

## ***Interactive comment on “Bunker Cave stalagmites: an archive for central European Holocene climate variability” by J. Fohlmeister et al.***

### **Anonymous Referee #2**

Received and published: 29 June 2012

This manuscript presents a state-of-the-art view of Holocene climate change in central Europe arising from the intensive, ongoing investigation of Bunker Cave. Four speleothems provide an archive of variability (3 stalagmites, one flowstone). Stalagmite BU4 is really the key record, as it covers >8ka of the record with an average growth rate of ~25microns yr<sup>-1</sup>. Stalagmite BU1 provides two overlapping intervals with BU4 and stalagmite BU2 and flowstone BU6 extend the BU4 record back to 10.8ka BP with a growth rate similar to BU4. This resource, especially with the duplicated intervals, is a good basis for inference of Holocene changes at the Bunker Cave site, but is not truly remarkable either in terms of the resolution or the degree of replication. On the other hand, the degree of monitoring and contextual analysis that has been done (and

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continues to be done) at Bunker IS remarkable. It is therefore the use of this supporting data to underpin inference of climatic variability that this study lives or dies upon.

I recommend that this paper is published, but have some thoughts as to ways the paper can potentially be improved further. 5 major comments are given in the next section with further minor comments after that.

Major comments: 1) Does the modern drip behaviour reflect the palaeo-drip behaviour? The MS suggests that some of the complications in - for instance - the carbonate isotope data reflects the fact that the entrance of Bunker Cave has (relatively recently) been enlarged. This enlargement will have altered ventilation, and there has the potential to alter the evolution of the dripwater from the moment of emergence right through to flowing down the flank of the stalagmites. This is a point of serious concern for this study - can the authors be certain that this change in ventilation has not altered the caves behaviour sufficiently that Reichelmanns data is not analogous to the cave conditions at the time of deposition of the samples?

This is a difficult question for them to answer but - given the specific significance of their work - it seems to me a basic and important thing they need to discount before using the monitoring data to underpin their interpretation of the palaeodata.

2 Mg/Cacalcite detrending; The suggestion that the evolution of the Mg/Ca strikes me as being very significant, and having major implications at least for those parts of the world that experiences major changes in soil composition through time. Although I do not challenge that this is a rational interpretation of the data, I would like to see some further analysis of the concept.

i) Is there any unweathered remnant of this loess soil that can be found anywhere? Preserved in the subsurface and revealed in boreholes, for example. It would be an absolutely key finding if the team presenting this work could find such a remnant, sample it and demonstrate what minerals (if any) have been lost in the weathered material above the cave. Not only would this further support this interpretation, but it would go

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some way to assisting future researchers who are wrestling with similar problems, but with less monitoring data supporting them.

ii) Whether a remnant can be found or not, a soil carbonate budget calculation would quantitatively assist the interpretation. How much loess dolomite would be needed to alter the Mg/Ca of the solution, given the degree of limestone aquifer dissolution today? What dissolution flux is necessary to sustain that mixing? Assuming that has to be sourced from a small volume directly above the cave, how much dolomite, as percentage of total soil, did you need to start with?

3) Detrended d13C resembles detrended Mg/Ca - smoothed d18O data resembles detrended Mg/Ca - can we have a correlation analysis?; It is always helpful to see either a cross plot or a correlation analysis of some kind when a claim like this is made, but I do not see one.

4) d13C behaviour between Bu1 and Bu4 consistent with likely kinetic differences; This may well be true. However, I am missing even a basic quantitative analysis demonstrating that the changes are of the right magnitude and of the right sign. Please can we have a short analysis of the differences in this and other parameters that can realistically be driven by kinetics, drawn from the Dreybrodt and Scholz model cited in the text please! Possibly Lines 1701/19 to 1702/4 are meant to convey that this analysis has been done, but it is confusing and I like to see the numbers if I can.

5) Dry period 9 to 7ka - consistent with broad cooling spanning 8.2 event?; The 8.2ka cooling is known to be inset within a wider, more subtle cooling but the exact duration of this longer event remains uncertain e.g. (Rohling and Palike, 2005). It would be useful for the authors to comment on what their data can contribute to unravelling this problem.

Minor comments:

Pg 1696, Lines 9-10; "Iscam enables to...". Awkward wording - amend to "Iscam can

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be used to ...." Pg 1696, Lines 14-15; "Iscam allows to prove....". Awkward wording - amend to "Iscam can be used to test ...." Pg 1696, Lines 18-19; "An additional constraint is given.....". Please explain! Pg 1696, Lines 9-10; "Iscam enables to....". Awkward wording - amend to "Iscam can be used to ...." Pg 1698, Line 24; Do you really mean "Rain water"? If so, could you briefly indicate how it was collected? Pg 1699, Line 3; Remove "S" from middle of citation. Pg 1699, Line 5; "on average", not "in average". Pg 1699, Line 6; change "...the stalagmite represents, thus, a mixture....." to "...the stalagmite therefore represents a mixture...." Pg 1699, Line 9; Provide reference for loess deposition above cave. Pg 1699, Line 25; change "foster" to "faster". Pg 1700, Line 24; Remove "S" from middle of citation. Pg 1703, Section 4.3; I understand what is being argued here, but can it be made more simple and clear? Pg 1706, Lines 1-2; The data does NOT show that there was a pronounced negative NAO anomaly during the LIA! This is your interpretation of the inference of cold/dry summers. Please say more precisely that your data is consistent with the idea that there pronounced negative NAO anomaly during this period. Pg 1706, Lines 12-16; Please elaborate the conclusions for the 8.2 ka even your can draw from your data. The d18O and Mg/Ca seem to give different perspectives, in that the former agrees with Ammersee and the latter does not. This deserves more than the cursory examination you give it.

Conclusions; You emphasise how your data agrees with previously published records. This is the same as accepting that your research has taught us nothing. Please can you amend the Conclusions to better emphasise what we have learnt from your hard work over all these years!

## References

Rohling, E.J. and Palike, H., 2005. Centennial-scale climate cooling with a sudden cold event around 8,200 years ago. *Nature*, 434(7036): 975-979.

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Interactive comment on Clim. Past Discuss., 8, 1687, 2012.

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