

***Interactive comment on “Chemical composition of modern and fossil Hippopotamid teeth and implications for paleoenvironmental reconstructions and enamel formation: 1. major and minor element variation” by G. Brüggemann et al.***

**Anonymous Referee #2**

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General comments: Brüggemann et al. have presented a rather extensive work on the trace element composition of modern and ancient hippo tooth material composition that I believe will greatly contribute to our knowledge of hippo tooth composition and reconstruction of past environments. I am also very interested in the implications this work has on recovering a primary ecological signal, both in terms of isotopes and trace elements, by sampling as close as possible to the EDJ. I think the scientific merit of this work is strong and it has informed me a great deal about my own research

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questions, as I'm sure it will others. My only negative remarks are in certain ecological and biological assumptions that are made that are not clear, such as which molar is used for sampling and the taxonomic identification of certain fossil hippos. This information has bearing on applying data obtained from these teeth to reconstructing individual hippo environments and constraining the data temporally within the hippo's lifetime. The authors also need to take care with spelling, grammar and referencing equations and specimen IDs, as noted below. Nonetheless, these problems do not undermine the overall quality of the work and can be easily corrected.

Specific Questions:

General questions: - It is not often clear which tooth is being sampled (i.e., molar, canine, etc.) Please check back through the text and make sure the sampled tooth is clearly indicated (M1, M2, etc.). Knowing which molar is used is critical because of differences in eruption/formation times for each tooth and whether or not there is an in utero effect on enamel composition. This is only surmised from what we know about tooth eruption/formation patterns in other mammal teeth, as it is currently unknown for hippos, but I would assume that there would be a strong in utero/weaning signal in M1 and M2, especially for Sr and Ca (see work of L.T. Humphrey: Humphrey LT, Dean MC, Jeffries TE. 2007 An evaluation of changes in strontium/calcium ratios across the neonatal line in human deciduous teeth and Humphrey, LT, Dirks W, Dean MC, Jeffries TE. 2007 Tracking dietary transitions in weanling baboons (*Papio hamadryas Anubis*) using strontium/calcium ratios in enamel, *Folia Primatologica*).

Specific: Page 5199, line 15 – “secondary enrichments” - too vague, are they isotopic, mineral, or both? Please specify. line 21 – how can the concentration be 300% of the enamel? Is it a 300% increase? Please clarify.

Page 5202, lines 28-29 – “compare. . . sites” again, this is a very vague sentence. Could you please provide a little more information on what was measured and what the conclusions were that differed, rather than driving the reader back to the original articles

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(if he or she isn't familiar with them)?

Page 5203, lines 4-6 – how do we account for the problem of time? i.e., environments are changing all the time, yet certain diagenetic conditions that result in a specific trace element distribution in fossil material might have only occurred during a very specific temporal window. Likewise, we're unsure of how long those conditions persisted. So, I suppose all we can say about past environments or climates based on diagenetically imposed trace element composition is that it may have occurred at some point, but how do we know when and for how long?

Page 5205, lines 14-17: I am concerned about analyses done on hippopotamids of unknown taxonomy. Hippopotamids have varied in the degree of their aquatic lifestyle and likely their ecology, which is essential for interpreting the isotopic composition of their enamel. If we don't know how reliant on an aquatic habitat these hippos are (as opposed to modern *H. amphibius* which is entirely reliant on a water source to live in), how can we draw conclusions on the reflection of trace elements in enamel and ancient habitats?

Page 5206, lines 10-11 – “outer part” refers to where, spatially, on the tooth? I believe only lower canines are predominately dentine, with a lateral strip of enamel on each (see Hillson's 2005 “Teeth” book for details). Lines 13 “to cover...variability.” - it is important to acknowledge that there could be a considerable amount of isotopic variation recorded in the middle of the profile that you did not sample and that samples at only the apex and cervix might not be present all possible compositional variation within a tooth. See hippo tusk profile in Cerling et al. 2008, Stable isotope ecology of the common hippopotamus (Journal of Zoology).

Page 5210, line 20 – citation to a table with results from ANOVA, please, or list values in text

Page 5215, lines 12-15 – I think this is very likely a key factor in observed differences in elemental variation, although it probably doesn't tell the whole story.

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Page 5216, lines 25-26, “one important...enamel.” - I would have been very interested in seeing this data for all specimens.

Page 5218, lines 1-2 – this surely would change depending on sampling frequency and the tooth used; i.e., many incremental samples of continuously growing canine enamel will reveal more sharp changes in enamel composition than a serial sample of a molar.

Page 5219, lines 22-24 “However, oxygen...2Ma.” – isotope data from pedogenic carbonates or tooth enamel?

Table 1-3: I would like to see standard deviations for all average values, especially for Lake Albert fossil value since it is an average of 18 specimens.

Technical Corrections:

Throughout:

- Change all “und” to “and”
- Correct spelling for “lacustrine” (no “k”)
- capitalize all instances of “Hippopotamids”, as you are referring to members of the family as a whole.

Page 5199, Line 9 – no comma after microprobe Line 14 – “. . .in particular FeO, MnO, SO<sub>3</sub> and F concentrations. . .” should be separated from the rest of the sentence either by dash or parentheses. Line 15 – remove “which” Line 25 – replace “variation” with “trend”

Page 5203, line 11 – add “of” between “volume information”

Table 4: Could write “ $\sigma$ ” instead of standard deviation; as is, the text looks choppy. Also, if a comment or footnote is being made below a figure, please put a symbol (like “\*”) to the first instance of where the comment refers to in the table itself, just for clarity.

Table 6: Na<sub>2</sub>O should be changed to Na<sub>2</sub>O. Also, please give equation used to calcu-

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late apatite composition, either presented in the text or in the supplementary information.

Fig. 2: There should be a scale bar in the backscattered images. Again, please indicate which teeth are imaged (M1, M2, etc.)

Fig. 3: Are these averages of all samples? Please indicate what samples are being displayed on the graphs.

Fig. 4: Specimen numbers refer to what localities? It isn't listed in the text and there's no citation referring the reader to the supplementary information where it can be found.

Fig. 6 and 7: Keep symbols consistent in the figures!! So, if one symbol represents data from Lake Albert, please don't switch it to represent another lake/system in a different triangle diagram.

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Interactive comment on Biogeosciences Discuss., 8, 5197, 2011.