

***Interactive comment on “Spatial variability of  
recent sedimentation in Lake Ohrid  
(Albania/Macedonia) – a complex interplay of  
natural and anthropogenic factors and their  
possible impact on biodiversity patterns” by  
H. Vogel et al.***

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Reply to Ref #2 (Andreas Dehnert)

We took all comments of Andreas Dehnert into consideration and reply as follows.

General comments by A Dehnert:

C3015

The paper provides spatially distributed surface sediment composition data of Lake Ohrid. The presented study includes novel data which clearly contributes to a better understanding of the recent sedimentation processes in Lake Ohrid and therewith fits well into a quantity of articles focused on Balkan lakes Ohrid and Prespa. The authors have analysed selected proxies (e.g. geochemical parameters, element concentrations, and grain-size distribution) to support the given interpretations and conclusions. However, it is not stated why these used proxies were chosen, and the reader somehow gets the impression that these data were specifically chosen to support some stated conclusions (e.g. a counter-clockwise surface current). A major issue of this paper is the incomplete presented grain-size data. This hampers a comprehensive discussion of the observed sediment composition and its spatial distribution. Figure 3 should therefore be replaced by a complete series of sub-figures showing all gathered data of this study (see detailed comments on Fig. 3) and the text should be supplemented with an elaborated discussion including grain-size data and other controlling processes than a surface current (e.g. turbidity currents or bottom currents). The chosen title of this paper allows expectation of an extensive discussion on the ‘possible impact on biodiversity patterns’ of Lake Ohrid, deduced from the data gathered in this study. The corresponding chapter, however, includes a general literature discussion without using the new surface sediment data. Please include your data in this discussion (see detailed comments on P3921 L1) or change the title of your paper accordingly.

Replies to general comments In accordance with A Dehnerts suggestions we added a full suite of interpolated spatial distribution maps for medium sand, fine sand, very fine sand, very coarse silt, coarse silt, medium silt, fine silt, very fine silt, and clay. We now added a discussion why we have chosen a selected suite of parameters and added a set of supplementary figures showing data previously not shown in our manuscript. We are aware of the fact that there might be other processes, such as catastrophic mass movement processes and bottom water currents, controlling sedimentation in large and deep lakes and potentially also in Lake Ohrid today. However, based on the admittedly small set of data, which unfortunately excludes data from long-term flow

C3016

velocity monitoring studies, we have at hand in combination with the rather scarce literature data available, we find our assumption that a counterclockwise surface water current, driven by the predominance of northerly and southerly winds, as explanation for sediment transport and deposition in Lake Ohrid quite convincing. The assumption of a counterclockwise surface water current as means of transport for clay to fine-sand sized clastic material is relatively well supported by the application of elements from very confined sources as tracers for sediment transport. We are aware of the fact that our previously chosen title might raise some expectations we can, at this stage, not fulfil and changed the title in accordance with the suggestion made by A Dehnert. The title does not include "the possible impact on biodiversity pattern" anymore. We find it appropriate, however, to leave in the discussion which is based on a literature review of basically all available references regarding the topic.

Replies to specific comments and technical corrections by Referee #1:

(1) Referee comment: P3912 L23: Albrecht et al., 2009 is correct, not "2006"

Reply: 2006 is correct. Unfortunately the reference was not listed in the MS. It is now included.

(2) Referee comment: P3913 L3: "Cvijic, 1911" is not in reference list!

Reply: added accordingly

(3) Referee comment: P3913 L27: please refer to Fig. 1 here (see comment on Fig. 1)

Reply: Done accordingly

(4) Referee comment: P3914 L9: change notation to  $m^3 s^{-1}$

Reply: done accordingly

(5) Referee comment: P3914 L15: what do you mean with "irregularly every seven years"?

C3017

Reply: Irregularly every seven years describes the approximate frequency of complete convective mixing in Lake Ohrid over a limited observational period. We now write roughly once per decade according to Matzinger et al. (2007).

(6) Referee comment: P3914 L20:  $mg l^{-1}$

Reply: changed accordingly

(7) Referee comment: P3914 L24: What do you mean with "highly oligotrophic"? Oligotrophic refers already to environments with (very) low nutrient levels. Give a value to confirm the term "highly" or remove it. (c.f. Wagner et al. 2009, J Paleolimnol 41)

Reply: we removed "highly" from the sentence.

