

## REVIEWER 1

**Review for Harning et al.** “High-resolution Holocene record based on detailed tephrochronology from Torfdalsvatn, north Iceland, reveals natural and anthropogenic impacts on terrestrial and aquatic environments”

**Structure of review:** A. Summary, B. Minor comments

### A. Summary

Harning et al. have effectively incorporated most of the reviewers' feedback, thoroughly addressing and responding to all suggestions. Notably, the title, abstract, and introduction now appropriately incorporate tephrostratigraphy, enhancing the manuscript's thematic coherence. The methods section has also been reorganized, presenting a clearer and more structured approach than in the initial version.

Despite the density of the manuscript, which still presents extensive datasets that could constitute two independent papers, I found it engaging and insightful.

I am pleased to recommend it for publication, pending the authors' addressing of some minor comments.

We kindly thank the reviewer for their continued time and effort providing detailed suggestions for manuscript improvement. Below we address each of their comments in blue.

For what it's worth, we also agree this could be two papers! However, a previous attempt to publish this as paired manuscripts (tephra and paleoclimate) was unsuccessful with reviewers suggesting it be merged into one...

### B. Minor Comments

#### 1 Introduction

L34: "...have analyzed physical..." Have the empirical records analyzed the properties?

Changed to "include"

L57: "Icelandic lake sediment studies provide optimal archives..." do the studies provide archive, or the sediments?

Removed "studies"

#### 2 Methods

From an organizational perspective, the manuscript is now concisely structured.

Thank you for the feedback.

#### 3 Results

L237: As your Fig. 3b shows, the SAR is not linear, but you have variations from 0.001-0.25, which is >20- fold of variation. This substantial variability could influence the interpretation of sedimentary fluxes and patterns.

My question about MAR from the first round has been replied to as follows: “Due to the linear sediment rate, calculating fluxes does not alter the structure of the proxy curves and therefore does not provide any difference in plots than those shown in the figures presented. This point was already made in the original manuscript. See L300.” While this explanation is understandable, it overlooks the considerable variability in SAR noted in Fig. 3b. MAR (mass accumulation rate, expressed as mass per area and year, e.g.,  $\text{g cm}^{-2} \text{yr}^{-1}$ ) differs from SAR (sediment accumulation rate, e.g.,  $\text{cm yr}^{-1}$ ). Typically, substance fluxes are calculated using MARs. Given the changes in the sedimentary matrix (minerogenic versus biogenic, as you have nicely detailed in your manuscript) and the variations in Corg, alongside changes in SAR, it is reasonable to anticipate a different flux pattern compared to the concentrations. I suggest calculating these fluxes and presenting the results in the supplementary information. If they are substantially different (in terms of trends), it would be interesting to see whether they would change the interpretation of the dataset.

We apologize for the confusion from the initial round of reviews. We had mistakenly calculated MARs without incorporating density into the equation. We have now added MARs for C, BSi, and algal pigments in the supplementary information for the reader's reference (Fig. S5) and reference them in the results although we retain our discussion focus on the relative changes and concentrations.

#### 4 Discussion

The first paragraph (L316–327) primarily describes and quantifies the tephra layers in a descriptive manner. To enhance the flow and logical structure of the manuscript, I recommend moving this section to the results section. Consequently, the first paragraph of the discussion (starting at L328) should be adjusted to reflect this change and maintain coherence.

Thank you for the suggestion. We have moved this paragraph to the Results Section 3.1 – Tephra stratigraphy and age model.

L323: I couldn't find the Veidivötn-B in Table 2 (also comment later)◇make sure to be consistent with IDs

Veidivötn-Barðarbunga tephra shards are present in some of the mixed tephra layers, as denoted in the second column of Table 2. As no tephra layers are dominantly from the V-B volcanic system, we have removed the V-B footnote from Table 2. We hope this clarifies the issue. However, in L323, we do provide reference to the supplemental material where these V-B tephra shards are described in detail.

L370: “have low C/N (7 to 26) and high  $\delta^{13}\text{C}$  values...”◇add “relatively”◇“relatively low” and “relatively high” values

Edited

L379: “...as they reflect all taxonomic groups...” remove “all” ◇ ...as they reflect taxonomic groups...

Edited

L392: in front of 10,000 is there a double spacing? Use search&find function in word processor to find and remove double spacing.

We searched and found no double spaces.

L479: are there other confounding factors influencing the abundance of cyanos, e.g. anoxic periods?

We do not currently have information on past anoxia from this lake but it is the motivation of some pending work.

L568: “the contaminant rise...” is this speculative? Rephrase it to anthropogenic landuse, or pressure or similar.

