Comments on

"Seismic and sedimentological evidence of an early 6th century AD earthquake at Lake Ohrid (Macedonia/Albania)"

by

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Major comment :

In their manuscript " Seismic and sedimentological evidence of an early 6th century AD earthquake at Lake Ohrid (Macedonia/Albania)", Wagner et al. present seismic reflection and core data of .Lake Ohrid. This manuscript is interesting, clearly written and the results are well exposed. However, I suggest some minor but needed changes and corrections which are listed in the 'major comments' and 'minor comments' parts.

The manuscript is interesting and presents a nice piece of research. I agree with the authors on the fact presented data that :

1. At least four mass wasting units are imaged by seismic data.
2. Sediment core 1262 reveals a mass wasting deposit which correlates to the upper mass wasting unit revealed by seismic data.
3. A tephra layer, which underlies the mass wasting deposit, dates from 472 or 512 AD and thus gives a maximum age for the mass wasting deposit.
4. A mean sedimentation rate of 1 mm/yr can be deduced from the above sediment sequence, which indicates, if the sedimentation rate was constant, that the mass wasting deposit must be from the 6th century.
5. Other archives (historical ? archeological ?) mention three earthquakes which could possibly have caused the mass wasting event.

However, from the presented data and manuscript, **other possible causes for this mass wasting deposit were NOT discussed**. This is the weak point of the article. A thickness map of the mass wasting deposit to indicate where it probably started, thus also leading to better interpretation, would be a nice to add.

Usually, an earthquake-related trigger is proven when multiple mass wasting units/deposits occur at the same stratigraphic level in the lake basin, and/or when other causes, such as changes in lake-level, delta collapse etc., are discussed and can be excluded. This is not the case in this manuscript. Thus, from the presented data, the article's discussion and conclusion need to be changed with the following content:

A) the 6th century earthquakes must be described as a possible cause of the youngest mass wasting deposit.

B) a short discussion on other possible causes must be included (spontaneous failure-earthquake or climate related etc.), taking example of discussions in publications from the same field (Girardclos et al. 2007; Kremer et al. 2012; Schnellmann et al. 2006; Strasser and Anselmetti 2008).

Girardclos S., Schmidt O.T., Sturm M., Ariztegui D., Pugin A. and Anselmetti F.S. 2007. The 1996 AD delta collapse and large turbidite in Lake Brienz. Marine Geology 241: 137-154.

Kremer K., Simpson G. and Girardclos S. 2012. Giant Lake Geneva tsunami in AD 563. Nature Geosciences doi:10.1038/ngeo1618.
Schnellmann M., Anselmetti F.S., Giardini D. and McKenzie J.A. 2006. 15,000 Years of mass-movement history in Lake Lucerne: Implications for seismic and tsunami hazards. Eclogae Geologicae Helvetiae 99: 409-428.
Strasser M. and Anselmetti F.S. 2008. Mass-movement event stratigraphy in Lake Zurich; A record of varying seismic and environmental impacts. Beiträge zur Geologie der Schweiz. Hydrologie 95: 23-41.

C) As a consequence, the title, and the abstract also need to be changed. New title ideas :

"Seismic and sedimentological evidence of early 6th century mass wasting deposit at Lake Ohrid (Macedonia/Albania)."

Or

"Possible earthquake trigger for 6th century mass wasting deposit at Lake Ohrid (Macedonia/Albania)."

Minor comments :

Abstract

Please rewrite completely the abstract taking in account all the modifications done in the manuscript.
For example, you can't write that "Here, we provide an example of linking tephrostratigraphic information and environmental changes with tectonic activity and anthropogenic impact." As you really don't bring new data or discuss in detail the anthropogenic impact. You also don't "link tephrostratigraphic information with environmental changes" but rather "link tephrostratigraphic information with xxx and xxx proxies interpreted as environmental changes". Also modify "This earthquake is documented in multichannel seismic profiles," by "This mass wasting unit is documented in multichannel seismic profiles,"
Idem change "and cross correlation with other sediment sequences with similar geochemical characteristics of the Holocene." with something like "and cross correlation with other sediment sequences with similar geochemical characteristics of the Holocene, thus allowing to possibly attribute it to one of the three known earthquake in the region in the 6th century"

Introduction

- Figure 1 please add the Mokhra and Galicia mountains (p 4336, line 1), as well as the ESZ (p4336, line 20) on your figure 1.

Methodology

- p. 4337 line 6, mention that it is a future coring site. It is not clear right now that it wasn't completed yet.
- Add a sentence to describe the theoretical vertical resolution of your two types of seismic data.

Results

- You should name the four mass wasting deposits which you are interpreting on your seismic lines. You can call them for example MWD1, MWD2, MWD3 and MWD4. Then use these names throughout the manuscript, the figures and figure captions. This will be more precise than 'lower mass wasting deposit' or 'upper mass wasting

deposit', and will improve the clarity of your work + help future authors to refer to these deposits.

- Figure 4: please highlight the small turbidites with grey background too. 960-980; 548-350 cm.
- P 4340 line 3. Change the sentence with "This is interpreted as the distal turbidite of a mass wasting deposit (for example: Schnellmann et al. 2005)."

