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Distribution of pollutants in Le An River

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Abstract—pH change, distribution of anions, metals and complexing capacity in riverwater along Le An River were studied during June, 1987 to November, 1989. A high SO_4^{2-} concentration was found in whole river, particularly at Gukou. High metal concentrations were found in upstream of the river, Cu, Fe, Ni and Co mainly from Dexing Copper Mine; Cd and Pb from Jishui River. Heavy water quality pollution occurred in the river section from Gukou to Daicun in Dexing Mine Area. Complexing capacity of Le An River was low as concentration organic ligands and a high metal concentration.

Keywords: heavy metals; complexing capacity; pollutants.

BACKGROUND

Le An River originated from the west foot of Huaiyu Mountains, where Jiangxi Province is demarcated with Anhui Province. The river flows through Wuyuan, Dexing, Leping and Poyang counties and converges with Xin River into Rao River at Caijiawan and finally flows into Poyang Lake. The upper-stream of Le An River passes through mountainous districts and the gradient of river bed is high (> 0.015%). After entering the Leping County, the river flows with lower gradient but the water at some river sections flow rather rapidly.

Water quality in tributaries of Le An River was affected by receiving effluents from Dawu River and Jishui River which were polluted by wastewater and solid wastes from mines and factories along Jishui River.

Sampling sites along the river, Haikou, Fuxikou, Gukou, Zhongzhou, Xiangtun, Daicun, Fushan, Jiedu, Hanjiadu, Shizhengjie, and Caijiawan were selected. Haikou or Fuxikou located at the upstream of Dexing Copper Mine were used as reference sites. Gukou and Daicun are the convergent sites between Dawu River and Le An River; Le An River and Jishui River respectively. Fushan near the Fushan Hydrological Station. Jiedu located at the upstream of Leping County near a coal-burning power plant with extensive river-sediment dredging (for gold) activities in its vicinity. Hanjiadu was selected at downstream of Leping County. It was told that there was a small copper smelter in the left riverbank upstream at Shizhengjie and

some heavy metals were being released. Sampling sites of waters and sediments at Caijiawan were shown in this issue.

pH change along Le An River

The pH of Le An River waters was measured and shown in Fig. 1. Anomalous pH values were found along Le An River from Gukou to Daicun in rainy season (1987). At Gukou it receives effluents discharged from mining, milling, draining and wastewater with acid or alkaline waters. In rainy season, a large amount of acid drainage flowed into the river and decreased its pH value. The lowest pH measured is < 4, caused by oxidation of sulfide minerals of Cu, Fe and other metals.

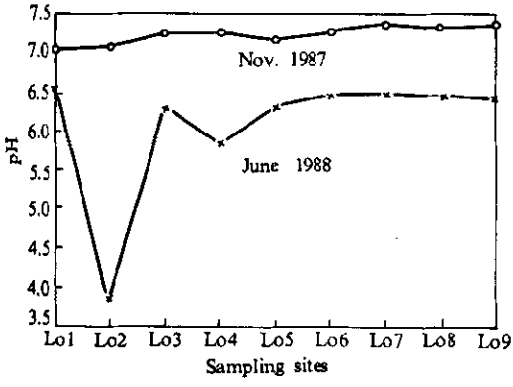

Fig. 1 Change of pH values along Le An River

As the acid drainage have been reserved in a large reservoir and neutralized by the alkaline water from ore dressing at a wastewater treatment plant, the pH of the effluents from the mine could rarely be kept neutral. The anomalous acidic or alkaline wastewater discharged directly into the river.

pH value of the river water at Gukou was diluted and gradually increased and remained neutral after passing Daicun in the rainy season, lower than that in dry season as the acidic contaminants are washed out by rain flooding from the mine district.

Anions in river water along the river

Some anions such as SO_4^{2-}, Cl^-, NO_3^-, F^-, HPO_4^{2-} of the river water samples were measured by ion chromatograph (DIONEX 4500i). F^-, Cl^-, NO_3^- and HPO_4^{2-} were found to be lower than the normal level. The SO_4^{2-} concentration is found to be highest at Gukou (Fig. 2), but decreased gradually from Gukou to Daicun with the change of pH values. The high SO_4^{2-} concentration caused mainly due to the oxidation of sulfide minerals in the mine and partly from oxidation of Na_2S used in the wastewater treatment plant. The lowest SO_4^{2-} concentration in Le An River was found in Haikou (reference site).

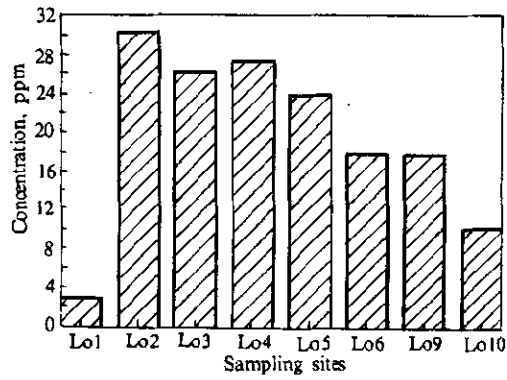

Fig. 2 Distribution of SO_4^{2-} along Le An River

Metal concentration in Le An River

River water samples in different seasons were taken by a plastic sampler from 10 cm surface below in order to avoid interference from surface layer. In situ the water sample was passed

through a 0.45 μm membrane by a hand vacuum pump. HCl was added into the sample bottle to keep its pH below 2. Metal concentrations in filtrated and unfiltrated samples were determined by AAS and ICP. Soluble metal concentration can be obtained from the filtrated samples, and total metal concentration from the unfiltrated water samples, the particle metal concentration from their difference.

