Dynamics of past aeolian dust deposition in Central Asia: a case study from the loess deposits of southeast Kazakhstan

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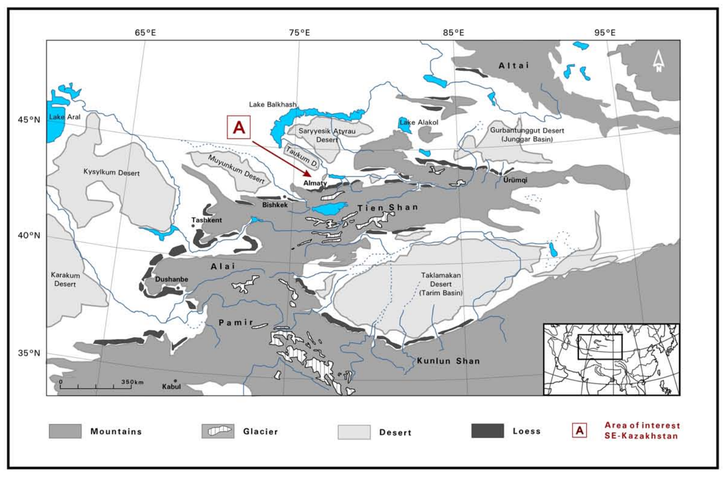
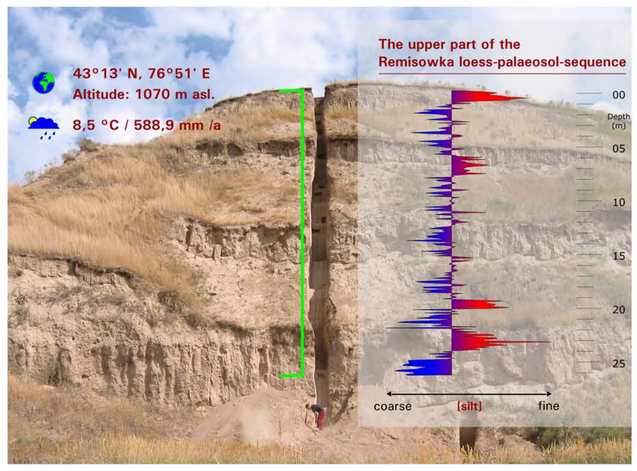
1 Introduction

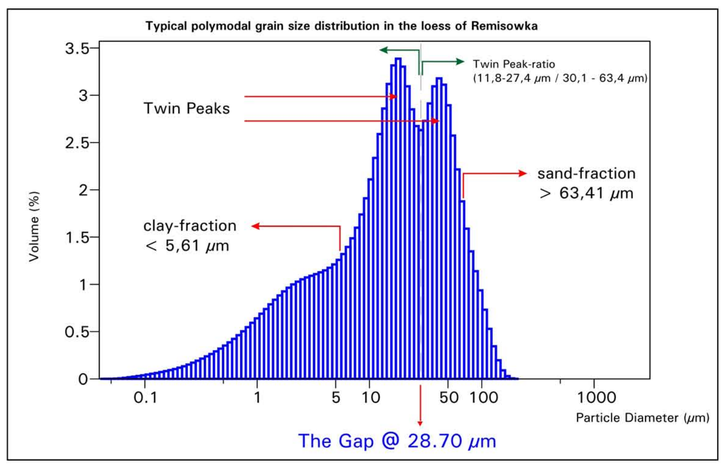


In Central Asia mighty loess sequences can be found particularly on the foothills and forelands of the high mountains, offering the possibility for interregional palaeoclimatical investigations along an almost continuously west-east running loess belt. The type of accumulated airborne dust, its origin and the natural mechanisms that supply the material depend on the general climatic situation. These dynamics are being recorded during the sedimentary deposition of loess. Therefore loess sequences are a direct proxy for the dynamics of aeolian dust sedimentation and may give an insight into past atmospheric circulation patterns.



