

Interactive comment on “Biogeochemical processes accounting for the natural mercury variations in the Southern Ocean diatom ooze sediments” by S. Zaferani and H. Biester

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We would like to thank professor Lamborg for the objective review of our manuscript and constructive comments/questions, which will improve the manuscript. Our responses to comments are shown below.

An excellent manuscript describing biogeochemical data associated with the accumulation of Hg in silica-rich sediments of the Antarctic margin. The fluxes of Hg are enormous on a per area basis, and if they extend beyond some very narrow band of continental shelf will beg a re-evaluation of sources and sinks in the marine Hg cycle. The data are of high quality and the authors carefully "game out" what the results might

C1

mean without straying beyond their dataset. I only have a few very minor presentation comments. These include:

1) To save one figure and facilitate "wobble matching," the authors could include Hg data in Figures 2, 3, 4 and 5 (and dropping Figure 6).

This is a good suggestion. We have done that.

2) Line 56, "...the re-emission flux of Hg₀ from productive regions will be lower..." should be modified with the caveat that all other factors being equal. To be sure, there are some high productivity areas, such as regions of equatorial upwelling, where productivity is high and Hg₀ fluxes to the atmosphere are high as well.

There are different assumptions about Hg behavior in the equatorial upwelling. Some suggest low Hg₀ concentration in seawater due to the removal of Hg by sinking particles and some suggest high Hg₀ and associated evasion due to biological reduction. The availability of Hg in seawater is a factor that controls the magnitude of Hg evasion. Therefore, in upwelling regions, where Hg sedimentation is high (due to enhanced removal of Hg by scavenging and particle sinking), the availability of Hg for reduction and evasion will be low. This hypothesis is also supported in equatorial upwelling regions (Soerensen et al., 2014; Munson et al., 2015). In a study by Soerensen et al., 2014 different regions with different productivity levels showed significantly different concentrations of atmospheric and aquatic Hg₀. Atmospheric and aquatic Hg₀ concentrations were lower in equatorial upwelling regions (with high productivity) compared to northern regions (with low productivity). Mason et al., 2017 also reported lower Hg evasion flux in a region with higher nutrient levels compared to regions with lower nutrients. However, we have modified this sentence in the manuscript.

3) Materials and Methods-is the age-depth model presented in Escutia et al., 2011? Make clear where this comes from and give a sense of the depth-in-core resolution of the samples in addition to the time resolution already presented.

C2

This information has been added: Age data and age model (which is based on Compound-specific ¹⁴C dating) were obtained from Yamane et al. (2014). "Samples in the upper core (3.2–25.05 mbsf) were taken at ~ 40 cm intervals (a resolution of ~ 20 years) and ~ 400 cm intervals (a resolution of ~ 200 years) in deeper sections (25.05–170.35 mbsf), resulting in a total of 78 samples."

4) In the last paragraph before Conclusions, the authors contemplate how it is that such large fluxes of Hg could be found, and conclude that it is possible that with 100% scavenging of Hg "below" a diatom bloom on just a few occasions could account for all the Hg observed in the sediments. How about on the other end of the spectrum? If there were no scavenging below the bloom and given our meager knowledge of Hg in diatom concentrations, how much Hg could be buried just by diatom uptake and sinking? Since we are in the early days of thinking about Hg scavenging, having these two bounds on the data might be useful.

This is a very interesting question. But unfortunately, we have analyzed the sediments and we cannot estimate it from our data. But this should be a subject of future researches by studying fresh algae.

5) Interesting to observe that in the PCA, Hg does not appear on the same factors as other chalcophilic elements such as Cu and Zn. Could the authors speculate?

Unfortunately, we have no water column measurements from Adelie Bain, but we speculate that essential elements for diatoms such as Cu and Zn are probably re-released to the water phase during organic matter decay and sinking.

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