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# The five major changes in the evolution of the Loess Plateau

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**Abstract:** On the basis of the geomorphology, paleosol, paleoclimate and loess age, major changes of the Loess Plateau were studied. There are five major changes in the evolution of the Loess Plateau in China. Among them, the first, second, third and fourth major changes have taken place since the formation of the Loess Plateau, and the fifth major change will happen in 100 years. The first major change, which occurred at about 2.50 Ma BP, was a transition from red earth plateau to the Loess Plateau, and reflects the climate from the warm-sub-humid to the alteration between cold-and-dry and warm-and-humid. The driving force of this first major change was climate. The second major change, which took place at about 1.60 Ma BP, was a vital transition of the main rivers in this area from non-existence to existence, and represented an important change on the Loess Plateau's neotectonic uplift from the slow rising to periodically accelerated rising, and making the river's erosion go from feeble to strong. The driving force of the second major change is tectonic uplift. The third major change which occurred at about 150 ka, was a great transition of the Yellow River's inpouring from a lake outlet to a sea outlet. At that time, the Yellow River cut the Sanmen Gorge. The transition led to the transformation of loess material from internal transportation to external transportation. The driving force of the third major change was running water erosion. The fourth one that occurred at about 1.1 ka was a change of the Loess Plateau from natural erosion to erosion accelerated by human influences. The driving force of the fourth major change is mainly human activities. The fifth major change, which is the opposite change to the fourth one, in which the motive power is human activity, too.

**Key words:** the Loess Plateau; major changes; the driving force; the age of change
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## 1 Introduction

What important transformations have taken place during the formation of the Loess Plateau in China? Research on this problem has especially important scientific significance for us to learn of the evolution of the Loess Plateau and predict the future of the Loess Plateau.

A lot of achievements have been made in researches on paleoenvironmental changes of the Loess Plateau (Hell *et al*., 1982; Kukla *et al*., 1988; Hove *et al*., 1989; Kemp *et al*., 1995; Porter, 2001; Guo *et al*., 2002; Kohfeld *et al*., 2003), on stratigraphical age and morphological divisions of the modern Loess Plateau (Sun *et al*., 1991; Chen *et al*., 1998) and on the paleomagnetic dating of rivers in this area. However, there are few systematic expositions on its important changes in morphology. Probing into the developing history and the important changes of the Loess Plateau can help us to know not only the history of the Loess Plateau, but also the history of water and soil loss and the reasons for accelerating erosion in the modern era.

## 2 The areas and sites investigated and research methods

The Loess Plateau lies in the middle reaches of the Yellow River in the middle latitudes (Figure 1). Because of its well-developed loess strata and loess morphology, it is an ideal area to study

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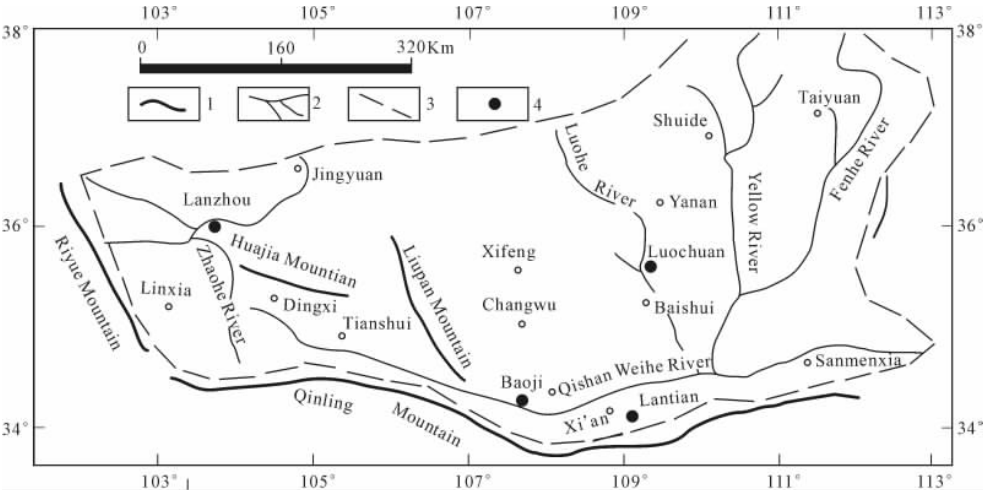

Figure 1 Range of the Loess Plateau and section sites studied
1. mountains; 2. river; 3. boundary of the Loess Plateau; 4. section sites studied

the evolution of loess morphology. According to extensive investigations, these terraces will be studied such as the Yellow River terraces at Lanzhou in the northwest of the Plateau, the Luohe River terraces at Luochuan, the Weihe River terraces at Baoji and the Bahe River terraces at Lantian in the southeast. In addition, the Pliocene red earth morphology that formed before the Loess Plateau will be studied also in Xi'an.

