Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2018-476-AC2, 2019

Interactive comment on "Ostracods as ecological and isotopic indicators of lake water salinity changes: The Lake Van example" *by* Jeremy McCormack et al.

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Received and published: 15 March 2019

C Neil Roberts (Referee #2) Referee comment: This is really nice study which combines some detailed and critical evaluation of their data sets (e.g. sampling sizes, potential biases due to vital effects, etc) with evaluation in terms of wider issues of Quaternary climate reconstruction. I am not an ostracod specialist so cannot comment in any detail on this aspect of the paper, and instead will focus my comments on the stable isotopes, carbonate mineralogy and climate stratigraphy. The stable isotope record of the PALEOVAN core record has been a bit of a puzzle. The pre-PALEOVAN core record from Lake Van, covering the last ∼15 ka and based on bulk carbonates, showed good overall correspondence to other lake isotope records from SW Asis (Roberts et al., Quat Sci Rev, 2008). However, the bulk carbonate isotope data for the PALEOVAN cores, older than ~15 ka BP, made no real sense, either in comparison with other proxies from the same cores (e.g. XRF Ca/K ratio) or with other sequences from the same climate region. Potential explanations for this discrepancy included isotopically-light glacial meltwater or inwash of detrital carbonate. The authors here focus on an alternative explanation, namely fractionation effect due to changes in carbonate mineralogy. They show, 1) that ïAËŻd’18O and ïAËŻd’13C measurements on ostracod shells do not correlate with equivalent stable isotope measurements on bulk carbonate, 2) that instead they correlate well with other proxies from the same core, 3) that there have been important shifts in carbonate mineralogy through the core sequence. The resulting hydro-climate reconstruction makes a lot more sense, with more positive isotope values (and low lake levels) during the last glacial stage (70-15 ka BP).

Authors response: Thank you for your approval of our work!

Referee comment: The effect of carbonate mineralogy on isotope values is most marked for dolomite, whose fractionation factor is substantially different from either calcite or aragonite. The authors might want to cite other studies where this has also been demonstrated (e.g. Nar lake, also in Turkey – Dean et al., Quat Sci Rev 2015). In contrast, the difference in the mineral-water fractionation factors of calcite and aragonite is small (ïAËŻd’18O of aragonite is 0.7‰ more positive than ïAËŻd’18O of calcite formed in the same ïAËŻd’18Olakewater and temperatures; Grossman and Ku, 1986; Kim et al., 2007), so seems unlikely to explain the much bigger offset between ïAËŻd’18Oostr and ïAËŻd’18Obulk in Lake Van.

Authors response: Differences in the fractionation factors alone are not enough to explain the isotopic differences between these inorganic carbonate phases (calcite, aragonite, dolomite). In another manuscript dealing with the bulk isotope record (McCormack et al., 2019) we demonstrate, that all three inorganic phases precipitate in isotopically variable parent waters. Dolomite precipitates during early diagenesis in cold bottom/porewater (resulting in variable δ13C and high δ18O values; see also McCormack et al., 2018). Both, calcite and aragonite precipitate in surface water, for which the isotopic composition is changing throughout the year. Calcite precipitates in spring, under close-to-freshwater-conditions within river plumes (resulting, in respect to aragonite, in lower δ13C and δ18O values), while aragonite precipitates in summer under evapoconcentrated conditions (resulting, in respect to calcite, in higher δ13C and δ18O values). The bulk δ18O values represent isotopically mixed signals shifted towards the volumetrically dominant inorganic carbonate mineral within a given sample (see page 11, lines 27-33). We suggest that the isotopic composition of ostracod valves document hydrological changes more faithfully than bulk samples integrating spring, δ18O-lower calcite and summer δ18O-higher aragonite values.

Referee comment: Although, in general, the new isotope, carbonate mineralogy and ostracod data match other data sets well, I think it would be worth highlighting those time periods when they do not match so well. For example, the end of MIS6 in L Van shows high % Candona and a low ACE index, both suggesting relatively high lake levels, in contrast to previous interpretations, and also in contrast to the last glacial period (MIS 2 and 4). MIS 5a also seems a bit mixed, with some indicators showing high lake levels (e.g. ïAËŻd'18O and ïAËŻd'13C) but others indicating low water levels (e.g. ACE index).

Authors response: This comment touches on an interesting question. The end of MIS 6 is characterised by very low ACE values, and the highest abundance of Candona, throughout the record, pointing to low salinity. However, the lithology implies a falling or low lake level. Based on diatom assemblage analyses North et al. (2017) suggested that during MIS 7e Lake Van has been hydrologically opened, though for a shorter time than during the MIS 5e. Here the difficulty lies in the data gaps – while North et al. (2017) present only discrete interval during MIS 7 our record starts only in MIS 6. None of our data is quantitative but we can imagine that MIS 6, following the MIS 7 period of hydrological opening was less dry /more humid than MIS 4 or 2. Consequently,

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although the lake level was relatively lower, and salinity relatively higher, it neither surpasses the ecological threshold of Candona, nor reached the one for halophilic euryarchaeota (ACE index) or Limnocythere sp. A. Following this scenario, the short-lived salinity increase during MIS 5d likely resulted in unfavourable conditions for Candona. This tentative explanation is supported by a near constant porewater salinity of approximately 20 g/kg found below a sediment depth of 100 m. Tomonaga et al. (2017) suggested a long-term balance between the salt input from rivers and the salt export resulting from burial in the sediments. Meaning, that for most of Lake Van's history salinity changes were probably less severe compared to the Last Glacial Period (which is accompanied by the disappearance of Candona and the emergence of Limnocythere sp A and heavily noded limnocytherinae). In this regard, it would be very interesting to investigate the taxonomy, morphology and geochemistry (isotopy and trace element content) of ostracod valves in the older sediments. Particularly interesting would be to see whether Candona is a frequent component of the ostracod assemblage in the older sediments as suggested from the porewater salinity profile.

As for the ACE index and MIA 5a, it was suggested by Randlett et al. (2017), that this proxy responded non-quantitatively in a binary way with low values (i.e. no archaeol from halophiles) indicating fresh(er) water conditions versus high values indicating the presence of halophiles at higher salinity. From combined salinity proxies (ostracod valves, ACE index and porewater salinity) we can tentatively estimate a general slow rise in salinity throughout MIS 5c to a, interrupted by lake level highstands, and followed by a stronger salinity increase throughout MIS 4-2. Further studies are required to estimate the sensitivity of each record to short time lake-level fluctuations and the duration of highstands.

Referee comment: Overall, though, I don't see much here that needs changing before full publication.

Authors response: Thank you very much. We appreciate your positive feedback.

Authors response references:

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