Clim. Past Discuss.,
https://doi.org/10.5194/cp-2019-117-AC1, 2020

Climate of the Past Discussions

Interactive comment on "Lagged variation of moisture conditions in central Asia compared with monsoonal Asia during the last four interglacials" *by* Jia Jia et al.

Jia Jia et al.

jhchen@lzu.edu.cn

Received and published: 3 February 2020

The study by Jia et al. deals with an interesting loess-palaeosoil section in Central Asia (Darai Kalon) with the concern to reconstruct palaeoenvironmental conditions for the last four glacial-interglacial cycles. Furthermore, the results are compared to a loess section from the Chinese Loess Plateau (Xifeng) in order to find spatial and temporal relations between humidity periods and atmospheric circulation patterns, especially related to the interaction between westerlies, the Indian Summer Monsoon and the East Asian Summer Monsoon. In its present form, this study reveals some weak points that mainly relate to the methodological approach for establishing chronologies for the

loess sections. (I) First, no independent age determination is presented that could support the chronology that is solely based on the assumed relation between grain sizes and ïĄď18O values from marine cores. Thus, the whole chronology remains very speculative. If the chronologies of loess sections from different areas are both established based on a peak matching between the grain-size curves and one ïĄď18O-curve, of course the resulting curves are synchronous - that is circular reasoning.

Response: As our response to Dr. Ujvari's comments, we agree it is better to construct the chronology with a high-resolution, absolute independent dating method in paleoclimate reconstruct studies. However, if we hope the age error of mid-Pleistocene loess is less than one thousand years, or even less, it is not easy. OSL dating method is a good choice to dating the Holocene aeolian deposit, especially for loess. If the material is good enough, the OSL age can limit the error in 200 years. However, for Last Interglacial loess, only 1% error means a 2 thousand years (ka) uncertainties range! For MIS11 loess, only 1% error means a 8 ka uncertainties range! I must say your work (Stevens et al., 2018) is an excellent work on OSL dating. However, even it, the age of Last Interglacial loess also still has an about 5 ka uncertainties range, or even more! As our conclusion, the lagging activity of moisture variation in Central Asia is mostly less than 5 ka. Therefore, the quality of OSL dating is not good enough for our story. That is why we had not selected OSL dating in this study. As reviewer mentioned that "If the chronologies of loess sections from different areas are both established based on a peak matching between the grain-size curves and one ïĄď18O-curve, of course the resulting curves are synchronous", it is very important for our study. Due to our aim is to compare the paleo-precipitation variation patterns between westerlies dominated Asia and monsoon dominated Asia, we select grain-size proxy to establish the relative chronology, which is independent with paleo-precipitation (Sun et al., 2004) and has close link with global ice volume (Hao, et al., 2015). And the synchronous variations on orbital scales between Tajikistan loess and Chinese loess had been proposed and demonstrated by paleomagnetic data (Ding et al., 2002).

References: Ding, Z.L., Ranov, V., Yang, S.L., et al., 2002. The loess record in southern Tajikistan and correlation with Chinese loess. Hao, Q.Z., Wang, L., Oldfield, F., 2015. Extra-long interglacial in Northern Hemisphere during MISs 15-13 arising from limited extent of Arctic ice sheets in glacial MIS 14. Scientific Reports, 5, 12103. Stevens, T., Buylaert, J.P., Thiel, C., et al., 2018. Ice-volume-forced erosion of the Chinese Loess Plateau global Quaternary stratotype site. Nature Communications, 9, 983. Sun, D.H., Bloemendal, J., Rea, D.K., et al., 2004. Bimodal grain-size distribution of Chinese loess, and its palaeoclimatic implications. Catena, 55, 325-340.

