record (at 10 cm intervals) for the Changwu loess section using the ratio of free Fe_2O_3 (Fed) (extracted by dithionite-bicarbonate-citrate method) to total Fe_2O_3 widely used by pedologists for characterizing the soil weathering intensity. The new proxy is highly consistent with other indicators of the intensity of pedogenesis: (1) the most developed S4, S5-1 and S5-3 have the highest Fed / Fet ratio; (2) for the three sub-units of S5, the ratio is the highest for S5-1 and lowest for S5-2, thus in close agreement with the macro and micromorphological observations; (3) the ratios for the soil units S6, S7 and S8 are similar to those for S2 and S3; and (4) the susceptibility time-series shows a major shift in amplitude at ~ 600 ka BP while that for the new proxy is at ~ 800 ka, similar to that defined according to the paleosols. Therefore the Fed / Fet ratio seems to be a better indicator of the strength of the East Asian summer monsoon than do variations in magnetic susceptibility.

We believe that the strong development of the S4, S5-1 and S5-3 soils is not solely a function of a longer period of soil-formation, but of climate conditions. The data match well with the higher $\delta^{13}C$ values (marine oxygen isotope stages 11, 13 and 15) in the marine record (see Raymon *et al.*, 1990, *Earth and Planetary Science Letters*, 97:353-368; and Oppo *et al.*, 1990, *Palaeoceanography*, 5:43-54). These periods also correspond with the periods of greatest Atlantic-Pacific benthic $\delta^{13}C$ gradients, suggesting a link with the rate of the deep-water formation in the North Atlantic.

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Reconstruction of Paleoclimate in the Loess Plateau using Non-Linear Mathematical Methods

In reconstructions of Quaternary climate, most researchers have made quantitative estimates of paleoclimate from linear relations between paleoclimatic proxy records and single climatic factors (e.g. temperature or precipitation), and established non-linear equations related to two climatic parameters such as temperature and precipitation by using response surface analysis. In this study, we use a non-linear inversion method to synthesize the data of three different proxy indicators and reconstruct paleoclimate. 63 records of Magnetic susceptibility (MS), 12 of the total Fe_2O_3 (Fet) and 28 of the mollusk species (*Vallonia* cf. *pulchella*) were taken from modern surface soils of the Loess Plateau and used as proxy indicators of physical, chemical and biological records. For stratigraphical study, we chose the Luochuan loess section, a standard section for Chinese loess. This section was sampled at intervals of 10 cm from S1 to S0. A total of 120 samples for MS, Fet and mollusks have been studied. The data for annual mean temperature (AMT) and annual mean precipitation (AMP) at the modern surface soil sites were used to set up the multiple regression climatic functions. *Fig. 3* shows temperature and precipitation variation in Luochuan over the past 11,000 ka based on the non-linear inversion method. From *Fig. 3*, we can see that there are some phase differences in the variations of the three proxy records. However, the AMT and AMP satisfy the non-linear relationship between the three climatic proxies and temperature and precipitation within acceptable limits, indicating a mutually consistent solution of the three climatic proxies.

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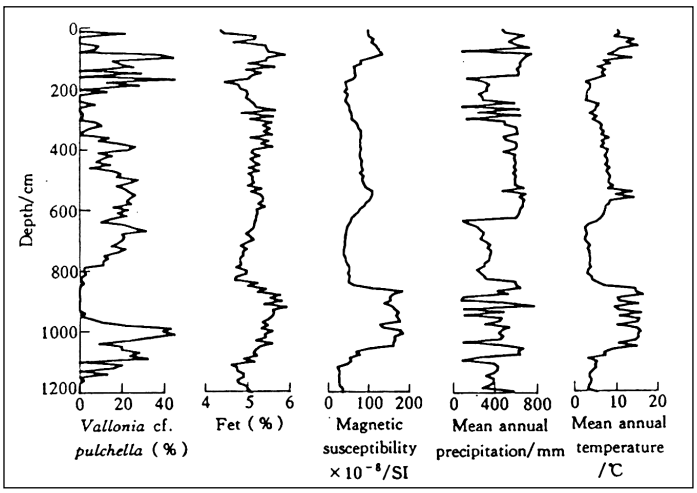

Fig. 3: Variations in the three proxy records of Vallonia *cf.* pulchella, *Fet and MS in the Luochuan loess section since the last interglacial together with variations in AMT and AMP as derived from the non-linear inversion of these three proxy indicators.*

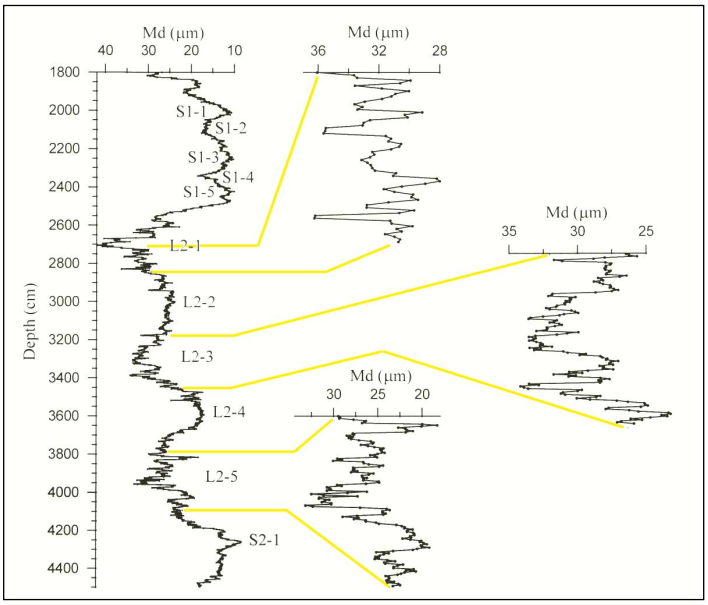

Fig. 4: Huining high resolution grain size record

Climatic Instability during the Penultimate Glaciation: Evidence from the Chinese Loess Deposits

