Climate
of the Past
Discussions

CPD

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C2, 2, 6-10: "What I would like to see in the ms is an assessment of the extent to which the fluid inclusion isotope data are in isotopic equilibrium with the calcite…………….. While isotope equilibrium is not a given for many speleothems, at least some consistency is to be expected between d18Occ and d18Ofi." Response: We concur with the reviewer's sentiment that difficulties in the correlation of the time-series are "uncomfortable", and this is why we approach the data by analysing large groups of datapoints rather than using a time-series approach. We are extremely pleased that this reviewer also feels that collection of the fluid inclusion dataset is "technically sound" (C1, 2, 7), and that the general accuracy of the dataset is supported by our quantitative analysis of it compared to modern rainfall isotopes (C2, 1, 1-2). It can only be concluded that these data are a good representation of this isotopic system, even though they look unusual.

We suggest that the apparently poor correlation of time-series likely arises from aliasing of a complicated signal in the fluid inclusions, and emphasise that it is unlikely the data presented are sufficiently resolved to demonstrate the two datasets actually have different structure. The correlation of the datasets is therefore ambiguous, rather than disproven. Sadly, the at least order-of-magnitude increase in the size of the fluid inclusion dataset needed to resolve this point is not realistic: indeed, this Reviewer notes that this dataset is already "comparatively large" (C1, 2, 1). The most appropriate way forward in this situation is to minimise the interpretation of the temporal structure of the fluid inclusion data we present, and this is what we have done. We are pleased that despite their discomfort, this Reviewer supports publication of this "interesting study" (C3, 3, 13-17).

A conventional equilibrium test is difficult to perform for this dataset, as each measurement comprises a mixture of inclusions with different compositions from each layer, and therefore an unknown position on the mixing line between these end members. Should we compute mean values (arithmetic or volume weighted); or extrapolate end members, and test for equilibrium of both? All these judgements require assumptions

we are not in a position to make. Consequently, we are only able to test for equilibrium in the subset of samples where the end members are sufficiently close together for the analysis to be fully "duplicable" (the subset shown in Figure 6). Modern mean winter temperature in Dernah (the nearest city to Susah Cave) is 11.9oC, with maximum 17.7oC and minimum 7.1oC. These fluid inclusions are therefore certainly at least close to isotopic equilibrium with the carbonate hosting them.

Table R1 (see attached)

C2, 2, 17-19: "It would perhaps be useful if the authors discuss that a bit more in the context of the interpretation of their record". Response: Agreed.

C3, 1, 5-10: "Bringing a third water source in, as is suggested in the ms, cannot really be supported by the data from my perspective. . . . . One could perhaps argue that slight isotope changes within each of these moisture sources can cause similar isotope patterns?" Response:, The Reviewer agrees with our analysis that the data does show a mixing pattern of western and eastern Mediterranean sources (C3, 1, 4-5). So, we assume the 'third source' mentioned above is therefore the Atlantic external water we argue for, and find in relatively small amounts. We happily agree this is the most speculative part of our analysis. However, we also note that finding no Atlantic moisture at all in this dataset is a rather more startling interpretation than our suggestion that we find only a little. Atlantic-sourced moisture contributes to rainfall in central northern Africa today, and this mode of rainfall has previously been argued to be greater in past humid phases (Toucanne et al., 2015). We therefore find this point of speculation actually rather conservative in its nature.

C4, 2, 1-2: "I'd like to know where your duplicable samples from Fig. 6 are located in the stalagmite (stratigraphically). All in one period, or distributed all over?" Response: See Table 1. All three Growth Phases are represented by at least one fully duplicated sample.

C4, 2, 2-4: "Do you have a better correlation with the d18O values of the carbonate

when you consider the duplicable dataset only?" Response: Beyond the differences between the three phases (see next response), it is difficult to judge whether there is true correlation between the reduced fluid inclusion dataset and the calcite isotope dataset, because the former is rather small. To make interpretations based on such a "correlation" would seem to us rather speculative. We are safer limiting the discussion of the time series.

C4, 2, 4-5: "Further, I'd like to see if, based on the duplicable set only, one can still observe clear differences between the three wet intervals." Response: The sample from Phase II is more depleted both in ïAd'18Ofi and ïAd'18Occ than any of the samples from Phases I and III, which show similar compositions. Our interpretation that the water driving this middle growth phase is different to the other two is therefore supported by this additional analysis.

C4 paragraphs 3, 4 and 5: "Figures" Response: See response to Reviewer 1.

C4, 6, 1-2: Error in text. Response: Correction will be made.

C4, 7, 1-5: "It would be interesting to know. . . . . could you have any sea spray effect?" Response: Given that we find no clear signal (or indeed, no variance beyond measurement uncertainty) in the Sr isotope record, these points cannot alter the interpretation and we are consequently unclear about their relevance (?).

C4, 8, 1-2 continued to C5, 1, 1-5: "Towards the end of the discussion, d13CC plays an important role. These data, however, are not shown. . . . . Shouldn't d18Ofi do the same as d2Hfi if your claim is correct?" Response: ïAd'13Ccc is actually shown, within Figure 8b. We do make greater use of ïAd'2Hfi towards the end of the discussion, because we are attempting to use the fluid inclusion data to better understand the carbonate isotope datasets, and hydrogen cannot be measured in carbonate and therefore provides valuable independent evidence of changes. As the fluid inclusion isotopes do correlate, it is indeed true that the ïAd'18Ofi shows a similar pattern.

C5, 2, 1: "Your statement in line 392 to 394 is not clear to me. Response: We will clarify that statement.

References

Sharp, Z.: Principles of stable isotope geochemistry, 2017.

Toucanne, S., Angue Minto'o, C. M., Fontanier, C., Bassetti, M.-A., Jorry, S. J., and Jouet, G.: Tracking rainfall in the northern Mediterranean border-lands during sapropel deposition, Quaternary Science Reviews, 129, 178-195, http://dx.doi.org/10.1016/j.quascirev.2015.10.016, 2015.

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2018-134, 2018.

Table R1

Duplicated Sample	Mean $\delta^{18}O_{fi}$	Mean $\delta^{2}H_{fi}$	Distance From Base (mm)	Age	$\delta^{18}O_{cc}$	Temperature (°C)[1]	Growth Phase
9	-4.35	-21.51	15-20	66394-66388	-3.78	13.3	I
11	-5.69	-19.95	56-61	66493-64393	-3.96	8.7	I
18	-5.92	-21.75	109-118	63487-63302	-3.98	7.9	I
23	-5.45	-25.62	260-267	59106-58490	-4.51	11.8	I
25	-5.38	-25.54	395-400	51687-51648	-5.21	15.0	II
33	-4.70	-26.72	556-561	37260-37221	-4.37	14.3	III
29	-5.08	-22.72	597-602	36957-36921	-4.6	13.7	III
35	-5.03	-21.37	652-657	36581-36284	-3.82	10.8	III
7	-4.96	-23.74	767-772	35688-35647	-4.32	13.1	III

[1] Calculated using the equation presented by (Sharp, 2017).

Fig. 1. Table R1