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Environmental change in Bashang Region historical periods

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Abstract: The Bashang region is a typical vulnerable eco-environmental zone. Our analysis of paleodunes, paleosol profiles, and lake changes taking place during last ten thousands years indicated that: (1) 10 – 6.9 ka B.P. was a post-glacial temperature-increasing stage, in which lakes had their high water level; (2) 6.9 – 3.0 ka B.P. was a large warm stage, during which four paleosol layers were developed and climate fluctuation has assumed 4 – 5 small cold-humid and cold-dry alternations. Since 5.4 ka B.P, the lakes tended to gradually shrink; and by 2.1 ka B.P., water level has fallen by 2.7 m; (3) since 3.0 ka B.P. a general trend of the region was to change into a dry, warm-dry and cold-dry environment.

Key words: Bashang region; environmental change

Introduction

The Bashang region is situated at east longitude 113°50′ – 118°00′ and north latitude 40°58′ – 42°42′, with an area of 17371 km^2 from Zhangjiakou of northern Hebei to the north of Chengde. The region lies in the middle section of a transition zone from agricultural to pastoral regions of northern China and is a typical vulnerable eco-environment area, i.e. the area sensitive to environmental change. There exist excellent conditions for study of environmental change during last ten thousands years. The region lies windward at more than 200 km from Beijing-Tianjin region and represents an ecological barrier and water source for the Beijing-Tianjin region. Thus the eco-environmental change in the region has significant effect on the Beijing-Tianjin region.

1 Outline of the region

The Bashang region is bounded on the north by Xilin Gol League and Hunshandak Sand Land, Inner Mongolia, on the west by Houshan area of Ulan Qab League, Inner Mongolia, on the south by Yanshan Montains, Zhangjiakou City, and Baxia area of Chengde City, and on the east by Da Hinggan Range. It is located on the southern margin of Inner Mongolia Plateau and is a topical continental monsoon zone with dry-semi-dry climate. In the region the Holocene paleodunes, loess-like and lacustrine sediments are distributed. Some soil layer are developed on the paleodunes and loess profiles. The soil layers are not as typical as those on Loess Plateau, but after all, they are not recent soil layers, so we temporarily name them paleosol layers. Paleodunes are mostly distributed in the Yudaokou Pasture Farm area of Weichang County, where two profiles were selected for the study.

(1) Tuligen River profile: The profile exposes paleodunes and paleosol interlayers, visible thickness of which is 518 cm in total. There are 5 paleosol layers in ascending order. The paleosol layers are brown or gray, and blackish in colour, contain plant roots, with worm burrows and clay complex structure, and are clearly different from sand layer (Fig.1).

(2) Profile across Yudaokou Pasture Farm lies at 3 km northwest of the Pasture Farm Headqurters. Thickness of the sediments on the profile is 512 cm and four paleosol layers were found. Sand layers can be distinguished into median- and fine-grained sand layers(Fig.2).

The Anguli Nur Lake is the largest lake in the region. It is located in the western part of Zhangbei County. Field investigation and interpretation of remote sensing images indicate that the lake extent has largely changed since the late Pleistocene, it has basically gradually shrunk. 2 – 3 layers of bog peat are developed on the profiles of lacustrine sediments at Erquanjing and in the northwest of recreational place. Development of the bog peat is not typical.

2 Methods for study

Samples from bog peat, paleosol layers, and dunes were dated by using ^{14}C and thermoluminescent methods. The result is listed in Table 1.

