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Timing and spatial distribution of loess and loess-like sediments in the mountain areas of the northeastern Tibetan Plateau

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ABSTRACT

Most studies on landscape evolution on the Tibetan Plateau during the late Quaternary have mainly focused on using lacustrine records. However, mantles of sandy silt and paleosols also provide valuable archives for reconstructing Holocene paleoenvironmental change. Yet little is known about the distribution and timing of these late Quaternary aeolian sediments. To enhance understanding and knowledge of aeolian sediments in Tibet and to help reconstruct the nature of Late Glacial through mid-Holocene landscape development, a loess–paleosol sequence, the Suohuduo section, located at the eastern margin of the Tibetan Plateau at about 4000 m above sea level is examined using sedimentological, geochemical and geochronological methods. A chronostratigraphy is established using nine optically stimulated luminescence and one radiocarbon ages. Sedimentation increased during the Late Glacial and the early Holocene with an upwards fining of sediments in the lower part of the section. Two mid Holocene paleosols that date to about 8.5 ka to 7 ka and ~5.5 ka to 4 ka reflect more humid climate conditions during the mid-Holocene than earlier times. The upper part of the section is mainly silt, which reflects a more open landscape with higher aridity since 4 to 3 ka this time. These data support evidence for similar climate/paleoenvironmental change in adjacent regions on the Tibetan Plateau.

1. Introduction

Loess sequences provide important and in some cases an almost continuous record of Quaternary paleoenvironmental change; some of sequences even provide a record extending into the Pliocene (e.g. Ding et al., 1992). These loess sequences are particularly impressive on the Chinese Loess Plateau (CLP) and have been studied in great detail (e.g. An et al., 1991; Pye, 1995 and references therein; Buylaert et al., 2008; Liu et al., 1985; Vriend et al., 2011). Loess and associated aeolian and slope deposits are also present in the high mountains at the northeastern margin of the Tibetan Plateau (Fig. 1). These deposits have the potential to provide valuable archives for reconstructing Quaternary landscape development in Tibet and they also provide important comparisons for the lacustrine archives, which have been regularly studied on the Tibetan Plateau. At the eastern margin of the Tibetan Plateau in basins at elevations ranging from 2000 m to 3500 m above sea level (asl), the slopes are covered with silt deposits with thicknesses up to several meters; at an elevation above 3500 m asl, thinner deposits of silty sand (<1 m thick) exist (Fig. 2; Lehmkuhl, 1997). These aeolian sediments, together with slope wash deposits, contain paleosol horizons and ash layers from burning that provide evidence for alternating times of landscape stability and geomorphic activity throughout the late Quaternary. To illustrate the potential and importance of these aeolian archives in Tibet, we examine a section loess–paleosol sequence, the Suohuduo section, located at the eastern margin of the Tibetan Plateau at about 4000 m asl. We compare this section with other aeolian mantles along a transect from the Sichuan Basin towards the upper reaches of the Huang He (Figs. 1 and 2).

Accumulations of loess in the valleys in eastern Tibet around 3000 m asl were first described by Tafel (1914), an early German explorer. He observed loess on the mountain slopes close to Songpan (see Fig. 1) and suggested that the predominate winds from NW to SE, especially winter storms, caused accumulation of aeolian dust (loess) on the northwestern slopes. In addition, Hövermann (1987) reported that loess is the dominant surface cover on the eastern slopes of the Anyemaqen Shan at elevations of 3500–3900 m asl where alpine meadows exist (Lehmkuhl, 1995, 1997; Lehmkuhl et al., 2000) supported the view that these sands and silts cover in several mountain areas of the Tibetan Plateau are aeolian in origin. The aeolian cover is predominantly sandy-loess in the areas above about 3600 m to 4300 m asl in eastern Tibet and up to more than 5000 m asl in western Tibet as well as in Mongolia (Lehmkuhl, 1997). Kaiser et al. (2007, 2009) and IJmker et al. (2012) published studies on mountain silts on the Tibetan Plateau. Yet most recently, Stauch et al. (2012) presented 51 new OSL ages from aeolian sediments from the Donggi Cona area.

