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The Force of Substance's Homogeneity and In-Homogeneity in Marine Bay

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Abstract: Previous studies showed that substance's contents in ocean has feature of homogeneity, which was meaningful in revealing and forecasting the change trend of substance's contents in marine bays. Taken Hg contents in Jiaozhou Bay China as an example, this paper researched the homogeneity of substance's contents. Results showed that Hg's contents in Jiaozhou Bay had features of homogeneity and in-homogeneity. Furthermore, it was found that the source input was the force of in-homogeneity, while hydrodynamic force was the force of homogeneity. By means of these two forces, substance's contents would be distributed in any positions in marine bay, and the change trend of substance's contents could be revealed and predicted.
Keywords: Homogeneity, In-homogeneity, Force, Substance, Marine bay

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1. INTRODUCTION

Many marine bays have been polluted along with the rapid increase of economic, and the ocean pollution has been one of the critical environmental issues [1-2], and understanding the environment behavior of of pollutants in marine bays is essential to pollution control [3-5]. Previous studies showed that ocean has feature of homogeneity, i.e., substance (e.g., HCH, PHC, CD, Pb) in the ocean could be transported to further place no matter substance's content was high or low, resulted in the homogeneous distribution [6-11].

Jiaozhou Bay is a semi-closed bay located in Shandong Province, eastern China. In order to provide basis information to scientific research and pollution control practice, this paper analyzed the feature of homogeneity of Hg contents. It was found that that Hg's contents in

Jiaozhou Bay had features of homogeneity and in-homogeneity, and the forces were the source input and hydrodynamic force, respectively.

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). The total area, average water depth and the wide of the bay mouth are 446 km^2, 7 m and 3 km, respectively (Fig. 1). This bay is connected to the Yellow Sea in the south, and cities of Qingdao, Jiaozhou and Jiaonan are located in the east, north and west of the bay, respectivey (Fig. 1). There are a dozen of rivers, and the majors are Dagu River, Haibo Rriver, Licun Rriver, and Loushan Rriver etc., all of which are seasonal rivers [12-13]. The investigation on Hg in surface waters in Jiaozhou Bay was conducted in May, July and November 1987, respectively. Hg in surface waters in six sampling sites was sampled and monitored follow by National Specification for Marine Monitoring (Fig. 1)[14].

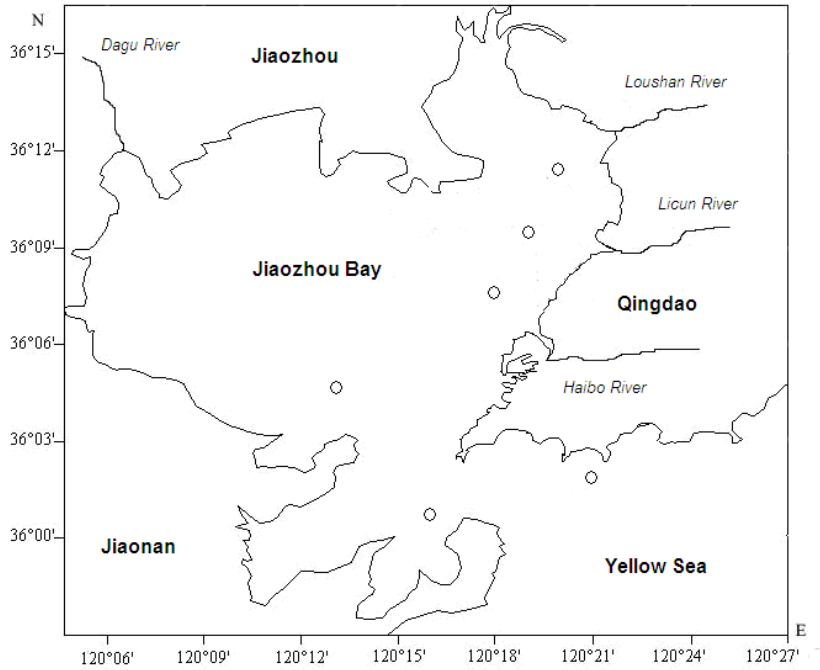
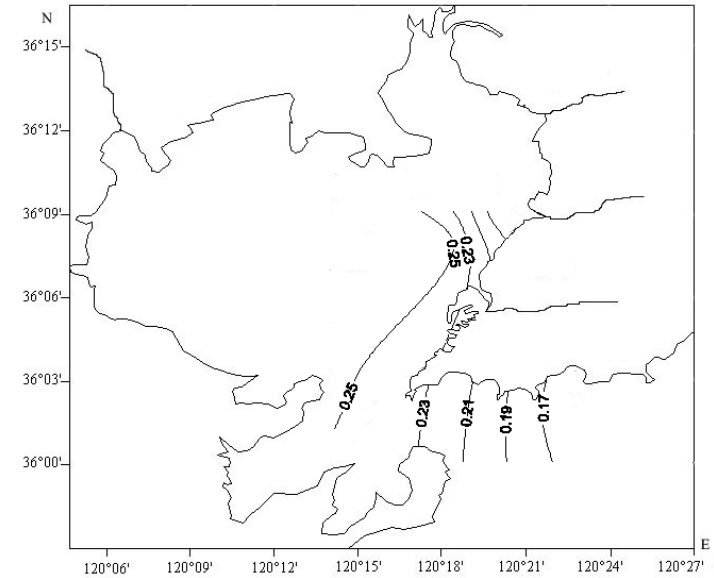