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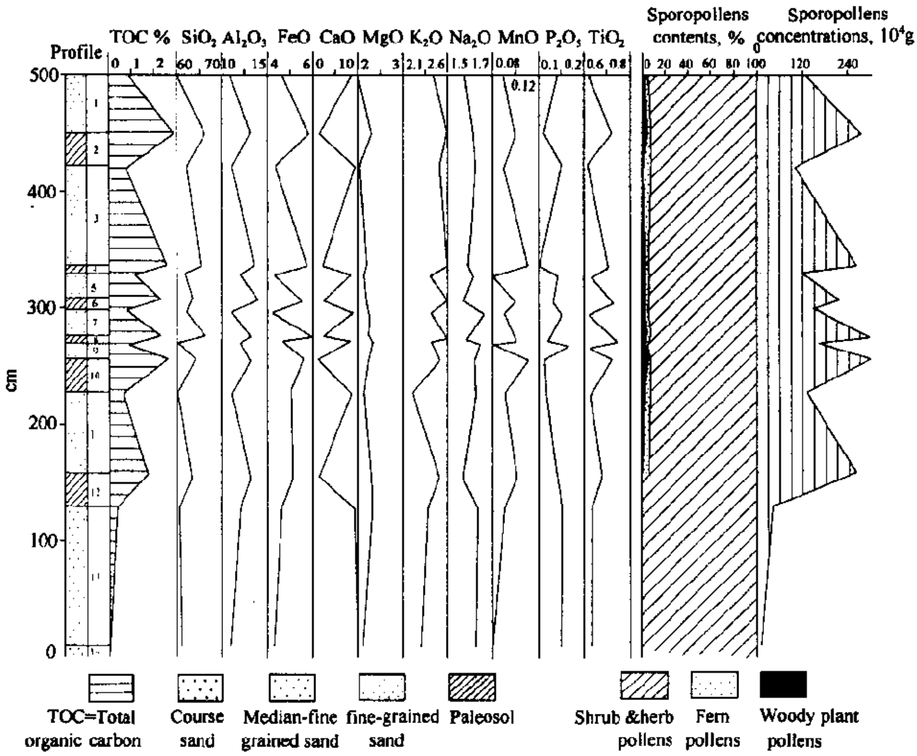

Fig. 1 Distribution of chemical element contents in paleodunes and plaeosol layers(%) and distribution patterns of sporopollens(Tuligen River profile)

Table 1 Age data of samples from the Bashang region

Sample	H-1-2	H-1-4	H-1-6	H-1-8	H-1-10	H-1-12	H-1-13(1)	H-1-13(2)	H-2-2	H-2-4	H-2-6	H-2-8
Age	3012 ±41	3543 ±58	4019 ±59	4639 ±61	5762 ±78	6919 ±76	10392 ±165	8249 ±106	4038 ±64	4573 ±72	5689 ±88	7011 ±98
Sample	H-3-1	H-3-2	H-3-3	H-3-4	H-3-5	H-3-7	H-3-9	H-3-12	H-3-15	H-2-9(2)	H-2-9(1)	
Age	2134 ±33	3212 ±43	4219 ±58	5412 ±76	8121 ±94	10912 ±109	21809 ±198	29432 ±209	35712 ±243	8123 ±102	7936 ±98	

Chemical analysis of mineral composition of the samples was done by using bulk analysis method and on X-ray fluorescence spectrometer and atomic absorption spectrometer. Total organic carbon and sporopollens in the samples were analyzed by using conventional methods.

The age of lacustrine sediments were determined in accordance with the change of lake extent, so as to determine the time-space sequence of the lake change.

3 Results

From the results of the study on Zhouyuan loess(Sun 1995) and Holocene loess on Loess Plateau(Wen, 1989) and others(Zhang, 1998; Chen, 1997), the variation of chemical element contents in sediments is an important index for understanding the paleo-environmental change during the Holocene. Migration and concentration of chemical elements dependent on their properties reflects the cold-warm and dry-humid conditions in the environment. For example, the relative concentrations of SiO_2, Al_2O_3, FeO, K_2O, MnO and TiO_2 reflect a warm-humid environment, while the relative concentrations of K_2O, CaO, and P_2O_5 reflect a cold-dry environment. Total organic carbon occurred only in paleosols.

After analysis of stratigraphical profiles and lake change, setup of chronological sequence, calculation and analysis of element contents, and analysis of sporopollens, we obtained the following results of environmental change during