(8) Referee comment: Give reference for this statement (e.g. meteorological data)

Reply: We now cite the National Severe Storms Laboratory Historical Weather Data Archives, Norman, Oklahoma, from their Web site at <http://data.nssl.noaa.gov>.

(9) Referee comment: P3915 L12: refer to Fig. 1 here

Reply: Done accordingly

(10) Referee comment: P3915 L16: better also indicate sampling positions in Fig. 2, as Fig. 3 is hard to read (see comment on Fig. 3)

Reply: We added sampling positions to Fig. 2.

(11) Referee comment: P3915 L18: use "plexiglass" or "Plexiglas<sup>®</sup>" or "acrylic glass", not "Plexiglas"

Reply: we now write "plexiglass"

(12) Referee comment: P3915 L22: "X-ray", not "x-ray"

Reply: Changed accordingly

(13) Referee comment: P3915 L25: "Total carbon (TC)", not "TC"

C3018

Reply: Changed accordingly

(14) Referee comment: P3915 L25: “infrared (IR) detector”, not “IR detector”

Reply: Changed accordingly

(15) Referee comment: P3916 L3: add something like “. . . with an IR cell in order to determine the total inorganic carbon (TIC) content.”

Reply: We believe the information given on the description of this standard procedure is sufficient.

(16) Referee comment: P3916 L5: Full word for Al, Cr, and Ni are not necessary; you already used “Cl” on P3916 L2

Reply: In accordance with this suggestion we now only use element abbreviations.

(17) Referee comment: P3916 L7: what did you use nitrous acid (HNO<sub>2</sub>) or nitric acid (HNO<sub>3</sub>)? To avoid further confusion, I suggest to use molecular formula only.

Reply: In accordance with this suggestion we now use molecular formula only.

(18) Referee comment: P3916 L10: again, what did you use boric acid (H<sub>3</sub>BO<sub>3</sub>) or borat acid (H<sub>3</sub>BO<sub>4</sub>)?

Reply: See reply above (17)

(19) Referee comment: P3916 L17: I guess you mean Fig. 3, not “Fig. 2”

Reply: Exactly – changed accordingly

(20) Referee comment: P3916 L20: “X-ray diffractometer”, not “X-ray-diffractometer”

Reply: changed accordingly

(21) Referee comment: P3916 L28: change to “CCD camera” or “CCD element” or “charge-coupled device (CCD)”, not just “CCD”

C3019

Reply: changed to “CCD element” accordingly

(22) Referee comment: P3916 L28: quote at least minimum and maximum values for your grain size classes

Reply: Added accordingly.

(23) Referee comment: P3916 L29: “Calculation of grain-size parameters and statistics . . .” where are these data? (see general comments)

Reply: Data are now shown in an additional supplementary figure.

(24) Referee comment: P3917 L1: give used version number of GRADISTAT if there is one

Reply: We cite “Blott and Pye, 2001”.

(25) Referee comment: P3917 L1: “Blott and Pye, 2001” is not in reference list!

Reply: “Blott and Pye, 2001” is now included in the reference list.

(26) Referee comment: P3917 L2: give version number of SURFER; did you use SURFER only for visualization or also for interpolation? What interpolation method (kriging, inverse distance weighting, . . .) was applied?

Reply: The version number of SURFER (8) and interpolation method (kriging) are now added to the text.

(27) Referee comment: P3917 L13: “. . . with its maximum in the silt size fraction (>80 vol%; Fig. 3).” This is not shown in Fig. 3! (see also detailed comment to Fig. 3)

Reply: In accordance with the reviewer comment we added a whole new set of figures as a supplement.

(28) Referee comment: P3917 L20: “. . . point to a significant transport by wind induced surface currents.” What about other current systems e.g. sub-surface currents, bottom currents, turbidity currents or external factors as common wind directions, . . . ?

C3020

Reply: Although currents at different depths might exist in such a large lake as Lake Ohrid we find our assumption that the observed distributional pattern of element/parameter (from very confined sources) concentration in surface sediments in combination with observations of a wind-induced counterclockwise surface current by different observers (cited in the text) and evidence from satellite imagery is intriguing. In addition we used cautious formulations without intentions to state that this is the "only" mechanism for sediment transport. For completeness we added a discussion of possible other factors like bottom and turbidity currents to the text in accordance with the referee comment.

