Source and Distribution of Dissolved Metal Ions in the Backwater Area of Pengxi River in Three Gorges Reservoir

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Abstract: This study uses the Gaoyang Lake section of the Pengxi River, the largest tributary on the northern bank of the Three Gorges Reservoir (TGR), as an example for exploring the distributions and dynamics of Ca, Zn, Fe, Cr, Pb, Cu and Hg ions in the tributaries of TGR where the water level fluctuates due to dam regulation. Samples were taken 21 times, once every 17.3 days, at four sampling sites in Gaoyang Lake, which is in a perennial backwater zone of the Pengxi River, during one year from June 5, 2013 to May 29, 2014. At each sampling site, water samples were taken from the surface layer (0-0. 5 m), middle layer, and bottom layer (0. 5 m above the bed mud). During winter when the water was not stratified, the middle layer samples were taken at 1/2 depth, and when water was stratified in other seasons, the middle layer samples were taken from the thermal layer. Inductively coupled plasma atomic emission spectrometry (ICP-AES) and cold-vapor atomic absorption methods were adopted to determine the concentrations of the metals. Excel and SPSS were used for data analysis and Matlab for building 3-D prisms displaying concentration distributions of Hg ions in the high water level period (175 m, November-April in the ensuing year), sluicing period(May-middle June), low water level in the flooding season (145m, June-August), and the storage period (September-November). The results provided the following observations ①Concentrations of Cr, Pb, Cu, Zn, and Hg ions were lower than those in Class III of the water environment quality standard (GB 3838-2002). ②Cr, Pb, and Cu had high peak values during the storage and sluicing period, and the lowest values during the high water level period. Cr, Pb, and Cu were derived from the main stream of Yangtze, while Fe and Zn were from the Pengxi River locally. The concentration of Hg ions was affected by both the main stream and endogenous sources. As the water column stratified, metal ions did not mix among the stratified layers in Gaoyang Lake. ③ The conductivity was significantly lower during the high water level period than during other water level periods. The main material that affects the conductivity of Gaoyang Lake could be nonmetallic ions.

Key words: Three Gorges Reservoir; Pengxi River; backwater area; metal ions; spatial and temporal distribution

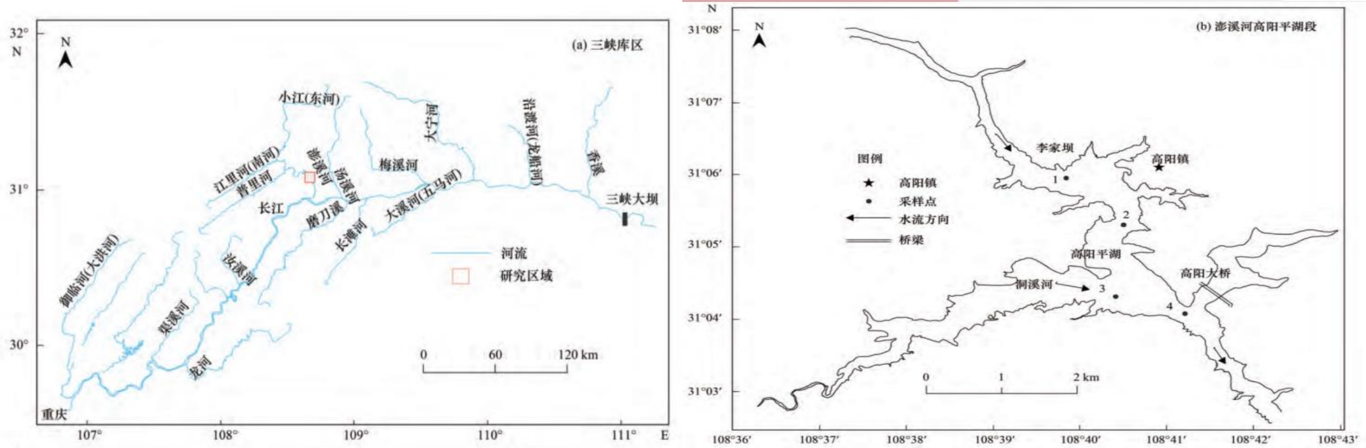

图 1　三峡库区澎溪河区位概况及采样点

Fig. 1　Location of Pengxi River and sampling sites in Three Gorges Reservoir area

表 2　高阳平湖金属离子在各水位时期质量浓度范围和特征/mg·L^{-1}

Table 2　Concentrations range and properties of metal ions for each water level period in Gaoyang Lake/mg·L^{-1}

