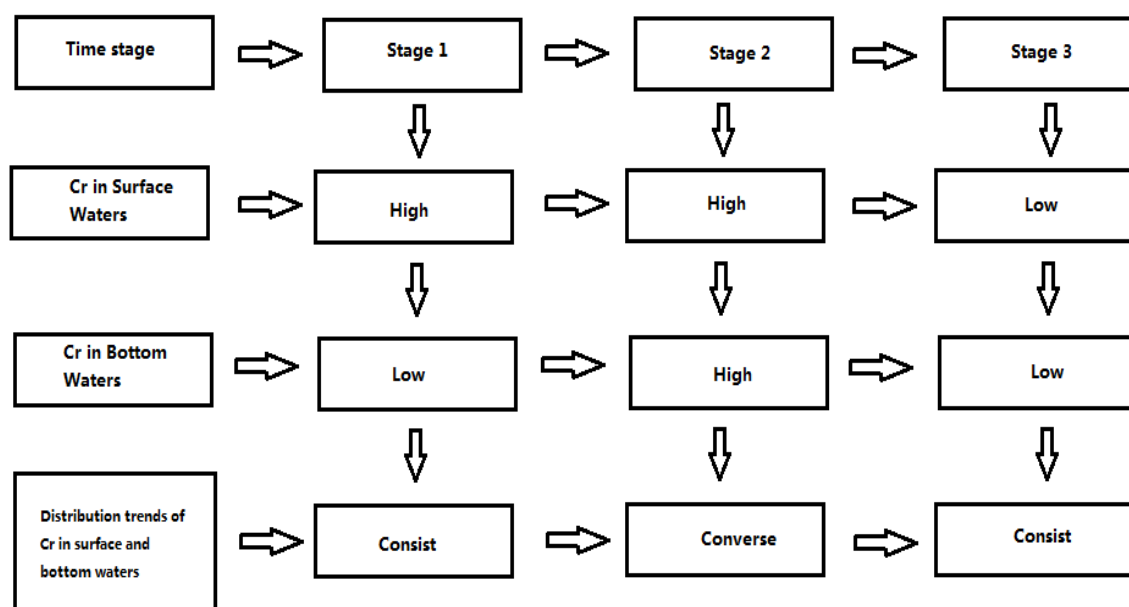


Fig. 2 The block model of distribution trends and stages of Cr in Jiaozhou Bay

#### 4. Conclusions

The distribution trends and migration process of Cr in marine bay were mainly determined by the input of Cr and the water body's effect. The transfer process of Cr in this bay could be divided into three stages, i.e., 1) the settlement of Cr was beginning, 2) the settlement of Cr was going on, and 3) the settlement of Cr was stopping. A block model was provided to describe the transfer process of Cr in Jiaozhou Bay. In according to the block model, the migrating paths and the traces of Cr could be defined intuitively, and the distribution trends of Cr could also be predicted.

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