A 20-ka climate record from Central Himalayan loess deposits

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ABSTRACT: The southwest monsoon that dominated Central Himalaya has preserved loessic silt deposits preserved in patches that are proximal to periglacial areas. The occurrence of such silts suggests contemporary prevalence of cold and dry northwesterly winds. Field stratigraphy, geochemistry, mineral magnetism, infrared stimulated luminescence (IRSL) and radiocarbon dating has enabled reconstruction of an event chronology during the past 20 ka. Three events of loess accretion could be identified. The first two events of loess deposition occurred between 20 and 9 ka and were separated by a phase of moderate weathering. Pedogenesis at the end of this event gave rise to a well-developed soil that was bracketed around 9 to >4 ka. This was followed by the third phase of loess accretion that occurred around 4 to >1 ka. Episodes of loess deposition and soil formation are interpreted in terms of changes in the strength of the Indian southwest monsoon. Copyright © 2005 John Wiley & Sons, Ltd.

KEYWORDS: loess; Central Himalayas; mineral magnetism; geochemistry; luminescence dating; monsoon.

Introduction

Loess deposits have been considered as sensitive recorders of past climatic changes (Kukla, 1977; Pant, 1993; Porter and An, 1995; Singhvi et al., 2001). In periglacial areas, loess deposition is controlled by meteorological parameters (Pant, 1993). Dust plumes generated by anticyclonic circulation at the glacier front move downslope by gravity or by katabatic winds, and are deposited as aeolian silt (loess) that blankets the regional (periglacial) topography (Pant, 1993). The resultant deposits are homogeneous, porous and well sorted, and satisfy the criteria of being designated as loess. Typical loess exposures form vertical bluffs that are strengthened by diffused carbonate (Kukla, 1977).

In India, Pant et al. (1978) were the first to identify loess–palaeosol sequences in the Kashmir valley where loess blankets the lacustrine Karewa deposits of Pleistocene age. Subsequently, Williams and Clarke (1984) reported loessic silts in the Son valley of central India. The present contribution reports a new occurrence of loess–palaeosol deposits on the high tablelands and ridges between 1800 m and 2500 m altitude, in Central Himalaya. Absence of tectonically stable surfaces has limited the spatial extent of loess deposition and preservation. Detailed field survey enabled identification of patchy deposits in a narrow zone lying between Dhakuri (Bageshwar district, NE) in the Pindar river basin and Chopta (Chamoli district, NW) in the Alaknanda river basin (Fig. 1). In the present study, three loess profiles in the Alaknanda and Pindar river basins were examined and more detailed investigation on a profile at Dhakuri Dhar in the Pindar river basin was carried out (Fig. 2).

Stratigraphic details

In the field, loess appears as a homogeneous and structureless silt deposit with a yellowish brown colour. The grain size analyses on unweathered loess are given in Table 1, showing dominance of fine silt (23–47%). The deposits were low in calcium carbonate possibly due to (a) freezing and thawing of winter snow cover (Pant and Dilli, 1985) and (b) leaching due to high precipitation in the region (>1500 mm a⁻¹).

The stratigraphy of an exposed, ~2 m section at the Dhakuri-Dhar is provided in Fig. 2. The section has ~30 cm thick pale yellow loessic silt at the base (200–170 m). This is overlain by a moderately weathered reddish-yellow loess horizon (~30 cm) at 170–140 m. Following this, unweathered loess continues up to about 90 cm and is succeeded by a 40 cm thick palaeosol designated as S₁ (Fig. 2).

S₁ has a well-developed 20 cm thick dark brown humus rich horizon (Aₙ). In its lower part, this horizon shows the presence of translocated clay coatings in the ped faces and hence can be designated as Aₕ₋ₕ horizon. This horizon in turn...