Since the recognition of millennial-scale climatic oscillations in the Greenland ice cores, high-resolution records derived from various deposits all over the world have convincingly demonstrated that paleoclimatic variability of this kind is recorded in different parts of the global climate system, implying that climate instability during the last glacial period may be regarded as a global phenomenon. However, most of the high-resolution proxy records obtained hitherto only cover the last glaciation, and so climatic variability on sub-Milankovitch time scales in the older glacial periods is poorly known. Recently, we generated a high-resolution grain size record at Huining, the northwestern part of the Loess Plateau. The loess-soil sequence accumulated during the last two glacial-interglacial periods is about 45 m thick in the Huining section. We took samples of this part at 2 cm intervals. This sample spacing yields an average depositional time resolution of below a hundred years. Examination of the grain size record for the last

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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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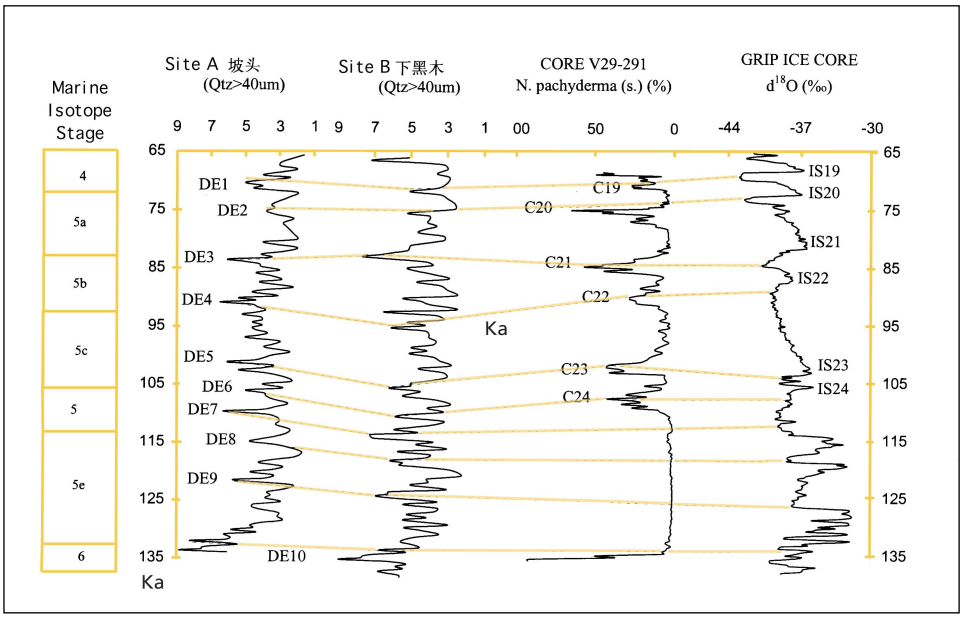

Fig. 5: Loess-Paleosol-Profiles in central China in comparison with North-Atlantic sediment cores and Greenland ice-sheet cores

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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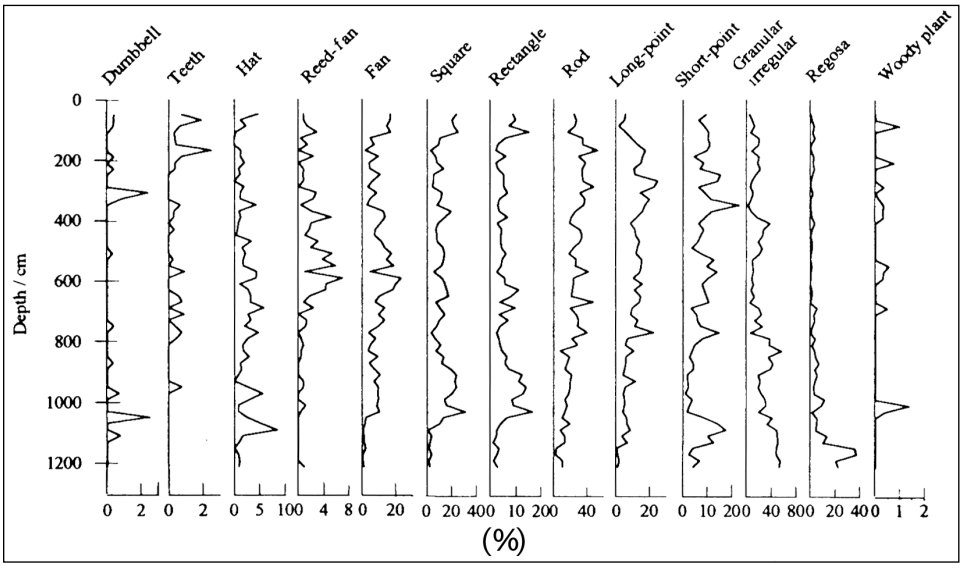

Fig. 6: Diagram of the percentage frequencies of 13 major phytolith types from the Baoji loess sequence for the last 150 ka.

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