

Palaeoclimate Environment of Susceptibility of Loess Section since 10KaBP in Xi'an ShaoLinyuan

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Abstract. Loess deposition age sequence during the Holocene in the region is established by the description of rock character of loess-paleosol stratum the partition and contrast of stratum of section in Xi'an ShaoLinyuan. According to the character of the curve expressed by substitution indication of climate of susceptibility, the changing regularity of this substitution indication in the section is expounded in this article. Also, on the base of careful analysis and verification to palaeoclimate stage trait during the Holocene in Xi'an area 5 climate stage nearly 10000 years in Xi'an are can be raised, for that, revealing the regularity of changes in the East Asian winter and summer monsoon, and providing a basis for Xi'an area, China and the global to predict future environment development trends is the work we did during the present study.

Introduction

Since the 1980s, many scholars research for climate change and effect, especially about climate change during the Holocene. They put forward that is very instability. The characteristics of the climate always like the Ice age. It's the most important to choose suitable parameter for researching. The study found that the susceptibility of Loess is a high resolution physical parameters for climate change of study, and based on the character of the susceptibility curve not only stand for the deep sea oxygen isotope curve, but also reflect the information for the ancient climate ^[1].

Begin to use the susceptibility of loess is that Dongsheng Liu in 1975 on the Luo Chuang Heimugou. Later, Heller measure the susceptibility from loess and paleosol, and they found susceptibility with the relevant soil, and the susceptibility curve the same as the deep sea oxygen isotope curve. The susceptibility of loess record is far-reaching significance to climate change all over the world ^[2].

Now, most of scholar use of susceptibility of loess in the Holocene of climate research widely.

The General Situation of the Geology

The Characteristics of the Profile. There's a loess deposition platform in the southeast of Xi'an. It's named that Plateau of the ShaoLinyuan. The plateau is neatly by the Chan River and Ba River. We take the samples from this plateau. The samples in Dachangsheng Fang, Xiao Changsheng Fang and KaoLao Cun between Sifujin (N34°8'7", E108°13', 518.4m) (Fig.1)

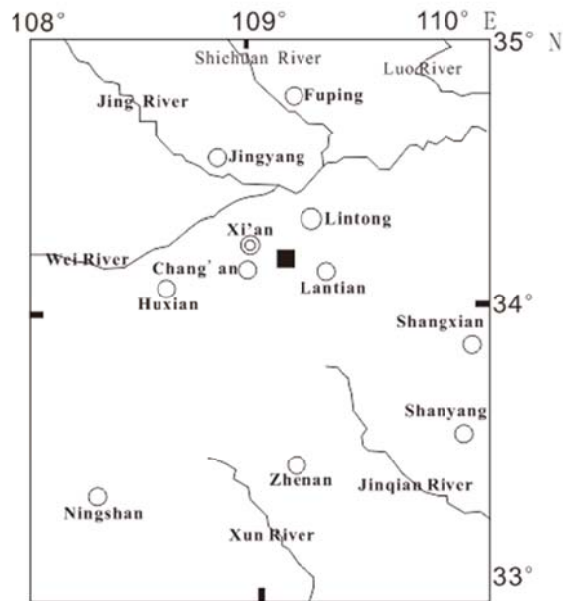


Fig.1 Map of geographical location of the study area
Research Locality

By observation and compared with other samples carefully, we found this loess-palesosol stratum not only horizon stability but also it's never been disturbed. Now, we take the samples from this plateau, 1~2cm interval sampling, 130, the depth of 1.7m. The characteristics of the stratum from new to old is that:

Topsoil layer (Ms): 0~0.1m, Yellowish gray, osteoporosis, it's include plant roots, There is much wormhole in stratum, small, particles, well-distributed. In a word, it's disturbed.

Loess (L0): 0.1~0.25m, Yellowish gray, small particles, well-distributed, and there's much wormhole and plant roots.

Paleosol: (S0) 0.25~1.3m, Reddish brown, paedogenesis weak, small particles, stickiness, and there's much wormhole.

