Changes of Cr contents during different migration paths

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Abstract. Jiaozhou Bay is a semi-closed bay located in Shandong Province, China. Using investigation data on Chromium (Cr) in surface and bottom waters in April and July 1989, this paper analyzed the seasonal variation and vertical variation of Cr. Results showed that Cr contents in surface waters were in order of spring > summer. By means of vertical water's effect, contents in bottom waters were in order of spring > summer. The variation ranges of Cr contents in spring were closed to summer. High contents of Cr in surface waters were diluted in bottom waters, while low contents in surface waters were diluted or accumulated in bottom waters. The changes of Cr contents in surface and bottom waters were demonstrated the rapid sedimentation process. By means of vertical migration, the horizontal distributions of Cr in surface and bottom waters were tending to be consistent. Furthermore, Cr contents were decreasing along with the migration paths.

1. Introduction

Cr has been widely used in various industries of metallurgy, electroplating, chemical industry, aviation industry, etc. [1-6]. A large amount of Cr-containing waste gas, water and slag, or flames and smoke along with the rapid development of industry in the past several decades [7-10]. However, the waste treatment was always lagging with the increasing of Cr-containing wastes. Therefore, many marine bays have been polluted by Cr since arine is the sink of pollutants [11-18]. Jiaozhou Bay is a semi-closed bay located in Shandong Province, China. Using investigation data on Chromium (Cr) in surface and bottom waters in April and July 1989, this paper analyzed the seasonal variation and vertical variation of Cr. The aim of the paper is to provide scientific basis for pollution control of Cr.

2. Study area and data collection

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 km2, 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 [22-23].

The investigation on Cr in surface and bottom waters in Jiaozhou Bay was conducted by North China Sea Environmental Monitoring Center in April and July 1989. There were two sampling sites in April (i.e., Site 89 and Site 90) and one sampling site in July (i.e., Site 90) (Fig. 1). The investigation and measurement of Cr were following by National Specification for Marine Monitoring [24].

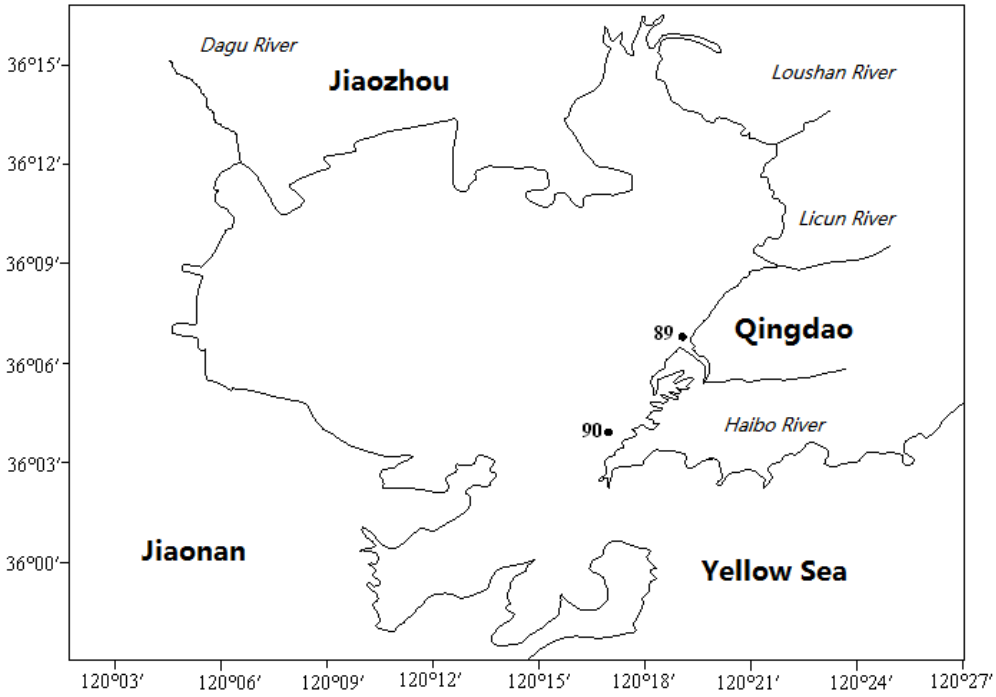

Fig.1 Geographic location and sampling sites of Jiaozhou Bay

3. Results

3.1. Cr contents in surface and bottom waters.

In April 1989, Cr contents in surface and bottom waters 1989 were 1.01-1.90 μg L^{-1} and 1.18-1.38 μg L^{-1}, respectively. In July 1989, Cr contents in surface and bottom waters 1989 were 1.64 μg L^{-1} and 1.08 μg L^{-1}, respectively. These contents were much lower than the Grade I (50 μg L^{-1}) for Cr in Sea Water Quality Standard (GB 3097-1997). The pollution level of Cr in bottom waters in Jiaozhou Bay in 1989 was very slight.

3.2. Seasonal variations of Cr in surface and bottom waters.

In study area, April and July belong to spring and summer, respectively. For seasonal variation, Cr contents in surface waters were in order of spring > summer. By means of vertical water's effect, contents in bottom waters were in order of spring > summer.

3.3. Variation ranges of Cr in surface and bottom waters.

In April 1989, Cr contents in surface waters were relative high (1.01-1.90 μg L^{-1}), and in bottom waters were also relative high (1.18-1.38 μg L^{-1}). In July1989, Cr contents in surface waters were relative low (1.64 μg L^{-1}), and in bottom waters were also relative low (1.08 μg L^{-1}). This was clearly displaying the vertical water's effect and horizontal water's effect [16-18].