Samples were taken at 10-30 cm intervals through four profiles. Paleomagnetic methods were used to determine ages. Particle-size distribution was analyzed by using the Sedigraph 5000ET Particle-size analyzer. $CaCO_3$ content was analyzed by the capacity method, and lastly, $Fe_2O_3$ and $Al_2O_3$ were analyzed by chemical method.

## 3 The major change from the red earth plateau to the Loess Plateau

What morphology had developed before the Loess Plateau formed? This is a question awaiting to be answered. In the light of our field investigation and research of predecessors (Wang *et al.*, 1985; Zhang *et al.*, 1989; Zhao, 2002), it is known that the Loess Plateau has risen about 300-400 m since 2.50 Ma BP. The raised height indicated by all terraces formed since 1.40 Ma BP is mainly between 54 m and 245 m (Table 1). The altitude of the modern Loess Plateau changes from 1200 m in southeast to 2000 m in northwest. Excluding the 400-500 m height raised and deposited since loess accumulation, it is known that the altitude of most of this area has been that of a plateau of more than 700 m before loess began to deposit.

The earliest age of loess deposition was about 2.50 Ma BP (Sun *et al.*, 1991; Yue, 1989). Before this period, Hipparion red earth developed widely in this area. The thickness of the red earth is mostly between 40 m and 100 m, and its microstructure composition, sorting characteristic and development of many $CaCO_3$ nodules show that this kind of red earth is aeolian (Zhao, 1989; Ding *et al.*, 1992; Sun *et al.*, 1997), which is the offspring of aeolian sediment affected by the soil formation. Research on the North Pacific deep sea core unveiled that in the Late Tertiary Period, the wind dust transported from China to the

Table 1 Thickness of deposit on terraces of the chief rivers in the Loess Plateau

| Rivers | T6 | T5 | T4 | T3 | T2 | T1 |
|---|---|---|---|---|---|---|
| Yellow River at Lanzhou | 333.0 | 218.4 | 118.9 | 56.3 | 36.7 | 18.3 |
| Weihe River at Baoji | | 128.0 | 104.2 | 88.3 | 16.8 | 4.2 |
| Luohe River at Luochuan | | 82.2 | 62.6 | 50.2 | 15.4 | 2.4 |
| Bahe River at Xi'an | | 76.8 | 30.7 | 24.8 | 20.6 | 6.0 |

Table 2 Characteristics of Pliocene red earth and Early Pleistocene loess at Duanjia village in Lantian

| Strata | Strata combination | Silt (%) | $Al_2O_3$ (%) | $Fe_2O_3$ (%) | $CaCO_3$ (%) | Mammal group | Climate |
|---|---|---|---|---|---|---|---|
| Early Pleistocene loess | Loess interbed with red paleosols | 51.4 | 13.76 | 5.52 | 8.2 | Equs group | Cole-warm change |
| Pliocene | Red earth with $CaCO_3$ | 42.5 | 51.4 | 16.14 | 6.52 | Hipparion group | warm |

North Pacific had had a large scale (Rea *et al*., 1998), and provided the important aeolian evidence of the Hipparion acted as a yellow-brown color because of arid climate in the northwestern part of the Loess Plateau. Therefore, it is thought that the Hipparion red earth was the first step to the loess accumulation. But, there are great differences between the Hipparion red earth and loess. A lot of $CaCO_3$ nodule layers and Bt layers developed in the Hipparion red earth (Zhao, 1989; Ding *et al*., 1992; Sun *et al*., 1997) indicated that the climate had changed at that time, but the amplitude was little. The fact that the intercalary loess did not exist in the Hipparion red earth shows that the climate at that time was mainly warm-subarid. By analysis of particle size, $Fe_2O_3$, $Al_2O_3$ and $CaCO_3$ in 64 samples of the red earth and Wucheng loess in Lantian profile (Table 2), it is known that climate was warmer during the red earth development than during that of Wucheng loess development. The widespread red earth proved that it was the red earth plateau that developed at that time in this area. There were also many large lakes showed by lake deposit in the area (Zhang *et al*., 1989; Sun *et al*., 1991; Zhao, 2002) instead of the red earth.