Malan Loess (L1) : 1.3~1.7m, grayish yellow, coarse particle, looseness of structure, and there is much big interspace.

Chronosequence

Kukla study found that susceptibility is signify for ferromagnetic material of concentration in loess. Every strata thickness indirect proportion to susceptibility and time product. We should interpolate in pale magnetic conversion interface, and we can use this consequence for calculate loess of age. On this article, we can use this equation to calculate loess of age^[3]. Latterly, we can get Chronosequence of loess:

Notes:

T_m —— Horizon age

T_0, T_1 —— the age between loess 0 to 1

n —— total horizon between loess all control point

m —— A horizon of the previous total horizon

a —— The thickness of a horizon

s ——The susceptibility of a horizon

This equation is used in ice age or interglacial period. In same age, we should choice appropriate node for control. If we can use it truly, this result will closer to the truth ^[4].

Holocene loess-paleosol stratum can broke into 3 parts: Topsoil (Ms), Loess (L0), Paleosol (S0). So, we can choice the Holocene of age, Ms/L0, L0/S0 and S0/L14 to calculate this Chronosequence. On this article, we use mass date to calculate the panel point of age: 0, 2000, 3400 and 10000aB.P (Table.1).

Table.1 Locus of control parameters

Number	Depth/m	Chronosequence /aBP	Basis
1	0	0	The modern age
2	0.15	2000	M _s /L ₀
3	0.5	3400	L _s /S ₀
4	1.15	10000	S ₀ /L ₁

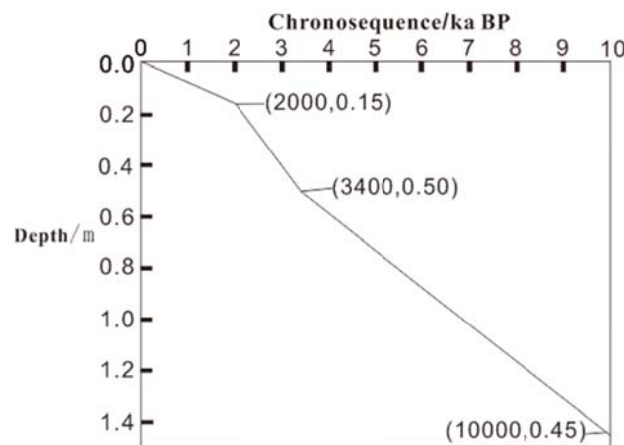


Fig.2 Map of chronology sequence

Susceptibility Curve of Loess Reflects Palaeoclimate

We get 160 susceptibility samples from ShaoLinyuan in the south of Xi'an (1~2cm a times). All the samples will be measured in the Key Laboratory of Continental Dynamics. Ministry of Education. Every sample is stave in 40°C. We can get sample about 20g put it in plastic bag. After, it can be measured by "MAG-NETIC SUSCEPTIBILITY MODEL-942". Every sample will be measured 3 times and took the average. The result is the susceptibility from the samples (Fig. 3)

