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glaciation shows that the millennial-scale climatic variations in the Loess Plateau can be correlated fairly well with the Dansgaard-Oeschger cycles documented in the Greenland ice cores. *Fig. 4 (previous page)* shows the grain size curve of the S2-L2-S1 portion at Huining. The soils S2 and S1 were accumulated respectively during the penultimate and last interglacial periods; the loess bed L2 during the penultimate glaciation. Grain size changes in L2 clearly indicate two maxima and three minima, which are obviously forced by the precessional changes in the Earth's orbit. When we increase resolution for parts of the grain size minima, as shown in *Fig. 4*, it is seen that frequent, large-amplitude, millennial-scale variability also occurred during the stadials of the penultimate glaciation. This preliminary result implies that millennial-scale climate variability could be a common feature in the glacial periods of the late Pleistocene.

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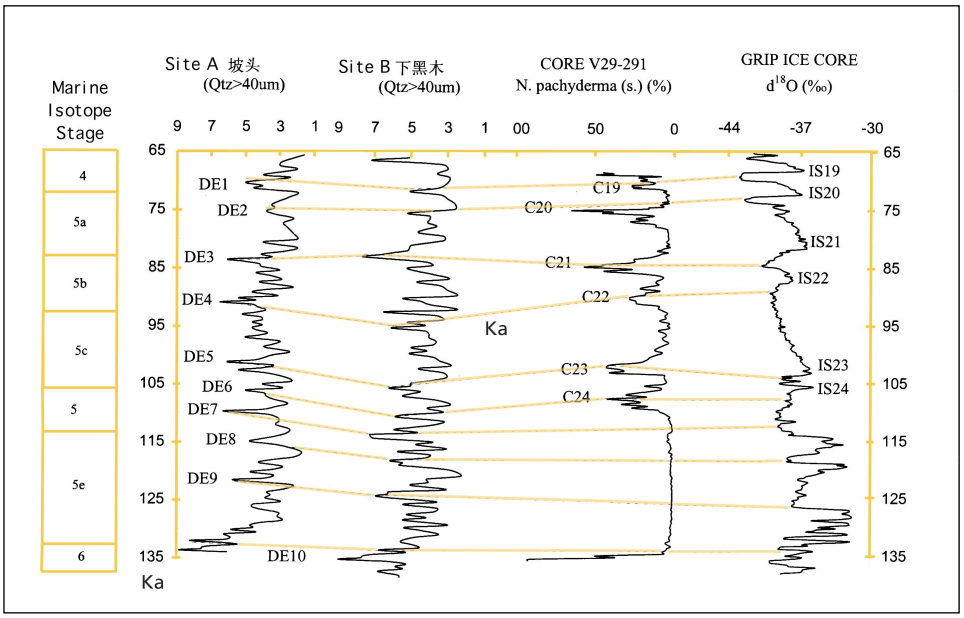

Fig. 5: Loess-Paleosol-Profiles in central China in comparison with North-Atlantic sediment cores and Greenland ice-sheet cores

Millennial-Scale Climatic Oscillations during the Last Interglaciation in Central China

Repeated southward excursions of North Atlantic polar water during the last interglacial ($\delta^{18}O$ stage 5, 130-74 ka) are recorded by planktonic foraminifera and ice-rafted detritus (IRD) in North Atlantic sediment cores, and Greenland ice-sheet cores display quasi-synchronous fluctuations. Comparable high-frequency variations in the East Asian winter monsoon climate are discernible in three loess-paleosol profiles in central China that span the last interglacial *(Fig. 5)*. Peak values of the >40 μm quartz fraction and bulk sediment samples from the S1 (last-interglacial) accretionary paleosol complex reflect major dust-flux events when winter monsoon winds strengthened. Frequent oscillations of the dust flux and nine significant dust events are recorded. Six events, falling between ca. 110 and 70 ka, are correlated with cold peaks (C19-24) identified in North Atlantic cores. Two comparable dust peaks occur within paleosol S1SS3 (= substage 5e); the older of these, dating to ca. 121 ka, may correlate with a brief cold event recently recognized in high-resolution marine and terrestrial climate-proxy records.

