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Research Article

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Temporal and vertical distribution of chromium in Tianjin coastal reservoirs

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ABSTRACT

Field investigation and sampling analysis method was conducted to seasonal variation and vertical distribution of heavy metal chromium for Beidagang reservoir and Beitang reservoir in the coastal region of Tianjin. Results show that the content of heavy metal chromium in the reservoirs water did not exceed the standard of surface water environment quality (GB3838-2002). In different sites of reservoirs, the average level of hexavalent chromium and total chromium of reservoir water was 0.026mg/L and 0.046mg/L respectively. The average level of hexavalent chromium/total chromium of reservoir water was 68.22%, and results show that the composition of total chromium was Hexavalent chromium for reservoir water sites. Seasonal variation characteristics of heavy metal chromium in reservoir were not obviously, and showed that in winter was higher than in spring. Vertical variation characteristics of the reservoir water of heavy metal chromium underneath the surface were not obvious, and presented that heavy metal chromium increased with the increase of depth, and this result shows that heavy metal chromium of reservoirs water were derived possible from release of chromium of sediment.

Keywords: Coastal reservoir; Hexavalent chromium; Total chromium; Seasonal; Vertical distribution

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INTRODUCTION

Reservoir sediment are important savings reservoir of heavy metals, and heavy metals of basin and surrounding area of the reservoir through the joint river input to the reservoir, and rainfall on the riparian zone of leaching heavy metals into the reservoir, most of which deposit on the bottom of the reservoir. When physical and chemical conditions of the reservoir system changed, the heavy metals in the sediments are likely to release into the water, and forming a contamination of the "endogenous"[1,2]. Heavy metal content of sediment for 45 large and medium-sized reservoir of Guangdong Province were found that Zn, Pb Cu and Cd content of the sediment were relatively low, but the content of Cr were high[3]. Heavy metal pollution of Miyun reservoir and upstream region of Miyun reservoir were mainly heavy metal chromium[4]. Heavy metal chromium of surface sediments in Yuqiao reservoir, Tuanbowa reservoir, Haihe River, Dagu River, Bohai Bay, and Tianjin coastal area was studied to found that the chromium pollution were lighter, and came mainly from human activities[5]. Content of copper and hexavalent chromium of water in Urumqi Wulabo reservoir reached "surface water quality standard" (GB3838--2002) in class II water standard, and content of As, Hg, Cd, Pb, Zn reached to I water standard[6]. Concentrations of lead, antimony, arsenic and selenium in Danjiangkou reservoir exceeded the international standard of drinking water, and effected on the water safety of region's residents[7]. Some scholars study to found climate effected obviously on the deposition of pollutants in the coastal area, such as the dry season promoted to the deposition of copper, iron, lead, chromium in fine-grained sediments [8].

Many scholars have conducted more research of heavy metals in coastal reservoir water, but temporal and spatial distribution of heavy metal chromium in reservoir involves very little. In this paper, seasonal and vertical distribution of characteristics of of heavy metal chromium for Tianjin coastal reservoir are identified by field

surveys and sampling. Results of research could provide a scientific basis and the underlying data for the Binhai New Area of reservoir water resources optimization scheduling, quantitative evaluation of water supply security and engineering design.

EXPERIMENTAL SECTION

Layout of sampling points and collection of sample

Monitoring method and principle refer to "surface water and wastewater monitoring technical specifications (HJ/T 91-2002)". Sampling points include 5 sites belong to 2 different reservoirs in the coastal region of Tianjin. Beitang reservoir has 3 sites(Entrance of the reservoir, Zhakou, Xiaomatou). Beidagang reservoir has 2 sites (Sanhaoshui and Shihaokoumen). In order to comparison, two surface water sites in Duliujian river near Beidagang were also selected reservoir (Duliujian river and outer of discharge salt gate). Water samples of each site were collected with fixed depth sampler in different water depth, such as the surface (0-0.5m), middle (1-2m) and bottom (3-4m).

Two different seasons, winter (November, 2011) and spring (March, 2012), were selected for collection of samples and analysis of water quality. Collection, preparation and preservation of samples were referred to "surface water and waste water monitoring technical specifications (HJ/T91-2002) ". In order to understand the characteristics of the distribution of coastal water quality of reservoirs of chromium , select the representative of the total chromium and hexavalent chromium . The indicators monitoring were according to the relevant national standards or professional standards and environmental monitoring technical norms. Diphenyl hydrazine spectrophotometric method(GB7467-87) are tested to chromium for water.