(II) Second, the direct correlation between grain-size values / magnetic parameters and the Specmap-isotope curve implies that the built-up of the curves (in the sense of the built-up of the loess-palaeosoil sequences from bottom to top) is a continuous, successive and more or less linear process. But loess sedimentation rates are highly variable and may even tend towards zero during interglacial periods (see e.g. the study by Frechen and Dodonov (1998) at the same section, cited in the manuscript). That means that phases of lacking (or strongly reduced) loess deposition that relate to periods of pedogenesis (that may extend over several thousands of years) are ignored in the age model in favor of producing a kind of continuous "loess graph" assuming uniform deposition rates between the time control points. In my opinion, beside all other uncertainties of the chronology, already this linear interpolation between a few age control points is a strong contradiction and produces large errors. This is all the more serious if the interpretation strongly relies on assumed time lags in the range of a few thousand years. Furthermore, pedogenic clay formation that leads to finer grain sizes in subsoil horizons is a secondary process that is decoupled from primary aeolian deposition, but it strongly affects the mean grain-size curve. The approach to directly correlate the gradual fining of the grain-size in a loess depth profile with a linear progression of time (e.g. sedimentary ïĄď18O-curves, SPECMAP) is far away from the general concept of the way in which soils are formed. In my opinion, this also applies to magnetic susceptibility curves as soon as it is assumed that increasing values are caused by pedogenic processes instead of sedimentary processes. Such an approach

could be just about acceptable for the aim to e.g. make a general charcterisation of soil formation or for realizing a rough comparison or correlation of different soils from different sections, but not for generating a precise chronology for pedogenically altered loess sections.

Response: Firstly, the study by Frechen and Dodonov (1998) exhibited an age gap during 120-96 ka. It must be caused by systemically younger dating and the unignored error of estimated dose rates (Zhang et al., 2018) evidenced by the thick carbonate illuvium. And the stratigraphy do not support such hiatus (Ding et al., 2002; Bronger, 2003). Actually, the recent OSL dating study suggested the interglacial loess sediment presented a stable sediment rate in central Asia (Li et al., 2018). Secondly, if the leaching of fine-grained material in strata can obviously influence the mean grain size of the sublayer, both two loess records should present the unparallel variations and the lagging changed magnetic parameter. However, our data exhibited XF section (Chinese loess), developed the strongly pedogenic soil units, records the synchronous variations between grain size and magnetic parameters, and DK section (Tajikistan loess), developed the weakly pedogenic soil units, records a lagging change of the magnetic parameter. It strongly supports the lagging changed magnetic parameter in the DK record is not caused by the secondary process as the reviewer mentioned.

References: Bronger, A., 2003. Correlation of loess-paleosol sequences in East and Central Asia with SE Central Europe: towards a continental Quaternary pedostratigraphy and paleoclimatic history. Quaternary International, 106-107, 11-31. Ding, Z.L., Ranov, V., Yang, S.L., et al., 2002. The loess record in southern Tajikistan and correlation with Chinese loess. Li, G.Q., Chen, F.H., Xia, D.S., 2018. A Tianshan Mountains loess-paleosol sequence indicates anti-phase climatic variations in arid central Asia and in East Asia. Earth and Planetary Science Letters, 494, 153-163. Zhang, J.J., Li, S.H., Sun, J.M., Hao, Q.Z., 2018. Fake age hiatus in a loess section revealed by OSL dating of calcrete nodules. Journal of Asian Earth Sciences, 155, 139-145.

(III) Third, as I understand it, the interpretation of time lags is strongly based on the respective position and the possible offset between peaks of the grain-size and frequency dependent susceptibility curves. Or alternatively, if a palaeosoil shows a thicker subsoil horizon and a less rapid clay decline with depths, also the frequency-dependent susceptibility may show a less rapid decline as these values are generally strongly correlated with clay contents. This may lead to a different or shifted slope of the susceptibility curve. In that case the assumed time lags are again caused by pedogenic processes, i.e. different soil development depths. Therefore, despite value curves/ peaks of different sedimentological/pedogenetic parameters appear in different soil depths, both may relate to the same formation time. Without showing the proxy-curves in a clear stratigraphic context, it is not possible to evaluate the plausibility of the used approach. Furthermore, it would be necessary to show the strength of correlation between clay and frequency-dependant susceptibility (FDS) values, because if they show a strong correlation, FDS is not an independent value and thus even more severely influenced by the tuning process.

Response: Actually, we do not use the offset between peaks of the grain-size and frequency-dependent susceptibility curves to determine the lagging variations of paleo-precipitation in Tajikistan, but to compare the offset between peaks of frequency-dependent susceptibility curves between Tajikistan and Chinese loess records. The grain size parameter is only used to construct the chronology. So, we have not faced the problem the reviewer mentioned.

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2019-117, 2019.