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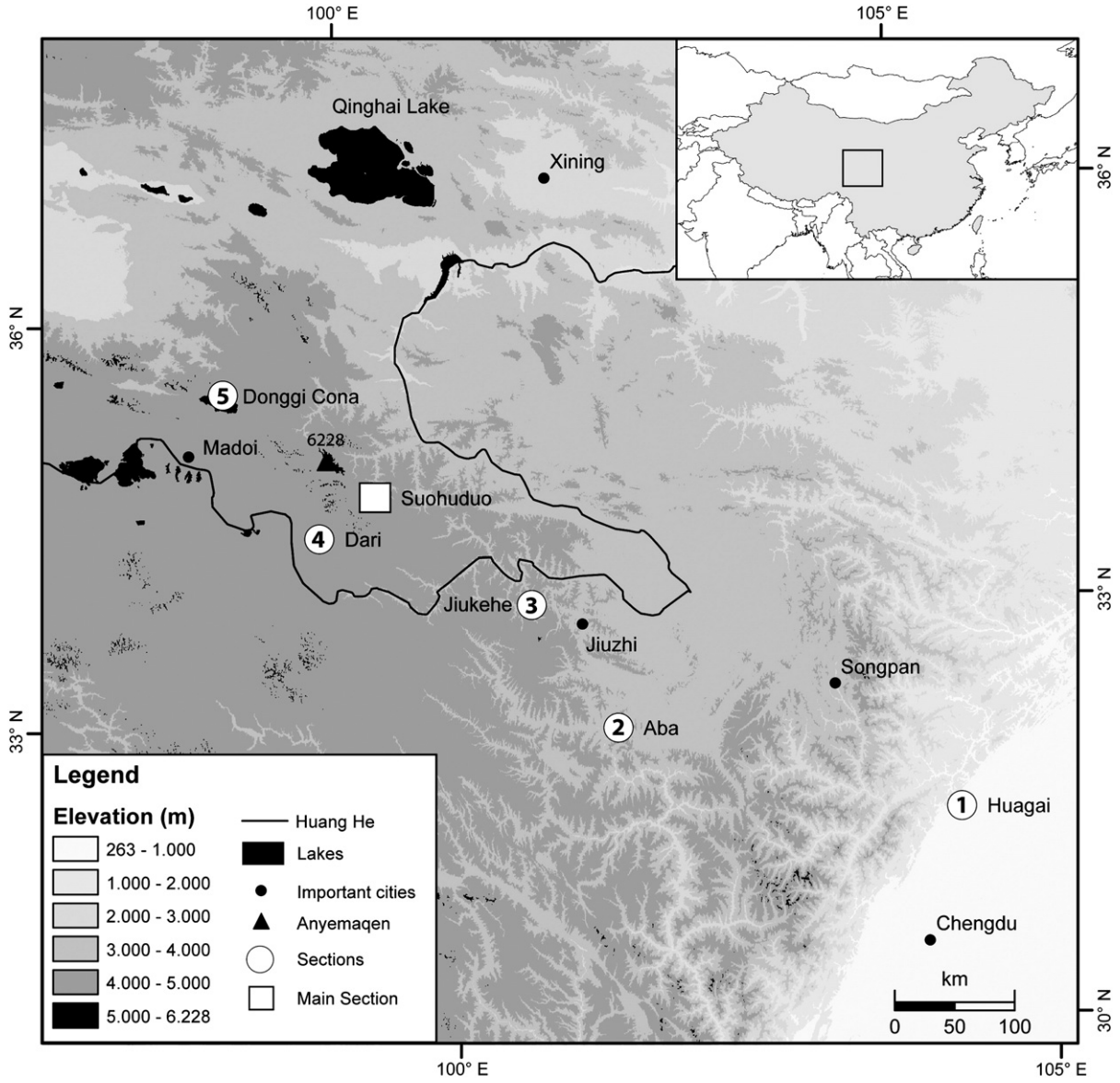

Fig. 1. Map of the northeastern Tibetan Plateau. The box shows the location of the main section Suohuduo at the southern margin of the Anyemaqen Shan. The numbers indicate further sections mentioned in the text.

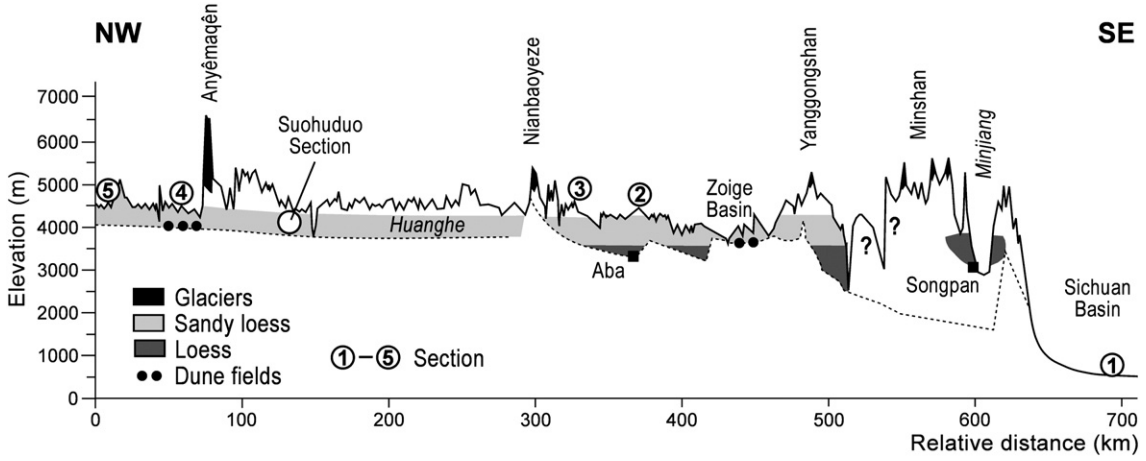

Fig. 2. NW–SE-cross section indicating the distribution of loess and loess-like sediments in eastern Tibet.