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PALAEOGEOGRAPHY OF THE LOESS DEPOSITS OF KASHMIR

D P AGRAWAL, NAVIN JUYAL *and* P SHARMA

Physical Research Laboratory, Navrangpura, Ahmedabad 380 009, India

RITA GARDNER

King's College, Strand, London, U K

and

HELEN RENDELL

University of Sussex, Sussex, U K

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The distribution, chronology and palaeogeography of the Kashmir loess deposits is discussed. The paper summarises data on field observations, TL and Radiocarbon dates of loess and the tectonic uplifts resulting in a differential deposition of loess in the valley. Loess deposition started *c.* 200Kyr and the Jhelum emerged *c.*85Kyr draining out the Karewa lake. Palaeogeographical inferences of the data are discussed.

Key Words: Loess; Kashmir; Chronologies; Palaeogeography

INTRODUCTION

LOESS deposits are found in several areas of the world, the thickest ones being in China and Central Asia. The origin of loess is a much debated subject, though generation of silt size particles of quartz through glacial abrasion is the most favoured mechanism. Other suggested mechanisms are aeolian abrasion[1] and salt weathering.[2] In China, however, there is a consensus that loess represents a wind borne deposit of silt derived from deflation of surficial rocks of desert and arid areas in the north and west. Compared to such massive loess deposits, the Kashmir loess profiles are very thin, of about 20m thickness.

The paper summarises results of a multidisciplinary study on the loess deposits of Kashmir to infer palaeogeographic changes and build stratigraphic and chronological correlations.

The Pir Panjal range, flanking southwest of the Kashmir valley (33°30′ to 34°30′ N; 74° to 75°30′ E) was upthrusted along the Himalayan axis, thus forming the Kashmir intermontane basin around 4.0Myr. The rapid uplift of the Southern block of the Pir Panjal in the late Pleistocene period terminated the lacustrine deposition of the lower Karewa (relict lacustrine sediments) which on the southwest are tilted and folded and are overlain by fanglomerates. The loess mantle covered these fanglomerates and other exposed sediments while the lacustrine deposits continued on the northern (NNE) side, into the shrunken lake. The loess deposits on the northern flank started only after the opening of the Baramula gorge and the emergence of the river Jhelum, an event marked by the incision of the valley. As a result, the loess deposits are about 20m thick on the Southern (SSW) flank and about 10m on the northern (NNE) side. To study the variation in the thickness and behaviour of the deposition *vis-a vis* the origin of the Kashmir loess, transects were taken on E-W, N-S and the NW-SE directions. Fig. 1 shows the Jhelum and its tributaries and the distribution of the loess sites in the Kashmir valley is given in Fig. 2. Fig. 3 shows five sections along N-S transect indicating

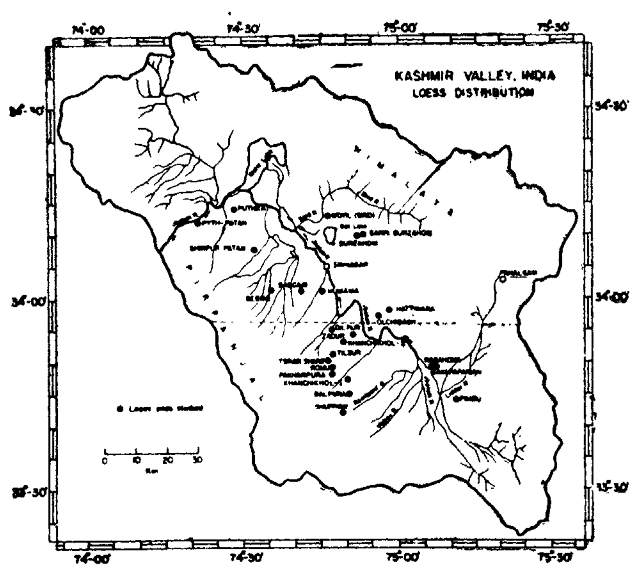

FIG 1 Map of Kashmir showing loess distribution and the studied sites.

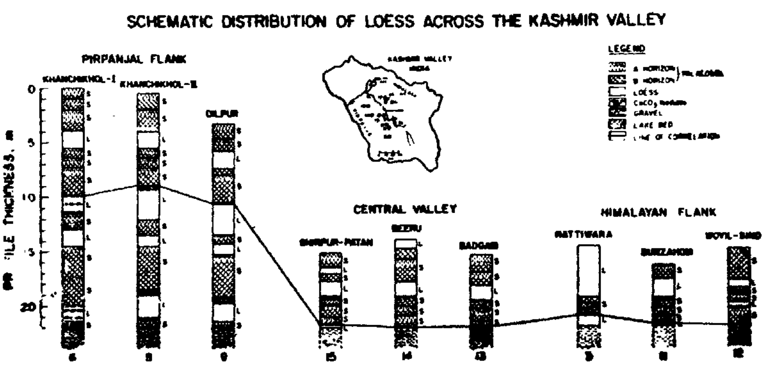

FIG 2 Schematic distribution of loess across the Kashmir valley. The inset shows the location of sites.

