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Climate of the Past Discussions



# *Interactive comment on* "Cryogenic cave carbonate – a new tool for estimation of the Last Glacial permafrost depth of the Central Europe" *by* K. Žák et al.

**Anonymous Referee #2**

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1. General comments.

The paper presents an overview of coarse-crystalline Cryogenic Cave Carbonate (CCC) utilized to detect and date the presence of permafrost in central Europe, and to estimate the minimum depth of permafrost penetration. Moreover, it expand the existing dataset with 19 new U/Th ages. The data presented are quite large and substantial and the paper is worth to be published on Climate of the Past. The descriptive part about the growth mechanism of calcite crystals in iced pools is interesting and can be incorporated in the title-abstract-conclusion as well. On the other hand, the paleoclimatic part with all his implications is the weakest one and has to be expanded and

corroborated by cross-referencing the relevant up-to-date literature.

2. Specific comments.

Suggested title modification: Coarse-crystalline cryogenic cave carbonate – a new tool to estimate the Last Glacial permafrost minimum depth in Central Europe.

2.1. Most of the paper and all the U/Th dates refer to coarse-crystalline Cryogenic Cave Carbonate (CCCCC) and not more generally to CCC. I would suggest, therefore, to confine the paper to this kind of carbonate and insert coarse-crystalline in the title and the notation (CCCCC) in the main text. The fine-crystalline powdery type of CCC can be mentioned in the introduction, in part 2, as well as in the stable isotope part(including Fig.1).

Page 2151 line 16: "The size of these crystals varies from several tenths of micrometers to several millimeters." Do you mean TENS of micrometers, or maybe tenths of MILLIMITERS?

Page 2152 line 1-2: I would insert one composite table with the most common CCCCC morphologies in the main text, and leave the supplement for more complex morphologies and CCC.

Page 2152 line 13: Have you analyses about the fact that the CCC are made of low-Mg calcite? This can be a useful data to insert. Otherwise, you should have to remove the sentence.

Page 2153 line 16: "In case of the coarse-crystalline CCC and slow water freezing in pools," change into: In case of the coarse-crystalline CCC formed by slow water freezing in pools.

Page 2154 line 6: substitute "carbon isotope reservoirs" with CO2 reservoir

Page 2154 line 15-16: "The paleoclimatic information of this novel archive is contained only in the presence of CCC (which is a proof of freezing temperature) at a given



CPD

8, C1060–C1066, 2012

site and at a given moment of the past." I would rephrase into: "The paleoclimatic information of this novel archive is given only by the presence and age of CCCCC (which is a proof of freezing temperature)."

Page 2156 line 5-6: "...were obtained from the original publications as well as FROM local caving clubs"

Page 2156 line 19-20: remove Schimpf et al. 2011, (not relevant to the topic)

Page 2157 line 3: remove Meyer et al., 2009, 2011, (not relevant to the topic)

4.1 Evidence for cryogenic origin of the CCC. This is an important part of the paper and should have not to be treated in just 9 lines, especially if you want to expand the growth mechanism part (for example, is not state clearly which kind of crystals developed at the pool bottom and which one, or which side, at the water/air interface. As stated above, I would restrict this discussion to CCCCC. Otherwise you should have to discuss why the fine-powdery CCC cannot be partially related to evaporative phenomena, being their isotopic composition (Fig. 1).

Page 2157 line 24: "or origin by disintegration of the host limestone is excluded": I think that no one would ever consider this possibility!

Page 2158 line 5: which all (with one exception) suggest formation within glacials. Rephrase into: "which suggest (with one exception) the formation within glacial or stadial periods.

Chapter 2.3. In the description of the different caves there are several information about the speleogenesis and the evolution of some cave systems. Being a kind of review paper I presume that all these information are available in the original papers and, anyway, they are not essential to the presented topic: I would suggest to remove them. On the other hand there are scattered and incomplete information about the host rock lithology. In some part of the paper is suggested the importance of the limestone host-rock for the development of CCCCC, but this hint is not further investigated. The



CPD

8, C1060–C1066, 2012



information about the host rock lithology and porosity can be added in the “Basic cave description” column in Table 1.

4.2 Ventilation of the studied caves. To properly evaluate this part more data about the MAAT and in cave MAT at the CCCCC sites are needed. I would suggest to insert two new columns in Tab. 1 with these data (when available) in order to give to the reader the tool to properly comprehend the subject.

