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An 11-Ma-old red clay sequence on the Eastern Chinese Loess Plateau

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ABSTRACT

Older red clay deposits on the Chinese Loess Plateau contain information of early paleomonsoon evolution and tectonic history of the Ordos platform and the Tibetan Plateau. A well-conserved eolian red clay sequence was recently discovered at Shilou, on the Eastern Chinese Loess Plateau. Paleomagnetic measurements demonstrate that polarity zones recorded in the Shilou red clay profile correspond well with polarity zones between C2An.1n and C5n.2n of the GPTS, and the basal age of the study profile is approximately 11.0 Ma. Field observation, grain-size frequency distribution and quartz grain morphology suggest a wind-blown origin for this sequence. This indicates that the Eastern Loess Plateau began to accumulate dust deposits at 11 Ma ago, implying earlier establishment of the East Asian paleomonsoon probably owing to uplifting of the Tibetan Plateau and ongoing global cooling. It also demonstrates that the Eastern Loess Plateau belonging to the Ordos platform was slowly uplifted and suffered from erosion in the early Neogene, and has no conserved eolian deposits older than 11 Ma as in the Western Chinese Loess Plateau.

1. Introduction

The Chinese Loess Plateau in Northern China has the thickest, largest, oldest and most continuous eolian deposits in the world (Sun and Xu, 2007). In recent years, Neogene red clay deposits (also called *Hipparion* red earth since this stratum contains abundant *Hipparion* fossils) underlying the Chinese loess have attracted more attention because they contain both paleoclimate and uplift history information of the Tibetan Plateau (Liu, 1985; Kukla and An, 1989; An et al., 2001; Ding et al., 1999; Qiang et al., 2001; Guo et al., 2001, 2002; Song et al., 2007; Sun et al., 2008). Field observations, sedimentology, geochemistry, geomorphology, pedology and rock magnetism studies all demonstrate an eolian origin for the red clay, similar to the overlying loess (Lu and An, 1999; Liu et al., 2003; Sun et al., 1997; Ding et al., 1998; Guo et al., 2002; Miao et al., 2004; Nie et al., 2007, 2008). Unfortunately, the thickness of the red clay sequence varies greatly ranging from 30 to >200 m, leading to great disparities in basal age from 6.2 to 22.0 Ma (Xue et al., 1995; Sun et al., 1997, 1998; Ding et al., 1998; An et al., 2000, 2001; Qiang et al., 2001; Guo et al., 2001, 2002; Yue et al., 2004; Zhu et al., 2008).

Until now the earlier aridity of northwest China is accepted. A loess section near Xining containing a Miocene portion aged ~14 Ma (Lu et al., 2004; Wang et al., 2006), eolian sand of 15 Ma in the Linxia basin (Wang et al., 1999), and a set of eolian deposits more than 12 Ma near Nanjing (Zhang et al, 2007) all indicate that Miocene eolian deposition involved a larger area and might have reached as far south as the Yangtze River (Guo et al., 2008).

However, most red clay sequences older than 8.35 Ma (Guo et al., 2002; Hao and Guo, 2004, 2007; Liu et al., 2005) were all found in the Western Chinese Loess Plateau delimited by the Liupan Mountains (Fig. 1). It seems that the Liupan Mountains were the dividing line for the onset of eolian deposits between the Eastern and Western Chinese Loess Plateaus. The question then arises as to why the main part of the Eastern Loess Plateau has no deposits of older red clay and whether any older deposits were not suitable for conservation or eolian deposits occurred much later. So older red clay deposits are crucial to understand the tectonic history of the Eastern Loess Plateau and furthermore comprehend the early development or evolution of the East Asian monsoon and uplifting of Tibetan Plateau.