In the later period of the Hipparion red earth development, the climate changed from the warm-subarid with weak fluctuation to a cold-and-dry climate with powerful fluctuations (Zhao, 1988, 2002). Correspondingly, the grey-yellow Wucheng loess developed on the Hipparion red earth. Although the red paleosols are within the Wucheng loess, the development of thick loess layers represented the prevailingly cold-and-dry climate. This transformation is clearly evidenced in the strata and the fossil assemblage (Table 2). The existence of the red-brown paleosols in Wucheng loess indicated that the climate at that time had fluctuated widely and the amplitude was becoming much larger than before. Meanwhile, the periodic climatic change of 0.1 Ma appeared. This change reflects not only the climatic transformation from warmness to coldness, but also the conversion of the East Asian monsoon climate. In view of the recent research, the East Asian monsoon did not form when the Hipparion red earth developed, but that silt-dust was transported by the west-wind circulation (Ding *et al*., 1999). However the East Asian monsoon had formed when the loess accumulation happened, which was the offspring of the winter monsoon's movement (Ding *et al*., 1999). Based on this, the major change showed that the atmospheric circulation which transported the silt-dust had a vital transformation (Ding *et al*., 1992). After this change, this area entered the main period of Loess Plateau development, but several short periods of red earth plateau had appeared at the same time, for example, the time nearly 500 Ka BP when the fifth-layer paleosol of 5-m thick formed (Zhao, 2003). The red earth and the loess, offspring of completely different climates indicated that the driving force leading to the major change was mostly climate. In this special area of the Loess Plateau, the uplift of the Qingzang (Qinghai-Tibet) Plateau had a helpful effect except for the aforementioned climate reason. The great climatic transformation had a global character (Heller *et al*., 1982; Yue, 1989; Sun *et al*., 1991), so the change is of worldwide significance. By the age of loess accumulation, the great change happened at about 2.50 Ma BP.

## 4 The major change of the main river´s development in the Loess Plateau

After the great change mentioned above, about 50 m of Wucheng loess developed at 1.20 Ma BP in the wide-ranged area of the Loess Plateau. In the middle and later period of Wucheng loess development, the second major change occurred, the appearance of large rivers. This change indicated important transformations of the neotectonic movement, the erosion basis, running water erosion and lake basins. It manifests itself in tectonic uplift, lake reduction and river formation. Before this change, lake deposits and piedmonts surface deposits comparatively developed, for example, the deposit of Sanmen lake in the Guanzhong area, lake deposit on two sides of upper Luohe River in Wuqi, the wide-distributed piedmont surface deposit layer in the front of the Qinling Mountains. Lake terraces and the surface deposit terraces did not develop before this change. This fact indicates that the periodic tectonic uplift was weak before this change. After this change, this area came into the periodic uplift period of the neotectonic movement, and the multiple terraces developed on the river valleys (Table 1). The periodic uplift of the neotectonic movement led to the decline of the erosion base level, which made the river erosion heavier than before. Because the Yellow River did not cut the Sanmen Gorge for a long time after the change, loess erosion and transportation were limited within the Plateau between this change and next change, which is a period of the internal erosion of loess material. Although there may have been rivers in this area before this change (Table 3), based on the estimation that the rivers' ages were commonly later than this change, those rivers should be few and small at that time, and the river action was weak. The reasons of rivers' scarcity was caused by lakes' wide distribution. The widely distributed lakes made running water in the small rivers out of mountain flowing into the lake basins, which limited the large-scale rivers' development, but the later lakes' reduction and disappearance provided advantages for the development of some large-scale rivers. The rivers' appearance and development made the river valley area larger, and the loess tableland less and alluvial deposit was formed (Figure 2). So, this change was very disadvantageous to the development of the Loess Plateau.

