Environmental changes in the eastern Tibetan Plateau since the last interglacial recorded from the Ganzi loess sequence

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INTRODUCTION
Loess sequences in the eastern Tibetan Plateau (TP) are valuable paleoenvironmental archives for reconstructing the environmental history related to the Indian summer monsoon (ISM). However, limited detailed information is known about these loess sequences. In recent years, increasing interest has been focused on these plateau loess sequences in order to derive the past environmental information of the Tibetan Plateau. In this study, we conducted optical stimulated luminescence (OSL) dating and environmental magnetism analysis of the Ganzi loess sequence that developed since the Last Interglacial.

MATERIALS AND METHODS
The study section, named Xindu (XS, 31°37′N, 99°59′E, 3400 m), is at the Ganzi county, in the eastern Tibetan Plateau. The XS section consists of three paleosols and two loess layers. We collected bulk samples along the depth at intervals of 2.5 cm for magnetic measurements. Luminescence dating and magnetic susceptibility measurements were carried out at the Key Laboratory of Western China’s Environmental Systems (MOE), Lanzhou University. Saturation isothermal remanent magnetization (SIRM), anhysteretic remanent magnetism (ARM) and χ/T curves were determined at the Institute of Tibetan Plateau Research, CAS.

RESULTS
Quartz and K-feldspar luminescence dating demonstrate that the XS section began to form after 127 ± 6 ka, which corresponds to marine isotopic stage (MIS) 5. Based on the luminescence ages and loess-paleosol layers, we identified the paleosols and loess horizons as S1, L1L2, L1S1, L1L1, and S0 from the bottom to the top, which approximately correlated to the MIS 5, MIS 4, MIS 3, MIS 2, and MIS 1, respectively.

The results show that each magnetic parameter varies significantly with changes in the loess and paleosol strata. Generally, the loess shows low values, and the paleosol shows high values for the magnetic proxies. The magnetic enhancements of the Ganzi loess since the LIG reflect an increase in concentrations of both pedogenic magnetite and maghemite. The contents of nano-magnetite and maghemite produced by soil formation have dominated the loess magnetic enhancement in the Ganzi loess. Thus, pedogenic processes and the corresponding climate factors are the main factors controlling the formation and transformation of magnetic minerals in the eastern TP. Therefore, the magnetic parameters of the XS loess sequence can be used for reconstructing the paleo-precipitation history since the LIG.

CONCLUSION
Magnetic properties of Ganzi loess are mainly controlled by the climate and can be used to reconstruct paleo-precipitation. The reconstructed precipitation history shows that rainfall has varied greatly since the LIG in the eastern TP. High values of precipitation occurred in MIS 5 and MIS 1, followed by MIS 3. The rainfall of MIS 3 fluctuated rapidly, with a gradual increasing trend. MIS variation and the precipitation in the eastern TP were mainly driven by the combined and interrelated effects of orbital changes, global ice volume, atmospheric CO2 concentration, and internal climate forcing on the glacial-interglacial timescale.

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