水位时期	项目	Cr	Pb	Cu	Zn	Ca	Hg	Fe
低水位期	最高值	0.003 7	0.015 3	0.004 7	0.026 6	82.6	9.42E-04	0.23
	最低值	0.000 9	0.002 2	0.001 0	0.003 9	63.6	3.74E-05	0.15
	均值	0.002 3	0.008 8	0.002 9	0.015 3	72.5	2.80E-04	0.19
	F	1.7	2.5	1.4	4.3	6.1	7.3	2.6
蓄水期	最高值	0.008 2	0.038 0*	0.009 1	0.040 8	69.7	3.35E-04	0.623
	最低值	0.000 6	0.002 2*	0.002 3	0.000 2	41.3	3.00E-06	0.008 6
	均值	0.000 9	0.020 5*	0.005 6	0.004 3	57.2	3.54E-05	0.12
	F	5.1	2.0*	2.8	2.0	5.0	3.0	3.2
高水位期	最高值	0.026 0	0.027 0*	0.006 9**	0.019 8	61.1	8.38E-05	0.49*
	最低值	0.000 6	0.001 7*	0.001 7**	0.000 4	35.2	3.80E-05	0.13*
	均值	0.001 6	0.014 0*	0.004 3**	0.010 1	48.0	6.42E-05	0.31*
	F	2.2	3.2*	7.2**	5.6	1.6	1.7	3.0*
泄水期	最高值	0.026 8	0.038 0	0.065 0	0.049 1	76.7	6.88E-05	0.053 3*
	最低值	0.000 6	0.000 9	0.000 6	0.0023	43.1	5.14E-06	0.023*
	均值	0.013 9	0.011 6	0.024 3	0.013 8	53.5	6.01E-05	0.17*
	F	3.1	2.4	4.2	1.9	3.4	6.3	3.1*

1）按照采样点分组，*F* 值为组间均方与组内均方的比值；样点使用单因素方差分析，* 表示 $P<0.05$，** 表示 $P<0.01$

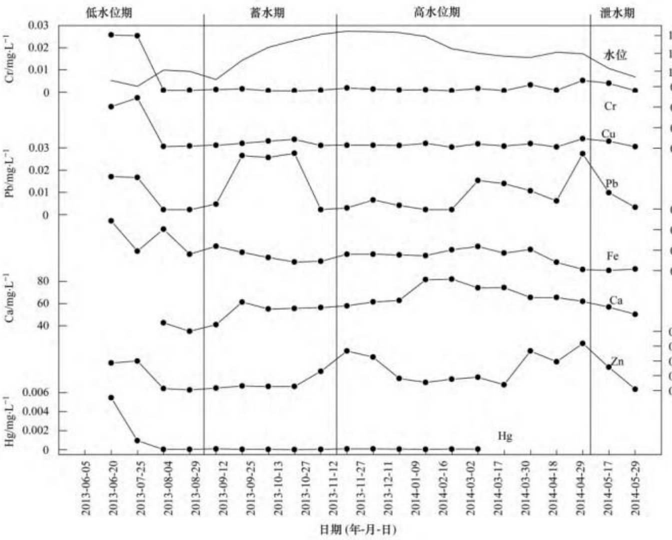

图 2　高阳平湖金属离子质量浓度时间维度上的分布

Fig. 2　Temporal distribution of metal ions in Gaoyang Lake

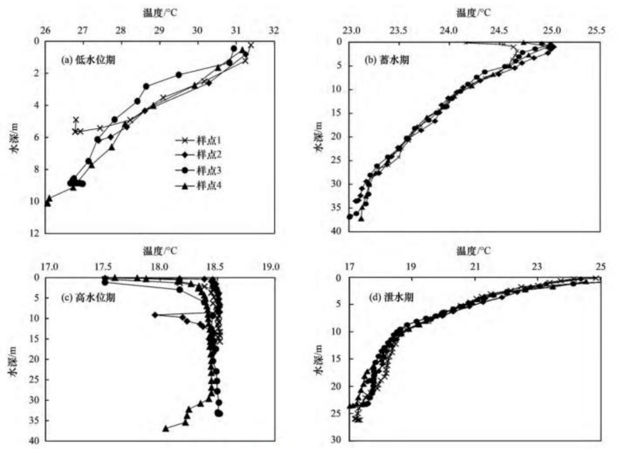

图 3　高阳平湖水深-水温变化曲线

Fig. 3　Depth-Temperature curves in Gaoyang Lake

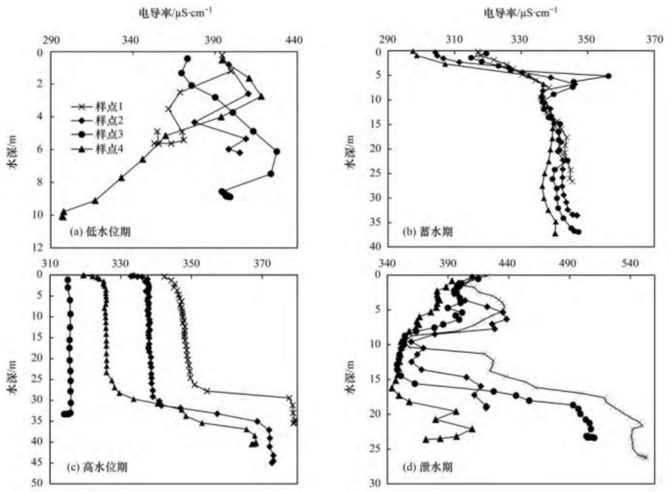

图 5　高阳平湖水深-电导率变化曲线

Fig. 5　Depth-Conductivity curves in Gaoyang Lake

表 3　低水位与泄水期溶解态金属离子浓度与电导率相关性分析

Table 3　Correlation analysis between the soluble metal ion concentration and conductivity during the low water period and sluicing period

项目	Cr	Pb	Cu	Zn	Ca	Fe	Hg
低水位	0.56	−0.1	−0.89	−0.7	0.98	−0.81	0.995
泄水期	−0.75	0.99	0.22	−0.6	0.99	−0.56	0.54