Table 3 Age and strata of the oldest terraces of the chief rivers in the Loess Plateau

| Rivers | The oldest terrace | Thickness of alluvial layer (m) | Thickness of loess strata (m) | The lowest paleosol in terrace | Magnetic age (Ma) | The oldest age of river estimated (Ma) |
|---|---|---|---|---|---|---|
| Yellow River at Lanzhou | $T_6$ | 20.0 | 310.0 | $S_{21}$ | 1.40 | 1.60 |
| Weihe River at Baoji | $T_5$ | 44.0 | 84.0 | $S_{15}$ | 1.20 | 1.40 |
| Bahe River at Lantian | $T_5$ | 8.4 | 68.4 | $S_{13}$ | 1.10 | 1.30 |
| Luohe River at Luochuan | $T_5$ | 2.4 | 74.4 | $S_{11}$ | 1.00 | 1.20 |

Note: Age of Yellow River, Weihe River and Luohe River is after Yue *et al*. ( 1997), age of Bahe River is by the author

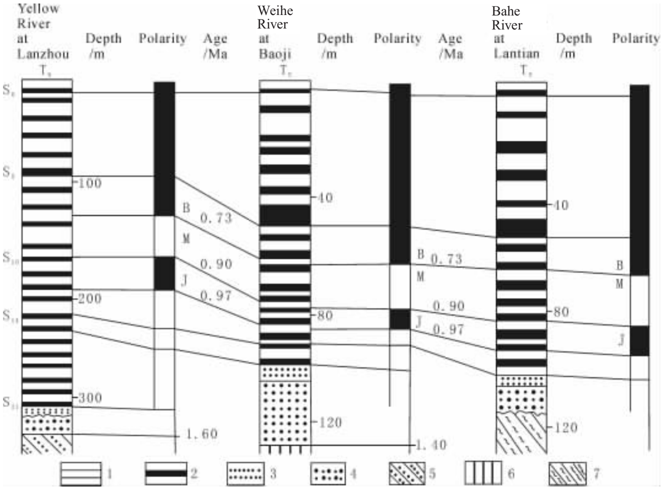

Figure 2 Strata and paleomagnetic age of the oldest terraces of chief rivers in the Loess Plateau
1. loess; 2. paleosol; 3. silt; 4. sand and gravels; 5. sandstone; 6. red earth; 7. killas
(Age of Yellow River and Weihe River is after Yue *et al.* (1997), age of Bahe River is by the author)

The rivers' appearance in this area was related to the following three aspects. One was the tectonic uplift, another was lake reduction and disappearance, and the last one was erosion. The tectonic uplift led to the decline of erosion bases level, and made the erosion heavier and rivers develop faster than before. The lakes' reduction provided advantageous terrain and space for the the rivers development. The fact that the exogenetic force erosion got faster was helpful to the appearance of the groundwater, and the quickening of the formation of the rivers. The lake reduction and the erosion of the exogentic force increase were mainly affected by the tectonic uplift, partly by the climate. Based on these reasons, the driving force of this change was mainly the tectonic movement's uplift. By measuring the paleomagnetic samples from deposits of the Yellow River, Weihe River, Luohe River and Bahe River (Figure 1), the age of this change could be established. It is known that in the oldest sixth terrace of the Yellow River, the Jaramillo Event lied in S10, L11 and S11 layers in Lanzhou (Figure 2). The paleosol was at the bottom of the profile (Figure 2). According to the susceptibility time standard and the foregone research result, the age of loess bottom-line was identified to be 1.40 Ma BP (Chen *et al*., 1989; Yue *et al*., 1997). It was estimated that the earliest formation age of the Yellow River in Lanzhou city was about 1.60 Ma BP. By making a comparison between the paleosols with paleomagnetic date, it is known that the oldest fifth-standing terrace age of the Weihe River as the first-standing tributary of the Yellow River was about 1.20 Ma BP in Baoji area (Figure 2 and Table 3). The Weihe River probably formed at about 1.40 Ma BP. The oldest 5th-standing terrace of Bahe River formed at about 1.10 Ma BP (Figure 2 and Table 3). At the earliest, the Bahe River formed at about 1.30 Ma BP. The oldest fifth-standing terrace of the Luohe River at Luochuan County formed at about 1.0 Ma BP (Figure 2 and Table 3) and the Luohe River itself probably formed about 1.20 Ma BP. The earliest river probably appeared about 1.6 Ma BP and the data (Table 3) shows how others developed later at different times.

## 5 The major change of loess material transportation from inner area to external area

After the second change, because the erosion of loess and its transportation were limited within the plateau, although 5-6 terraces were developed in the river-valley area, the loess accumulation thickness and the distributed area did not decrease. On the contrary, it constantly increased and became wider. It should be said that the period between the second and the third changes was a period of the Loess Plateau's great development.

