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Biogeosciences Discussions

Interactive comment on "Chemical composition of modern and fossil Hippopotamid teeth and implications for paleoenvironmental reconstructions and enamel formation – Part 2: Alkaline earth elements as tracers of watershed hydrochemistry and provenance" *by* G. Brügmann et al.

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Discussion of the comments of referee #1

Thank you for the thoughtful criticisms and the positive reception of our contribution to the understanding of the process of amelogenesis and to the application of alkaline

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Interactive Discussion

Discussion Paper

earth elements as proxies of environmental change. The comments are related to two issues: (1) a likely oversimplification of the tooth biology and the dispersal abilities of extant hippopotamids in particular, and (2) the manuscript should present more details on specimens, sampling procedures and intra-individual variations.

We agree that the introduction of the manuscript appears to be biased towards the behavioural biology on just one of the extant species, Hippopotamus amphibius. We will correct this impression by also referring to the second recent species, Choeropsis liberiensis, although the biology of this taxon is substantially less known. We will also give the more encyclopedic literature on hippopotamids more room (e.g. Eltringham, 1999). After all differences, however, both extant species are amphibious, with a terrestrial foraging habit at night and spending more or less daytime submerged in water. The high abundances of fossil hippopotamid remains in river and lacustrine basin deposits indicate that the ancestral forms were also adapted to a semi-aquatic life in a very similar way such as their modern analogues (e.g. Boisserie et al., 2005). The amphibious nature of fossil hippopotamids has to our knowledge not been challenged so far. In addition, recent studies, for example Boisserie and Merceron (2011), confirm that fossil species also primarily fed on terrestrial plant assemblages, such as C4 or C3 grasses. Thus, our assumption that hippopotamids are non-migratory and water-dependent herbivores and that the chemical composition of their diet (food and drinking water) is reflected in the chemical composition of bioapatite forming the tooth is evident for extant and fossil species.

With regards to the sampled tooth types: we used the term "molar" in a rather general way rather colloquially embracing both, premolar and molar teeth. We will correct that, particularly in the abstract. We have no indication for the presence of primary teeth specimens in our sample set. A distinctive feature of primary teeth would be the presence of the neonatal line and relatively thin enamel compared to other specimens in the sample. Such features have not been recognized in our tooth samples. We could also not observe preweaning effects. For example, it is well established that the

BGD

9, C1503–C1506, 2012

Sr content in enamel changes significantly after weaning off pups (e.g Humphrey et al., 2008). Such sudden concentration changes have not been observed across apical and cervical enamel profiles, excluding diagenetic overprint. Although in a couple of less well preserved specimens these features might have been obliterated, in enamel from most specimens the neonatal line or the chemical signature of weaning should have been recognized. As this is not the case, we regard these specimens to represent permanent teeth and it is the chemical composition of the enamel of these samples which provides the basis of our interpretations and conclusions. We may also point out that the results of our study are not based on the interpretation of the element distribution in a single specimen. The interpretation of spatial and temporal distribution patterns are common features observed in all well preserved or in well defined groups of teeth.

The statement that "Hippopotamid teeth [: : :] represent the most common mammalian fossils in African terrestrial sediments" is based on our experience in the Lake Albert region and other fossil sites in lake sediments. Even if we compare the number of finds on a family level we collected more remains of Hippopotamidae than of Suidae or Bovidae. Nevertheless, we will moderate the statement.

The second complex of comments asks for more details on the location of sampling profiles and to further investigate intra-individual tooth variations. We concede our discussion did not focus on the distribution within individual teeth. Nonetheless, we analyzed concentration along cervical, apical and longitudinal sections if permitted by the specimen size. Although this is mentioned in the text, it is not systematically presented in the data file and we will identify the location of the profiles (apical, cervical) in the electronic supplement. We actually have shown some of the data of apical and cervical profiles in single specimens in Figures 2 and 4, but we did not explicitly discuss them. In these figures it can be demonstrated that Ba and Sr concentrations as well as concentration gradients are very similar along apical and cervical profiles. Along longitudinal sections, i.e. parallel and close to the enamel-dentin junction, concentra-

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9, C1503–C1506, 2012

tions vary by <10% and do not show systematic trends. These observations suggest that the animals did not experience significant diet changes at least until the end of amelogenesis. There are no data on permanently growing tusks, which might provide additional information on the diet habits at later live times. We will add these remarks on the chemical variation within single teeth to the "Result" chapter and to the figure captions describing the concentration variation in individual teeth.

Finally, we were advised by the editor to pay attention to the length of our manuscript. Therefore, for details regarding sample locations and geological background we like to refer to our previous publications (Brachert et al., 2010; Brügmann et al., 2012). If warranted, however, we could add a figure to the electronic supplement showing sample location and stratigraphic levels of the finds.

Interactive comment on Biogeosciences Discuss., 9, 3645, 2012.