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Provenance of Neogene eolian red clay in the Altun region of western China—Insights from U—Pb detrital zircon age data

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ABSTRACT

Aridity of the Asian interior plays an important role in the accumulation of eolian deposits in both eastern (monsoon regime) and western China (westerly wind regime). A better understanding of the provenance of those eolian deposits (loess and red clay) will shed light on the history and mechanisms of Asian aridification. In eastern China, decrease in grain size from northwest to southeast shows that the Neogene red clay of the Chinese Loess Plateau (CLP) was derived from the desert and arid lands of northwestern China by the East Asian winter monsoon. However, in western China, outcrops are limited, and this is an obstacle to studies of the spatial variation of the provenance of eolian deposits. We use U—Pb geochronology of detrital zircons to determine the provenance of the Altun Red Clay, a recently discovered and continuous eolian deposit in western China. Our comparison of detrital zircon age spectra for the Altun Red Clay with those of potential source regions, and with results for the coeval red clay of the CLP, indicates that: 1. the main zircon age components of the Altun Red Clay are very different from those of the red clay on the CLP, suggesting that these deposits were sourced from different areas, and 2. the Altun Red Clay was likely sourced from the Taklamakan Desert, and transported via westerly winds.
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1. Introduction

Within the larger scheme of Cenozoic aridification of the Asian interior, east-central China is dominated by northwesterly and southeasterly monsoon winds, whereas western China is dominated by a westerly wind regime (Fig. 1a; An et al., 2000; Guo et al., 2002; Li et al., 2014; Qiang et al., 2011; Sun et al., 2010, Sun and Windley, 2015; Xu et al., 2009; Yue, 1995). Studies of the provenance and transporting wind patterns of the typical eolian deposits of loess and red clay have provided a basis for reconstructing Neogene–Quaternary sediment transport pathways and paleogeography.

Most progress has been made by numerous studies in the monsoon-dominated area of east-central China due to the depth, continuity, and large areal extent of the loess and red clay deposits on the Chinese Loess Plateau (CLP) (Che and Li, 2013; Nie et al., 2014, 2015; Pullen et al., 2011; Shang et al., 2016; Stevens et al., 2013; Xiao et al., 2012). Studies of the microstructural surface features of quartz grains (Lu et al., 1976), geochemical and mineral tracers, and Nd and Sr isotopes (Chen et al., 2007; Jahn et al., 2001; Li et al., 2009; Sun et al., 2008), have been widely used to trace the provenance of eolian dust on the CLP. The grain size of Quaternary loess and Neogene red clay on the CLP also decreases gradually from north to south, indicating that the desert and arid lands of northwestern China (Fig. 1a) are the major eolian provenance areas and that dust was transported mainly by the northerly winter monsoon (Lu et al., 2001; Miao et al., 2004; Sun et al., 2010). The Alxa arid lands are still a center of modern dust storm activity in northern China (Sun et al., 2001; Wang et al., 2004). Furthermore, recent studies have led to a new conceptual model associating loess on the CLP with the development of the Yellow River system during the Pliocene and Pleistocene (Stevens et al., 2013; Nie et al., 2015).

Fewer studies have been undertaken in western China (Fig. 1a), where limited Neogene red clay sequences have been explored in the Junggar Basin (Sun et al., 2010) and in the Altun Shan (Li et al., 2014). Pronounced differences in Sr and Nd isotope compositions of eolian deposits in the Junggar Basin and the CLP imply that the two deposits had different sources, and that the Junggar Basin deposits were probably transported from Kazakhstan in the west (Sun et al., 2010). However, there have been no provenance studies of the Altun Red Clay, which might have had sources different from those of the Junggar Basin deposits, particularly given the large distance (c. 700 km) between the two areas and their different ages of deposition.