In the long period after the second change, the Yellow River and its branch rivers flowed into the lake basin. As the Yellow River overflowed, it cut the Sanmen Gorge and flew into the east China sea instead. Eroded loess therefore flew into the

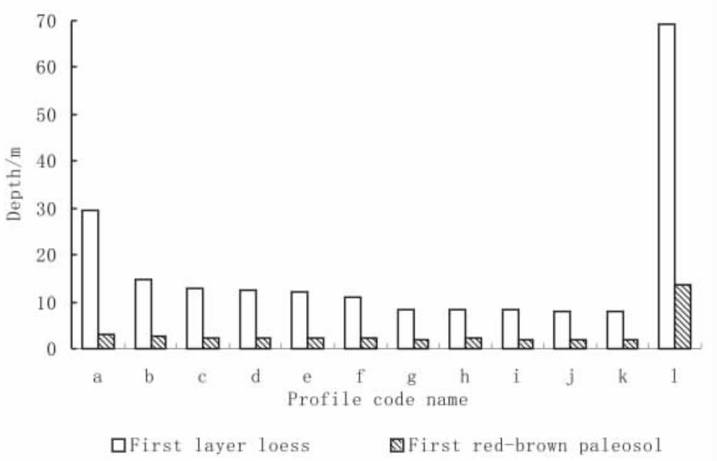

Figure 3 Thickness change of first layer loess and first layer paleosol on the Loess Plateau

a. Huoxianggou in Xifeng; b. Beiyuan in Linxia; c. Shancheng in Huanxian; d. Dazhaizhi in Pingliang; e. North Zhenyuan town; f. Qinjiazhai in Luochan; g. East Huangling town; h. Lingyuan in Baoji; i. Zhengjiapo in Wugong; j. South Xi'an; k. Weiqu in Chang'an; l. Mangshan in Zhengzhou;
1. First layer loess; 2. First layer red-brown paleosol

North China Plain and the eastern China sea. This was the third change. Tablelands were slightly affected and loess continued to accumulate at a faster rate than the river erosion rate, however, in the river valley area, lateral and retrogressive erosion removed the loess from this area. The animateness of the change was firstly the Yellow River's erosion for a long time and secondly was the erosion caused by gravity and temporary running water toward the Sanmen Gorge.

The age of the change occurrence should be confirmed by the age when the Sanmen Gorge was cut, thought to be about 1.40 Ma BP (Sun *et al*., 1991) but later research suggested 150 ka BP (Wu *et al*., 1998). According to thickness change of the first-layer paleosol and the first-layer loess (Figure 3) in the Loess Plateau and the east of the Sanmen Gorge near Zhengzhou City, the Yellow River eroded the Sanmen Gorge just before the first paleosol developed and subsequently removed loess eastwards. This rich source of silt carried by the Yellow River deposited on river flood plains made the thickness of the first-layer paleosol and the first-layer loess 8-10 times thicker than that of the same layer in the Loess Plateau (Figure 3). According to the research on soil erosion and geomorphology, there is an eroding period and a development period of gullies at about 150 ka BP (Zhao, 2002). So, it can be confirmed that the change took place about 150 ka BP.

## 6 The major change from normally natural to abnormally accelerative erosion

After the occurrence of the third change, although the loess erosion increased, the 10 m-thick loess stratum widely developed in the Loess Plateau over 150 ka. The change from normally natural erosion to abnormally accelerative erosion was the fourth change, which occurred about at 1.1 ka BP. The data indicated that the loess lost from the Loess Plateau was up to 1.6 billion tons every year (Chen *et al*., 1988). If the quantity of loess was averagely allocated in the total 440,000 km$^2$ of Loess Plateau, the average erosional rate was 363 g/cm$^2$.ka (Zhao, 1994, 2002), which was 38.7 times greater than the mean accumulation rate in the Pleistocene (9.3 g/cm$^2$.ka) (Liu, 1985). If it progresses at this speed, the loess would be eroded away completely after 11.85-5.92 ka BP. So, it can be known that the modern times was the erosion accelerative stage of the Loess Plateau (Chen *et al*., 1988; Zhao, 2002).