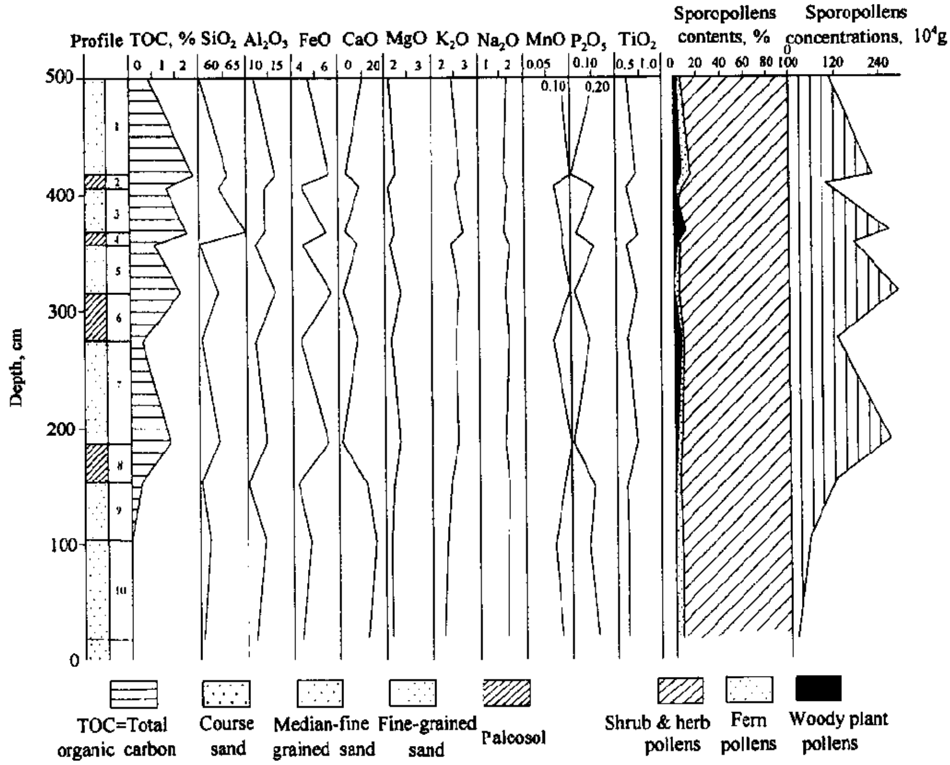

Fig.2 Distribution of chemical element contents in paleodunes and paleosol layers (%) and distribution patterns of sporopollens (profile across Yudaokou Pasture Farm)

last ten thousands years (Fig.3): (1) 10 – 8.2 ka B. P. was a temperature-increasing stage, during which high water level appeared in lakes, brown-yellow median- and fine-grained sand layers were deposited, total organic carbon was absent, and sporopollens were few, from zero to 41 grains. (2) During 8.2 – 6.9 ka B. P., climate tend to be cold-humid, CaO content reached 11% – 14%, and the lake had also high water level. Sporopollens in Yudaokou Pasture Farm profile reached 97 grains in total, and 90 grains of them are of shrub-herb. (3) 6.9 – 30 ka B.P. is a large warm stage of the Holocene. During this time 4 – 5 paleosol layers were developed in paleodunes in the region. In particular, in 6.9 and 5.7 ka B.P., the thickness of formed paleosol layers reached 20 30 cm. SiO_2, Al_2O_3, FeO, Na_2O, MnO, TiO_2 and other element contents clearly increased, while CaO is only 1.12% – 1.32% (Fig.2). Total organic carbon content reached more than 2%, and total amount of sporopollens increased, 259 grains on profile 1, and 8 species of woody plants appeared. The lakes retained their high water level. The environment became warm-humid.

In 4.6, 4.0 and 3.5 ka B. P. stage, 2 – 3 paleosol layers were developed, with less thickness, several centimeters only. Variation of most chemical elements in these paleosol layer does not so significant as that in previous two paleosol layers. CaO reaches about 2.4% – 2.5%. Amount of sporo-pollens in these paleosol layers are also less on profile 1, only 61, 10 and 112 grains, respectively. Since 5.4 ka B. P., lakes gradually shrunk. All these facts indicate that the environment has tended to gradually develop into dry, though it was still warm-humid.