(29) Referee comment: P3917 L22: use ">0.4 m s<sup>-1</sup>"

Reply: changed accordingly

(30) Referee comment: P3917 L23: use m s<sup>-1</sup>

Reply: changed accordingly

(31) Referee comment: P3917 L24: use m s<sup>-1</sup>

Reply: changed accordingly

(32) Referee comment: P3917 L25: "These own observations ..." How did you do your flow velocity measurements? These measurements/data are mentioned neither in chapter 2 nor in chapter 3.

Reply: We used a qualitative/semi-quantitative approach without involvement of flow meters.

(33) Referee comment: P3918 L1: use m s<sup>-1</sup> (two times)

Reply: changed accordingly

(34) Referee comment: P3918 L4: use g kg<sup>-1</sup>

Reply: changed accordingly

C3021

(35) Referee comment: P3918 L11: Why do you give Al concentrations in "g kg<sup>-1</sup>" but Cr and Ni concentrations in "mg kg<sup>-1</sup>"? Use a uniform unit for all elements (Al, Cr, and Ni) if possible (e.g. "g kg<sup>-1</sup>").

Reply: For better readability we now use "g kg<sup>-1</sup>" as unit for all element concentrations.

(36) Referee comment: P3918 L14: "Based on the distribution of feldspar ..." Why don't you state this in P3918 L10 right after "... catchment is significantly lower."?

Reply: One could also do it as stated in the referee comment but it won't change much except for the order of its appearance.

(37) Referee comment: P3918 L27: "The common pattern of transport ... is primarily driven by a counter-clockwise current in Lake Ohrid." What about grain-size effects?

Reply: Surface currents equally influence grain size distribution. Ni and Cr are enriched or transported along with (coarse) silt-sized material. The source of Ni and Cr is very confined the pattern of their distribution in surface sediment of Lake Ohrid can hardly be explained by grain-size effects. Our newly included figures on grain-size distribution might provide a somewhat clearer picture with respect to this issue.

(38) Referee comment: P3919 L9: I guess you mean "wt%".

Reply: we added "wt" accordingly

(39) Referee comment: P3919 L19: "overall low C/N ratio (<12) ..." but in Fig. 3h you show C/N values of 12.2-14.5. What is correct?

Reply: we changed the text accordingly.

(40) Referee comment: P3920 L5: High TOC values and C/N ratios? What about reduced degradation of OM in the deepest parts of the lake? Have you noticed the positive correlation of TOC and C/N over the entire lake basin; signal of terrestrial input (e.g. by soil)? Beside that grain-size data are not proper presented, can you see any grain-size effects on TOC or TN?

C3022

Reply: Degradation might indeed be reduced in the deeper parts of the basin – this is now added to the text. Except for 5 samples, taken close to riverine inlets, C/N ratios are (well) below 10 (lake algae 6-9, soil organic matter 13-20, Meyers and Terranes 2001) over the entire lake basin. If we now consider the C/N ratio as a tracer for the source of organic matter it seems as organic matter, except for sites close to riverine inlets, is primarily of autochthonous origin in surface sediments of Lake Ohrid. According to our newly included cross-plots grain-size effects are not obvious. In order to improve our manuscript as suggested by the referee comment we have now included a more extensive discussion on factors influencing organic matter (concentrations, sources) in surface sediments of Lake Ohrid.

(41) Referee comment: P3920 L10: remove either “total inorganic carbon” or “(TIC)”

Reply: We removed “total inorganic carbon” accordingly.

(42) Referee comment: P3921 L1: Chapter 4.3 should represent one major part of your study (see title “. . . and their possible impact on biodiversity patterns”. But this chapter is only based on references and not on a discussion of your data. It is hard to follow your arguments without any figure or table. Why don't you show for example some data of Hauffe et al., 2010 or Matzinger et al., 2007 in combination with your own data?

Reply: We intended to raise a cautionary note on recent sedimentation and “their possible impact on biodiversity patterns”. It seems that the inclusion in the title raised high expectations as to a real analysis of such impacts. This however is impossible to date since the sampling design was not prepared for such a task. It was always planned as a discussion topic using the published record available. In order to avoid confusion, we decided to simply skip the part “their possible impact on biodiversity patterns” from the title.

