

Interactive comment on “Impact of seasonal oxygen deficiency on the phosphorous geochemistry of surface sediments along the Western Continental Shelf of India” by Josia Jacob et al.

Anonymous Referee #3

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This study focuses on the phosphorus geochemistry of surface sediments from the western and eastern continental shelf of India. The authors specifically focus on the effect of seasonal variations in bottom water oxygen on sediment P forms. The major conclusion is that a significant decline in surface sediment concentrations of Fe-bound P occurs during periods of hypoxia on the western shelf. This decline corresponds with an increase in dissolved PO₄ in the water column. On the eastern shelf, in contrast, such a seasonality is not observed because there is no hypoxia there. While the western shelf has been studied earlier, these are the first data on the eastern Indian shelf

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that I have seen so far.

I have one major concern, however: The authors report large changes in the P speciation and organic carbon contents between seasons. These also involve P components that are not expected to respond to seasonality such as detrital P and authigenic Ca-P. The same holds for sediment organic carbon: a loss of several wt% over a season due to degradation is not possible. Thus, it seems likely that there is a large spatial variability in sediment composition the region, and that, like in other shelf regions, the surface layer is frequently resuspended and transported elsewhere, precluding simple seasonal comparisons of the surface sediment. More compelling evidence for the suggested release mechanism from the shelf could be obtained by studying the porewater composition in both seasons (dissolved Fe²⁺ and PO₄) with depth in the sediment. This could be combined with depth profiles of sediment P species. Besides providing more mechanistic insight, the link between the sediment processes and water column chemistry could then be made more quantitative.

Detailed comments

Page 6090: Line 3: please be more specific: the biogeochemistry of what?

Line 15-19: Apart from the Fe-bound P fraction, the surface sediment P speciation typically will not change on seasonal time scales. Thus, changes in the authigenic and detrital fractions as observed here likely reflect spatial variability not temporal variability.

Line 18. Correct the spelling of “fluorapatite”. Are the authors sure that this is the phase present in their sediment? Wouldn’t it be safer to call this “detrital apatite” or simply detrital P?

Line 23-25: have the authors calculated how large the change of P in the sediment should be to explain the change observed in the water column? What about changes in release of P from organic matter?

Line 26. The data for the eastern continental shelf are part of this study and should be

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presented as such. The way the abstract is now phrased, it looks like these are data from other previously published studies.

Page 6091: Line 3: what evidence do you have for labile organic matter? How are preservation of labile organic matter and phosphorus geochemistry related exactly? This is a surprising result because in an oxygenated area you would expect to find less preservation of organic matter.

Line 19. There is also enhanced release of P from organic matter under anoxia. See the cited references and Ingall et al., 1993 GCA). This should be discussed.

Page 6091. Line 19. Change to "Van Cappellen"

Page 6092. Line 9. "the N/P ratio" . An average? Please specify.

Line 10. Provide a reference for "Richard's stoichiometry"

Line 13. Specify what type of "redox conditions prevail".

Line 15. Reductive dissolution by itself does not lead to a transfer of P from the sediment to the overlying water, as suggested here. The P is released from the Fe-oxides in the sediment and then is lost through diffusion (or bioirrigation).

Lines 24-and further. Again, it should be made more clear that the work presented for the eastern continental shelf is part of this study. Here, it is first stated that the study is about the western continental shelf (WCSI). Then, at the end of the paragraph on page 6093 it suddenly becomes clear it is also about the eastern continental shelf and that this the first time that such data for this region are presented.

Page 6093. Line 10. What is meant by "terminal end of"?

Line 18. Please explain why these can be considered as "inner shelf"

Page 6094. Line 22. The primary reference for the SEDEX procedure is Ruttenberg (1992) – that reference should be added.

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Page 6094. Kraal et al. (2009; GCA) recently showed that the exposure of carbonate-poor sediment samples to air may lead to oxidation artefacts and changes in sediment P speciation as detected by SEDEX. Can the authors exclude that this is important here?

Page 6095. Line 7: is this truly fluorapatite? see earlier comment.

Page 6096. Line 4. Temperature is not a "physico-chemical parameter". Please rephrase.

Page 6098. Lines 10-16. + Figures 7 & 8. And further. Most of the differences in P speciation between sampling periods are likely due to spatial variability. As a consequence, presenting them in the context of seasonal changes related to hypoxia is not meaningful. It also would be good to add the P speciation data (in ppm or umol/g) in a table.

Page 6102. It is not clear why the ancient deposits are relevant here.

Page 6103. Lines 19-21. This finding that seasonal oxygen deficiency leads to enhanced P release may not have been shown for this region before, but otherwise is not new. Please identify what truly new things we can learn from this work.

Table 1: are all numbers given here significant?

The English needs to be improved. Some examples:

Page 6090. Title: change "phosphorous" to "phosphorus" Line 4: remove "the" before "seasonal" Line 28: rephrase "where any kind of...has not been reported yet" to "where seasonal oxygen deficiency

Page 6092. Line 1. Change to "an intensification" and "since the 1970s" or "since the early 1970s" or "since 1970" whatever is applicable. Line 3. Change to "along the WCSI" Line 5. Here both past and present tense are used in one sentence.