Aeolian Research 49 (2021) 100660

Contents lists available at ScienceDirect

Aeolian Research

journal homepage: www.elsevier.com/locate/aeolia

Constraining the timing and deposition pattern of loess-palaeosol sequences in Kashmir Valley, Western Himalaya: Implications to paleoenvironment studies

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ARTICLE INFO

Keywords:
Loess palaeosol sequence
OSL dating
Climate anomaly
Last Glacial Maximum, Kashmir Valley

ABSTRACT

Terrestrial loess palaeosol sequences (LPS) are the most extensive paleoclimate archives documenting dynamic sedimentary processes in response to glacial (cold-dry) and interglacial (warm-wet) phases. In the present study, we provide chrono-stratigraphy and paleoenvironmental implications of a 600 cm LPS outcrop from the Kashmir Valley, Western Himalaya. The Optically Stimulated Luminescence (OSL) dating revealed development of polycyclic palaeosol units with variable thickness, a parent loess horizon and pedogenically modified loess during the last ~65.8 ± 7.2 ka to ~14.7 ± 5.4 ka. The multiproxy analysis revealed four major climate phases that prevailed between 65.8 ± 7.2 ka to 14.7 ± 5.4 ka. Sediment deposition from ~800 to ~640 cm suggests moderate climate, followed by development of an unaltered loess horizon (~640 to ~600 cm depth; C horizon) suggesting arid/dry climatic conditions with relatively higher wind velocity. Occurrence of a well-developed palaeosol (600 to 450 cm) suggests prevalence of warm/wetter climatic conditions. Cambisol deposited with high $CaCO_3$ content followed by a weakly developed palaeosol (450 to 200 cm) suggests dominance of cold/dry climate conditions and progression of the climate during the latter phase. Subsequently, the accumulation of parent loess ceased at ~14.7 ± 5.4 ka and the sedimentary environment was overtaken by the fluvial activity probably caused by widespread precipitation and/or glacial melting.

1. Introduction

Climate of the Quaternary Period was characterized by alternate cold-glacial and warm-interglacial phases (Berger et al., 2016), which are very well preserved in proxy records of marine sediments (Olsen et al., 2013), lacustrine sediments (Herzschuh et al., 2016) and continental LPS (Liu, 1985; Muhs and Bettis, 2003; Ding et al., 2002). Among these, terrestrial LPS are considered as important archives for reconstruction of the Pleistocene–Holocene climate shifts (e.g. Frechen et al., 2003; Dodonov et al., 2006; Qingzhen et al., 2008; Antoine et al., 2009, 2013; Stevens et al., 2011; Obreht et al., 2015; Krauß et al., 2018; Rashidi et al., 2018). The LPS are aeolian derived sediments, transported regionally or locally and efficiently capture signatures of past wind activity and post depositional environments (Pye, 1987; Krauß et al., 2018). Specifically, the formation of loess is related to dry/arid climatic conditions followed by pedogenic modification of the parent loess during warm/wetter conditions (Lee et al., 2014). The development of both parent loess horizons and intervening paleosol units makes this sedimentary archive as important indicators of the Quaternary climate changes. Significant climate shifts that occurred during the Late Quaternary period have been reported using both terrestrial and marine archives. As such, during MIS-4 through MIS-2 stage, (~73.5–14.7 ka) extreme warm events termed as Dansgaard-Oeschger (D-O) cycles; Sanchez Goni et al., 2017) were identified using the Greenland ice core records (Dansgaard et al., 1984). Similarly, prevalence of cold/dry climate conditions such as the Heinrich events (HE) were reported

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https://doi.org/10.1016/j.aeolia.2020.100660
Received 23 April 2020; Received in revised form 5 December 2020; Accepted 9 December 2020