Metal concentrations in Haikou were found to be lowest in the whole river except zinc, as zinc was discharged from the active carbon factory located at upstream of Haikou. The highest copper concentration in the river was found at Gukou coming from the mining activities. The metal concentrations were decreased rapidly from Gukou to Zhongzhou (about 5 km downwards), and gradually to Daicun (Fig. 3).

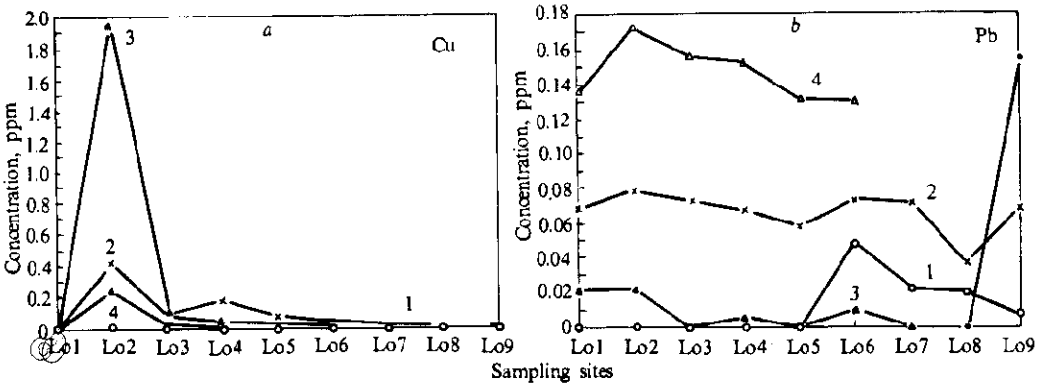

Fig. 3 Distribution of metal concentration along Le An River
1. June 1987; 2. Nov. 1987; 3. June 1988; 4. Nov. 1988

The ratio of lead and zinc in the particles to their soluble metal concentration (Fig. 4) was found to be higher than that of copper at each site, particularly at Gukou which indicated that copper mainly came from milling, tailings and wastewater treatment and Pb and Zn from acid drainage. At the downstream of Leping County, the zinc concentration became lower and lower, but copper and lead increased gradually till at Caijiawan (Fig. 4).

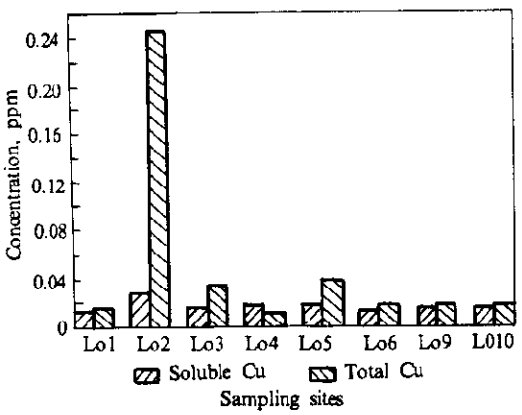

Fig. 4 Ratio of metal concentration in particles and in soluble form

Metal concentrations of river water in dry season were lower than those in rainy season caused by the decreased water flow rate, and the setting of sizeable quanti-

ties of metal particles. It was found that there was a potential pollution source at left bank near Shizhengjie which might affect the river continually at Caijiawan.

Complexing capacity of Le An river water

An amperometric titration method was used to determine the complexing capacity of metal in the riverwater (Shuman, 1977; Florence, 1977; Batley, 1978). The complexing capacities (Zhao, 1990) of Le An riverwater were shown in Fig. 5.

As the river bed is consisted of coarse sand and gravel, the organic ligand contents are low. The humic matter content in the sediments is only 0.9 mg/ g, thus the complexing capacity is low as far as the whole river is concerned. As shown in Fig. 5, the complexing capacity approached zero or near zero in some sites. There is a rather high complexing capacity for Cu at Fuxikou, as there is an Active Carbon Factory at its upstream. It was found to be zero at Gukou as large amount of metal ions discharged from Dawu River (copper mine). Again, the complexing capacity at Daicun was low as a large amount of metals in Jishui River flowing into Le An River. High Cu complexing capacity was expected at Xiangtun as a large amount of metal were precipitated with particulates in sediments and natural organics were increased.

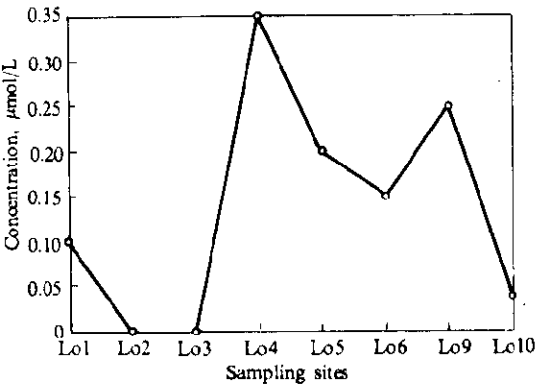

Fig. 5 The complexing capacity of Cu along Le An River

CONCLUSION

pH value in Le An River was in the normal range except in the river section from Gukou to Daicun having received pollutants from Dexing Copper Mine and Jishui River. Distribution of metals and anions were anomalous in this river section. Complexing capacities of Cu in river water were low because of its low organic ligand and high metal concentration. There was a potential pollution source at Shizhengjie and metals in sediments may be released into river water rather easily at the dredging sites.

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