U—Pb geochronology of detrital zircons provides a new opportunity to determine the source of eolian deposits (Nie et al., 2014; Pullen et al.,

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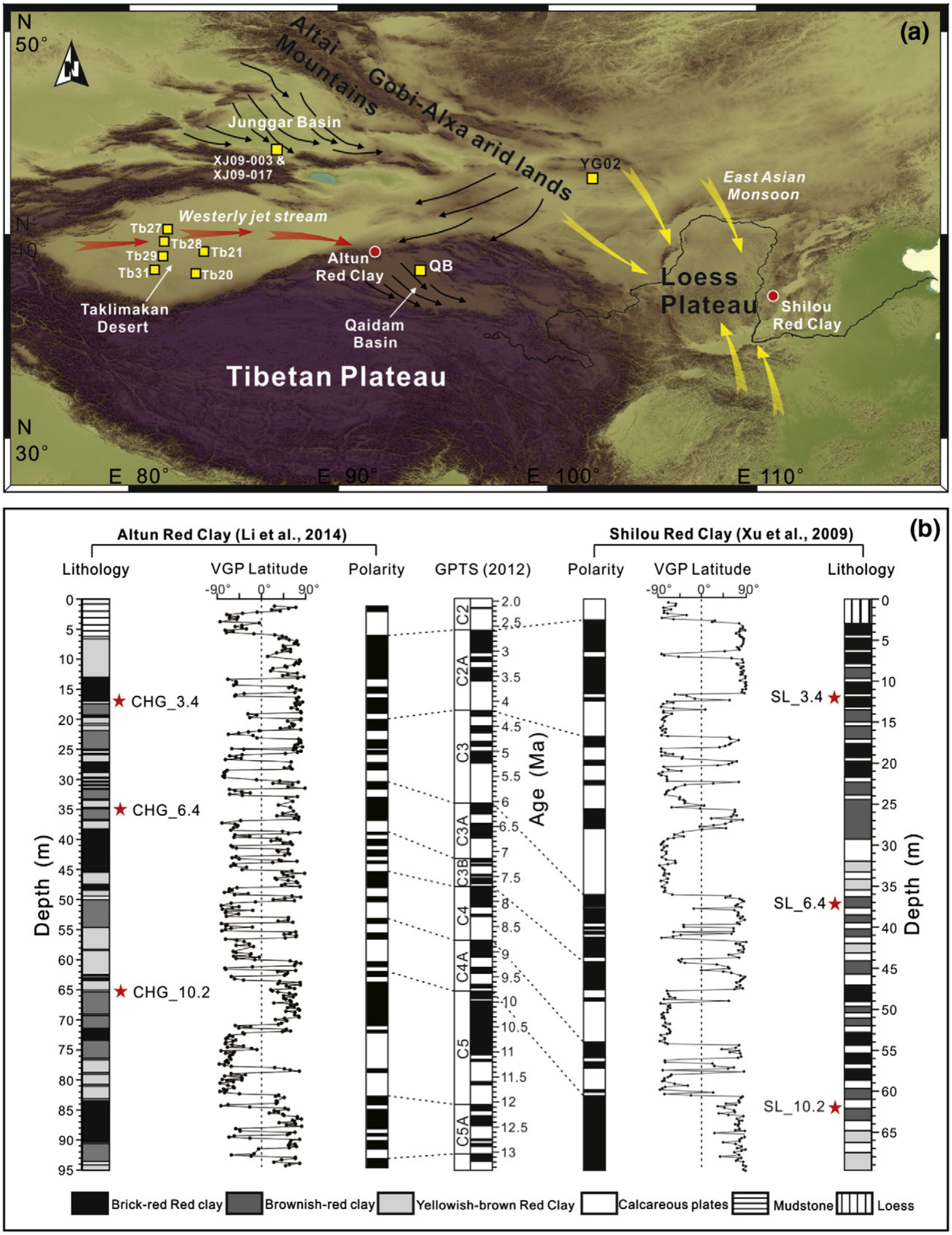

Fig. 1. (a) Map showing the present major wind system in northern China, and the locations (circles) of the Altun Red Clay in the northern Tibetan Plateau, and the Shilou Red Clay on the Chinese Loess Plateau. Squares indicate the locations of potential source area samples with published zircon ages: dune samples from the central sand sea of the Taklamakan Desert (Tb20, 21, 27, 28, 29, 31, Rittner et al., 2016); fluvial sediments from the Gobi–Alxa arid lands (YG02, Che and Li, 2013); fluvial-lacustrine sediments from the Qaidam Basin (QB, Pullen et al., 2011); and Neogene fluvial sediments from the Junggar Basin (XJ09-003 and XJ09-017, Yang et al., 2013). Black arrows show the prevailing near-surface winds; larger arrows show the pathways of the westerly jet stream and the East Asian monsoon. (b) Lithology and magnetostratigraphy of the Altun and Shilou Red Clay. Red stars indicate samples for U—Pb zircon dating.

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