

Clim. Past Discuss., referee comment RC2  
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## Comment on cp-2021-32

Jeremy Caves Rugenstein (Referee)

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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-RC2>, 2021

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Baldermann and co-authors provide new data from the well-studied Valley of Lakes section in central-southern Mongolia to understand the sedimentological and paleo-environments during late Paleogene and early Neogene Mongolia. The authors find that a number of paleo-environmental indicators, such as CIA, track global climate signals, but that  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$  do not; they conclude that stable isotopes of authigenic carbonates in this section reflect, to a much greater extent, uplift of the Altai and Tian Shan.

I found this paper easy to read; the figures support the text, and; the paper is well-referenced. I believe this paper is appropriate for a journal such as *Climate of the Past* subject to minor revisions. Below, I present a few comments, which I think will make the paper more robust. Please note that I am not an expert on Ar-dating of clays; I therefore restrict my comments to the paleo-environmental aspects of the paper.

I'm curious why the stable isotopes—particularly the  $\delta^{13}\text{C}$ —do not track with the weathering indices, such as CIA. The authors interpret their  $\delta^{13}\text{C}$  record in terms of precipitation; strictly, this isn't correct particularly over long timescales. Rather,  $\delta^{13}\text{C}$  records the balance between atmospheric  $\text{CO}_2$  and the soil respiration flux (Cerling, 1999, 1984; Cerling and Quade, 1993). Over this time frame, changes in atmospheric  $\text{CO}_2$  need to be considered. However, for most of Asia, changes in plant productivity—probably driven by changes in the atmospheric  $\text{CO}_2$  via the  $\text{CO}_2$  fertilization effect—seem to be the larger driver of soil carbonate  $\delta^{13}\text{C}$  changes (Caves et al., 2016; Caves Rugenstein and Chamberlain, 2018). This is likely to have an effect on weathering, since plant-produced  $\text{CO}_2$  plays a vital role in breaking down primary minerals. Thus, it is curious why these weathering indices and  $\delta^{13}\text{C}$  are decoupled, and some speculation from the authors on why would be helpful. We recently published a paper that dealt with this issue in the late Cretaceous Songliao Basin in NE China (Gao et al., 2021).

The relative lack of change in  $\delta^{18}\text{O}$  is not too surprising. In such a continental, semi-arid

setting as the Valley of Lakes, small changes in hydroclimate are unlikely to produce changes in  $d_{18}O$ , given that most moisture is recycled in this setting and there is very little runoff. Such predictions for meteoric water  $d_{18}O$  in continental settings has been detailed in a number of studies (Caves et al., 2015; Chamberlain et al., 2014; Kukla et al., 2019; Winnick et al., 2014).

I'm curious why the authors attributed many of the paleo-environmental changes to uplift of the Tian Shan and Altai mountains, rather than uplift of the Hangay mountains to the north. There is, of course, some dispute about the paleo-elevation of the Hangay mountains through time (McDannell et al., 2018; Sahagian et al., 2016) and my own work (Caves et al., 2014) suggests that the Hangay play an important role in blocking moisture to this part of the Valley of Lakes. Some discussion of why the authors have decided to attribute hydroclimatic changes to uplift of the Tian Shan and Altai versus changes in Hangay paleo-elevation would be appropriate and would be of interest to a broad swath of researchers who are interested in tectonics and paleoclimate in Mongolia.

Minor Comments:

Line 90: I think you mean to cite Xiao et al., 2010 here.

Figure 8: How is the position of the dashed yellow, vertical lines in the  $d_{18}O$  panel positioned? For the uppermost samples, is this line placed along the minimum values because there is evidence that there is evaporative effects for the higher  $d_{18}O$  samples? What evidence is this?

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