(43) Referee comment: P3921 L9: do you mean Hauffe et al. (2010)? If not: “Hauffe et al., submitted” is not in reference list. Avoid citing unpublished studies and data.

C3023

Reply: We ment “Hauffe et al., submitted” - an article included in the same special issue. The way we cited this article is accordance with suggestions by the editorial board. In the meantime, the very paper has been published in BGD and is cited now with its respective DOI.

(44) Referee comment: P3922 L4: “Albrecht, unpublished data”: do not cite unpublished data, it is not present for the reader and hence not valid for further discussion

Reply: We removed “Albrecht, unpublished data”.

(45) Referee comment: P3922 L19: do you mean Kostoski et al. (2010) (see comment on P3925 L18)? If not: “Trajanovski et al., submitted” is not in reference list. Avoid citing unpublished studies and data.

Reply: The authorship of this particular paper was changed after submission of our article. We changed the citation in accordance.

(46) Referee comment: P3923 L1: “Based on the grain-size distribution pattern, . . .” This pattern is not shown. How can you draw conclusions on data that are not present for the reader?

Reply: Grain-size distribution patterns are now shown in form of a supplementary figure.

(47) Referee comment: P3923 L5: “. . . a counterclockwise rotating surface current can best explain . . .” It is your only explanation. There is no discussion of other possibilities than a surface current.

Reply: See comments above.

(48) Referee comment: P3923 L17: “. . . pose real threats to the primarily benthic endemic biodiversity of Lake Ohrid.” This conclusion is not based on the data presented in this study. It is just drawn by a literature discussion in chapter 4.3.

Reply: The reviewer is right in that this conclusion is not directly drawn from data

C3024

presented in this study. Since pollutions of the kind presented always pose a certain kind of threat, particularly to benthic organisms, this statement is not even Lake Ohrid specific. Since these threats have earlier been stated for Lake Ohrid, however, we changed the very sentence in order to address the reviewers concern. The sentence now reads "...is believed to pose real threats to the...".

(49) Referee comment: P3924 L4: correct title is "Mollusc biodiversity and endemism in the potential ancient Lake Trichonis, Greece"

Reply: Changed accordingly

(50) Referee comment: P3924 L13: correct names are "Donohue, I. and García-Molinos, J." Change citation in text accordingly

Reply: Changed accordingly

(51) Referee comment: reference for Hauffe et al. 2010 has changed completely and is now "Hauffe, T., Albrecht, C., Schreiber, K., Birkhofer, K., Trajanovski, S., and Wilke, T.: Spatially explicit analyses of gastropod biodiversity in ancient Lake Ohrid, Biogeosciences Discuss., 7, 4953-4985, 2010."

Reply: After submission of our article this citation has changed. Now we changed it accordingly.

(52) Referee comment: P3924 L21: correct title is "Speciation in ancient lakes"

Reply: changed accordingly

(53) Referee comment: P3925 L15: update reference if available

Reply: reference will be updated once it is available.

(54) Referee comment: Fig 1: As you are referring to the watershed area, please mark individual catchment areas of Lake Ohrid and Lake Prespa here (c.f. ILEC, 2005. Lake Basin Management Initiative (LBMI) Final Main Report - Managing lakes and

C3025

their basins for sustainable use: A report for lake basin managers and stakeholders. International Lake Environment Committee Foundation, Kusatsu, Japan.)

Reply: For better visualization we decided to show only a limited, though in light of the topics discussed in our manuscript, sufficient part of the Lake Ohrid catchment. For a complete overview of the catchment and hydrology of the lake (system) we refer to Popovska and Bonacci (2007) in the text.

(55) Referee comment: Fig. 1: "Reicherter et al. (unpublished)" Do not cite unpublished data; the reader can not verify it. You can cite geological maps for example.

Reply: Available geological maps from that particular region often come without any citeable reference. The map presented by the authors is the result of the work of Reicherter and colleagues and was therefore cited as is. However, in accordance with the referee's suggestion we changed the caption as follows: "Geological overview map of the Lake Ohrid vicinity on the base of accessible geological overview maps of Albania (e.g. (Albanian geological survey 1999) and Macedonia modified after Reicherter et al. (unpublished). Also shown are densely populated and agricultural areas, major streams and inlets including annual discharge rates and loads of soluble reactive phosphorus (SRP) according to Matzinger et al. 2007".