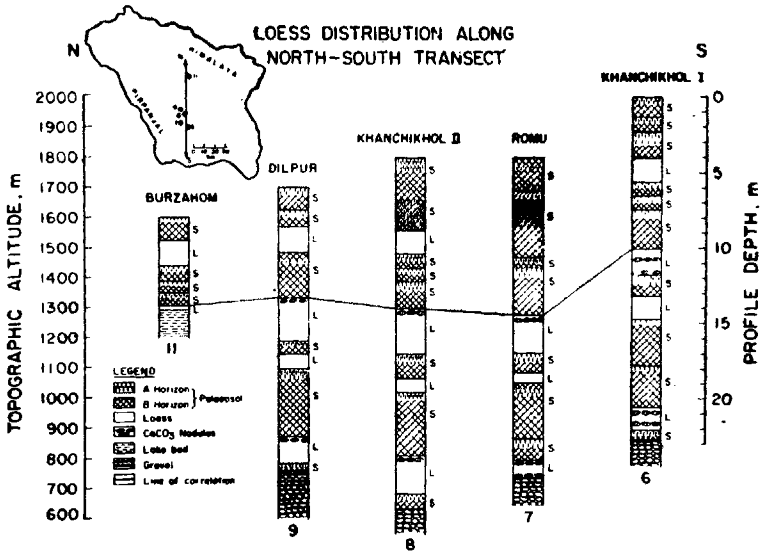

FIG 3 A transect along N–S showing the main loess site sections. The inset shows the location of sites.

topographic relief and depth of the individual profiles together with the lithology of the sections and Fig. 4 provides sections of loess sites along NW-SE transect.

Before discussing the significance of these transects for palaeogeographic reconstruction, we need to discuss the chronology of the loess deposits.

Chronology of Loess

Burbank[3] hypothesises a southward jump of basin thrust front (BTF), where ancestral Pir Panjal range was located. The lithologic and palaeocurrent changes that are observed in the Jhelum reentrant at 4–5Myr are a direct reflection of the Southward relocation of the BTF and the initial elevation of the Pir Panjal Range. An accelerated phase of uplift in the Brunhes terminates widespread intermontane basin sedimentation and initiates folding and erosion of the basin fill.[4]

On the basis of magnetostratigraphy and fission track dating of the Romushi lithozones, a broad chronology of the nine Romushi lithozones can be worked out. We have calculated the rate of sedimentation on the basis of mudstone thickness alone as the sandstone deposition is supposed to be very rapid.[5] A sedimentation rate of 14.6cm can be deduced for the 255m mud-deposition between the Matuyama Gauss and Brunhes/Matuyama boundaries spanning 1.75Myr. Thus for the Baltal section we get a time span of only 445Kyr for a thickness of 65m and for the total section which encompasses Romzones V, VI, VII, and VIII (lithostratigraphic zones exposed by the River Romushi).[6] As the overlying loess (Romzone IX) also shows normal polarity (Brunhes chron), it can only have a time span of *c*.200Kyr (730 minus 550Kyr). The TL dates are in confirmity with these estimates (Rendell

