

Dear Editor, Dear Authors,

The manuscript (egusphere-2022-349) presents a detailed speleoclimate monitoring in a mountain permafrost area and a unique cryomineral association. The study is principally well-written, follows a logical structure and the illustration material is of high-quality. The study provides the first report about the co-occurrence of cryogenic calcite and gypsum and the presented  $\delta^{34}\text{S}$  data of cryogenic gypsum are also novel. Therefore, I strongly support the publication of the study following some minor revision.

- We thank referee #1 for the detailed review and the positive comments on the manuscript. We add here our responses while the modifications to the text and figures according to reviewers' comments will be in the track-changes version of the manuscript after the editor's decision.

#### Major comments:

The title of sub-section 3.3 needs revision. The current title is misleading. The section is not about sampling but about the methodology of the applied mineralogical and geochemical analyses.

- We will change the title of sub-section 3.3 from "Mineralogy, water and mineral sampling" to "X-ray diffraction, ion chromatography, and sulphur isotopes"

It is also quite strange that there is not any reference for the applied methods. Please consider citing the proper references in the revised manuscript.

- In general, these methods are all well established. Nonetheless, we will include in the revised manuscript some papers using the same methodology for X-ray diffraction (e.g. Rodríguez-Salgado et al., 2021) and sulphur isotopes (e.g. Giesemann et al., 1994).

An additional related comment is that it is stated in section 4.4.2 that "*XRD analyses yielded ... gypsum, calcite, ... pyrite and goethite,*" however no evidence is presented. I suggest adding some annotated diffractograms (at least in a supplementary document) in the revised version.

- We will include the XRD results in a supplementary document of the revised version and the figure will be referenced in the text.

#### Minor comments:

lines 73-78: This sentence somehow doesn't fit to the other parts of this paragraph. Please consider omitting it or moving it to another place where it fits better.

- The sentence will be moved to the end of line 67 and re-phrased. On the other hand, we will update this section with recent publications.

line 210: I suggest expressing the lapse rate as  $5.5^\circ\text{C km}^{-1}$  because the current expression is confusing. It suggests  $0.55^\circ\text{C}$  change by 0.01 m.

→ We will change the expression as suggested.

line 214: Please capitalize “Midi”

→ We will capitalize it.

line 244: Maybe “Bragg-Brentano geometry” or “ $\theta/2\theta$ -mode” would be the appropriate expression.

→ We will change as the suggested.

line 290: Please explain it a bit more what is “an increase of  $\sim +1.5\text{ }^{\circ}\text{C}$ ”. A trend value? or the difference between the mean of a certain period at the beginning and at the end of the record? or what?

→ The temperature increase refers to the trend of the temperature series since beginning of the record. We will rephrase this sentence to “*The PMBS MAAT record (Fig. 3b) shows a warming of  $+1.5\text{ }^{\circ}\text{C}$  since the beginning of the measurements in 1882*”.

line 299: Please check the dimension.

→ We will change “ $\text{kh}/\text{m}^2$ ” by “ $\text{kWh}/\text{m}^2$ ”

lines 321-329: I cannot see the usefulness or necessity presenting the correlation year-by-year in these lines? I suggest simplifying this part similarly to lines 334-337.

→ The text about correlations will be simplified in the revised manuscript (lines 322-331) but we prefer to keep the seasonal correlations since there are important differences between winter and summer regarding the synchronicity of external and internal temperatures.

line 346: I suggest replacing “small” with “weak”.

→ We will include this change.

line 511: I suggest replacing the term “beginning of the Industrial Era” with “late 19<sup>th</sup> century”. As far as I know the Industrial Era begun much earlier than the PMBS record.

→ We will change it to “late 19<sup>th</sup> century”.

lines 546-552: Discordancy without visible detrital layer could also indicate unconformity. A nice example can be found in Fig5 of Hercman et al., 2010 ([http://www.geochronometria.pl/pdf/geo\\_36/Geo36\\_05.pdf](http://www.geochronometria.pl/pdf/geo_36/Geo36_05.pdf)). This type of discordancy/unconformity could be also considered in this part of the discussion.

→ We agree with that observation, thanks for pointing it out. We will add the reference to the discussion section. We are currently working on detailed stratigraphic descriptions, isotopic trends, and the chronology of these deposits to fully understand the meaning of these unconformities and the history of the deposits and this information will be part of a separate publication. At this point of the

research, we prefer establishing a robust chronology before discussing the meaning of the unconformities.

line 554: Maybe “These” instead of “Our”.

→ Will be changed.

lines 574-575: I suggest omitting the bracketed comment.

→ Will be changed.

lines 676-679: I think that this info could be moved forward in the section.

→ We think these lines are in coherence with the text in this section but more information about mineralogy in the Results section (4.4.2 Mineral deposit) will be added. Besides, lines 676-679 will be rephrased.

line 723: Please consider adding “ice mass” between the word large and loss to clarify the meaning of the sentence.

→ We will add it.

line 816: I think “Minimax Workshop” should be deleted here.

→ We will remove it.

line 854: Please capitalize the name of the ice cave.

→ We will capitalize it.

line 1034: Please correct the publication date of this paper. 2014 instead of 2013.

→ We will correct it.

## References

Gieseemann, A., Jaeger, H.-J., Norman, A. L., Krouse, H. R., and Brand, W. A.: Online Sulfur-Isotope Determination Using an Elemental Analyzer Coupled to a Mass Spectrometer, *Anal. Chem.*, 66, 2816–2819, <https://doi.org/10.1021/ac00090a005>, 1994.

Rodríguez-Salgado, P., Oms, O., Ibáñez-Insa, J., Anadón, P., Gómez de Soler, B., Campeny, G., and Agustí, J.: Mineralogical proxies of a Pliocene maar lake recording changes in precipitation at the Camp dels Ninots (Pliocene, NE Iberia), *Sediment. Geol.*, 418, 105910, <https://doi.org/10.1016/j.sedgeo.2021.105910>, 2021.