Contaminant was an error – meant to read “concomitant”. This has been corrected and aligns with the reviewer’s suggestion.

## 5 Conclusions

L573: “high-resolution age model” is overselling here. Varves would be high resolution, or age control every 100 years, here it is every 550 years.

High-resolution edited to “detailed”.

BTW. In Figure 2 I only count 18 age markers, but you claim that there are 22 in the conclusion, and in the figure legend you describe 20, what is correct?◇be consistent

Apologies for the confusion. There are 20 age control points. 22 was mistakenly written and two PSV tie points were accidentally not marked as they overlapped with 14C ages. These issues have now been fixed.

## Supplementary data

The supplementary material provides a comprehensive and well-structured tephrography, which is clear and informative. I also appreciate that the data tables are now accessible. However, I noticed that the cluster coordinates for the tephra layers (e.g., 'Hekla') are not provided in a tabular format. Including these coordinates in a spreadsheet would enhance the utility of the supplementary data for future users.

Aside from this, the collection of biplots is exhaustive and very well done—great work!

The cluster coordinates are usable for any potential user through the plots provided in the supplement. We are still working to publish this database as a formal study that will include such data so that users can plot volcanic source fields in their preferred software.

Thank you for the feedback!

## Minor comments - Figures

### Figure 3

- How many control points? I count 18 in the figure, see 20 in the figure caption, and 22 in the conclusion section...

20 – see reply above

### Figure 4

- The PCoA Axis 1 curve (plot f) seems to be cut-off in the Early Holocene, is this on purpose?

We apologize for the error cutting of the data slightly. The y-axis has been expanded to include the Early Holocene data.

- Suggestion: Add vertical lines, such as dashed lines, at regular intervals (e.g., every millennium) to facilitate readability of the years.

We tried this suggestion during the first round of revision and found it made the plots too busy with the other bars and guided annotations. As such, we prefer to not add these to this paper.

### Figure 8

- Increase scale bar (on the left of the figure), it is not readable as is

Edited

## Minor comments - Tables

### Table2

- Action: Add a column containing the core-ID to facilitate finding the tephra layers in Figure 2. This hasn't been implemented yet.

Only two tephra layers from Table 2 are used in the age model (H 1766 and H 1300). To facilitate easier connection between the two, we have removed abbreviations in Table 2 for tephra names.

- In the footer of the table you describe "V-B, Veidivötn...", however, there is no Tephra ID visible in the table, either remove this, or add the tephra layer.

Following an earlier related comment we have removed V-B from the footnote.

## REVIEWER 2

1. 1) Scientific significance: excellent (1)
2. 2) Scientific quality: excellent (1)
3. 3) Presentation quality: excellent (1)

For final publication, the manuscript should be: accepted subject to **technical corrections**

### Summary:

The current version of the manuscript and the response to reviewers document nicely address my comments on the original manuscript. The figures are excellent. Below are a few follow-up minor comments (line numbers based on those in the track changes document). I support accepting this paper after these technical corrections are made.

Thank you for the opportunity to review this work.

We kindly thank the reviewer for their continued time and effort providing detailed suggestions for manuscript improvement. Below we address each of their comments in blue.

### Minor Line Comments:

L19: consider listing pigments of interest in parentheses

L32: consider adding “for paleoclimate reconstructions” or “for these studies” to clarify why Iceland is an “ideal location”

L105: a key template for what? Being specific here would be good.

L310: add “are” to “are inversely correlated”

L317: “be” should be “by”

L564: “is” should be “are”

L572: consider including the correlation statistics ( $p$ ,  $R^2$ )

L766: I think you mean “concomitant” rise in Iceland’s population instead of “contaminant”?

All line comments edited

### Minor Figure Comments:

**Figure 1:** it is unclear what the yellow dotted/dashed line indicates, please specify in caption or legend

The yellow dotted lines were remnant from an older version of the manuscript that is not discussed here. We have removed them now.

**Figure 2:** in the figure legend and caption, are the calibrated ages mean or median? They both indicate mean, but I believe they might be median based upon Table 1.

14C ages are presented as mean  $\pm 1\sigma$  as written

**Figure 4:**

- it looks like the highest value in panel f got cut off around 10,000 cal a BP

We apologize for the error cutting of the data slightly. The y-axis has been expanded to include the Early Holocene data.

- TLF is explained as tephra layer frequency, but it is unclear what exactly this is in relation to. Are the units per year? Per hundred years? Same comment for Figure 5

TLF is the number of events identified in each tephra layer (see Table 2). We have now clarified this in captions for Figs 4 and 5.

**Figure S5 and S6:** consider adding the PCoA loadings of different variables onto these plots so that readers can evaluate where datapoints lie in relation to different variables.

Added