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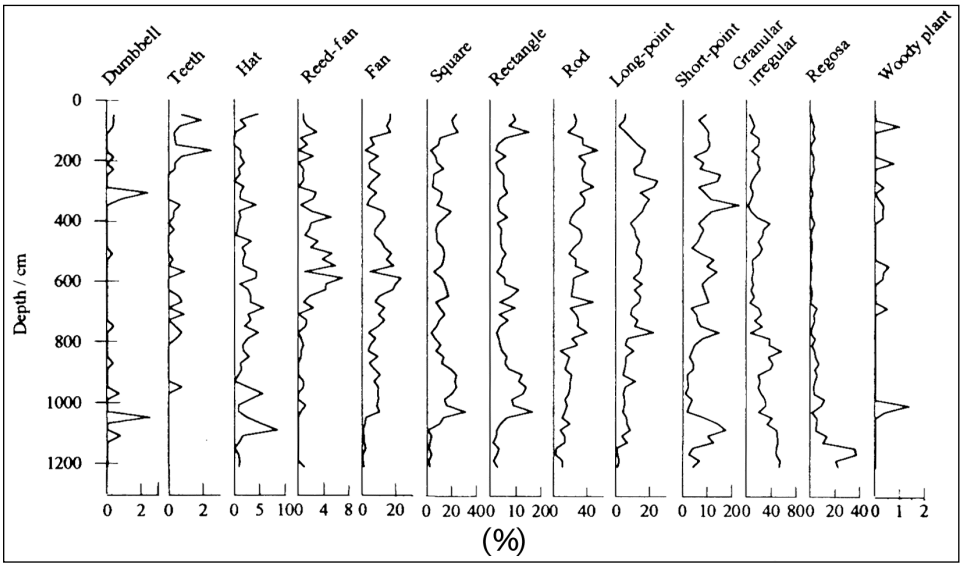

Fig. 6: Diagram of the percentage frequencies of 13 major phytolith types from the Baoji loess sequence for the last 150 ka.

Seasonal Climatic Variation recorded by Phytolith Assemblages from the Baoji Loess Sequence in Central China over the last 150 ka

153 samples from modern surface soils in China were collected and analyzed quantitatively alongside related meteorological data. 25 types of opal phytoliths, with significant climatic linkages, were selected to establish climatic transfer functions. The modern climatic parameters used in this study are based on data for annual mean temperature and annual mean precipitation over the past 40 years from the Chinese National Meteorological Bureau (1995). *Fig. 6* is a percentage diagram of 13 major phytolith types from the Baoji loess sequence in the south of the Loess

Plateau. *Fig. 7* shows the phytolith-based reconstructions of temperature and precipitation in Baoji over the last 150 ka and the 95% confidence interval.

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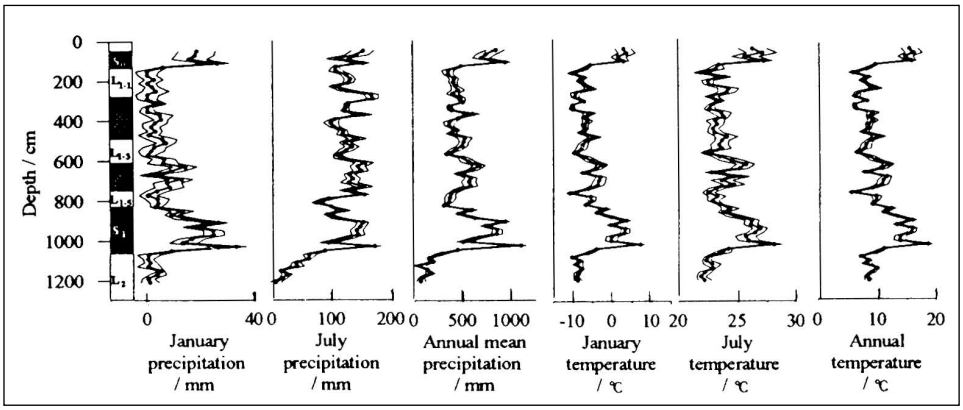

Fig. 7: Estimated temperature and precipitation variations in Baoji during the last 150 ka based on phytolith-climate transfer functions. Thick lines represent estimated regression values, fine lines are 95% confidence intervals.

Comparison of East Asian Monsoon Proxies from the Central China Loess Plateau and Lake Biwa

The pattern of climate in eastern Asia is dominated by the summer and winter monsoons (Gao, 1962). The loess-paleosol sequence on the Loess Plateau of central China constitutes an excellent proxy record of variations in East Asian monsoon climate over the past 2.5 Ma (An *et al.*, 1990; 1991; Ding *et al.*, 1995). Magnetic susceptibility (MS) of the loess and paleosols has been used as a proxy indicator for the summer monsoon intensity, i.e., high magnetic susceptibility values reflect increased summer monsoon intensity (An *et al.*, 1991); while the median diameter of quartz (QMD) isolated from the loess and paleosols can be regarded as a proxy index of the strength of winter monsoon winds, i.e., the greater the quartz median diameter, the stronger the winter monsoon winds (Xiao *et al.*, 1995). Studies on grain-size distribution, oxygen isotope composition and micromorphological features of monomineralic quartz isolated from sediments of Lake Biwa, central Japan suggested that quartz particles finer than 10 μm were derived, through the transport of the winter monsoon, from arid/semiarid regions of the Asian continent, and thereby can be regarded as eolian quartz (Xiao *et al.*, 1997a). By contrast, quartz grains coarser than 20 μm in the Lake Biwa sediments were considered to be derived, through soil erosion, from the surrounding terrain of the lake (Xiao *et al.*, 1997b). Eolian quartz flux (EQF) to Lake Biwa provides direct information on variations in the East Asian winter monsoon strength, i.e., the higher the eolian quartz flux, the stronger the winter monsoon winds (Xiao *et al.*, 1997a); whereas the fluvial quartz flux (FQF) reflects significant changes in paleoprecipitation over the lake area, and thus can be associated with the intensity of the summer monsoon, i.e., high fluvial quartz flux values imply increases in summer monsoon intensity (Xiao *et al.*, 1997b).