4.3 Age and model of formation of the studied CCC. This part of the discussion and the followings are the most important ones, but the paleoclimatic implications of the CCCCC ages are suggested but not completely exploited. Being the specific target of Climate of the Past I would recommend to investigate and discuss in more detail this part:

1. How the age distribution compare with the growth periods and growth frequency variations of “usual” speleothems (cfr. Baker et al., 1993) and stable isotopes speleothem records (cfr. Genty et al., 2003; Boch et al., 2011 and ref. therein)? (If you modify Fig.4 with a growth histogram (see below) you can comment more precisely on this point).

2. Can you explain in more detail the CCCCC formation in the 50-58 and 80-85 ka intervals during which “usual” speleothems commonly growth in Europe (cfr. Baker et al., 1993, Boch et al., 2011)?

3. The concepts of the Dansgaard-Oeschger (D-O) events with Greenland Interstadials and Greenland Stadials has to be introduced (cfr. Lowe et al., 2008) and discussed.

Page 2159 line 11: Marine Isotope Stage (MIS) are here introduced without any references.

4.4 Estimation of past permafrost thickness. As stated above, the information about present-day MAAT and MAT at the CCCCC sites should have to be incorporated in specific columns in Tab.1 to allow the reader to evaluate the temperature difference with respect to permafrost conditions.



CPD

8, C1060–C1066, 2012

Page 2162 line 16: remove “Central”

Page 2162 line 21: substitute “glacials” with “glacial periods”

Page 2164 line 3: remove the sentence: “the whole cave system was explored after 2004” (not relevant to the topic)

4.5 Further interpretation possibilities for CCC data. The part on d18Owater calculation is rather an appendix than do not present any new insights with respect to the data presented in Fig.1. For the d18Owater calculation the less negative (initial) values plotted in Fig. 1 vary between -7 and -13 ‰ PDB for the lowlands caves. By using the Kim & O’Neil (1997) eq. (the more commonly used in speleothem studies) the corresponding d18Owater should vary between -10 and -16 ‰ SMOW and not -15 ‰ as stated in the paper. Anyway, it is not possible with the presented data to properly test these values and their implications. I would suggest to remove this part completely (preferable) or rather present and discuss in a more proper and detailed manner. Also the part about the possible calibrations of “clumped isotope thermometry” at low temperatures is rather speculative, by the fact that has to be tested a priori the equilibrium isotope fractionation of these calcite crystals. I would suggest to remove it, at least in the conclusions.

3. Technical corrections.

Table 1: Specify B.P. (1950) in the CCC age column; Insert host rock lithology information in the “Basic cave description” column. Add two additional columns for cave MAT at the CCCCC sites (when know) and MAAT at the cave entrance (where available at/near the cave site)

Table 2 and 3: Specify B.P. (1950) and errors in $2\sigma$ in the captions;

Fig.1: Substitute Coarse grained CCC with CCCCC in the legend

Fig.2: Washburn (1980) is not in the references.



CPD

8, C1060–C1066, 2012

Fig.3: The cave sections are really small to read. The plate should be possibly assembled in a more square proportion in order to enlarge the final scale.

Fig.4: Substitute the age data line with a histogram. Possibly highlight in different color /shading in the histogram the data relatives to high-elevation (and/or low present-day temperature) caves. Remove the vertical gridlines and substitute them with the boundaries of the relevant MIS or GI stages. Add VPDB and VSMOW respectively to the axis titles.

REFERENCES:

Several of the cited references are abstracts of congresses that are difficult to obtain and, therefore, is not possible to evaluate their properness in the context. Being the fact of the large number of published material, I would suggest to cite only the relevant papers and exclude the abstracts of congresses that did not presented new findings and data (for example: Lauriol et al., 2006a; Kempe, et al., 2003, 2006; Richter and Riechelmann, 2007).

Remove the followings:

Meyer et al., 2009, 2011 Schimpf et al. (2011) OrvoËĞsov′a, M. and VlËĞcek, 2012 (not cited in the text)

Add and/or consider the followings:

Baker et al., 1993. Northwest European palaeoclimate as indicated by growth frequency variations of secondary calcite deposits. Palaeogeog. Palaeoclim. Palaeoecol. 100: 291-301

Boch et al., 2011. NALPS: a precisely dated European climate record 120–60 ka. Clim. Past, 7, 1247–1259, 2011 1,2,

Genty et al., 2003. Precise dating of Dansgaard-Oeschger climate oscillations in western Europe from stalagmite data, Nature, 421, 833–837, 2003.



CPD

8, C1060–C1066, 2012

Lowe et al., 2008: Synchronisation of palaeoenvironmental events in the North Atlantic region during the Last Termination: a revised protocol recommended by the INTIMATE group. Quaternary Sci. Rev., 27, 6–17.

Washburn (1980)

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Interactive comment on Clim. Past Discuss., 8, 2145, 2012.