

Biogeosciences Discuss., referee comment RC1
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Comment on bg-2021-318

Wytze Lenstra (Referee)

Referee comment on "Linking sediment biodegradability with its origin in shallow coastal environments" by Justine Louis et al., Biogeosciences Discuss.,
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"Linking sediment biodegradability with its origin in shallow coastal environments" by Louis et al.,. In this current manuscript the authors evaluate the effect of different types of organic matter on the degradability of the organic matter and use different types of measurements to evaluate the sources of the organic matter. To quantify the biodegradability of the sediment incubations are carried out under oxic conditions and benthic flux measurements of PO₄ and NH₄ were done. With this manuscript I have two main comments (1) the link between the measured fluxes and biodegradability of the sediment is made in a too simplified way in my opinion. There are many factors that can control the benthic release of PO₄ and NH₄ from the sediment such as macrofaunal activity and bottom water redox conditions. These factors are discussed in a few sentences in the discussion but I think that these should also be introduced in the introduction. (2) I found it difficult to find the comparison of the measured fluxes and the measured rates of the incubations. Do these match with each other? The way I understood the manuscript these are both used to quantify the degradability of the sediment so I think a comparison between these parameters should at least be made in that case. See my detailed comments below:

L16: "controlled by the origin, quantity and accessibility". There are also other factors controlling the mineralization such as for example temperature or the presence of electron acceptors. In my opinion this is written in a too absolute way.

L27: "the eutrophication" remove "the"

L24: can you already mention what kind of samples were taken here in the abstract. All surface sediment?

L28: "oxic conditions" will this not lead to strongly enhanced mineralization of organic matter? In that case should "potential" not be replaced by "maximum"?

L30: " The physical and chemical sedimentary characteristics ". Can you already give examples here in the abstract? ..such as...

L28:" 5 and 1.5 fold higher on the PO₄ and NH₄⁺ fluxes respectively". Does this mean compared to the oxic incubations? In that case the degradability cannot be quantified/compared by using fluxes of PO₄ and NH₄. In oxic conditions PO₄ will be affected by the presence of Fe oxides (i.e. lower benthic flux) and NH₄ will be removed via nitrification for example.

L36: Is this corrected in any way for the bottom water redox conditions?

The introduction is in general well written and has a clear flow. The only thing I miss in the introduction is information on geochemical processes that control NH₄ and PO₄ mobilization in the sediment and their benthic release. There is at this point no information about different pathways for PO₄ mobilization for example. While NH₄ (and CO₂) mobilization can be coupled to (anaerobic) organic matter degradation for PO₄ this is more difficult because release of P bound to Fe oxides is often an important source of P in sediments. Also P cycling in sediments is strongly affected by mineral precipitation in the sediment such as for example vivianite and apatite and adsorption onto Fe oxides (mostly in oxidized sediments near the sediment water interface for the latter). This means that even at sites where the OM degradation is high the benthic flux of P can be limited. Also if benthic fluxes are presented, the effect of macrofaunal activity on these fluxes should in my opinion also be explained a bit more (i.e. bioturbation and bioirrigation).

L42: "at the sediment water interface" microbial degradation of organic matter does not only occur at the SWI and continues when the OM is buried. Especially when linking this to the benthic fluxes of CO₂, ammonium and phosphate the deeper sediments are very important as well in the degradation of organic matter and production of porewater CO₂, ammonium and phosphate.

L46: Mn oxides occur also as Mn(III) or combinations of Mn(IV) and Mn(III) birnessite or manganite for example. I would just call this "Mn oxides" and in that case also "Fe oxides".

L50: "e.g. oxic conditions)" why is this text included here? Do you mean "redox conditions"?

L53: so the other factors mentioned earlier in this paragraph are ignored?

L83: remove "phenomena"

L102:"ii) to use this variability to go back to the variability of OM sources" is it not easier to just quantify the OM variability of the different OM types at the source? I do not understand the importance of this point.

L107:"(NH₄⁺ and PO₄)" why not CO₂ in this case? That was also introduced earlier in the introduction.

L112: It would be nice to end this introduction with the most important finding of this study.

L120: what is the depth interval of this surface sediment?

L145: can you add the original reference for this method in this sentence.

Section 2.5. Are there also quality controls to discard a flux when the R² of the measurements is not high enough?

L184: Can you add how many samples are taken in time? Is the water that is removed during sampling replaced with new artificial seawater?

L187: how are these oxic conditions maintained and controlled? What is the reason these were carried out under oxic conditions? Oxygen often only penetrates a few mm in the sediment and therefore these oxic conditions might be artificial and alter geochemical processes that control the degradation of the sediment.

L232:"(response variables), " what does this mean.

L261:"Over all sediment samples, " for me it is unknown which depth interval is used. This is key information given the strong gradients often observed in the parameters discussed below.

Table 2: are bottom water redox conditions also measured for all the sites? If yes can this information be added somewhere in the paper because it is highly relevant for the benthic release of NH_4 and PO_4 .

L365: add space before "The"

Caption Fig. 7 is not correct. "Boxplot of the benthic NH_4^+ (A) and PO_4 flux (B) ($\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{h}^{-1}$) " (A) = (C) and (B) = (D)

L376: It would be good to have some information of the quality of the measurements of these fluxes. I also cannot find this in the original paper (i.e. Louis et al., 2021). What are the changes in concentrations during the measurements? This could be added to the supplements as a figure or a table. Concentrations of solutes during the incubation can vary quite a bit in time and increases (effluxes) are not always linear. At this point it is not clear to me how many samples there were taken in time. In the case of only two samples (beginning and end) this has to be stated somewhere and also the uncertainty should be mentioned in my opinion.

Caption figure 9: Change (A) in the caption to (a), also for b,c and d.

L536: "oxic conditions" are the oxygen concentrations monitored during the incubations? How do the authors know O_2 is not depleted at some point in the bottles?

L453: "The mineralization process...". Do the authors mean that because these incubations are carried out under oxic conditions the quality of the OM is not very important anymore because it will be degraded with O_2 anyway? This statement is not very clear to me. If this is the case I'm not sure if this statement is valid on the timescales of these incubations.

L552: typo in y-1

L564: "realistic". What does this mean? Are the incubations carried out under the in-situ redox conditions or at redox conditions the authors find realistic? I would like to see the bottom water redox conditions for the different sites somewhere in this manuscript or in the supplements.

567:"Under these redox....". I agree that the lability is important in this case however the presence of electron acceptors or the presence of macrofauna is also very important. I think only mentioning the lability of the OM is too much of a simplification in this case. The authors should in my opinion also discuss other controlling mechanisms or at least mention them.

L569: "We thus suggest...". I agree that the origin plays a role but just ignoring other main controlling mechanisms such as bottom water O₂ is not possible in my opinion. Especially for PO₄ bottom water redox conditions are very important.

L573:"All parameters...". Can you mention which ones are the most important.

L596: "...assuming that this results from an increase in sediment biodegradability. " Why assuming in this case. Can the authors not compare this with the incubations they did to quantify this biodegradability? In this paragraph I miss the comparison between the measured fluxes and the degradation rates that were presented earlier. Do they match?

L617:"remains unexplained here" Can the authors elaborate a bit more on which mechanisms might be responsible for these variations? i.e. bottom water O₂, mineral formation etc.

L625: "link with sediment potential biodegradability and nutrient release". I actually miss the comparison between the incubations and the measured fluxes in this manuscript.

Wytze Lenstra