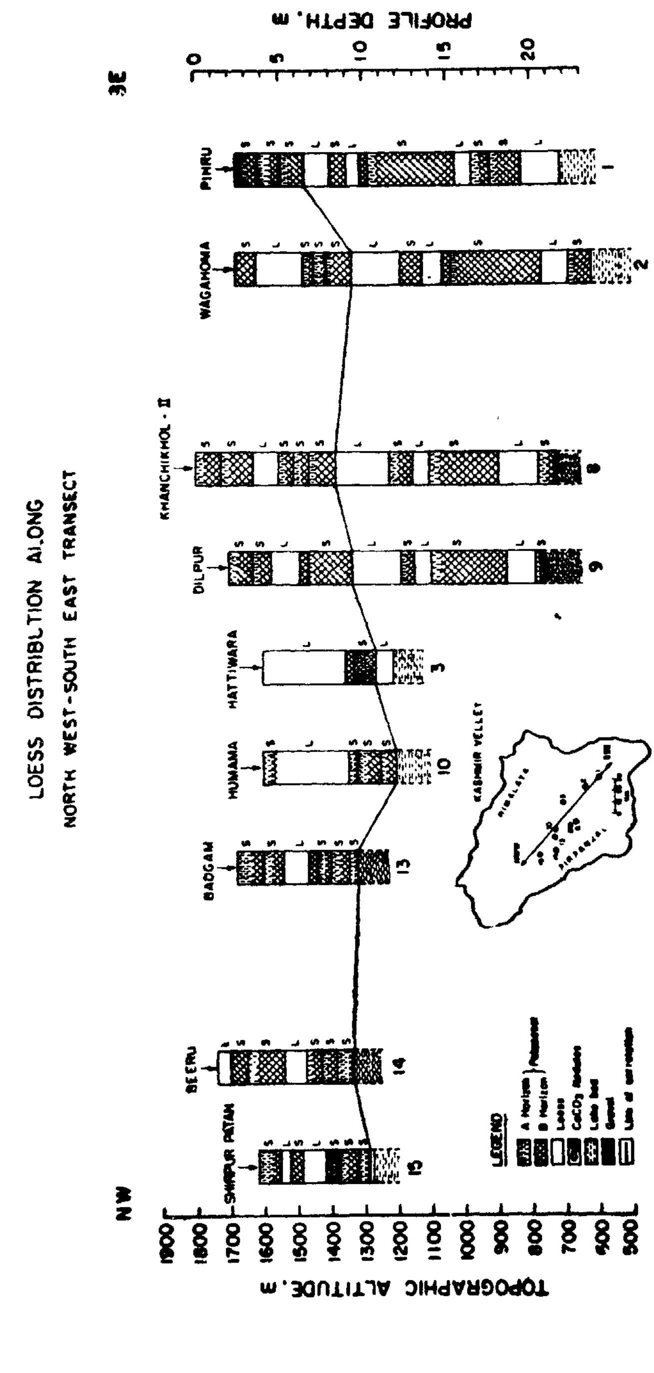

FIG 4 A transect along NW-SE showing the main loess sections. The inset shows the location of sites.

and Townsend, this issue). They hold that the TL dates >100Kyr are only minimal ages due to the limitations of the technique. The radiocarbon dates for loess fall in five clusters[7] and date the topmost 3 palaeosols within 25Kyr and the fourth one is outside the radiocarbon range viz., > 31Kyr.

All this chronological evidence indicates that the lower Karewa sedimentation ceased < 200Kyr marking the advent of loess deposition. The Jhelum emerges at *c*.85Kyr and drains out the shifted Karewa lake thus providing further exposed sediment surface for loess deposition on the NNE flank. In view of the above considerations, Bronger *et al*'s.[8] hypothesis of 5 glacial/interglacial cycles in the loess time span is untenable as it will require more than 500Kyr for the time span covering the loess deposit. The Romushi lithozones (including the topmost loess member) covered by the Brunhes chron show 3 main cold (glacial) periods separated by warm temperate (interglacial) oscillations in the Baltal locality (Dodia, this volume).

Distribution of Loess and Palaeogeographic Inferences

Broadly speaking there are three types of loess profiles in the valley: (*i*) loess deposits on the plateau with ~ 20m thickness and about 10 palaeosols; (*ii*) plateau loess with < 10m thickness and 5–6 palaeosols; and (*iii*) terrace loess on the Rembiara and other streams. As terrace loess deposits do not provide a complete record, we are not discussing them here.

The origin of Kashmir loess is also a polemical issue. To understand the behaviour of loess deposition *vis-a-vis* the shifting of the Karewa lake and the emergence of the Jhelum we took transects across the valley. The thickness variation does not show a preferene to any one direction and therefore a common external source of loess cannot be sustained. We have plotted loess profiles across N-S, NW-SE and also across the valley on Pir Panjal, Central Valley and the Himalayan flank (Figs. 3, 4). These investigations lead us to the following palaeogeographic conclusions.

(i) The Group-I loess deposits approximately south of the 33° 55′ N latitude are of about 20m thickness and therefore one can infer that this Southern (SSE) region of Pir Panjals was rapidly uplifted and confined the Karewa lake to the North. It may be emphasized, however, that the boundary between the upper Karewa and the lower Karewa lake has to be zig-zag and in a SSW-NNE direction. The Group-I loess profile comprising 10 palaeosols and ~20m thickness covers the sites exposed by the Vishav-Rembiara, Romushi-Liddar etc., (e.g., Khanchikhol-I, Romu, Tsrar-Sharif, Dilpur, Shupian, Wagahoma, Pehru, Tilsur, etc.) (Figs. 2, 4).

