

High sedimentation regions and laws of As in Jiaozhou Bay

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Abstract: Using investigation data on Arsenic (As) in bottom waters in Jiaozhou Bay in April and August 1981, this paper researched the contents and horizontal distributions of As in bottom waters. Results showed that As contents in April and August 1981 were 1.04-2.40 $\mu\text{g L}^{-1}$ and 1.00-1.80 $\mu\text{g L}^{-1}$, respectively. The contents of As in bottom waters Jiaozhou Bay 1981 was very slight and confirmed to Class I in Sea Water Quality Standard (GB 3097-1997). High As contents regions were in the coastal waters in the east, northeast, and north of the bay. The terrestrial As sources were 2.00-2.70 $\mu\text{g L}^{-1}$, and resulted in relevant high sedimentation regions. In April 1981, high sedimentation region was in bottom waters in the estuary of Haibo River (2.40 $\mu\text{g L}^{-1}$). In August 1981, high sedimentation region was in bottom waters in coastal waters in the northeast of the bay (1.80 $\mu\text{g L}^{-1}$). We found the law of high sedimentation as different sources result in different high sedimentation regions. Furthermore, in bottom waters in the bay mouth, and at any time, substance contents are decreasing while passing through the bay mouth.

1. Introduction

As is widely used in industry and agriculture, and a great deal of As-containing wastes are generated and discharged into the environment. However, As is high toxic, and the excessive existence of As is harmful to organism. For instance, arsenic trioxide is one of the most famous toxicants in ancient China. Nowadays, many marine bays have been polluted by As [1-3]. Jiaozhou Bay in a semi-closed bay in Shandong Province, China. As contents in bay waters were changing by means of As's source input and vertical water's effect [4-6]. Using investigation data on As in 10 sampling sites in Jiaozhou Bay in April and August 1981, this paper researched the contents and horizontal distributions of As, defined the high sedimentation regions, and revealed the laws. The aim of this paper was to provide basis for researching on the migration process of As in marine bay.

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), with the total area and average water depth of 446 km² and 7 m, respectively. The bay mouth is very narrow (3 km) between Tuandao and Xuejiadao, and is connected to the Yellow Sea.



There are a dozen of rivers, and the major rivers include Dagu River, Haibo River, Licun River, and Loushan River etc.. All of which are seasonal rivers strongly impacted by seasonal factors [7–8]. The investigation on As in bottom waters in Jiaozhou Bay was carried on in April and August 1981 in 10 sampling sites (i.e., A1, A2, A3, A5, A6, A7, A8, B5, and D5) (Fig. 1). As in waters was sampled and monitored follow by National Specification for Marine Monitoring [9].