Variations of the grain size (silt fraction) in the upper part of the Remisowka loess sequence (SE-Kazakhstan, Central Asia)

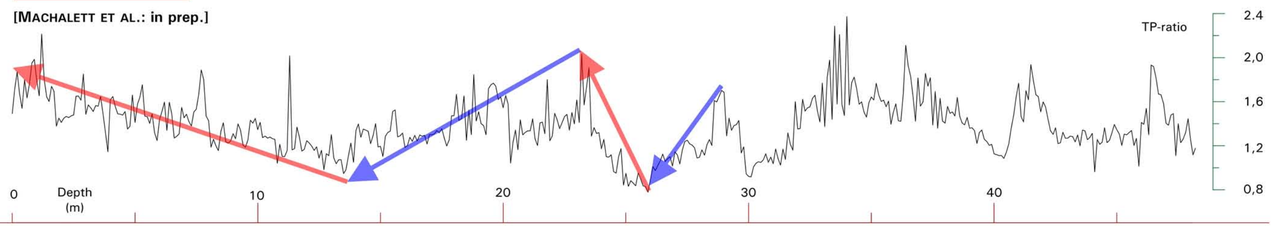
2 Methods & Results



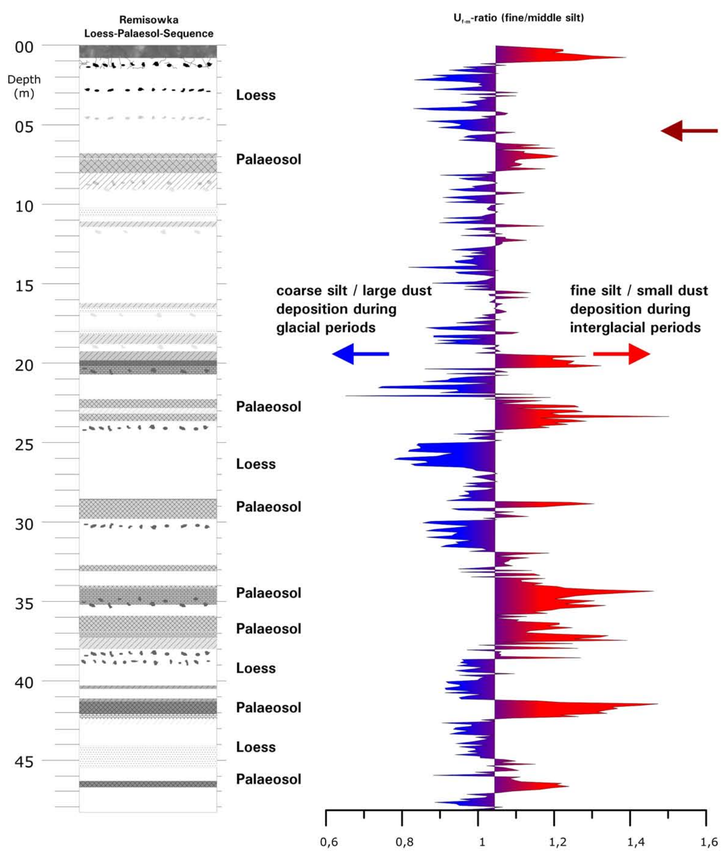
The Remisowka loess sequence is situated in the southern suburb of Almaty surrounded by the perimontane loess hill zone of SE-Kazakhstan. During the fieldwork grain-size samples were taken at 2 cm and 5 cm intervals from the loess. The granulometric results show a bimodal grain size maximum in the silt fraction (Twin Peak), with significantly varying peak heights over the profile. Applied ratios (e.g. Twin Peak ratio, U-f/m-ratio [after Vandenberghe et al. 1997]) allow a clear distinction between cold and warm cycles. The granulometric results are in excellent agreement with the stratigraphical record. Furthermore the Twin Peak curve shows continuous trends on a glacial-interglacial scale, probably reflecting long term seasonality changes.