During large warm stage, there were also 3 – 4 cold-

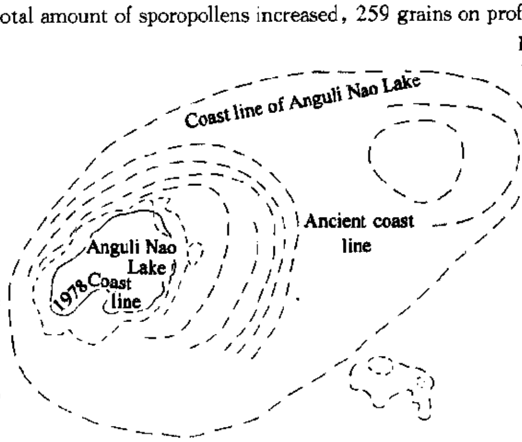

Fig.3 Change of Anguli Nao Lake basin

humid and cold-dry environmental changes(5.7 – 4.6 ka, 4.6 – 4.0 ka and 4.0 – 3.5 ka B. P.). Variations of chemical elements, total organic carbon, and sporopollens (Fig.1 and Fig.2) indicated a multi cyclicity of the environmental change. Total organic carbon was in a range of 0.5% – 0.7%, species of woody and fern plants decreased, only 1 or zero species. By 4.2 ka B. P., water level in lakes fell 0.9m, and by 3.2 ka B. P., it again fell 0.8 – 1.0m.

Since 3.0 ka B. P., a general trend of the environment is mainly dry, though there was yet small change. By 2.1 ka B. P., water level in lakes again fell 1.0m. During 2.1 ka B. P., another paleosol layer occurred on profile 1. Total amount of sporopollens reached 279 grains and woody plants reached 9 species. Since then, climate became warm-dry till the Song and Yuan dynasties(ca. A. D. 960 – 1360) and cold-dry in the late Ming Dynasty and early Qing Dynasty(ca. A. D. 1600 – 1700). During last 200 years, the environment in the region is characterized by aridity, there 26 serious drought occurred and some of them lasted several years, frequently three or four seasons in a year. Nine droughts in ten years became a typical phenomenon in the region. During last years the Anguli Nao Lake nearly completely dried up and becomes a wide white salinized beach.

4 Discussion

The main stage of environmental change in the region during last ten thousands year was later than in adjacent regions at the same latitude zone(Shi, 1992). It may be related with its geographical location and topographic height.

During last ten thousands years some paleosol layers were formed in paleodune in the region. They are not typical, and number and level of the paleosol layers are irregular, in particular there are unstable in the top part of profiles, sometime thick palelosol layers were forme in short time. The paleosol layers may not be originally formed. By the non-typical paleosol layers are significant for study of environmental change in the region.

During last 50 years, the eco-environment in the region was gradually deteriorated. But the available data indicate that during last 40 years the natural environment in the region tended to well develop, heavy wind and dust storm days decreased significantly and wind velocity is also reduced. At present, the eco-environmental deterioration is mainly caused by human unreasonable development and resource utilization(Sun, 1994).

The eco-environmental deterioration in the region is serious influencing Beijing-Tianjin area. During last years studies on eco-environmental change in the region have mostly focused on the land decertification and effect of human activities(Zhao, 1997; Yang, 1998), but rarely on historical environmental change. In order to more understanding recent status of environmental change and predicting its future trend, the study on the regularities of historic environmental change is needed.

References:

Chen J, Li J F, Chou G, Lu H Y *et al.*, 1997. Geochemical study of weathering degree of Luochuan loess in Shannxi[J]. Scientiae Sinica(Series B), 27(6):531—536.

Shi Y F, Kong Z Z, 1992. Climate and environment in China in large warm phase of the Holocene[M]. Beijing: Oceanological Press 48—65.

Sun J Z, Yang M H, Sheng X B *et al.*, 1994. Characteristics of vulnerable eco-environment in Bashang region[J]. Hebei Deserts in China, 14(4):37—46.

Sun J Z, Dai Z H, Zhou K S, 1995. Geochemical characteristics of Holocene Zhouyuan loess[J]. Scientia Geologia Sinica, 4(3): 423—430.

Wen Qi Z, 1989. Geochemistry of loesses in China[M]. Beijing: Science Press. 21—44.

Yang Z R, 1998. Preliminary study on climate and environment in west-central area of Inner Mongolia during large warm phase of the Holocene[J]. Scientia Bulletin, 18(5): 479—485.

Zhao X, Zhao W Z, Bao Y *et al.*, 1997. Eco-environment in Bashang region and its remediation [M]. Beijing: Chinese Environmental Science Press. 1—28

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