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Pedostratigraphy of aeolian deposition near the Yunxian Man site on the Hanjiang River terraces, Yunxian Basin, central China

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ABSTRACT

Since 2010, we have found stone artifacts at the Houfang and Dishuiyan loess sections on the second terrace of the Hanjiang River and the Wolonggang thick natural loess section on the fifth terrace of the same river near the Xuetangliangzi site. We dated Dishuiyan and Houfang loess sections by optically stimulated luminescence (OSL) and thermally transferred OSL (TT-OSL) methods respectively. Dating results showed that the loess–paleosol deposited on the second Hanjiang River terrace as L1, S1, L2, and S2 in sequence. We dated the Wolonggang loess section by high-resolution paleomagnetostratigraphic analyses. The Jaramillo subchron was found at this section. Correlating with the central Loess Plateau, we recognized the continuous loess–paleosol sequence from L9 to L15. Investigations showed that loess was continuously deposited on the terraces of the Hanjiang River at Yunxian Basin since at least 1200 ka.

1. Introduction

Two fossil human crania show features associated with *Homo erectus* were successively discovered in the Xuetangliangzi (Yunxian Man) site at the Yunxian Basin, Hubei province, central China in 1989 and 1990 (Li and Etler, 1992, 1994; Li and Feng, 2001; Feng, 2004, 2008). The preliminary paleomagnetism dating suggested an age about 0.8 Ma (Yan, 1993). A later high-resolution magnetostratigraphic dating result put the age approximately at 0.9Ma (De Lumley and Li, 2008). A recent ESR dating showed a result of about 1.10 Ma (Feng et al., 2011). Until now, the pedostratigraphy study of the Xuetangliangzi site was limited, and the ages of the Yunxian Man and the Yunxian Paleolithic assemblages remained controversial.

At the Xuetangliangzi site, the deposition cover is only 7 m thick with only one loess unit and one paleosol complex. This caused problems in paleomagnetism dating and loess–paleosol sequence correlation with the central Loess Plateau. Furthermore, previous investigations regarded the widely distributed Quaternary deposits in Yunxian Basin as fluvial sediment (Huang and Li, 1995; De Lumley and Li, 2008).

Aeolian deposits are widely distributed in China (Liu, 1985). The Qinling Mountains are a natural barrier blocking the spread of dust from the north to the south. In the north, many thick aeolian depositions have been well studied (Liu, 1985; Liu and Ding, 1998; Ding et al., 1998, 2001; Lu et al., 1999, 2004). A small quantity of fine particle dust suspending at higher levels could cross over the Qinling Mountains (Yang et al., 1997; Han, 1988; Xiong et al., 2000, 2002; Qiao et al., 2003, 2011; Lu et al., 2008, 2011; Sun et al., 2012). Yunxian Basin is located south of the Qinling Mountains (Fig. 1).

Since 2010, during our field investigations in the Yunxian Basin, we found that the sediment cover in this area was aeolian. Stronger weathering and pedogensis processes were clear during the field observation. Aeolian silts were deposited on the Hanjing River terrace system with a thickness ranging from 2 to 30 m. There were some thick sections containing distinct loess–paleosol sequences near the Xuetangliangzi section. These aeolian sections could provide more information about the pedostratigraphy and ages of the

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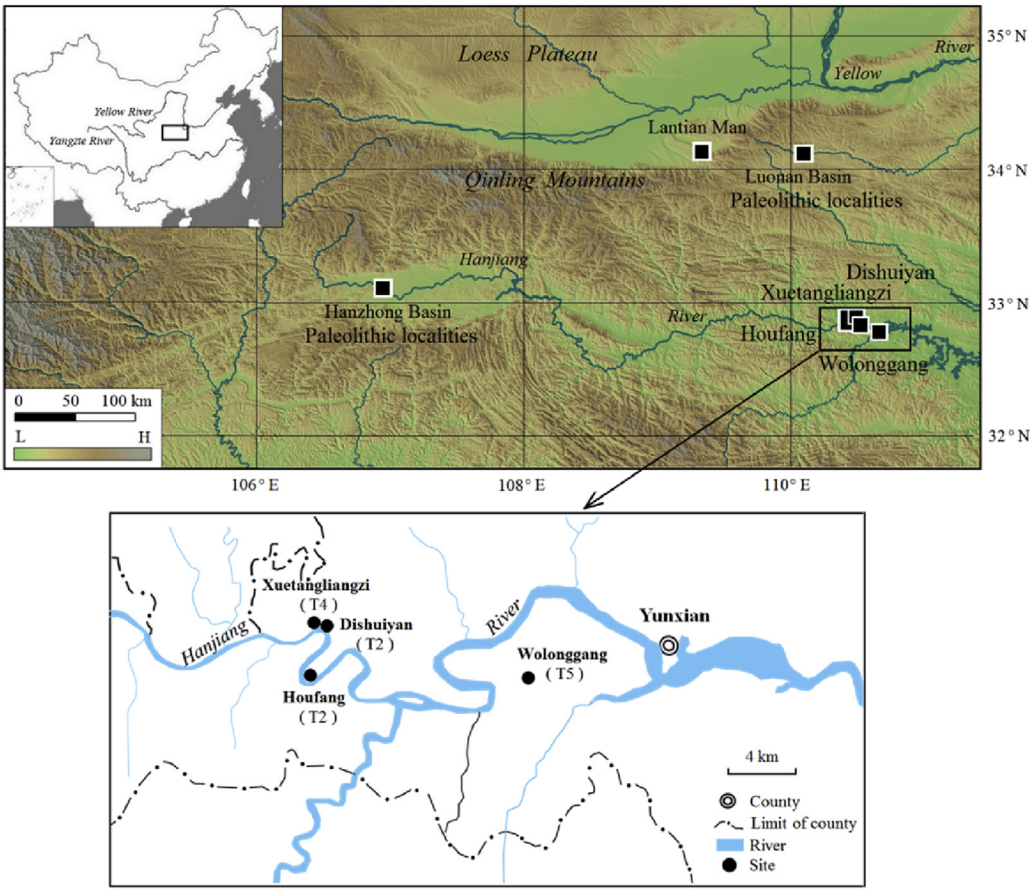