Fig. 1 Geographic location and sampling sites in Jiaozhou Bay

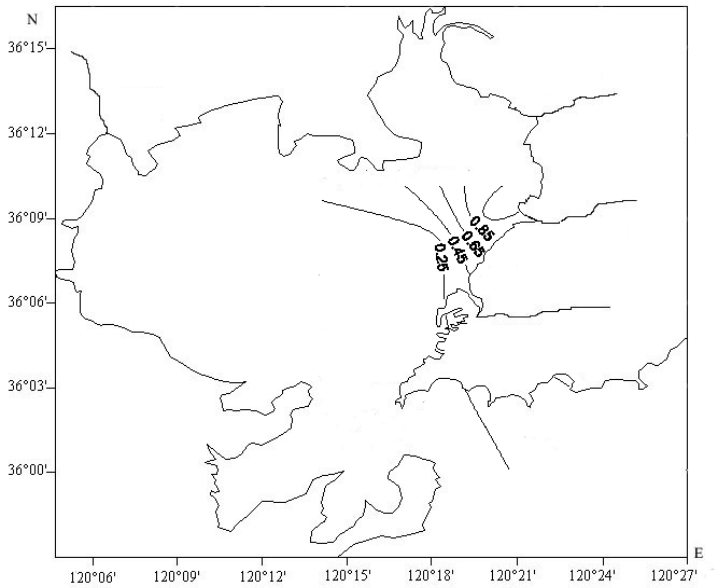
3. RESULTS AND DISCUSSION

Horizontal distributions and sources of Hg. In according to the horizontal distributions, the major sources of Hg in different months could be defined. In May 1987, the highest Hg content (0.264 μg L^{-1}) was occurring in estuary of Haibo River in the northeast of the bay, and Hg contents were decreasing along with the flow direction of Haibo River to the bay mouth (0.241 μg L^{-1}) and the open waters (0.150 μg L^{-1}) (Fig. 2 a). In July 1987, the highest Hg content (1.104 μg L^{-1}) was occurring in estuary of Licun River in the northeast of the bay, and