RESULTS AND DISCUSSION

3.1Detecting Characteristics of Chromium in Coastal Reservoirs Water

3.1.1pH

The pH of reservoir water sites was essentially stable in the range of 8.2 and 9.4, and the average level was 8.8, and was weak alkaline. The pH of reservoir water sites did not exceed the surface water environment quality standard (GB 3838-2002). The pH of Beidagang reservoir water was essentially stable in the range of 8.2 and 8.6, and the average level was 8.4. The pH of Beitang reservoir water was essentially stable in the range of 9.0 and 9.4, and the average level was 9.2. The pH of Duliujian river water changed greatly in the range of 8.2 and 9.2, and the average level was 8.7.

3.1.2 Hexavalent chromium

The variation range of the content of hexavalent chromium for reservoir water sites was large in the range of 0.014 mg/L and 0.040mg/L, and the average level was 0.024mg/L, and hexavalent chromium of reservoir water sites did not exceed the surface water environment quality standard (GB 3838-2002). The content of hexavalent chromium of Beidagang reservoir water was in the range of 0.024mg/L and 0.041mg/L, and the average level was 0.032mg/L. The content of hexavalent chromium of Beitang reservoir water changed greatly in the range of 0.014mg/L and 0.044mg/L, and the average level was 0.064mg/L. The content of hexavalent chromium of Duliujian river water was in the range of 0.022mg/L and 0.046mg/L, and the average level was 0.034mg/L.

3.1.3 Total chromium

The variation range of the content of total chromium for reservoir water sites was large in the range of 0.057mg/L and 0.030mg/L, and the average level was 0.046mg/L. The content of total chromium of Beidagang reservoir water was in the range of 0.041mg/L and 0.060mg/L, and the average level was 0.049mg/L. The content of total chromium of Beitang reservoir water was in the range of 0.040mg/L and 0.057mg/L, and the average level was 0.046mg/L. The content of total chromium of Duliujian river water was in the range of 0.030mg/L and 0.060mg/L, and the average level was 0.043mg/L.

3.1.4 Hexavalent chromium/Total chromium

The variation range of hexavalent chromium/total chromium for reservoir water sites was large in the range of 35.2% and 94.65% and the average level was 68.22%. Hexavalent chromium/ Total chromium of Beidagang reservoir water changed greatly in the range of 38.8% and 80.5%, and the average level was 64.1%. Hexavalent chromium/Total chromium Beitang reservoir water changed even bigger in the range of 35.2% and 91.9%, and the average level was 65.0%. Hexavalent chromium/Total chromium of Duliujian river water changed slightly in the range of 65.2% and 94.7%, and the average level was 77.1%. Results show that the composition of total chromium was Hexavalent chromium for reservoir water sites.

3.2 Seasonal Variation of Chromium in Coastal Reservoirs Water

3.2.1pH

The seasonal variation of pH for reservoir water sites was very small. The pH of Beidagang reservoir and Beitang reservoir in winter was slightly higher than in spring, while the two sites of Duliujian river presented that in spring was slightly higher than in winter.

3.2.2 Hexavalent chromium

The seasonal variation of the content of hexavalent chromium for reservoir water sites was very small. The content of hexavalent chromium of Beidagang reservoir and Beitang reservoir in winter was slightly higher than in spring, while the two sites of Duliujian river presented that in spring was slightly higher than in winter (Table 1).

Table.1 Hexavalent chromium of reservoir water sites in different season

Sampling sites		Statistical parameter	Hexavalent chromium (mg/L)	
			Winter	Spring
Beidagang reservoir	Sanhaoshui	Max	0.036	0.030
		Min	0.032	0.024
		Average	0.034	0.026
	Shihaokoumen	Max	0.041	0.033
		Min	0.036	0.028
		Average	0.039	0.027
Beitang reservoir	Entrance of the reservoir	Max	0.046	0.027
		Min	0.033	0.020
		Average	0.041	0.024
	Zhakou	Max	0.040	0.028
		Min	0.036	0.020
		Average	0.037	0.023
	Xiaomatou	Max	0.038	0.020
		Min	0.036	0.014
		Average	0.037	0.017
Duliujian river	Duliujian river	Max	0.038	0.046
		Min	0.028	0.028
		Average	0.032	0.035
	Outer of discharge salt gate	Max	0.028	0.043
		Min	0.022	0.036
		Average	0.025	0.041