Fig. 1. Location of the Yunxian Man (Xuetangliangzi) site in the Yunxian Basin at the south Qinling Mountains and the Middle Pleistocene archaeological sites around the Qinling Mountains.

Yunxian Man and the Yunxian Paleolithic assemblages. Based on investigations of these aeolian sections from the first to the fifth terraces (Fig. 2), we could outline the pedostratigraphy of the aeolian deposition at the Yunxian Basin.

2. Geographical setting and sampling

Previous studies differentiated four Hanjiang River terraces in the Yunxian Basin (Shen et al., 1956; Huang and Li, 1995; De Lumley and Li, 2008). In 2012, we carried out detailed investigation and measurement on the Hanjiang River terrace system (Fig. 2). In this study, we identified six terraces near the Xuetangliangzi site, Yunxian Basin. The first terrace was found along both sides of the river. The fluvial cobbles occurred 5–10 m above the modern riverbed and the loess cover was about 5 m thick. The second terrace was also found on both the north and south banks, with most village buildings on it. The fluvial sand and cobbles occurred 20–25 m above the modern riverbed, and the aeolian deposit on top was less than 10 m thick. On the third terrace, the base of fluvial sand and cobbles was 40–45 m above the riverbed. The loess cover was very thin, less than 5 m. Some small villages were built on the third terrace. The fourth terrace was at 50–60 m above the current riverbed. The aeolian deposit on the fourth terrace was 5–10 m thick and contained a thin loess unit and a paleosol complex. The Xuetangliangzi site was on this terrace. The fifth terrace was 65–75 m above the riverbed and was covered by thick loess comprising indistinct loess–paleosol alternations. We also found a sixth terrace which was about 90 higher than the current riverbed. On the sixth terrace, fluvial pebbles were exposed on the bed rock.

In 2010, many stone artifacts were excavated by the team of Professor Li Yinghua at the Houfang site (Li and Sun, 2013). The Houfang site was only about 2 km away from the Xuetangliangzi site, about 187 m above sea level. It was on the second Hanjiang River terrace. We found a loess unit and two paleosol complexes at the Houfang loess section (Fig. 3). We took sediment samples for luminescence dating at the top, middle, and bottom of the section.

In 2012, numerous stone artifacts were excavated by the team of Professor Feng Xiaobo at the Dishuiyan site, which was adjacent to the Xuetangliangzi site (Liu and Feng, 2014). The Dishuiyan site was also on the second Hanjiang River terrace about 181 m above sea level. We found two loess layers and a paleosol unit at the Dishuiyan loess section. We took OSL samples from the top, the middle, and the bottom of the section.

In 2012, we found a thick natural loess section at the Wolonggang village (Fig. 3). This section contained distinct loess–paleosol alternations at about 230 m above sea level. The Wolonggang section was on the fifth Hanjing River terrace. It was 15.5 m thick and approximately 14 km from Xuetangliangzi section. During the field observation, we could easily make out the loess–paleosol sequence, which contained 8 loess units and 7 paleosol complexes (Fig. 3) based on changes of soil color. Loess units were light yellowish brown 10YR 6/4 and 10YR 6/6 (Munsell). Paleosol layers were brown 7.5YR 5/6 and strong brown 7.5YR 4/6. Loess units in southern China differ from those in northern China. They are closer to weakly developed soil (Sun et al., 2012; Zhang et al., 2012).