As shown in figure 8, the EQF and FQF records of Lake Biwa sediments can be well compared with the QMD and MS records of the Chinese loess and paleosols. The intervals of high EQF values correspond to the periods of great QMD values, whereas the intervals of high FQF values correlate to the periods of high MS values. The EQF and the QMD as winter monsoon proxies indicate that the winter monsoon strengthened during periods marked by high EQF and QMD values, and it was relatively weaker when EQF and QMD values were lower. As as summer monsoon proxies, the FQF and the MS reveal significant variations in the intensity of the summer monsoon, i.e., the higher the FQF and MS values, the stronger the summer monsoon circulation. Variations in winter monsoon strength indicated by the EQF and QMD proxies bear a general inverse relation to those in summer monsoon intensity inferred from the FQF and MS proxies.

These four proxy records of East Asian paleomonsoon climate can be correlated with the SPECMAP marine $\delta^{18}O$ stages 1 through 6 (Martinson *et al.*, 1987) *(Fig. 8)*. The main intervals of low EQF and QMD values and high FQF and MS values apparently coincide with SPECMAP $\delta^{18}O$ substages 5e, 5c, and 5a, stage 3, and the early part of stage 1, while the main intervals of great EQF and QMD values and low FQF and MS values occurred during $\delta^{18}O$ stages 4 and 2.

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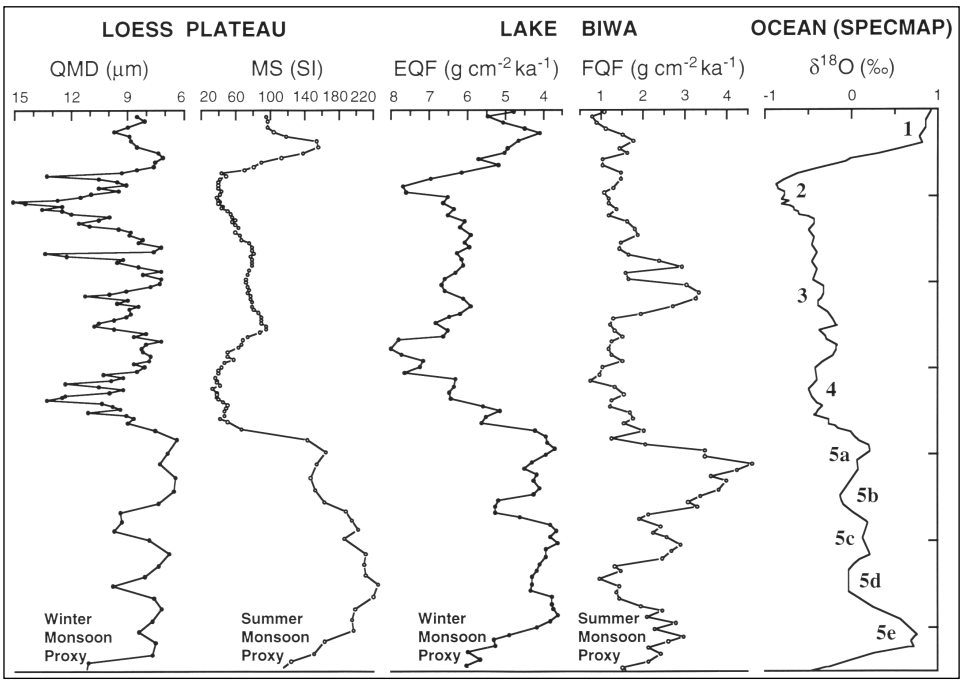

Fig. 8: Time series of the last ca. 130,000 years comparing the quartz median diameter (QMD) and magnetic susceptibility (MS) of the loess-paleosol sequence at Luochuan in the central part of the Loess Plateau and the eolian quartz flux (EQF) and fluvial quartz flux (FQF) of Lake Biwa sediments the SPECMAP $\delta^{18}O$ record (from Quaternary Science Reviews, in press).