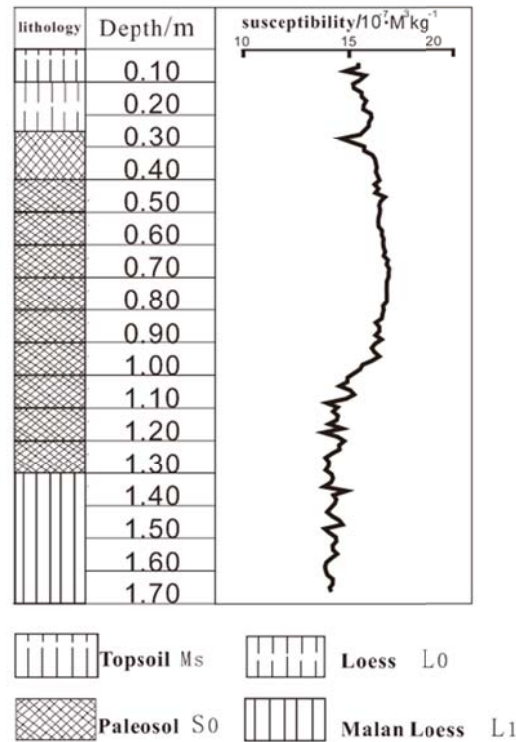


Fig.3 Map of susceptibility curve of Holocene loess section in Xi'an ShaoLinyuan

It's shown from the analysis results that the susceptibility of loess vary with depth and wide fluctuation in the susceptibility curve. The maximum present to paleosol (S0) (0.8m , $19.13 \times 10^{-7} \text{m}^3 \text{kg}^{-1}$). The minimum present to Malan loess (1.2m , $11.47 \times 10^{-7} \text{m}^3 \text{kg}^{-1}$). The curve like “3”, and it is wide fluctuation [5].

From this curve, we found that is completely in conformity with universal law in Loess-paleosol. The susceptibility is the double of the loess of susceptibility.

These map can reflect Malan loess to the Holocene topsoil is higher and the susceptibility more and bigger, even to the biggest. In the paleosol (S0), the susceptibility is the maximum, and we found that the paleosol of the susceptibility is increases at first then decreases. The susceptibility curve go up rise or descend under the loess formation. The pedosphere is stabilize, and it indicates present climate. From this curve, we found that can indicate this area of the Holocene loess-paleosol of the depositional environment and climate characteristics obviously.

The curve in the Malan loess (L1) goes out of the low placidly. The winter monsoon dominates this stage. It's lower paedogenesis and lesser susceptibility and the temperature is closer to the Holocene. The curve in the paleosol is wave crest and the susceptibility is maximum. The susceptibility becomes bigger and bigger from a below to above.

From that, the summer monsoon dominates this stage, and its stronger paedogenesis and higher. In this stage, the temperature is warmth in the Holocene. The curve is declining from 0.7m to 1.0m , and it indicates that the temperature becomes lower and lower. The susceptibility is Lifting continuous fluctuation in the loess formation. It indicates that alternation of summer and winter monsoon. The temperature is lower than the paleosol. The topsoil is a straight line, and it indicates present climate.

Discussion

The loess of susceptibility us substitute index in East Asian monsoon ^[5], and its indirect proportion to weathering intensity. The higher susceptibility indicates the summer monsoon is strong, higher temperature, or more rainfall. The researches show that this surroundings is in favour of weathering intensity and make susceptibility higher. So, the susceptibility reflects the temperature rise. This susceptibility curve in ShaoLinyuan, Xi'an compared with other 3 sporopollen spectrum curves in the temperature (Fig.4). We found that, the 4 curves is very similarity. So, we can provide the basis to environment evolution since the Holocene.