Schnellmann M., Anselmetti F.S., Giardini D. and McKenzie J.A. 2005. Mass movement-induced fold-and-thrust belt structures in unconsolidated sediments in Lake Lucerne (Switzerland). Sedimentology 52: 271-289.

- P 4340 line 4-5. Modify the sentence as follows "These deposits are, however, likely too small to be visible in the hydro-acoustic data due to their dm-scale (? please indicate the right value) vertical theoretical resolution."
- P4340 lines 5-15 Please rewrite this long paragraph starting from the overall description and then going into details.
- P4340 line 15-17 please add a sentence at the end to say how you are interpreting this upper layers.
- P4340 line 21-22 change "allow a good chronological control of the entire core and the mass wasting deposit between 320 and 121 cm depth." with "allow a good chronological control of the entire core and specifically of the mass wasting deposit MWDx (complete name !)"
- P.4340 line 24 please changes into "reaches back into the last glacial or Late Glacial period"
- P.4341 line 2, please add one more sentence including a ref to explain why you interpret data this way "The TIC and Ca minima around 750cm are likely correlated with the 10 Younger Dryas cold reversal."
- P.4341 line 16-18, I don't understand what you want to say with this sentence "The distinct increase of Ca counts and TIC suggest sedimentation during Holocene times after Mercato deposition and is similar to other sediment records from Lake Ohrid". Please complete or rephrase.
- P.4341 line 22-24, to add clarity please change into "High TIC and Ca characterize the period after the 8.2 ka cooling event and are explained by warmer temperatures, higher carbonate precipitation and better carbonate preservation".
- P.4341 line 28, add Coltelli et al. 2000 in the ref list !
- P.4341 line 29 - p.4342 line 1. "A significant decrease of TIC and Ca around ca. 2500 cal yr BP was observed in other cores from Lake Ohrid (Fig. 4), when anthropogenic impact led to higher erosion in the catchment and increased the clastic matter input into Lake Ohrid." : I don't see how you can interpret this without explaining it. Please discuss this interpretation in detail, exploring other possibilities, to explain why this is the best explanation.
- p.4342 line 20, Change "Right on top of the 472/512 AD tephra," by "Above the 472/512 AD tephra,"
- p.4342 line 24, change "or 2500 cal yr BP" by "(2500 cal yr BP)
- p.4343 line 3-4, change "Although the bioturbated structure of the sediment core and the impossible the differentiation between the 472AD and 512AD tephra do not allow …" with "Although the bioturbated structure of the sediment core, as well as the impossible differentiation between the 472AD and 512AD tephras do not allow …"
- p.4343 line 20-22, "and are relatively high compared with other sites from the northeastern or southeastern part of the lake." Please give indication of the values, quantify your comparison.

- p.4344 line 3-4, add refs as follows “and/or contourite drift as observed in Lake Prespa nearby (Wagner et al., 2012) and in many other lakes (amongst others; Gilli et al. 2005; Girardclos et al. 2003).”

Gilli A., Anselmetti F.S., Ariztegui D., Beres M., McKenzie J.A. and Markgraf V. 2005. Seismic stratigraphy, buried beach ridges and contourite drifts: the Late Quaternary history of the closed Lago Cardiel basin, Argentina (49°S). Sedimentology 52: 1-23.

Girardclos S., Baster I., Wildi W. and Pugin A. 2003. Bottom-current and wind-pattern changes as indicated by Late-Glacial and Holocene sediments from western Lake Geneva (Switzerland). Eclogae geologicae Helvetiae 96: 39-48.

- p.4344 line 10, Does the ‘Udenisht Slide’ figure on your seismic lines ? or on your map (Fig. 1) ? If yes please indicate this on both. If not, then explain why.
- p.4345 line 4-5, Please change your sentences as follows : “cannot be clearly correlated with the 472AD or the 512AD tephras due to their geochemical overlap. Despite these uncertainties, the lack of apparent erosional discordance…”
- p.4345 line 8-10, change the sentence as follows “This allows a correlation of the of the mass wasting deposit with a historical earthquake, which destroyed the city of Ohrid in the early 6th century AD.”
- p.4345 line 10-12, please change into “However, historical documents indicate three different ages for major earthquake, varying between 518 AD, 526 AD, and 527 AD.”
- p.4345 line 13-17, I don’t understand the following sentence. “The thick mass wasting deposit, which underlies core sequence Co1262, could be a valuable example for an older mass wasting deposit triggered by an earthquake, as most existing sediment records spanning into the last glacial cycle have disturbed sedimentation at the Late Pleistocene/Holocene transition.” Explain what you are meaning and add refs to prove your interpretation.

References

- As already mentioned, add “Coltelli et al. 2000” to the list.
- Don’t forget to complete ALL the refs that are in online, in review or accepted form, such as : Aufgebauer et al.; Damaschke et al.; Lindhorst et al. 2012a; Wagner et al. 2012, Zanchetta et al. And remove those which are not published yet.

Figures

Figure 1: As already mentioned, add mountain names and ESZ zone of the map.

Figure 2: As already mentioned, number the MWDs and use those labels everywhere in the text. What are units A,B and C. Either explain in the text and caption, or remove from the Figure.

Figure 3: add labels (i.e. names) from the above mentioned MWDs on this figure.

Figures caption

Figure 1: “as well as coring locations Co1204 and Co1215 from former field campaigns at Lake Prespa (add refs) “