Table.2 Total chromium and Hexavalent chromium/Total chromiumof reservoir water sites in different season

Sampling sites		Statistical parameter	Total chromium (mg/L)		Hexavalent chromium/Total chromium(%)	
			Winter	Spring	Winter	Spring
Beidagang reservoir	Sanhaoshui	Max	0.049	0.049	73.9	60.9
		Min	0.046	0.046	64.2	49.5
		Average	0.048	0.048	70.1	53.9
	Shihaokoumen	Max	0.057	0.060	80.5	80.5
		Min	0.046	0.041	72.0	38.8
		Average	0.051	0.051	77.2	55.4
Beitang reservoir	Entrance of the reservoir	Max	0.052	0.057	87.8	62.5
		Min	0.044	0.043	74.7	35.6
		Average	0.050	0.048	82.4	50.4
	Zhakou	Max	0.051	0.048	88.3	59.6
		Min	0.041	0.044	77.9	42.8
		Average	0.046	0.046	80.4	49.4
	Xiaomatou	Max	0.044	0.049	91.9	41.6
		Min	0.040	0.040	81.9	35.2
		Average	0.042	0.043	87.5	39.4
Duliujian river	Duliujian river	Max	0.044	0.060	86.2	76.1
		Min	0.035	0.041	78.0	65.2
		Average	0.038	0.049	83.2	70.1
	Outer of discharge salt gate	Max	0.033	0.059	94.7	76.9
		Min	0.030	0.048	66.2	72.8
		Average	0.031	0.054	79.8	75.4

3.2.3 Total chromium

The seasonal variation of total chromium for reservoir water sites changed slightly. Total chromium of Beidagang reservoir and Beitang reservoir in winter was basically same with in spring, while the sites of Duliujian river presented that in spring was higher than in winter (Table 2).

3.2.4 Hexavalent chromium/Total chromium

The seasonal variation of hexavalent chromium/total chromium ion for reservoir water sites changed greatly. hexavalent chromium/total chromium of Beidagang reservoir, Beitang reservoir and Duliujian river in winter was higher than in spring, while the sites of Outer of discharge salt gate presented that in spring was higher than in winter (Table 2).

3.1Vertical variation characteristics of chromium in coastal reservoirs water

3.3.1 pH

The vertical variation characteristics of each site's pH were not obvious, and the difference was small.

3.3.2 Hexavalent chromium

The vertical variation of hexavalent chromium for reservoir water sites changed not obviously. Hexavalent chromium of Beidagang reservoir, Beitang reservoir and Duliujian river increased gradually with the increasing of the depth(Fig.1). In the surface layer of Beidagang reservoir, the variation range of hexavalent chromium for water sites was large in the range of 0.024mg/L and 0.041mg/L, and the average level was 0.031mg/L. The variation range of middle layer of Beidagang reservoir was in the range of 0.020mg/L and 0.036mg/L, and the average level was 0.028mg/L. The variation range of bottom layer of Beidagang reservoir was in the range of 0.030mg/L and 0.040mg/L, and the average level was 0.034mg/L. In the surface layer of Beitang reservoir, the variation range of hexavalent chromium for water sites was large in the range of 0.014mg/L and 0.038 mg/L, and the average level was 0.028mg/L. The variation range of middle layer of Beitang reservoir was large in the range of 0.017mg/L and 0.044mg/L, and the average level was 0.031mg/L. The variation range of bottom ayer of Beitang reservoir was in the range of 0.020mg/L and 0.046mg/L, and the average level was 0.031mg/L. In the surface layer of Duliujian river, the variation range of hexavalent chromium for water sites was in the range of 0.024mg/L and 0.036 mg/L, and the average level was 0.030mg/L. The variation range of middle layer of Duliujian river was in the range of 0.028mg/L and 0.043mg/L, and the average level was 0.032mg/L. The variation range of bottom layer of Duliujian river was large in the range of 0.028mg/L and 0.046mg/L, and the average level was 0.039mg/L.

