The western Loess Plateau contains the thickest loess deposits in the world. The combination of rapid, often continuous accumulation and weak pedogenesis (hence limited, post-accumulation overprinting by subsequent weathering), provides one of the best opportunities to reconstruct past monsoon climatic changes with high temporal resolution. This in turn points to the area as a crucial one for shedding light on climate variability during the Eemian Interglacial (S1-c), which may correlate with oxygen isotope record of the GRIP ice core from Greenland (Dansgaard et al., 1993).

A late Pleistocene high-resolution loess-paleosol sequence has been obtained from a 40-m well dug in a loess section at Jiuzhoutai in the City of Lanzhou in the western Loess Plateau of China. The last interglacial interval consists of three individual paleosols marked downwards as S1-a, S1-b and S1-c separated by two loess layers L2-1 and L2-2 (Fig. 9a).

Previous study has shown that paleosols S1-a, S1-b and S1-c correlate with sub-stages 5a, 5c and 5e of marine isotope records (MIS), respectively (Fig. 9c). Samples were taken at 1-2.5 cm intervals for S1 series, yielding resolutions of c. 60-150 years per sample. The Blake Event was found in the paleomagnetic record at the boundary between loess L2-2 and paleosol S1-c after thermal demagnetization and measurement on a 2G magnetometer. This provides an age estimation of 119.97 - 114.47 kyr BP for this part of sequence (Fig. 9d), in good agreement with TL-dates (Fang et al., 1997) (Fig. 9b).

Super-paramagnetic (SP) or ultra-fine (mainly < 0.03 μm) grains have been shown to have a pedogenic origin and are highly sensitive to climatic change, thus providing a powerful tool to reveal summer monsoon. Direct measure of SP grains on MPMS by thermal decay of low temperature isothermal remanence (Fig. 9f) accords well with estimates from saturation-magnetization (Ms)-normalized mass-specific susceptibility (Fig. 9e) for the studied section. Both show that SP grains are much more abundant in paleosols than in loess and reach highest values in S1-c (Figs. 9e and f). However, within S1-c large fluctuations in SP grain content are evident, characterized by three sharp peaks lasting ca. 1-3 kyr and culminating at about 128 kyr, 118 kyr and 116 kyr. The amplitude of the second of these fluctuations, lasting about 4 kyr, reaches ca. 75 percent of the full range of variation between paleosol peak and loess values and (Figs. 9d-f). These results suggest that the Asian summer monsoon experienced significant climatic changes during the Eemian Interglacial (MIS 5e), in good agreement with previous conclusion derived from non-magnetic indicators (Fang et al., 1996).

Last Interglacial sharp Monsoon Fluctuations: Rock Magnetic and Paleomagnetic Evidence from High Resolution Loess-Paleosol Sequence, Lanzhou, China

Fig. 9: Diagram showing the loess-paleosol sequence of the Jiuzhoutai well section (a) in Lanzhou on the western Loess Plateau, its age-depth relationship (b), volume magnetic susceptibility measured in the well (c), variations of mass-specific susceptibility (χ) (d), χ / Ms (saturation magnetization) (e) and super paramagnetic (SP) grains measured on MPMS in the depth 35.3-38.5m. The black bar indicates the Blake event (Fang et al., 1997). Note the covariant changes of χ/Ms and SP grains (f) suggest that the summer monsoon experienced large amplitude and rapid changes during the Eemian Interglacial (S1-c), which may correlate with oxygen isotope record of the GRIP ice core from Greenland (Dansgaard et al., 1993).