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## **Review of the Manuscript entitled “Hydroclimatic variability of opposing late Pleistocene climates in the Levant revealed by Dead Sea sediments” by Yoav Ben Dor and co-authors.**

Anonymous Referee #2

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Referee comment on "Hydroclimatic variability of opposing Late Pleistocene climates in the Levant revealed by deep Dead Sea sediments" by Yoav Ben Dor et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2020-161-RC2>, 2021

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### **General Comments**

The preprint by Ben Dor et al. presents relevant scientific questions which are within the scope of Climate of the Past. The abstract gives a good summary of the work, which is well written, and has a good structure. The authors present a novel data set of microfacies analysis in two distinct time intervals of the Dead Sea geological history. The time frames were chosen to encompass periods of lake level rise (approx. 18kaBP) and lake level fall (approx. 27 kaBP), which have been proved to react climate sensitively by several previous workers in the region. The microfacies analyzed therein are mm to sub-mm laminae couplets composed of aragonite and detrital sub-layers, and the latter may show several sub-divisions of detrital pulses. In each of the selected time frames, an interval with 700 laminae couplets was counted. The indexes obtained in such a microfacies analyses were the thickness of the individual sub-layers (aragonite and detrital), and hence also implicitly a 'total' thickness, and the number of detrital pulses in one sub-layer. This generates two time-series which potentially hold climate information of distinct synoptic trends, a deglacial situation, and a Heinrich event.

One aspect of this work is that a heavy load of statistical analysis hides a bit the premises of the geological interpretation. I think the work would benefit from clarifying the knowledge vs. assumptions about the formation of the laminae couplets, and based on that, a fair discussion about what are the inherent limitations of the analysis. The thickness of the aragonite laminae are taken to represent the annual inflow, and the detrital pulses the flood frequency. While the identification of the flood frequency is straightforward, the controls on aragonite precipitation in the Dead Sea are still debated. Also, in face of recent findings and discussion about the nature of the laminations in the Dead Sea sediment record; I would recommend tackling the following issues:

(i) in brief: why can these laminae couplets be used as annual record. At the same time,

it's worth reflecting whether an annual character of the time-series is needed a priori for the proposed discussion, or if it can result from it.

(ii) clear statements on the bicarbonate and alkalinity sources to the Dead Sea, that ultimately contribute to aragonite precipitation. Even under the simplest assumption that these are only hydrological in nature, aren't the floods themselves also a source of bicarbonate? Thus, how can the proxies be 'independent' as proposed in L110-115; L440-449?

(iii) Moreover, it was recently shown that calcite dust is an important bicarbonate source in the region, and exerts control on aragonite precipitation in the Dead Sea. This of course adds complexity to the issue, given the logical implication would be that the thickness of the aragonite laminae is not exclusively under hydrological control.

Thus, my concern is that by targeting a hydroclimate interpretation per premise, the work may lose some important information on the way. I think this detailed dataset can make a very relevant contribution to the Levant Paleoclimate already by searching for answers to the superordinate question about the climate-type-signal contained in the laminae couplets. It would be nice to have at least clear statements about the pointed-out topics (i-iii).

### **Specific Comments**

L17-18: "aragonite ... serve as a proxy of annual inflow (...), whereas detrital laminae (...) record floods": How can floods and the annual inflow be differentiated by the proxies given that the first also contribute to the ionic sources of aragonite precipitation? Also, what is the mineral composition of the detrital sub-layers, do they contain carbonates? Eventually treat the time-series as sub-sets, or inter-dependent?

L14&54: briefly explain why these laminations can be regarded as having annual character. Or is this perhaps something to be explored, in face of recent discussions? One possibility would be treating the time-series as a floating chronology, and search for pattern-types that might support the annual character. Arguments supporting that arise for example from statements such as on L398-399 and L364 (however independent records), about the encountered periodicities.

L80-90: This paragraph tries to connect the different microfacies with the different synoptic climate features. However, a distinct causality between aragonite/detrital sub-layers, and the Mediterranean cyclones/Red Sea troughs/subtropical jet streams, remains unclear. This is rather a subject for the discussion.

L110 -115: while the hydroclimate variables might be independent; the proxies obtained herein have some degree of dependency (aragonite sub-lamina thickness, and number of detrital pulses). Aren't the floods also sources of (bi)carbonate ions, and thus won't they contribute to the aragonite thickness? And this is regardless of the timing of aragonite precipitation. I think this is one of the aspects that needs some more reflection within the discussion below.

L440-449: This part of the discussion would benefit from additional reflection/explanations.

L445: What properties? What frequency? Is the frequency relatable to the encountered flood frequency? Here it remains unclear why Red Sea troughs and active subtropical jet stream disturbances contribute to the flood frequency, but not to the annual inflow. While this might be true from a hydroclimate perspective, how does it translate to the sedimentary system?

### **Technical Comments**

Figure1: This Figure has a lot of information in it, a good amount of which can only hardly be recognized. Ideally 1A and 1C would make a good combination; and then 1B, D and the microfacies in a separate Figure.

L37: "available data", do you mean historical series?

L49: "mild and wet"; "dry and hot"; replace/complete with defined meteorological information

L50: What properties? Re-phrase.

L60: "The segments were continuously sampled(...)" ; segment length? Thin section length? Overlap? Some more details would be nice here. Place in L135

L61: "high-resolution microfacies": aren't the latter high-resolution per definition?

L77: " (...) or gypsum are (...)" sentence is incomplete

L80: specify what is meant with the "climatic gradient"

L81: are perhaps "sediment transport-paths" meant?

L82: a call to Figure 1c would be helpful here

L92: it would be helpful to have the timing of Lisan/Dead Sea evolution stated here

L97&100: consider replacing "exposures" by "outcrops" here (if natural).

L109: " (...) may form both (...)": do you mean " (...) may be triggered by both (...) " ?

L135: "continuous thin sections" ? or "thin sections were sampled continuously" ? some more details would be nice here. See also L60.

L137: The details and text in Figure S1 are not intelligible.

L140: the call to Figure 2 at this point is confusing, because therein results are given. Better to call the microfacies panels within Figure1.

L157: what is Appendix B? There are Supplement 1, 2, and over 30 Figures...

L159-160: echo to 'visual inspection'

L164-178: the amount of supplement figures called in one paragraph (10) and their order (not chronological), are not helpful, but rather distracting to the reader.

L221-226: seems somehow incomplete. Would be nice to have a sentence on the differentiation between the ERDs and the detrital (sub-)laminae; and at least a brief microfacies characterization of the detrital (sub-)laminae. Mineral components?

L228: "2259  $\mu\text{m}$ " Be consistent with the 'thousand' separator for the laminae thicknesses

Supplement materials: while I appreciate the detailed statistics and the effort of the authors to guide the readers step by step through it in the method section, I would suggest reducing the number of supplements from the given 34 pages, to what can be considered essential for the main message of the work.