TWIN PEAK RATIO with continuous trends of coarser dust (interglacial > glacial) and finer dust (glacial > interglacial) deposition

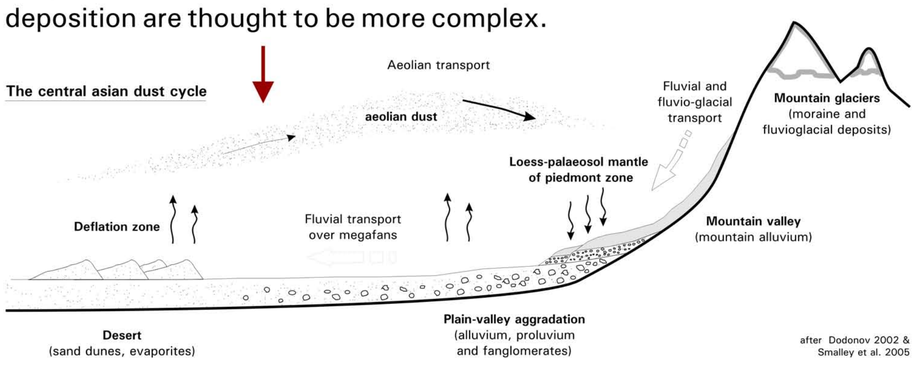
[MACHALETT ET AL.: in prep.]



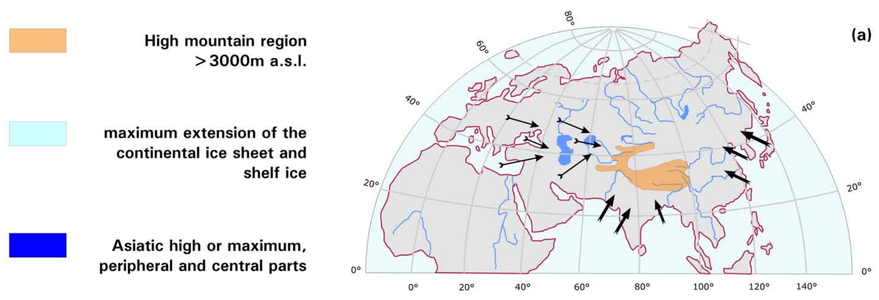
3 Discussion & Conclusion



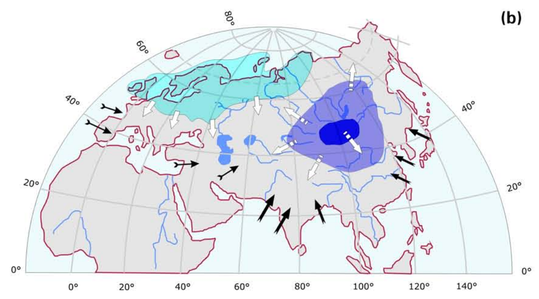
Our highly resolved granulometric analyses display the regional dust dynamics during the Middle and Upper Pleistocene and show the strong relation of the type of dust sedimentation to the climatic characteristics of the region. Previous models, e.g. Dodonov´s scheme, suggest that the winds from the super high pressure cell over Siberia dominated during the cold cycles and that the westwinds have controlled the dust sedimentation in Central Asia during the warm cycles. Looking at the recent climatic circulation pattern this model seems too simple, the mechanisms that determine the dust deposition are thought to be more complex.



