Vertical distribution of total carbon, nitrogen and phosphorus in sediments of Drug Spring Lake, Wudalianchi

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Abstract: The content of total organic carbon, total nitrogen and total phosphorus in sediments of Drug Spring Lake was detected and their vertical distribution characteristic was analysed. Results showed that there were significant changes to the content of total organic carbon, total nitrogen and total phosphorus in different depth of the columnar sediments. Their highest content both appeared in the interval of 10cm to 25cm corresponding to the period of 1980s to 1990s, when the tourism of Wudalianchi scenic area began to develop. It reflected the impact of human activities on the Drug Spring Lake. That means the regulation was still not enough, although a series of pollution control measures adopted by the government in recent years had initial success.

1. Introduction
Drug Spring Lake is a volcano dammed lake formed by the new period volcano eruption, located in the heartland of Wudalianchi nature reserve in Heilongjiang province. Not only as a famous scenic spot, but make-up water for Drug Spring mountain-mineral water belt [1-4].

In recent years, with the vigorous development of tourism in Wudalianchi nature reserve, pollutants discharged into the Drug Spring Lake increased sharply year by year and led to its eutrophication becoming more and more serious. It affected the landscape function and aquaculture of the Drug Spring Lake, as well as the security of Drug Spring mountain-mineral water belt.

Both as the cite of various pollutants to be accumulated and transformed in lake system, sediments can reflect the lake’s pollution changing history on the base of its carried environmental information.

In this paper, the content of total organic carbon, total nitrogen and total phosphorus in columnar sediments of Drug Spring Lake was detected and their vertical distribution characteristic was analysed, in order to provide theoretical basis for the comprehensive pollution control on Drug Spring Lake.

2. Materials and Methods
In March 2016, 55 cm columnar sediments samples were collected from the ice caves to be cut in winter in the middle of Drug Spring Lake. Several segments were divided each 5cm and filled into brown Polyethylene bottles. Then the following procedures were carried out successively: using freeze drying, removing stones, animal residues and plant residues, sieving through 20 mesh nylon sieves, screening out required amount with four points method, grinding and sieving through 120 mesh nylon sieves. The content of total organic carbon was determined by combustion oxidation method.
content of total nitrogen was determined by semi-trace kelvin method. The content of total phosphorus was determined by sodium hydroxide and molybdenum antimony method.

3. Results

3.1 Vertical distribution characteristics of total organic carbon

Figure.1 Vertical distribution of total organic carbon in columnar sediments of Drug Spring Lake

The content of total organic carbon is a basic parameter describing the occurrence of the organic matter in sediments and the quality of the lake [5]. As shown in Figure.1, the content of total organic carbon in each segment was between 17.1 mg/kg and 55.8 mg/kg. The mean was 34.05 mg/kg. In the beginning, the content of total organic carbon increased gradually with the depth and peaked at 20cm, then gradually decreased with the depth. It may be related to the increasing eutrophication of Drug Spring Lake. Garbage and sewage generated from the living and production, aquatic plants and algae, and the rubbish from aquaculture, all led to the sharply increasing content of the total organic carbon in lake. A series of pollution treatments had been carried out, such as return the grain plots to forestry, ecomigration, shrinkage the aquiculture, dredging sediments and aquatic plants, which had got initial effect but not enough. The content was still far higher than in the past.

3.2 The vertical distribution characteristics of total nitrogen

Figure.2 Vertical distribution of total nitrogen in columnar sediments of Drug Spring Lake
Nitrogen is a very important ecological factor leading to the eutrophication of the lake. As shown in figure.2, the content of the total nitrogen in each segment was between 2.2 mg/kg and 6.8 mg/kg. The mean was 4.09 mg/kg. In the beginning, the content of the total nitrogen increased gradually with the depth and peaked at 15cm, then gradually decreased with the depth. The change trend was very similar to the total organic carbon, confirming the high synchronicity between them [6]. It further showed that the nitrogen pollution in Drug Spring Lake was closely related to human activities.

3.3 Vertical distribution characteristics of total phosphorus

The phosphorus in sediments is one of the important nutrient sources of the eutrophication, also the crucial endogenous load of the lake ecosystem. As shown in Figure.3, the content of total phosphorus gradually decreased with the depth after peaked in the initial 10cm. Then it was stable at the depth of 25cm. In view of Drug Spring Lake is a typical imported lake, the content of total phosphorus increased sharply with the input of pollutants through various ways, just like the total organic carbon and the total nitrogen. The slight change in the surface was related to the governance in recent years.

4. Discussion

There were significant changes to the content of total organic carbon, total nitrogen and total phosphorus in different depth of the columnar sediments. Their highest content both appeared in the interval of 10cm to 25cm corresponding to the period of 1980s to 1990s, calculated by the sediments deposition rate in the literature [7], when the tourism of Wudalianchi scenic area began to develop. It reflected the impact of human activities on the Drug Spring Lake. That means the regulation was still not enough, although a series of pollution control measures adopted by the government in recent years had initial success. The following management measures must be executed: the waste gas and effluent discharged by factories, units and farmers must be under strict supervision. The sewer in the scenic area should be completely paved and used. The management system for the emissions of vehicle exhaust should be strengthened. The passage of motor vehicles with tail gas exceeding the allowed must be banned. The government must guide the local resident to buy and use eco-cars. In the meantime, gradually replace fishing vessels and cruise ships using diesel instead of electric power. The return farmland to forest should be further promoted. Comprehensive management measures of tourism pollution in the lake and the monitoring of the water resources must be strengthened.

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References
[1] Yuling Yan and Liying Wang 2001 A brief analysis of the formation of Drug Spring mountain-mineral water belt in Wudalianchi. *Black River Tech* 2 38
[2] Haibo Zou and Mary R 2003 Constraints on the origin of historic potassic basalts from northeast China by U–Th disequilibrium data. *Chem Geo* 200 189-201
[3] Yigang Xua, Huihuang Zhang 2012 Oceanic crust components in continental basalts from Shuangliao, Northeast China: Derived from the mantle transition zone? *Chem Geo* 328 168-184
[4] Takeshi Kuritani, Jun-Ichi Kimura, Eiji Ohtani, Hideaki Miyamoto, Katsuhiro Furuyama 2013 Transition zone origin of potassic basalts from Wudalianchi volcano, northeast China. *Lithos* 156-159
[5] Yuqing Zhang 2001 Control principle and method of capacity of water pollutants in functional areas of the river. *Chin Envir Science Press* 11-18
[6] Wenchao Li. 1997 The accumulation of nitrogen and the deposition of aquatic plants in sediments of east Taihu. *Chin Envir Science* 7 (5) 418-421
[7] Zhifan Gui, Bin Xiu, Shuchun Yao and Wenjia Wei 2011 Environmental changes of Wudalianchi lake inferred from lake sediments in the past century. *Fourth quarter study* 31 (5) 544-550