

Clim. Past Discuss., referee comment RC1
<https://doi.org/10.5194/cp-2021-32-RC1>, 2021
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Comment on cp-2021-32

Anonymous Referee #1

Referee comment on "Palaeo-environmental evolution of Central Asia during the Cenozoic: new insights from the continental sedimentary archive of the Valley of Lakes (Mongolia)" by Andre Baldermann et al., Clim. Past Discuss.,
<https://doi.org/10.5194/cp-2021-32-RC1>, 2021

Review of paper Preprint cp-2021-32: "Palaeo-environmental evolution of Central Asia during the Cenozoic: New insights from the continental sedimentary archive of the Valley of Lakes (Mongolia)" by Baldermann et al.

General comments

The valley of lakes in Mongolia is certainly a key area for investigating Cenozoic mammal evolution and climate changes in Central Asia. It is significance to reconstruct the paleoclimate evolution history during late Eocene to early Miocene based on sedimentological, petrographic, mineralogical and geochemical signatures recorded in a sedimentary succession in the valley of lakes in Mongolia. In this study, Baldermann et al. extended the existing mineralogical and (isotope) geochemical dataset reported in Richoze et al. (2017) to constrain provenance, paleoenvironmental conditions and post-depositional alteration history of the Eocene-Miocene sedimentary succession. Their reconstruction provides good data support for refining the evolution of hydroclimate and weathering conditions in Central Asia in the early Cenozoic. However, there are still some main issues that need further discussion.

Specific comments

- The chronological framework for sedimentary succession is the basis of paleoclimate reconstruction. In this study, authors thought that authigenic "hairy" illite minerals

were formed during coupled petrogenesis and precipitation from hydrothermal fluids originating from major basalt flow events, and illite crystallization ages in sedimentary succession were used to establish the chronological framework in this study. Noticeable, the age of basalt I is ~31.5 Ma at ~40-45m (as shown in Figure 2), which is much younger than illite crystallization age (34.2 Ma) at ~35 m. Authigenic illite crystallization ages possibly are ages when sedimentary strata were affected by hydrothermal fluids, should not be the ages when the sedimentary strata were deposited. Therefore, it should be careful to use the illite crystallization ages to establish the chronological framework of sedimentary succession. Detailed magnetostratigraphic work in the valley of lakes in Mongolia had been done by Sun and Windley (2015). It is suggested to consider their established magnetostratigraphic age framework in this study.

- As mentioned in this paper, the depositional setting was characterized by an ephemeral braided river system draining prograding alluvial fans, with episodes of lake, playa or open steppe sedimentation. It means that the sedimentary facies in the study area have been changed many times during late Eocene to early Miocene. The chemical weathering index may change with different sedimentary facies. Therefore, it is suggested that sedimentary facies should be added to the Figure 8.
- The scatter in the $\delta^{18}\text{O}$ isotope composition of the soil carbonates in the upper Eocene was attributed to playa lake sedimentation (as shown in Figure 8), but there was no petrographic-sedimentological evidence for sediment deposition in a lake or playa environment. Why is there such a paradox?
- The $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ profiles showed that significant aridification occurred between ~62-92 m (maybe ~30-24 Ma) in the valley of lakes, and the aridity weakened above ~95 m (after ~24 Ma). The change trend in chemical weathering indexes were not consistent with $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ profiles. In the range of 50-85m (maybe ~31-26 Ma), chemical weathering indexes fluctuated frequently, but generally decreased; they increased significantly at ~26 Ma, and maintained relatively stable high values during the early Miocene. What causes the difference between isotope data and chemical weathering indexes? Sedimentary facies? Post diagenesis? Basalt flow events? Or regional tectonic activities? Noticeable, without the precise chronological framework, it is not significant to make one-to-one correspondence between the fluctuations of chemical weathering indexes and global climate events.

Technical corrections

- The formation names marked in Figure 6 are wrong, please check it carefully.

e.g. a) Tsagaan Ovoo formation should be Loh Formation

- c) Loh should be Tsagaan

Sun, J.M.& Windley, B.F. (2015). Onset of aridification by 34 Ma across the Eocene-Oligocene transition in Central Asia. *Geology*, 43(11), 1015-1018.