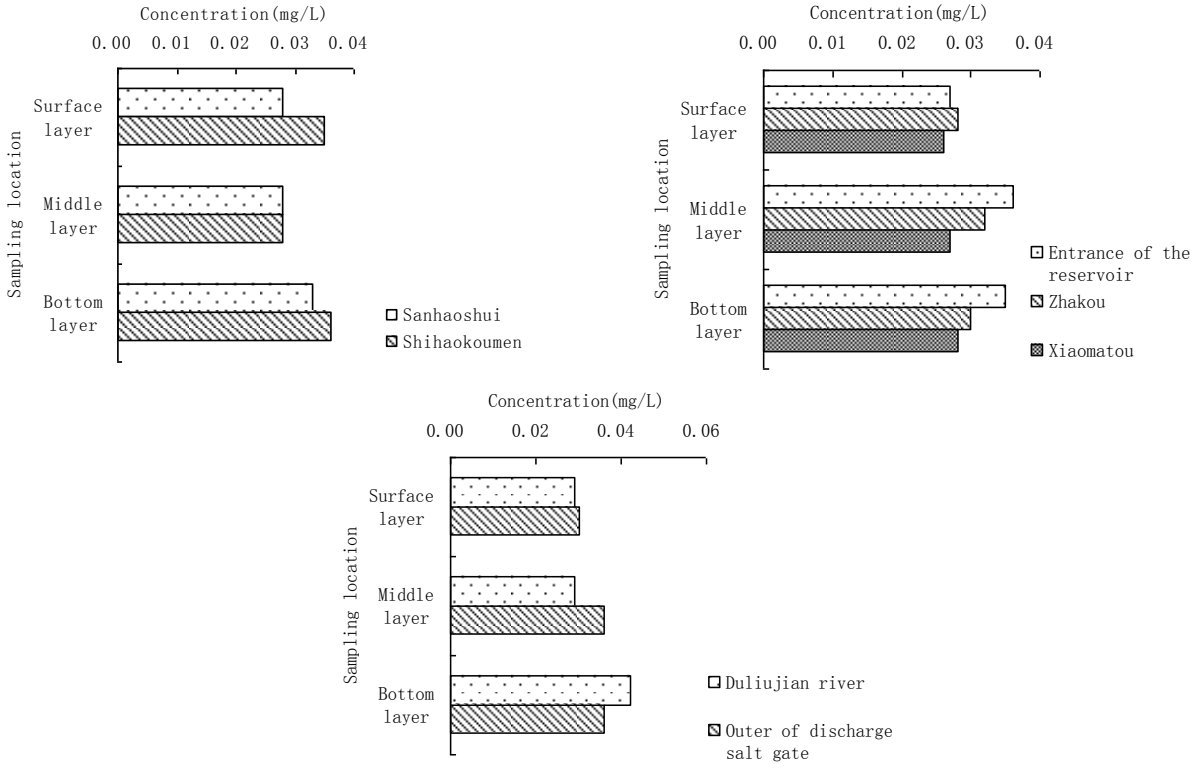

Fig.1 Vertical variation characteristics of Hexavalent chromium of the reservoir water in different sites

3.3.3 Total chromium

The vertical variation of total chromium for reservoir water sites changed not obviously. Zhakou site and Xiaomatou water site of Beitang reservoir, Sanhaoshui site of Beidagang reservoir and the two sites of Duliujian River showed total chromium of water increased with the increasing of the depth, but Shihaokoumen water site of Beidagang reservoir and the Entrance of Beitang reservoir presented the opposite rule, and showed total chromium of water decreased with the increasing of the depth(Fig.2). In the surface layer of Beidagang reservoir, the variation range of total chromium for water sites was large in the range of 0.048mg/L and 0.060mg/L, and the average level was 0.053mg/L. The variation range of middle layer of Beidagang reservoir was in the range of 0.046mg/L and 0.052mg/L, and the average level was 0.048mg/L. The variation range of bottom layer of Beidagang reservoir was in the range of 0.041mg/L and 0.049mg/L, and the average level was 0.047mg/L. In the surface layer of Beitang reservoir, the variation range of total chromium of the water sites was large in the range of 0.040mg/L and 0.057mg/L, and the average level was 0.047mg/L. The variation range of middle layer of Beitang reservoir was in the range of 0.041mg/L and 0.052mg/L, and the average level was 0.045mg/L. The variation range of bottom layer of Beitang reservoir was in the range of 0.040mg/L and 0.052mg/L, and the average level was 0.047mg/L. In the surface layer of Duliujian river, the variation range of total chromium for water sites was large in the range of 0.030mg/L and 0.048mg/L, and the average level was 0.040mg/L. The variation range of middle layer of Duliujian river was large in the range of 0.033mg/L and 0.056mg/L, and the average level was 0.041mg/L. The variation range of bottom layer of Duliujian river was large in the range of 0.030mg/L and 0.060mg/L, and the average level was 0.048 mg/L.