The driving force of this change was probably a combination of climate, tectonic uplift and the human activities. The modern climate does not favour development of the Loess Plateau (Zhao, 2002). In the cause of the Loess Plateau's development, it suffered from several alternations of accumulation and erosion. Apparently, this period saw a big deceleration of the loess deposit or discontinuousness deposit. Because the loess deposit was on grassland, the accumulation discontinuousness stage was also the erosional stage. Higher precipitation promoted fluvial erosion. Certainly in the warm-and-humid or the humid-and-hot stage, plant cover prevented erosion but at the same time because there was little dust available the Loess Plateau did not develop. The modern Loess Plateau is in the relatively warm-and-humid interglacial period, so the Loess Plateau theoretically belongs to the erosional stage.

Now, it is analyzed whether the current loess acceleration erosion was related to the currently erosional stage. In the course of the development of the loess strata, more than 30 red-brown paleosols formed (Liu, 1985; Zhao, 1988, 1994, 2003). Investigation proved that the paleosols developed in a warmer and more humid climate than present. The red-brown paleosol development (Zhao, 1988, 2002, 2003) represented the loess accumulation discontinuousness or the big deceleration of deposit. But according to the fact that the erosion seldom existed on the surface of the paleosols, it is proved that in the warm-and-humid erosional stage, the erosion action was less obvious than in modern times. The development of the paleosols from the first to the eighth layer, lasted altogether nearly 300,000 years (Liu, 1985). The warm-and-humid climate lasted for about 1,000,000 years (Zhao, 1994, 2002) during the development of all red-brown paleosols. Providing the erosional speed at that time was close to that of the current, it was impossible that the Loess Plateau developed, so it couldn't and didn't develop. Based on this, the

Table 4 Change in the number of people in the Loess Plateau (unit: persons/km$^2$)

| Years (AD) | 140 | 280 | 639 | 806 | 980 | 1078 | 1213 | 1330 | 1490 | 1820 | 1940 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total number of people | 7700 | 7300 | 9000 | 10100 | 10900 | 25800 | 29500 | 21800 | 35800 | 78600 | 59400 |
| Population in plains (%) | 84.7 | 83.7 | 72.0 | 62.1 | 55.5 | 58.0 | 49.2 | _ | 65.0 | 56.0 | 56.0 |
| Population in hilly areas (%) | 15.3 | 16.3 | 28.0 | 37.9 | 44.5 | 42.0 | 50.8 | _ | 35.0 | 44.0 | 44.0 |

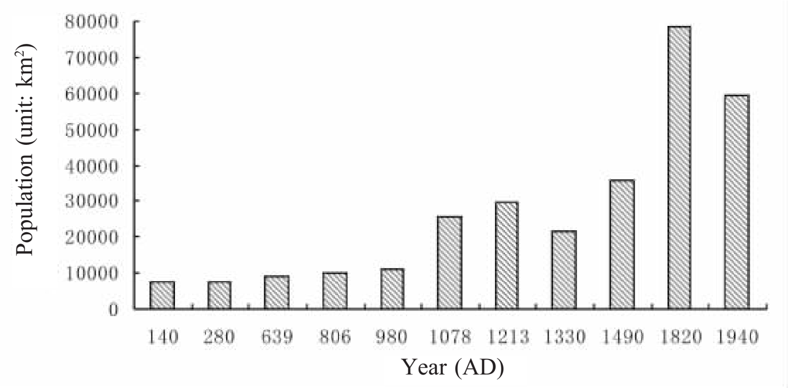

Figure 4 Change in the number of people in the Loess Plateau from 140 to 1940 A.D.

erosional aggravation of the modem Loess Plateau was not animated by the climate.

Terraces in the Loess Plateau area represent periods when tectonic uplift quickened, but the loess developed continuously on the terraces (Figure 2). The deposit discontinuousness and the erosion surface do not exist. Even in loess strata covered on multiple river terraces, the erosional surface does not exist. When the tectonic uplift got faster, the erosion led to increase of stormed cracks, which made the erosional action heavier than before to a great extent. As far as the height of the neotectonic uplift in the modern Loess Plateau is concerned, it is impossible that natural erosion action reached modern erosion's speed and made the Loess Plateau disappear because of erosion. The height of the Loess Plateau and erosion basis surface during Late Pleistocene are close to that in modern times, but the natural erosion of more than 100,000 years did not make the Loess Plateau disappear. On the contrary, the widely distributed Malan loess deposited about 10 m thick, so the erosional acceleration stage of the Loess Plateau was not caused by the neotectonic uplift.

