**The Paleosol Complex S₅ in the China Loess Plateau - A Record of Climatic Optimum during the last 1.2 Ma**

An Zhisheng, Prof. Dr.; Liu Tungsheng, Prof. Dr.; Zhou Yizhi, Dr.; Sun Fuqing, Dr., Xian Laboratory of Loess and Quaternary Geology, Academia Sinica, Xian, China
Ding Zhongly, Dr., Institute of Geology, Academia Sinica, Beijing, China

**ABSTRACT:** Having investigated the loess-paleosol sequence in various loess deposition basins in the China Loess Plateau, authors have found that the paleosol complex S₅ is of special significance in terms of Pleistocene paleoclimate. Palaeopedological, micromorphological, palynological and paleomagnetic evidences indicate that this paleosol complex formed in the interval of 460,000 to at least 560,000 years BP, which was a climatic optimum.

In the recent years, scientists pay more and more attention to the "Green House Effect" caused by the increase of CO₂ in the atmosphere. Because there exist different arguments about the tendency of modern climate change, scientists are peculiarly interested in reconstructing the climatic optimum during the Quaternary period, that may provide a reference pattern of the average climatic condition for the possible temperature rise period in the future.

It has been confirmed that the interval of about 5,000-6,000 yr BP is a climatic optimum of the Holocene in the N Hemisphere. However, the records of climatic optimum in Pleistocene are still rather obscure.

Since the 1970s, having investigated the loess-paleosol sequence in various loess deposition basins in the China Loess Plateau, authors have found that the paleosol complex S₅ (Fig 1) is of special significance in terms of Pleistocene paleoclimate.

In the China Loess Plateau, the paleosol complex S₅, consisting of three paleosol layers and two sandwiched thin loess layers, was named "Luochuan marker layer" (Liu Tungsheng et al. 1966). The S₅, with the thickness of about 5 m in Luochuan, is the marker layer to separating the Upper Lishi Loess from the Lower Lishi Loess (Fig 2). In the field, the very apparent S₅ is characterized by dark reddish brown colour, by the high clay content, by polyhedral to prismatic structure, as well as by abundant clay illuviations in B₄ horizons.

On the basis of palaeopedological and micromorphological studies, An Zhisheng and Wei Lan Ying (1980) stated that the paleosol complex S₅ was a type of brown cinnamon soil and had suffered from the strongest pedogenetic processes among the 15 paleosol layers (S₀ - S₁₄) formed in the past 1.2 Ma (Fig 3).

In the various curves of indirect climatic indices in Luochuan section (Fig 4), for example, the grain size distribution of cf. loess and paleosols (represented by M₀ and Kₐ/Cl, M₀ - average grain size; Kₐ/Cl - the ratio of the content of the coarse silt fraction 0.05 - 0.01 mm to the clay fraction <0.005 mm, the CaCO₃ content, the ratio of Fe₂O₃ to FeO, and the magnetic susceptibility SI, the upper part of the paleosol complex S₅(S₅₋₁) shows the finest grain size distribution, nearly no CaCO₃, the highest Fe₂O₃/FeO ratio and the highest susceptibility values. According to these results S₅₋₁ had recorded a relatively warm and humid paleoclimate environment since 1.2 Ma.

The micromorphological study was also carried out (An Zhisheng and Wei Lan Ying 1980). Under the microscope, the argillitic horizon of S₅₋₁ shows relatively high weathering degree of the primary minerals, much more hematite and goethite mottles,
abundant reddish-brown and optically oriented clay flakes in channels and voids, that reflect rather dense vegetation coverage, relatively warm and humid climatic condition as well as strong eluviation and illuviation occurred in the pedogenesis of S5-I.

At the same time, tree pollen (mainly Pinus, Quercus and Betula) amounting up to 73 %, herb pollen (mainly Artemisia, Gramineae) 26 %, and spores 0.6 % in the total of 300 grains have been identified in the samples of S5-I at Qingchi of Luochuan (Liu Tungsheng et al. 1985).

On the basis of these preliminary studies, authors consider that the upper part of paleosol complex S5 (S5-I) should be classified as forest soil, and the middle and lower parts (S5-II, S5-III) as forest-steppe soils. The same situation is also found in the Lantian section, Shaanxi Province and in the Xifeng section, Gansu Province, where S5-I also shows the strongest pedogenetic processes. Therefore, it seems that in comparison with other paleosols formed during the last 1.2 Ma, S5-I is the record of the most favourable climate in the China Loess Plateau. The black loam S0 (a type of steppe soil) in Luochuan is regarded as the record of the Holocene optimum.

From the estimation based on the magnetic polarity boundaries in the Luochuan section and the loess deposition rate, the paleosol complex S5 was formed approximately in the interval of 460,000 to at least 560,000 years (Liu Tungsheng et al. 1985). So, this interval of 460,000-500,000