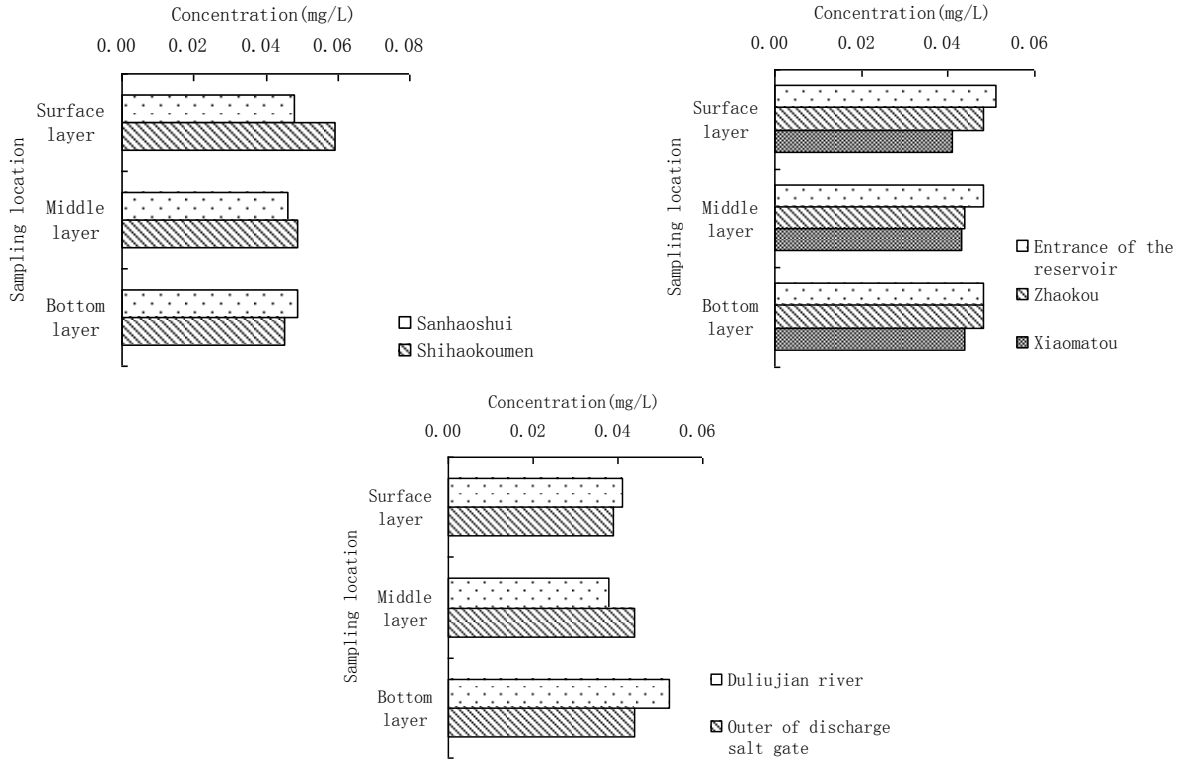

Fig.2 Vertical variation characteristics of Total chromium of the reservoir water in different sites

3.3.4 Hexavalent chromium/Total chromium

The vertical variation of hexavalent chromium/total chromium for reservoir water sites changed obviously, and presented that the hexavalent chromium/total chromium for reservoir water sites increased with the increase of depth (Fig.3). In the surface layer of Beidagang reservoir, the variation range of hexavalent chromium/total chromium for water sites was large in the range of 46.9% to 72%, and the average level was 58.15%. The variation range of middle layer of Beidagang reservoir was large in the range of 38.8% to 79.1%, and the average level was 61.7%. The variation range of bottom layer of Beidagang reservoir was large in the range of 60.9% to 80.5%, and the average level was 74%. In the surface layer of Beitang reservoir, The variation range of hexavalent chromium /total chromium for water sites was large in the range of 35.2% to 88.8%, and the average level was 58.9%. The variation range of middle layer of Beitang reservoir was large in the range of 41.6 % to 88.3%, and the average level was 69.8 %. The variation range of bottom layer of Beitang reservoir was large in the range of 41.4% to 91.9%, and the average level was 66.3%. In the surface layer of Duliujian river, The variation range of hexavalent chromium /total chromium for water sites was large in the range of 69.2% to 78.6%, and the average level was 74.5%. The variation

range of middle layer of Duliujian river was large in the range of 66.2 % to 86.2%, and the average level was 74.5%. The variation range of bottom layer of Duliujian river was large in the range of 72.8% to 94.7%, and the average level was 82.3%.