(ii) The Group-II sites are located on the Sindh-Dudhi Ganga etc. (e.g., Puthka Pitha-Patan, Shirpur-Patan, Beeru, Badgam, Humama, Burzahom, Garhi Burzahom, Woyil, etc.). All these Group-II sites (Fig. 2) are < 10m thickness and have 6 palaeosols or less.

As discussed, ~ 200Kyr a large area of the valley which was under the primaeval Karewa lake became exposed for loess deposition as a result of a tectonic uplift which seems to have an epicentre in SSW (Pir Panjal) resulting in the northward shift of the lake. The steep dips (> 50°) at Dubjan, compared to Ningal Nallah (15°) further north; the almost normal direction of the southern rivers (e.g., Vishav, Rembiara) with respect to the plain of the proposed uplift; the attenuation of both the thickness and particle size from SSW to NE; the distribution of ~ 20m thick loess deposits to the proposed uplifted area etc can all be explained only by assuming a recent and rapid uplift >200Kyr which shifted the lake northwards (NNE). The exact demarcating line of the uplifted area is now being worked out.

The ~ 10m thick loess deposits generally start with the triplet palaeosols at > 85Kyr, after the emergence of the Jhelum, which drained out the lake from most of the valley. The emergence of the Jhelum also incised the valley and the already uplifted and exposed Karewa sediments. Such a model of tectonic events explains the presence of fanglomerate below the ~ 20m loess deposits in SSW; the lower Karewa deposits underlying the ~ 20m loess in the Martand plateau (e.g., Wagahoma, Pehru etc); and ~ 10m loess deposit overlying the upper Karewa lake sediments or incised channels even on the uplifted plateau.

A word about 'Lower' and 'Upper' Karewa. As discussed above, all lake sediments deposited before the cessation of sedimentation on the S and SW Karewa lake, before the deposition of ~ 20m loess (200Kyr) are termed by us as Lower Karewas. The Upper Karewas will comprise the sediments of the shifted (younger lake) and ~ 10m thick loess deposit.

Palaeogeographically, the Karewa lake continued to occupy the whole of the valley till about 200Kyr. There was a rapid uplift of the Southern Pir Panjal block, probably manifested near Aharbal, which resulted in the lake being confined to the NNE side. The loess deposition started only after this event on the exposed land surfaces, be they lacustrine deposits, fanglomerates or gravels, in the valley. The Jhelum emerged sometime after 85Kyr resulting in the incision of the valley and exposure of lacustrine and gravel surfaces on which loess deposition took place. Soon after, the "marker triplet" palaeosol formed. Thus the northern Group II loess deposits are < 85Kyr.

SUMMARY

To recapitulate, the underlying Romushi lacustrine Karewa sediments, which started with the Bruhnes Chron at 0.73Myr, show at least 3 major cold fluctuations separated by relatively warm phases as shown by Dodia (This volume). The rapid uplift of the S-SW block which terminated the lake deposition will therefore be < 200Kyr and not 350Kyr, as postulated by Burbank and Johnson[3] and used by Bronger *et al.*[5] There is a convincing internal consistency in the time bracket of the marker-triplet (S_5-S_7) palaeosols, which fall between 40-80Kyr. The topmost three palaeosols (S_{10}-S_8) fall within *c*.25Kyr as shown by ^{14}C dates in Table I of Kusumgar *et al.* (1986).[7]

As shown elsewhere (Agrawal, this volume), the climatic variation as inferred from pollen, mineral magnetic (χ_L) and stable isotopic data, shows that in the last

0.73Myr the valley has witnessed several cold periods separated by interglacials/ interstadials. In fact, the sea surface fluctuations for the last 130Kyr show a remarkable concordance with the χ_L variations marking climatic fluctuations as recorded by the loess profile. S_9 palaeosol, datable *c.*18Kyr is matched by a dominance of broad leaved elements at the cost of conifers at this time in the Butapathri-I profile as shown by Dodia *et al.* (1984).

Conclusions

To sum up, lacustrine deposition in the Kashmir valley continued till about 200Kyr when the southern block (SSW) flanking the valley uplifted thus exposing the lacustrine sediments for aeolian deposition of loess and shifting the lake roughly north of about 33° 55′ N. Around 85Kyr ago, the Jhelum emerged and drained out the remaining lake. The aeolian deposits roughly north of 33° 55′ N are therefore $<$85 Kyr and $<$10m and have only 5–6 palaeosols.

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