3.4. Horizontal distributions of Cr in surface and bottom waters.

In April 1989, Cr contents in surface waters were decreasing from Site 85 in the center of the bay to Site 90 in the bay mouth in the south of the bay, which were consist with the horizontal of Cr contents in bottom waters. However, the horizontal distributions of Cr contents in surface and bottom waters

were unclear in July 1989 since there was only one sampling site.

4. Discussion

4.1. Sedimentation process of Cr.

By means of vertical water's effect, Cr contents were changing a lot during the migration path through water body [25-27]. The growth and reproduction of marine organism are increasing from spring to summer, and at the same time a lot of colloids are generating that increasing the absorption capacity of suspending particular matters [23].Therefore, a big part of Cr was absorbed to the suspending particular matters and was transferring to sea bottom by means of gravity force and marine current [1-6]. This continuous settlement process were fully displaying the vertical migration process of Cr.

4.2. Seasonal changing process of Cr.

In surface waters, Cr contents in April 1989 were relative high, yet were increasing to a relative low. The reason was that the major Cr source in spring was atmosphere deposition whose source strength was relative strong, while the major Cr source in summer was river flow whose source strength was relative weak. Hence, Cr contents in surface waters were in order of spring > summer. By means of vertical water's effect, horizontal water's effect and water's effect [12-19], Cr contents in bottom waters were also in order of spring > summer. The variation ranges of Cr contents in spring were closed to summer. The changes of Cr contents in surface and bottom waters were demonstrated the rapid sedimentation process.

4.3. *Vertical changing process of Cr.*

For vertical distribution, Cr contents in bottom waters would be relative high/low in case of r contents in surface waters were relative high/low. The reason was that the changes of Cr contents in bottom waters were able to consist with Cd contents in surface waters by means of rapid and continuous settlement process. In according to vertical water's effect, horizontal water's effect and water's effect [12-19], high contents of Cr in surface waters were diluted in bottom waters, while low contents in surface waters were diluted or accumulated in bottom waters. The changes of Cr contents in surface and bottom waters were demonstrated the rapid sedimentation process. By means of vertical migration, the horizontal distributions of Cr in surface and bottom waters were tending to be consistent.

4.4. Changes of Cr in different migration paths.

Jiaozhou Bay is a semi-closed bay whose bay mouth is very narrow (Fig. 1). The influences of human activities on Cr contents in Jiaozhou Bay are mainly depending two paths. One path is the Cr-containing waste gas could be impacting Cr contents in marine bay by means of atmosphere deposition, whose source strength was 3.29 μg L-1 (Fig. 2). Another path is the Cr-containing waste in land surface would be washed and transported to marine bay by means of rainfall-runoff, whose source strength was 2.36 μg L-1 (Fig. 2). The influence of the first path is direct, while for the second path is relative indirect since the migration path is longer. Hence, Cr contents were decreasing along with the increasing of the migration paths.

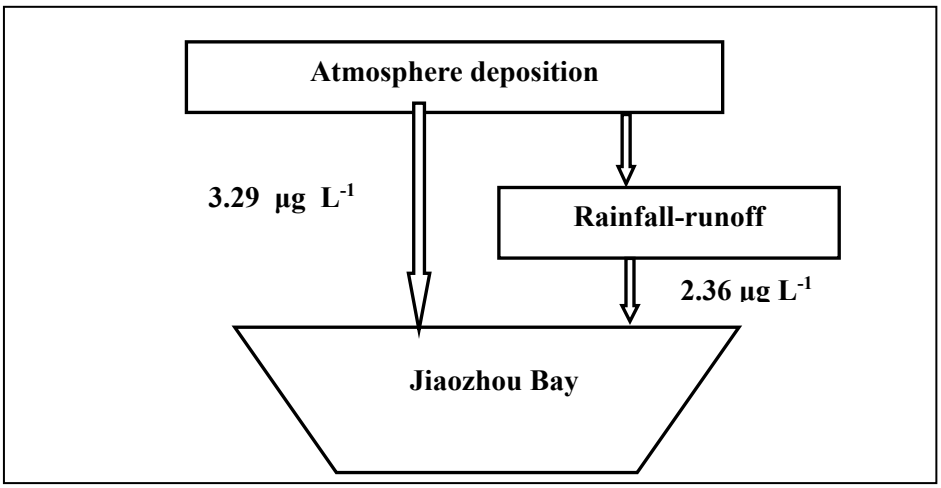

Fig. 2 Two major migration paths of Cr in Jiaozhou Bay

5. Conclusion

Cr contents in surface waters were in order of spring > summer. By means of vertical water's effect, horizontal water's effect and water's effect, Cr contents in bottom waters were also in order of spring > summer. Cr contents in bottom waters would be relative high/low in case of Cr contents in surface waters were relative high/low. By means of vertical water's effect, horizontal water's effect and water's effect, high contents of Cr in surface waters were diluted in bottom waters, while low contents in surface waters were diluted or accumulated in bottom waters. Hence, the horizontal distributions of Cr in surface and bottom waters were tending to be consistent. The influences of human activities on Cr contents in Jiaozhou Bay are mainly depending two paths of atmosphere deposition and rainfall-runoff. The influence of atmosphere deposition is direct, while for rainfall-runoff is relative indirect since the migration path is longer. Cr contents were decreasing along with the increasing of the migration paths.

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