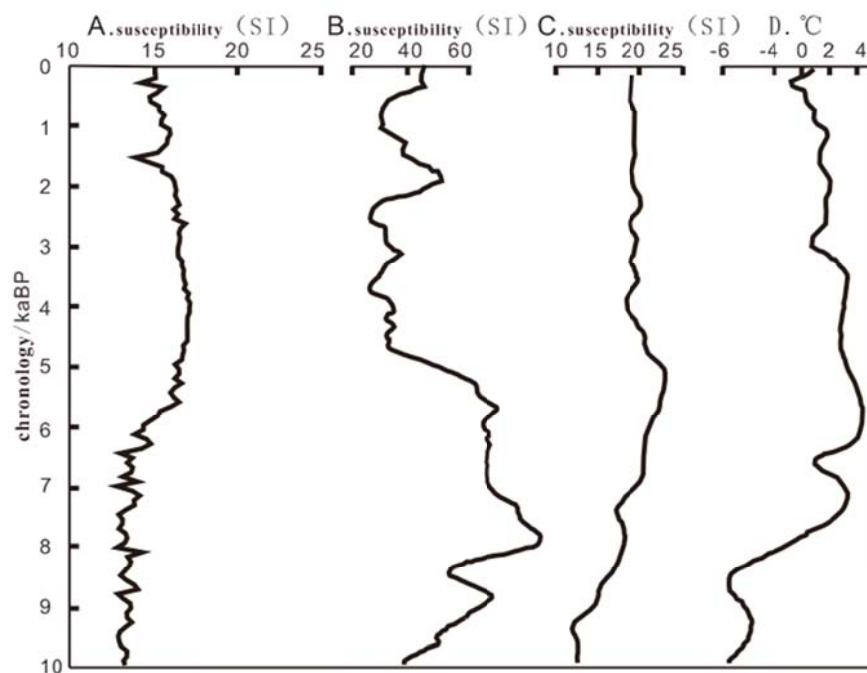


Fig.4 Contrast of susceptibility curve and sporopollen spectrum temperature curve in Xi'an ShaoLinyuan

10~8.5kaBP(the early Holocene): that warming and cooling shifts, the curve is lower susceptibility about 9.5kaBP. It's cold weather in this stage. We think this stage is correspond to the "XieHu cool period" in Chinese eastern. The temperature is lower 3.5℃~5.5℃ than now ^[6]. The susceptibility is bigger and bigger in 9.5~8.5kaBP, climate warming, and rainfall increases.

8.5~3.4kaBP (the mid Holocene): that warm period in the Holocene the period up to 5ka. This stage have a lot of climatic variation and cold event ^[7]. It's similarity to the warm period in the Holocene from Mr. Shi. The susceptibility is higher is warm and moist in the mid Holocene. This stage is longer time, so we can apart 3 period in this stage:

①8.5~7kaBP, cold-warm-cold trend. Shi Yafeng puts forward this period is in 8.5~7.2kaBP. But this susceptibility curve is more special than other for this region. For example, this curve in 8.5~7.0kaBP is a rising wave type. Its high temperature and wet climate. The temperature is higher than now 2℃. It's the same as the Kingston ice age, such as 7.8kaBP and 7.3kaBP.

②7~5kaBP, the warm period in a period of great prosperity in Holocene. The susceptibility is staying at a high level, and small fluctuation. We found that the weather wet and warm in this period. The period is the same as Yang Shao culture (7~5kaBP) from Zhu Shiguang put

forward. The temperature is higher than now 2°C. We can found this conclusion from Curve “C” and “D”.

③5~3.4kaBP, changing in temperature sharp fluctuation in the phase. The temperature is higher in 5.0kaBP. The climate is warm wet gradually lower, the temperature fluctuation is large, present trough until 4.0kaBP curve, and “Kingston DE cores” in wide shallow $\delta^{18}O$. Until 4.0kaBP the rise of temperature, but also marks the Holocene warm period ends.

(3)3.4kaBP~Now, the late Holocene. The temperature drop before they are stable. From the susceptibility curve, the susceptibility began to decrease, and the temperature around here has dropped in this time. The present climate is close to 3kaBP. The curve become slower gradually. We found that the climate tends to stabilize.

Conclusion

By the lithological description, classification and correlation of the Holocene loess-palesosol stratum in typical section of loess plateau in southern Chang'an, and loess deposition age sequence of the studied area is established.

On the basis of careful analysis and verification, the palaeoclimate stage features during the Holocene in the Xi'an area thoroughly discussed. 5 climate stages in most recent 10000years have suggested and they are:

10.0~8.5kaBP, being a conversion stage when the climate turned from cold to warm;

8.5~7.2kaBP, a frequently fluctuated climate stage;

7.0~5.0kaBP, a warm phase;

5.0~3.4kaBP, a turbulent, warm and cold alternated stage;

3.4kaBP to present, a warm semi-humid and semi-arid stage.

Now there is evidence showing that the climate fluctuation in Xi'an city, Shaanxi province is consistent with the general trend of climate change in East Asia and even the whole world. During the Holocene, the evolution of climate in Xi'an area is reflected by the cycle, instability and trends of it.

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