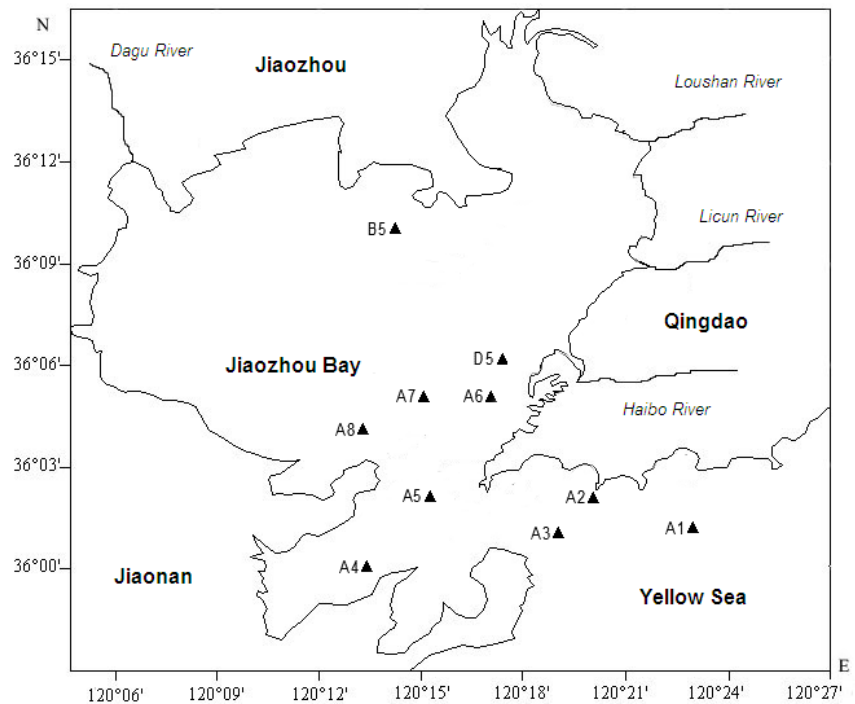


Fig. 1 Geographic location and sampling sites of Jiaozhou Bay

3. Results

3.1 Contents and distributions of As contents. As contents in bottom waters in April and August 1981 were $1.04\text{--}2.40\ \mu\text{g L}^{-1}$ and $1.00\text{--}1.80\ \mu\text{g L}^{-1}$, respectively. The contents of As in bottom waters Jiaozhou Bay 1981 were very slight and confirmed to Class I ($20\ \mu\text{g L}^{-1}$) in Sea Water Quality Standard (GB 3097-1997). In bottom waters in April 1981, high value of As contents was in Site D5 in estuary of Haibo River, and the contour lines of As contents were decreasing from the high value center ($2.40\ \mu\text{g L}^{-1}$) to the bay mouth $1.40\ \mu\text{g L}^{-1}$, and the open waters ($1.36\ \mu\text{g L}^{-1}$) (Fig. 2). In bottom waters in August 1981, high value of As contents was in Site B5 in the coastal waters in the north of the bay, and the contour lines of As contents were decreasing from the high value center ($1.80\ \mu\text{g L}^{-1}$) to the bay mouth ($1.44\ \mu\text{g L}^{-1}$), and the open waters ($1.10\ \mu\text{g L}^{-1}$) (Fig. 3). In according to the horizontal distributions of As contents, it could be defined that the major As sources in April and August 1981 were river flow and overland runoff, respectively.

3.2 High sedimentation regions of As contents. In April 1981, As contents in bottom waters were $1.04\text{--}2.40\ \mu\text{g L}^{-1}$. As contents were decreasing from coastal waters in the estuary of Haibo River to the inner side of the bay mouth, the bay mouth, and the outer side of the bay mouth. This indicated that high sedimentation region was in coastal waters in the estuary of Haibo River in the northeast of the bay. In August 1981, As contents in bottom waters were $1.00\text{--}1.80\ \mu\text{g L}^{-1}$. As contents were decreasing from coastal waters in the north of the bay to the inner side of the bay mouth, the bay mouth, and the outer side of the bay mouth. This indicated that high sedimentation region was in coastal waters in the north of the bay. Hence, high sedimentation regions in April and August 1981 were in coastal waters in

the estuary of Haibo River and coastal waters in the north of the bay, respectively.

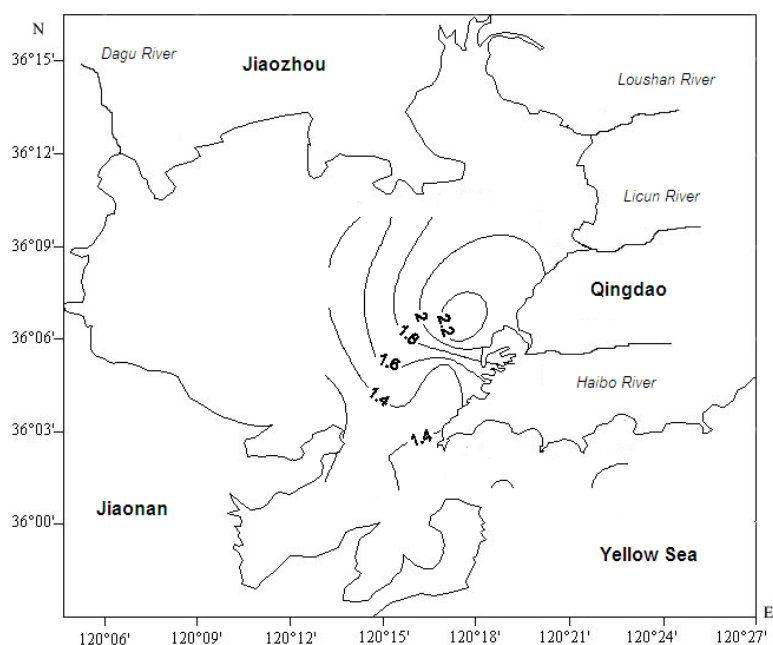


Fig. 2 Horizontal distributions of As contents in bottom waters in Jiaozhou Bay in April 1981/ $\mu\text{g L}^{-1}$

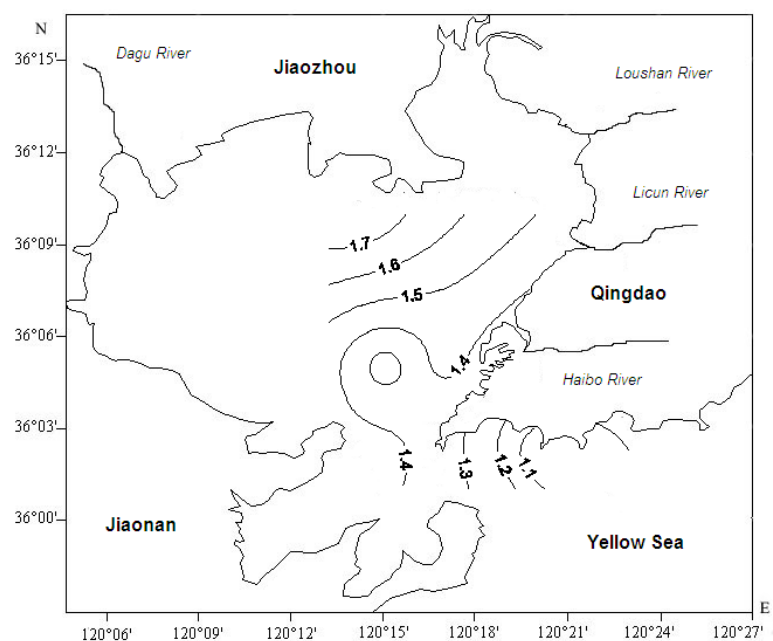


Fig. 3 Horizontal distributions of As contents in bottom waters in Jiaozhou Bay in August 1981/ $\mu\text{g L}^{-1}$

