

## ***Interactive comment on “Late Miocene-Pliocene climate evolution recorded by the red clay covered on the Xiaoshuizi planation surface, NE Tibetan Plateau” by Xiaomiao Li et al.***

### **Anonymous Referee #1**

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The manuscript from Li, et al. presents new geochemical records and environmental reconstructions from the Xiaoshuizi section on the western Chinese Loess Plateau. These records are interesting because they help to constrain the westward reach of the East Asian Monsoon in the Late Miocene and Pliocene. When combined with records from the central and eastern plateau, the new Xiaoshuizi shows that significant increases in moisture availability did not occur until after 4.8 Ma, and coincided with the wettest periods observed on the eastern Loess Plateau. Generally, I found the manuscript to be interesting and well organized and have a few suggestions detailed below.

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I think the manuscript needs to present the geochemistry data versus stratigraphic depth, in addition to just age. There also needs to be more discussion on the relationship between sedimentation rate and pedogenesis. For example, it would be helpful if Figure 3 was plotted vs. depth and there was also a column that plots sedimentation rate, and the presence of nodule horizons. This is important because the interval between 4.5 and 4.3 Ma, for example, shows a strong increase in magnetic evidence for pedogenesis and also coincides with a noticeable drop in deposition rate. Therefore, it needs to be discussed if this increase in pedogenesis was driven solely by wetter conditions, or was there also more time for soil formation and leaching of Ca. I do think more stratigraphic context will help some of the arguments presented in the text. For example, upon my initial reading of the text and figure, the division into the 2 primary intervals placed at 4.8 Ma seemed somewhat arbitrary looking at figure 3 (i.e. why not 4.6 or 5.1). But it makes much more sense in terms of the large decline in sedimentation rate around  $\sim 4.8$ , which accompanied by the deposition of a carbonate nodule layer, and then the noted increase up-section in nodule horizons underlying leached zones. Also with deposition of loess being connected to regional wind patterns, is it significant that there was a notable  $\sim 200$  kyr drop in sedimentation rates before a shift to generally wetter/more seasonal conditions?

I am somewhat confused by the explanation of K/Al ratios as a weathering proxy (lines 238-245). With time, Al can mobilize and become depleted at the top of a paleosol and enriched down profile. And in certain situations, you might expect K to be enriched at the soil surface, due to its biological importance. So, within the same well developed soil, you might expect a higher K/Al ratio at the top, and a lower ratio deeper in the profile. This is never plotted, so it might be worth eliminating this text?

The various magnetic susceptibility terms are well described in the discussion, but I think it would help readers if at least some of this information was moved up to either the results or methods. This would help provide context to all of the values presented in the results.

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Minor suggestions:

Line 57: suggest “occurring” or “underway” instead of “ongoing”

Line 76: suggest “supplied” instead of “prepared”

Lines 75-88: I’m guessing the sentence beginning with “Make clear. . .” on line 78 was accidentally left in as a comment, which I still think needs to be addressed. I think I understand what the authors are going for within the paragraph, but I think the logic can be expressed more clearly. The strength/onset of the Asian monsoon is linked to these globally significant events (Tibetan uplift, northern hemisphere ice, etc). Therefore, by constraining paleoclimate across the Chinese Loess Plateau not only does this improve our understanding of regional climate, but it can also provide insight about the paleo-monsoon, and therefore changes in the global climate system during the Pliocene.

Line 96: suggest removing “condition” and changing “aridification process” to “regional aridification”

Line 104: change “to be” to “that”, and I think it would be helpful for the future readers not just to say “gleying”, but instead state briefly what that means (waterlogging, and iron reduction) and why it matters for the magnetic susceptibility record.

Line 105-106: This sentence does not make sense. Are you trying to say that climate in this region is influenced by the strength of both the westerlies and the monsoon, and that those two factors may not be directly related?

Lines 114-115: What makes the XSZ red clay different geomorphologically?

Line 118: suggest “are” instead of “have been”

Line 121: This sentence is slightly off.

Line 133: suggest “reconstruct and discuss” instead of “discuss”

Line 133-134: not sure exactly what is meant here. Is the XSZ core characterized by

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more continuous deposition and records a longer time interval than the Shangyantian core?

Line 136: capitalize China

Lines 137-138: Not sure what is meant by the sentence beginning with “The East Asian Monsoon.” Are you trying to explain how these two factors together control climate at the study site. This could be elaborated.

Line 144: Where in the section is the increase in gravel? From the strat column it looks like it is at the base. Say this in-text.

Lines 145-147: Clarify if most carbonate horizons are overlain by a brownish red-layer, or if the carbonate zone in its entirety underlies a larger brownish-red layer. Lines 148-150: It’s not clear as written if carbonized root channels have more abundant Fe-Mn staining.

Line 168: Is all of the remaining Ca in silicate minerals? Won’t a lot of it be loosely bound to clay minerals in the soils? Also, the correction for Phosphorous also needs to be explained. I’m guessing you are assuming some component of Ca-bearing phosphate minerals, but what is the basis for this assumption.

Line 199: What do you mean by durations? Are you saying there are some thicker intervals of high magnetic susceptibility?

Line 256: space between “susceptibility” and “of”

Line 257: suggest removing “two”

Line 314: Spelling of “Multiproxy”

Line 317-318: suggest “a significant change is recorded by most of the proxies that occurred”

Line 318: K/Al is not plotted, but K/Na is plotted. Based on the comment above, I think

this is probably a better choice.

Line 327: suggest “relatively” instead of “relative” and “and” instead of “which”

Line 328: Not sure what this sentence is trying to say.

Line 329: I suggest clarifying the beginning of this sentence to say something along the lines of “Carbonate content becomes more variable after 5.5 Ma, which is. . .”

Line 333: spelling of “indices”

Line 345: suggest “central and eastern” instead of “hinterland of the”

Line 377: suggest rewording the sentence beginning with: “Look around the globe,. . .”

Line 415: I’m not sure what “humid toward arid direction” means

Line 521: suggest “provides the opportunity constrain and discuss. . .”

Line 526: again suggest “central and eastern” instead of “hinterland of the”

Line 531: suggest removing “obviously”

Figure 1: I think it would help if you put a larger non-circle shape on panel A corresponding to the study site. Then you can remove the Xiashuizi label, which slightly obscures the vector. Then, match this symbol on panel C You are missing the white reversals between C3n.1n, C3n.2n, and C3n.3n on the Polarity plot for the XSZ section. These were included in the age model presented in Li et al. (2017). What do the black bars on the lithology column represent.

Figure 2: I think it would help if the line thicknesses were slightly thinner.

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