Human action caused plant's destruction, which is the strongest factor of holding back the water and soil flow away and may become the driving force of loess erosion acceleration. In Pleistocene and early-middle Holocene, population was very sparse in the loess area. They lived on non-agricultural means such as hunting. Plant cover reduced erosion, which conserved the loess and allow the Loess Plateau develop. According to historical records, at 1078 A.D. of the early Northern Song Dynasty, there was a great increase in population in the Loess Plateau and reached 25,800 persons per km$^2$ (Table 4 and Figure 4), and there were a lot of people living in the loess hilly areas (Table 4). Excessive population changed the dependence of non-agriculture's survival into the opposite ways of living. Because of unreasonable cultivation practice and wanton felling of trees, large area of natural vegetation no longer existed, the ecological balance was destroyed, and the running of water and soil loss became more serious. Before the early Northern Song Dynasty, natural forest-steppe vegetation developed well in the Loess Plateau but has destroyed seriously by human action since then (Wang, 1990). Not only wasteland in plains was reclaimed but also wasteland in hilly areas was reclaimed in the Loess Plateau in the Northern Song Dynasty (Du, 1993), which resulted in accelerated soil erosion. Predecessors thought that unnaturally accelerative erosion took place at about 3.0 ka BP (Chen *et al.*, 1988). By the above-mentioned discussion, we can determine that the fourth major change happened at about 1.1 ka BP.

## 7 Calculating the change of the Loess Plateau in 100 years

Future change of the Loess Plateau in 100 years will result from both natural turn and and human influences. The natural turn has been analysed at first. The factors which effect the evolution of the Loess Plateau are the neotectonics, climate, landform, lithologic character and vegetations. These changes are different in a short period. The change in lithologic character and landform is slow and likely to be negligible in the next 100 years. The neotectonic uplift is slowing so erosion slows too. The investigated area is raising with an annual rate of 2.5 mm, so the uplift height is about 200-500 mm in the future 100 years, hence there will be little change in erosion basis decline and landform gradient reduction. It cannot cause great change of the Loess Plateau. The change of climate affects loess erosion, deposition and vegetation greatly and quickly. When the climate changes towards cold and dry, the loess deposition would increase. When the climate changes towards warm and humid, the water erosion would be accelerated whereas a change towards cold and dry would increase loess deposition. Loess deposition is a slow process: about 5-6 mm thick per 100 years. Though the climate will develop towards cold and dry, it cannot compensate the eroded loess, of which the average eroded thickness is about 5 mm a year. What is more, the cold and dry climate makes it difficult for plants to grow so less plant cover means increasing erosion and further degradation of the ecological environment. It is certain that the climate would develop gradually towards cold and dry but not too cold and dry in 100 years. It is sure that the great natural change would not happen in the Loess Plateau because both climate and vegetable would not change too much in 100 years. However, human activities could have a great impact. However, the accelerating erosion in the Loess Plateau could be reversed. By planting trees scientifically and taking engineering measures to prevent soil erosion, we can not only stop the abnormal erosion and arrest natural erosion. With government investment in the use of science and technology project in Northwest China we are entering an era of active Loess Plateau management. The fifth great change is coming: a change from abnormal accelerative erosion to normal erosion or less than normal erosion.

From all the above, the greatest influence on increased loess erosion has been the degradation of vegetation due to human activity.

## 8 Conclusions

In all, we can draw the following conclusions.

(1) From the development of wind dust, we can learn the Loess Plateau had already formed by the Late Pliocene, and has experienced four major changes since its development.

(2) The first major change was a great transition from red earth plateau to the Loess Plateau, and the driving force of it was climate change about 2.50 Ma BP. The atmospheric circulation which transported the powder-dust changed dramatically.

(3) The second major turning-point was the appearance of large-scale rivers and the terraces, the driving forces of which were mainly the neotectonic uplift and partly the climatic desiccation. This change happened 1.60 Ma BP. This period of accelerated uplift promoted the river erosion from weak to strong with a great impact on relief.

(4) The third major change came when the Yellow River cut the Sanmen Gorge 150 ka BP. when inland drainage changed to drainage to the sea carrying eroded loess with it. The plateau became more dissected.

(5) The fourth major change is a turn of Loess Plateau's normal natural erosion to accelerative non-natural erosion. The driving force of it is human action, the age of which is 1.1 ka BP to the present. This change accelerated the Loess Plateau's erosion.

(6) The fifth great change is a turn from abnormal accelerative erosion to normal erosion or under normal erosion. The driving force is human action. It will happen in 100 years.

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