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Between the high mountains and the deserts: reconstructing palaeoenvironments in the Arid Central Asian loess

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Central Asia lies at the arid core of the largest and most populous continent on Earth – Eurasia – and at the intersection between the major climatic drivers of the North Atlantic westerlies, the polar front and the Asian monsoon. It furthermore represents a global "hotspot" for future desertification, facing a potent combination of sensitive climate dynamics and intensive land use. However, we know little about the role of Central Asia in global climate dynamics past and present. This is largely because we have yet to realise the full potential of the widespread loess archives which extend across the semi-arid piedmonts to the north of the Asian high mountains, at the southern margins of the Silk Road deserts. These records have been largely overlooked by scientific investigation, despite correlations between the well-studied loess archives of Europe and China. In spite of its key position in the northern hemisphere climate circulation systems, the climatic history – and trajectory – of arid Central Asia remains largely unknown.

Here we reconstruct palaeoenvironmental change over the last 40 ky from three sites in the loess foothills of the northern Tien Shan. Our emerging sedimentological, palaeopedological, geochemical and geochronological datasets suggest that aeolian deposition in this semi-arid region responds in a more complex way to climate than the classical sequences of the Chinese Loess Plateau and Danube basin. In arid Central Asia, landscapes appear to have responded not only to the cooler and warmer conditions of the glacial and interglacial periods respectively, but also to the availability of moisture. Variations in precipitation patterns may have been out of phase with the ice ages, and the impact of precipitation regime change may have been intensified by an extreme continental climate. Emerging data from the Central Asian loess suggest that past climates may not only have been subject to spatial migration, expansion and contraction of the major climate subsystems, but also the compression and the blockage of system teleconnections. These hypotheses set the scene for future, targeted research based on quantitative palaeoclimate reconstruction from loess records in the heart of Eurasia.