In the past, researchers ignored the eastern edge of the Loess Plateau and failed to explore older eolian deposits. Recent studies indicate that the piedmont of Lüliang Mountains provides suitable conditions for preservation of older red clay deposits. Li et al. (2009) discovered some red clay lumps and carbonate nodules dated older than 8 Ma that have experienced transformation by water flows and show good gradation and fine psephicity in the piedmont of Lüliang Mountains. This indicates that there is an older red clay that underwent reconstruction and was conserved as clastic sediments. Therefore a large-scale field survey was carried out in the piedmont of the Lüliang Mountains, and a continuous 70-m-thick eolian red clay section at Shilou was found. Detailed magnetostratigraphy,

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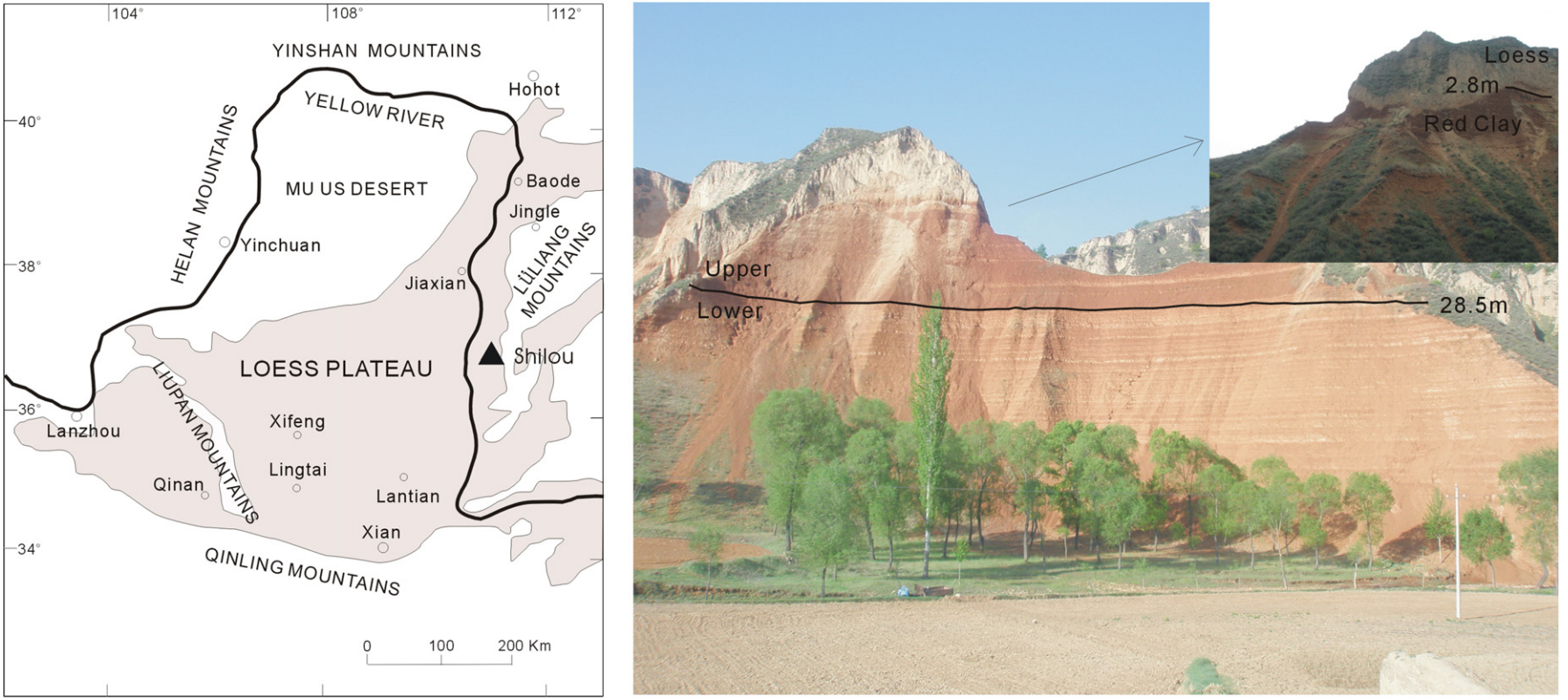

Fig. 1. Schematic map showing the location (on the Chinese Loess Plateau; left) and field characteristics (right) of the Shilou section.