Advances in Engineering Research (AER), volume 148
3rd Workshop on Advanced Research and Technology in Industry Applications (WARTIA 2017)

Migration rules of Cr in Jiaozhou Bay: fundamental theories

Dongfang Yang[1, 2, 3, a], Zhenqing Miao[4, b,c], Haixia Li[1,2], Jun Ding[1,2], Longlei Zhang[1]

[1]Center for Accounting and Auditing Informatics, Xijing University, Xian 710123, China;

[2]Accountancy Shool, Xijing University, Xian 710123, China;

[3]North China Sea Environmental Monitoring Center, SOA, Qingdao 266033, China

[4]College of Fisheries, Zhejiang Ocean University, Zhoushan, 316022, China.

[a]dfyang_dfyang@126.com, [b] corresponding author, [c]mzq@zjou.edu.cn

Keywords: Cr; Migration process; Migration rule; Migration theory; Jiaozhou Bay.

Abstract: Many marine bays have been polluted by various pollutants including Cr, and therefore understanding the migration rules and theories is essential to pollution control and environmental remediation. Jiaozhou Bay is a semi-closed bay located in Shandong Province, China. Based on the research on the distributions, trends, and migrations of Cr in Jiaozhou Bay, this paper provided five fundamental theories for migration rules of Cr, including 1) omogeneous theory for substance's content, 2) environmental dynamic theory for substance's content, 3) horizontal loss theory for substance's content, 4) migration trend theory for substance's content, and 5) vertical migration theory for substance's content. These fundamental theories were essential to environmental decision making and scientific research.

1. Introduction

Many marine bays have been polluted by various pollutants including Cr, and therefore understanding the migration rules and theories is essential to pollution control and environmental remediation [1-4]. 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^2, 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].

Based on investigation on Cr in Jiaozhou Bay during 1979-1983 [12], as well as relevant researches on the distributions, trends, and migrations of Cr in Jiaozhou Bay [1-11], this paper provided five fundamental theories for migration rules of Cr, including homogeneous theory for substance's content, environmental dynamic theory for substance's content, horizontal loss theory for substance's content, migration trend theory for substance's content, and vertical migration theory for substance's content. These theories provided comprehensive and systematic basis for scientific research, and were meaningful to environmental decision making and scientific research.

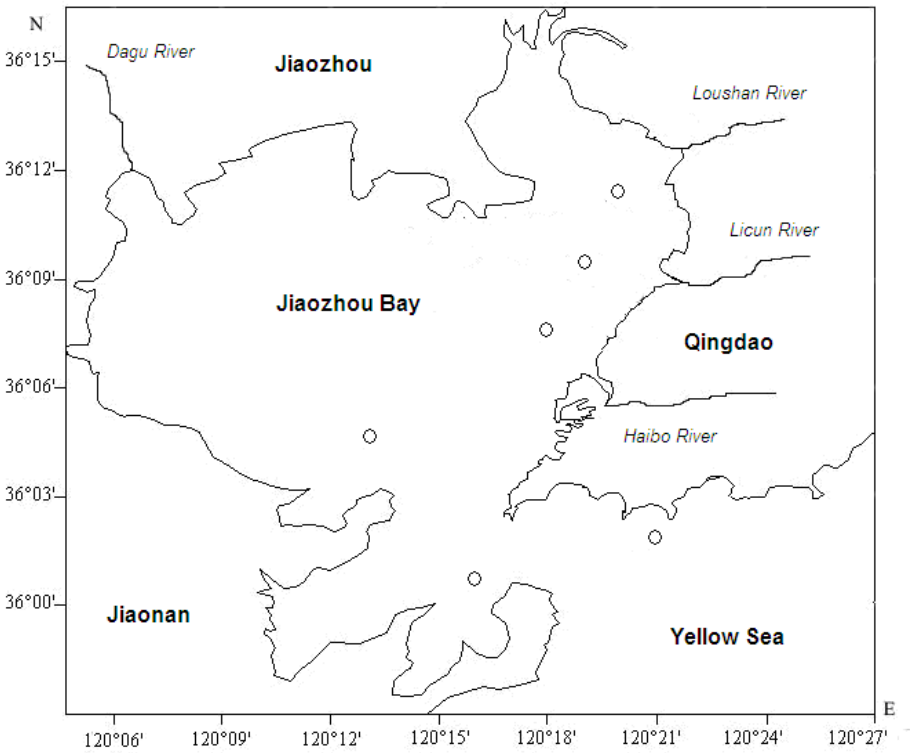

Fig.1 Geographic location and sampling sites of Jiaozhou Bay

2. Fundamental theories

2.1 Homogeneous theory for substance's content.

Identifying the distribution trends of pollutants in marine bays are meaningful to both scientific research and practical environmental decision making. Based on investigation on Cr in Jiaozhou Bay during 1979-1983, it was found that in case of there was Cr input to the bay, the distribution of Cr in waters was inhomogeneous. In case of there was no Cr input to the bay, the distribution of Cr in waters was homogeneous. However, the distribution of Cr in waters would be changing from inhomogeneous to homogeneous along with time. Tide was playing the major role in coastal waters, while marine is responsible in open waters, as well as storm and earth quake. In generally, ocean or marine bay are playing roles of containers, and the substances inside were stirring and transporting by tide and current, and were tending to be homogenous in waters. Hence, the distributions of the substances in the ocean were going to be homogenous, and the ocean had homogeneity, and therefore Cr contents in bay waters were tending to be homogeneous horizontal distribution.