after Dodonov 2002 & Smalley et al. 2005

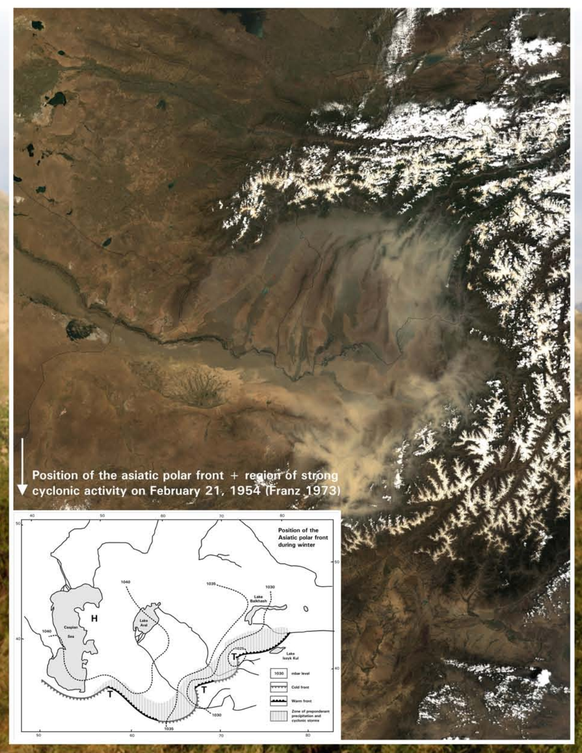


Dodonov's scheme of air mass circulation in Central Asia during interglacials (a) and glacials (b)



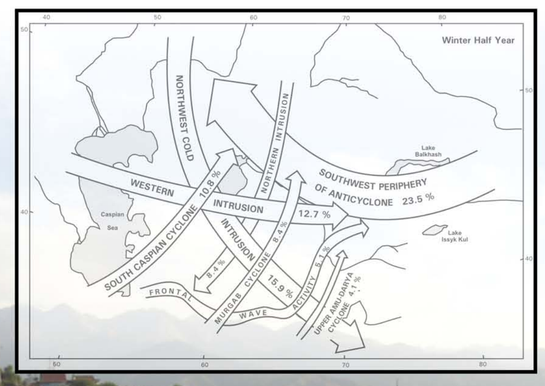
after Dodonov & Baiguzina 1995

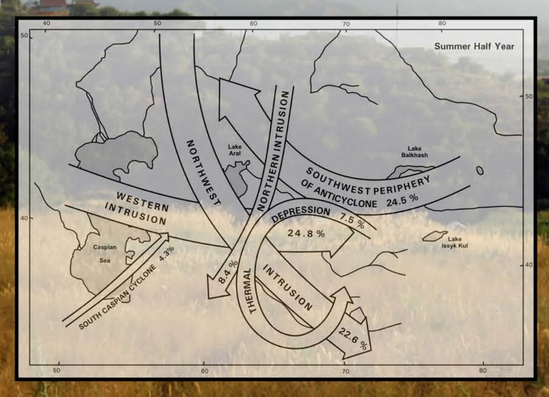
Dust storm in South Uzbekistan, Tajikistan and North Afghanistan, captured by MODIS on the Terra satellite on June 26, 2003, caused by cyclonic activity instigated by a thermal depression in the Aral sea region



During winter and summer a complex pattern of atmospheric air flow exists in Central Asia. Cyclonic storms caused by different atmospheric circulation patterns have a major impact on the dust sedimentation in the region. In particular at the fringe of the high mountains intensive cyclone activity leads to strong surface winds, accentuating the dust transport into the piedmont region of Central Asia. In analogy to the present winter situation in this area, it can be assumed that during the global cold phases the polar front with strong cyclonic activity had been intensified, respectively dominated through the year with a longer permanence, mainly determining the higher and coarser dust accumulation during glacial cycles. We believe that eventually the shift and duration of the polar front lead to a cyclical changing seasonality, as the Twin Peak grain size ratio indicates.

Percentage frequencies of types of air flow in Central Asia during a Winter and a Summer half year (after Bugaev 1957)





in brief

There are more active players in the aeolian dust dynamics in Central Asia than the Asiatic High and the Westerlies - other parameters have to be taken into account – e.g. the position of the Asiatic polar front

Different grain size fractions can hardly be matched with distinct areas of origin or atmospheric systems – moreover the composition of grain size distributions may result from changing seasonality in the dust transport of Central Asia

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