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Biogeosciences Discussions

Interactive comment on "Vivianite formation in ferruginous sediments from Lake Towuti, Indonesia" *by* Aurèle Vuillemin et al.

Anonymous Referee #3

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This paper describes the formation/presence of vivianite minerals and nodules in lake sediments (Lake Towuti) in Indonesia. They show the presence of large vivianite crystals and nodules in distinct layers is the sediment and discuss how these grow in time. Lake Towuti is a ferruginous lake and the authors argue that this lake could be used as an analogue for the Archean ocean. The paper is very well written and well referenced. The authors used a wide range of techniques to investigate the vivianite minerals found in the sediments. The data is of high quality and is very well presented in clear and structured way. All methods used are clearly described.

General comments

-In my opinion the impact of the paper could increase by adding an implications section at the end of the discussion. Here the authors could present a mass balance for

P and discuss the importance of vivianite in the burial of P in this and other lake sediments. Now it is only briefly mentioned that vivianite might act as the main sink for P at P11.L31.

- The authors mention in the abstract and introduction that Lake Towuti can be used as an analogue for the Archean ocean. However, in the discussion I miss the implications that this study has for the Archean ocean.

- I would like to also see the Fe extraction data for this core. It is mentioned in the method section that Fe extractions were carried out, however, they are now only used to calculate to total Fe present.

Detailed comments:

Introduction

P2.L8: "under anoxia". Here reducing conditions are also important, not only anoxic conditions.

P2.L8: "..phosphate..". Phosphate should be phosphorus (or P) in this case.

P2.L10: This is only the case when there is sufficient organic matter, otherwise there is no formation of sulfide and eventually Fe sulfides.

P2.L12: "Formation of iron phosphate minerals..". Mention that these are reduced iron phosphate minerals.

P2.L22: "In such systems.." Besides the presence of P also the rate/amount of Fe reduction is important in oligotrophic environments. When the organic matter content is low this can lead to limited Fe reduction, low concentrations of porewater Fe and limited formation of vivianite. This has recently been shown in a modeling study for an oligotrophic estuary in the Bothnian Sea (Lenstra et al., 2018; biogeosciences: https://doi.org/10.5194/bg-15-6979-2018)

P2.L27: "..(Egger et al., 2015; Dijkstra et al., 2016)". These studies show viviniate

formation in brackish (not marine) environments. The formation of vivianite, when there is sufficient organic matter, is sensitive to the production of sulfide in the sediment. So at a higher salinity (enhanced sulfide production) the formation of vivianite is expected to be lower. The dependence of vivianite formation on salinity is also discussed in the modeling study I mentioned at P2.L22 (Lenstra et al., 2018; biogeosciences).

P3.L22: "..is stable under anoxic conditions..". Add that it is also important to have non-sulfidic conditions. (anoxic/non sulfidic)

Section 2.3

P5.L2: In these steps you do not extract Fe present in pyrite. I guess this is a very small pool in these environments but to correctly determine the HR Fe pool this should be included or mentioned that this is not included.

P5.L2: How is the non-reactive Fe fraction determined?

Section 2.4

P4.L10: Was this carried out under anoxic conditions?

Section 2.5

P6.L6: "Below and above this interval, vivianites are rarely present in the sediment, which was confirmed by smear slide analysis (Russell et al., 2016) and X-ray diffraction (Supplementary Fig. S2)." This should be moved to the discussion section.

Section 3.2

It would be interesting if you can also show your Fe extraction results in this section. Maybe in the appendix, if you don't want to add an additional figure to the manuscript.

Section 4.1

P11.L24: Is it possible that the orientation of the mineral in the sediment changed during coring? I wonder because the mineral is located very close to the core liner.

P11.L27: Would it be possible to include the solid phase Fe speciation in the paper?

P11.L30: But concentrations of phosphate are generally low not only at places where vivianite is found. I would therefore, based on only the phosphate data, not suggest that vivianite is the main sink of P.

P12.L10: Here and elsewhere Potsma should be Postma

P12.L11: "..depending on the local pH, CO2, PO43-, and the amount of reactive ferric oxides buried..". Here, also the amount and reactivity of organic matter is important.

Conclusions

P13.L5: I do not understand what partially dissolved iron oxides are.

References

Lenstra, W. K., Egger, M., van Helmond, N. A. G. M., Kritzberg, E., Conley, D. J., and Slomp, C. P.: Large variations in iron input to an oligotrophic Baltic Sea estuary: impact on sedimentary phosphorus burial, Biogeosciences, 15, 6979–6996, https://doi.org/10.5194/bg-15-6979-2018, 2018.

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