2.2 Environmental dynamic theory for substance's content.

In according to the definition and structural model of environmental dynamic value of substance in marine bay, as well as basic background value, environmental background value, input value and environmental dynamic value, we could define the changing processes, changing regions and structural variables of the substance contents. Based on investigation data on Cr in 1979, and by means of these definitions and the structural model, it was defined that the environmental dynamic value, basic background value, environmental background value and river input of Cr in Jiaozhou bay were 0.20-112.30 μg L^{-1}, 0.10-1.40μg L^{-1}, 0.20 μg L^{-1} and 0.00-112.10μg L^{-1}, respectively. In according to basic background value, environmental background value, and river input of Cr in Jiaozhou bay, the environmental dynamic value could be constructed, and the changing process and trend of Cr in Jiaozhou Bay could be defined.

3. Horizontal loss theory for substance's content.

A horizontal loss rate model was provided to reveal the unit-distance loss rate of substance contents in marine bay during the transferring process. By means of this model, we found the laws of horizontal loss rate of substance that, for a certain substance and in a same water body, if the relative unit-distance loss rate was stable and constant, the relative horizontal loss rate for a certain substance and in a same water body would be same and closed. An example to show the performance of this model based on investigation data on Cr in 1979 in Jiaozhou Bay, China. Results showed that from costal waters in the north to the center of the bay, Cr content was losing 13.92 μg L^{-1} for each 1 km, while from the costal waters in the middle to the bay mouth in the south of the bay, Cr content was losing 2.80 μg L^{-1} for each 1 km. Form the coastal waters in the north of the bay to the bay mouth in the south, the horizontal relative loss rate was 12.40-14.77 YDF.

3.1 Migration trend theory for substance's content.

Based on the analysis on the migration trends of Cr in surface and bottom waters in Jiaozhou Bay, it was identified that there were three different stages of migrating process including 1) the settlement of Cr was beginning, 2) the settlement of Cr was going on, and 3) the settlement of Cr was stopping. The different stages of migration process of Cr in Jiaozhou Bay revealed that the sedimentation of the substances was rapid, and the accumulation of the substances was notable. Meanwhile, the spatial-temporal changing trends in surface and bottom waters, as well as their relationships could be defined bay this theory. A block model was provided to describe the transfer process of Cr in Jiaozhou Bay that the migrating paths and the traces of Cr could be defined intuitively, and the distribution trends of Cr could also be predicted.

3.2 Vertical migration theory for substance's content.

The vertical variations of Cr was reveal, theories and identification of absolute sedimentation amount, relative sedimentation amount, absolute accumulation amount and relative accumulation amount were provided. By means of this theory, sedimentation and accumulation of Cr could be quantified. Based on investigation data on Cr in Jiaozhou Bay during 1979-1983, it was found that the absolute sedimentation amount, relative sedimentation amount, absolute accumulation amount and relative accumulation amount of Cr were calculated as 0.30-2.18 μg L-1, 62.5%-92.8%, 0.37-1.84 μg L-1 and 681.4%-1336.3%, respectively. The sedimentation and of Cr and the accumulation of Cr in bottom waters were notable. The sedimentation amount of Cr was large in case of Cr contents in surface waters were high, yet would be small in case of Cr contents in surface waters were low, resulting in the consistency of Cr contents in surface and bottom waters. The results were essential to pollution control and environmental remediation.

4. Conclusions

This paper provided five fundamental theories for migration rules of Cr, including Homogeneous theory for substance's content, environmental dynamic theory for substance's content, horizontal loss theory for substance's content, migration trend theory for substance's content, and vertical migration theory for substance's content. These theories provided comprehensive and systematic basis for scientific research, and were meaningful to environmental decision making and scientific research.

Acknowledgment

This research was sponsored by Doctoral Degree Construction Library of Guizhou Nationalities University, Education Ministry's New Century Excellent Talents Supporting Plan (NCET-12-0659), the China National Natural Science Foundations (31560107) and (31500394), 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).

References

[1] Yang DF and Miao ZQ: Marine Bay Ecology (I): Beijing, Ocean Precess, (2010), p. 1-320. (in Chinese)

[2] Yang DF and Gao ZH: Marine Bay Ecology (II): Beijing, Ocean Precess, (2010), p. 1-330. (in Chinese)

[3] Yang DF, Gao ZH, Sun JY, et al.: Coastal Enginerring, Vol. 27 (2008), p. 48- 53. (in Chinese with English Abstract)

[4] Yang DF, Wang FY, He HZ, et al.: Applied Mechanics and Materials,Vol. 675-677 (2014), p. 329-331.

[5] Yang DF, Zhu SX, Wang FY, et al.: Applied Mechanics and Materials, Vol. 644-650 (2014), p. 5325-5328.

[6] Yang DF, Zhu SX, Wang FY, et al.: 2014 IEEE workshop on advanced research and technology industry applications. Part D, Vol. (2014), p. 1018-1020.

[7] Yang DF, Zhu SX, Sun ZH, et al.: Advances in Engineering research, Vol. (2015), p. 1375-1378.

[8] Yang DF, Zhu SX, Yang XQ, et al.: Advances in Engineering research, Vol. (2015), p. 1383-1385.

[9] Yang DF, Wang FY, Sun ZH, et al.: Materials Engineering and Information Technology Application, Vol. (2015), p. 562-564.

[10] Yang DF, Chen Y, Gao ZH, et al.: Chinese Journal of Oceanology and Limnology, Vol. 23 (2005), p. 72-90. (in Chinese with English Abstract)

[11] Yang DF, Wang F, Gao ZH, et al.: Marine Science, Vol. 28 (2004), p.71-74. (in Chinese with English Abstract)

[12] State Ocean Administration. The specification for marine monitoring: Beijing, Ocean Precess, (1991). (in Chinese)