(56) Referee comment: Fig. 1: "... including discharge rates ..." What kind of discharge rate do you refer to (annual or daily averages, maximum, ...)?

Reply: Figure caption modified accordingly (see above)

(57) Referee comment: Fig. 1: Change "t/yr" to "t a-1" and "m3/s" to "m3 s-1"

Reply: changed accordingly

(58) Referee comment: Fig. 2: Give a reference for this/these figure/data (e.g. Wagner et al. 2009, J Paleolimnol 41)

Reply: The data originates from a Diploma-Thesis. The data has previously been

C3026

published in a somewhat different format by Albrecht & Wilke 2008. We will cite it now as modified after Albrecht & Wilke 2008.

(59) Referee comment: Fig. 3: This figure is your main figure but it is definitely too small. Why don't you separate it into at least three individual figures each with four sub-figures (e.g. grain-size data / Al-Fsp-Cr-Ni data / TIC-TOC-C/N-Chl a data)? The phrase "Simplified bathymetric maps showing..." is unfavourably chosen here. You show 'interpolated spatial distribution maps' including the bathymetry for orientation, don't you? Explain the different legend types in the figure caption(s).

Reply: In the free access online (pdf) version of our manuscript the reader gets the opportunity to zoom in and thus enlarge parts of the figure using free access software such as adobe acrobat reader. Separation into subfigures including the demanded additional data to be presented, as suggested by the two referees, would result in up to 7 individual figures and thus 6 additional pages added to our manuscript. In this case and even though it sounds tempting to present larger figures in our manuscript we believe that the size we used to present our data is sufficient and all major and minor aspects are visible. We will however ask the editorial board of BG if it is possible to present the figures in a somewhat higher resolution. The figure has further, for better readability, been improved according to the suggestions by anonymous referee #1.

In accordance with the referee's suggestion we now write: "interpolated spatial distribution maps". Different legend types are added to the figure caption.

(59) Referee comment: Fig. 3a: vol% or wt%? Why does your 'single sample' legend (dots) end with 26 % but your 'spatial distribution' legend (colour gradient) included one class above that 26 % boundary? What is your correct maximum value?

Reply: We added "vol". The correct max value is 26 vol% and the class of our 'spatial distribution' legend incorporates values of 26vol% and above, though values above 26 vol% (e.g. 27 or 28 vol%) were not inferred.

C3027

(60) Referee comment: Fig. 3d: Why do you change the scale of the unit here (Al was g kg-1)? Change to "g kg-1" (and rescale values of course); Again, maximum value of the 'gradient' legend exceeds the highest measured sample!

Reply: The scale of the unit for Al was and is g/kg. we changed the format to g kg-1. The maximum value is incorporated in the 'gradient' legend (see reply above (59)).

(61) Referee comment: Fig. 3e: Change unit to "g kg-1" (see comment above). Again, given minimum value of the interpolation does not fit to data legend (dots).

Reply: Unit changed to g kg-1. Minimum value of the interpolation is included in data legend (see reply above (59, 60)).

(62) Referee comment: Fig. 3f: I guess you mean "wt%".

Reply: We added "wt" as suggested.

(63) Referee comment: Fig. 3i: Why does your 'dot' legend include classes >6.6, while your map shows only green and blue dots, and why does your interpolation exceeds the 6.6  $\mu\text{g g}^{-1}$  too (figure and legend)?

Reply: One red dot was due to its position close to another sampling site overlain by another dot. We moved the red dot in front for better visibility.

(60) Referee comment: Fig. 4: Please explain briefly what is shown by a "radar satellite image" in your figure caption. What (suspension load, wave height, etc) causes the visible colour differences (darker/lighter colours)? Do you have an idea what causes these fan-like structures near the shoreline in the south and east? As you discuss surface water current speeds (see P3917L20-P3917L1) it would be helpful to state current velocities or some meteorological data for the 30th September 2009. Is this possible for you?

Reply: We now briefly explain what is shown on the image. Monitoring data (flow velocities/directions) are unfortunately lacking but we provide some general meteorological

C3028

data in chapter 2 “setting” and added wind direction and speed from the time the image was taken to the figure caption.

On behalf of the authors, Hendrik Vogel

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Interactive comment on Biogeosciences Discuss., 7, 3911, 2010.

C3029