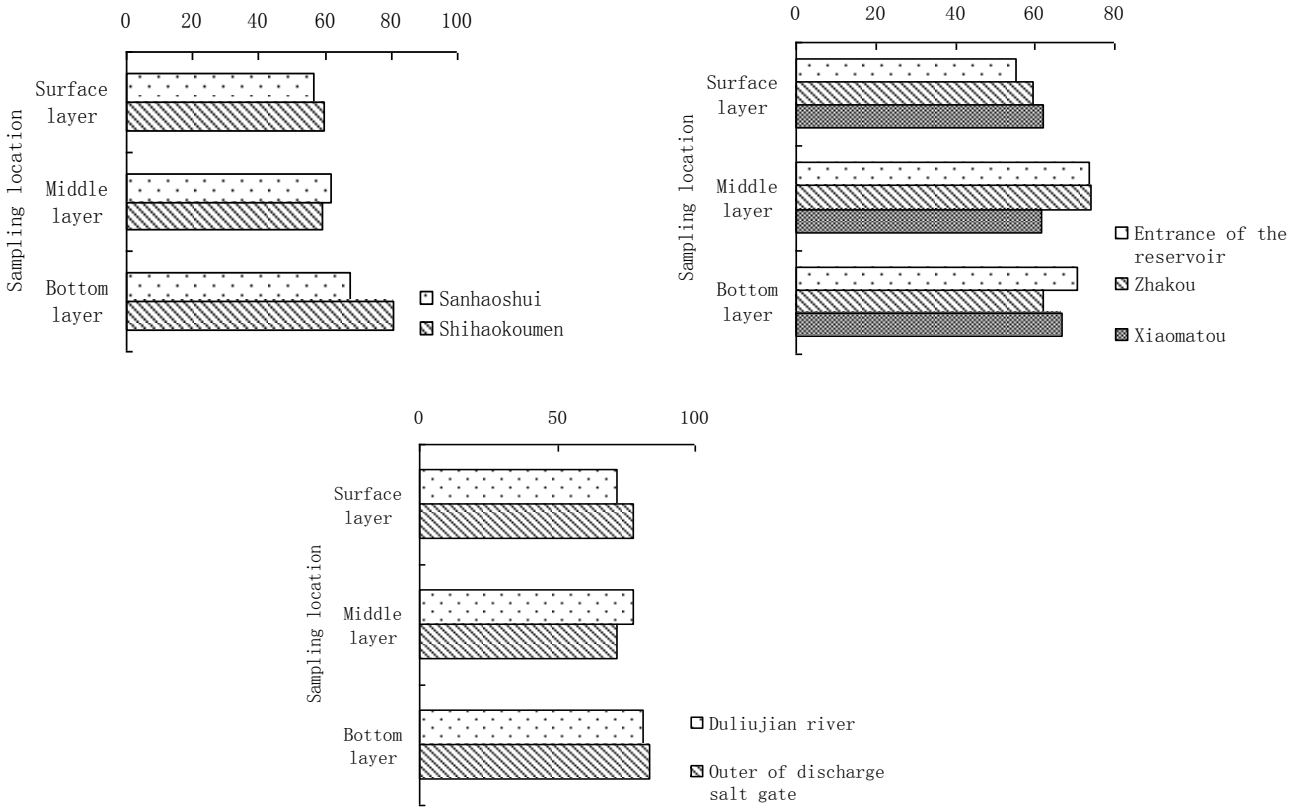

Fig. 3 Vertical variation characteristics of hexavalent chromium/total chromium of the reservoir water in different sites

CONCLUSION

(1) Form the sampling analysis of different season in Tianjin coastal reservoir, the hexavalent chromium variation range was large in the range of 0.014mg/L and 0.040mg/L, and the average level was 0.026mg/L, and the average level of total chromium was 0.046 mg/L, and the average level of hexavalent chromium/total chromium was 68.2 %.

(2) Seasonal variation characteristics of hexavalent chromium and total chromium were obviously, and showed that in winter was higher than in spring.

(3) Vertical variation characteristics of the reservoir water of chromium underneath the surface were not obvious. Vertical variation characteristics of the reservoir water of hexavalent chromium/total chromium changed significantly, and basically showed increased with the increasing of the depth.

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