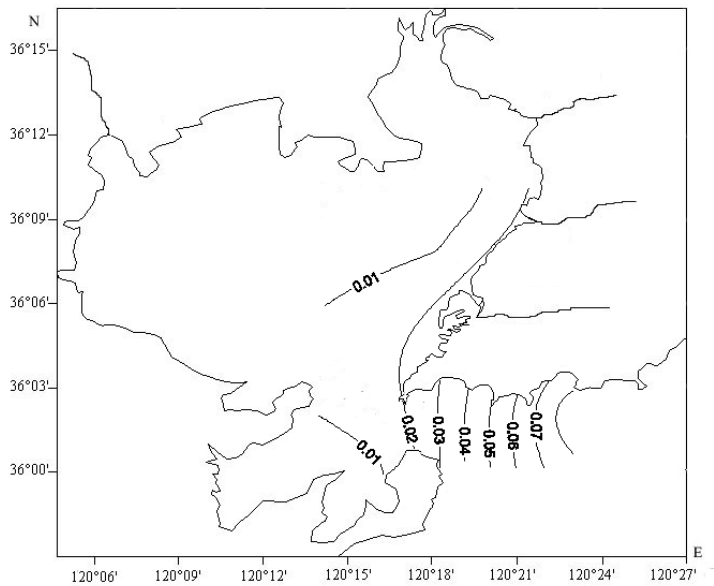
Hg contents were decreasing along with the flow direction of Licun River to the bay mouth (0.088 μg L^{-1}) (Fig. 2 b). In July 1987, the highest Hg content (0.088 μg L^{-1}) was occurring in the open water, and Hg contents were decreasing along with the flow direction of marine current to the bay mouth (0.007 μg L^{-1}) (Fig. 2 c). It could be found that river flow was the major Hg sources in May and July, respectively, resulted in relative high Hg contents in surface water, while in November there was little source input, and resulted in very low Hg contents in surface waters. In general, river was the major Hg source in 1987, and the source strength was moderate, strong and weak in May, July and November, respectively.



(a)



(b)



(c)

Fig. 2 Horizontal distributions of Hg contents in a) May, b) July and c) November 1987/μg L^{-1}

Force of in-homogeneity. Supposed that substance's contents in a survey were ranging from *a* to *b* μg L^{-1}, the varied length was calculated as:

$$L = b - a \tag{1}$$

The varied length of substance's contents was defined as the index of the homogeneity of in-homogeneity of substance's contents in ocean. The higher L, the stronger in-homogeneity or weaker homogeneity. The varied lengths and source strengths of Hg in May, July and November 1987 were listed in Table 1. It could be seen from Table 1 that the varied lengths of substance's contents were strongly determined by the source strengths of substances. The stronger source strength, the bigger varied lengths, and the stronger in-homogeneity or weaker homogeneity. Hence, the force of in-homogeneity of substance's contents was the source input. In according to the horizontal distributions and the varied lengths of Hg contents in Jiaozhou Bay, it could be defined that the major source in May and July was river flow, and the source strength of river flow was the force of in-homogeneity of Hg's contents.

Table 1 The varied lengths and source strengths of Hg in May, July and November 1987

Month	May	July	November
Varied length/μg L^{-1}	0.086	1.016	0.007
Source strength/μg L^{-1}	0.264	1.104	0.000

Force of homogeneity. In according to the horizontal distributions and the varied lengths of Hg contents in November in Jiaozhou Bay, it was defined that the source input from river flow was very little, yet the distributions of Hg contents was very homogeneous. By means of hydrodynamic force (e.g., tide, marine current), the low contents of Hg in Jiaozhou Bay were shaking and stirring, resulting in the homogeneous distributions of Hg contents. Hence, it could be concluded that hydrodynamic force was the force of homogeneity of substance's contents in marine bay. In general, Hg contents in Jiaozhou Bay would be transported to further place finally no matter Hg's content was high or low, resulted in the homogeneous distribution, which were consistent to previous studies on other pollutants (e.g., HCH, PHC, CD, Pb) in this bay [6-11].

4. CONCLUSION

Features of homogeneity and in-homogeneity of substance's contents were analyzed based on a case study on Hg in Jiaozhou Bay. The varied length of substance's contents was defined as the index to quantify the homogeneity of in-homogeneity of substance's contents in ocean. Substance's contents had features of both homogeneity and in-homogeneity.

Source input was the force of in-homogeneity, while hydrodynamic force was the force of homogeneity. All of the substances in Jiaozhou Bay would be transported to further place finally no matter substance's content was high or low, resulted in the homogeneous distribution.

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