4. Discussion

4.1 Migration process of As in the bay. In April 1981, high values of As contents in surface waters were in estuaries of Haibo River, Licun River and Loushan River, and were $2.70 \mu\text{g L}^{-1}$, $2.00 \mu\text{g L}^{-1}$ and $2.06 \mu\text{g L}^{-1}$, respectively. This indicated that the source strengths of river flow were $2.00\text{--}2.70 \mu\text{g L}^{-1}$. While in coastal waters in the north of the bay, high value of As contents was $2.06 \mu\text{g L}^{-1}$. This

indicated that the source strengths of overland runoff was $2.06 \mu\text{g L}^{-1}$. Hence, by means of vertical waters' effect [4–6], the high sedimentation region in April 1981 was in the estuaries of the major rivers especially Haibo River in the northeast of the bay. In August 1981, high values of As contents in surface waters were in estuaries of Haibo River, Licun River and Loushan River, and were $2.02\text{--}2.60 \mu\text{g L}^{-1}$, $2.32\text{--}2.50 \mu\text{g L}^{-1}$ and $2.0\text{--}2.50 \mu\text{g L}^{-1}$, respectively. This indicated the source strengths of river flow were $2.02\text{--}2.60 \mu\text{g L}^{-1}$. While in coastal waters in the north of the bay, high value of As contents was $2.20 \mu\text{g L}^{-1}$. This indicated that the source strengths of overland runoff was $2.20 \mu\text{g L}^{-1}$. Hence, by means of vertical waters' effect [4–6], the high sedimentation region in August 1981 was in coastal waters in the north of the bay. In surface waters, high value regions of As contents were commonly in coastal waters due to the inputs of As from major rivers and overland runoff. The source strengths of As were $2.00\text{--}2.70 \mu\text{g L}^{-1}$. By means of vertical water's effect, As in surface waters were settling to bottom waters rapidly and continuously, and as a result there were high sedimentation regions ($1.80\text{--}2.40 \mu\text{g L}^{-1}$) in coastal waters closed to the major sources. Hence, the law of sedimentation process of As was that, in any time, As was firstly entering into surface waters, and then was transporting through water body, and was finally settling to sea bottom. Since the sources of As was different, As contents in surface waters were also different in time and space, and therefore were resulting in different high sedimentation regions in the bay. In general, the high sedimentation regions of As were determined by As sources.

4.2 Changing of As contents in the bay mouth. In April 1981, in according to the horizontal distributions of As contents in bottom waters, it could be found that As contents were decreasing from coastal waters in the estuary of Haibo River ($2.40 \mu\text{g L}^{-1}$) to the bay mouth ($1.40 \mu\text{g L}^{-1}$), and the outer side of the bay mouth ($1.36 \mu\text{g L}^{-1}$) (Fig. 2). This indicated that As contents in April 1981 were decreasing while passing through the bay mouth. In August 1981, in according to the horizontal distributions of As contents in bottom waters, it could be found that As contents were decreasing from high value center in the north of the bay ($1.80 \mu\text{g L}^{-1}$) to the bay mouth ($1.44 \mu\text{g L}^{-1}$), and the open waters ($1.10 \mu\text{g L}^{-1}$) (Fig. 2). (Fig. 3). This indicated that As contents in August 1981 were also decreasing while passing through the bay mouth. Jiaozhou Bay is a semi-closed bay, and the water exchange is strong in the bay mouth. By means of water exchange, substance's contents are decreasing continuously [10]. Therefore, in bottom waters in the bay mouth, and at any time, substance contents are decreasing while passing through the bay mouth.

5. Conclusions

The contents of As in bottom waters Jiaozhou Bay 1981 were very slight and confirmed to Class I. High sedimentation regions in April and August 1981 were in coastal waters in the estuary of Haibo River and coastal waters in the north of the bay, respectively. The law of sedimentation process of As was that, in any time, As was firstly entering into surface waters, and then was transporting through water body, and was finally settling to sea bottom. The high sedimentation regions of As were determined by As sources. By means of water exchange, substance's contents are decreasing continuously. In bottom waters in the bay mouth, and at any time, substance contents are decreasing while passing through the bay mouth.

Acknowledgement

This research was sponsored by Research Projects of Guizhou Nationalities University ([2014]02), Research Projects of Guizhou Province Ministry of Education (KY [2014] 266), Research Projects of Guizhou Province Ministry of Science and Technology (LH [2014] 7376).

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