

***Interactive comment on* “The effect of meter-scale lateral oxygen gradients at the sediment-water interface on selected organic matter based alteration, productivity and temperature proxies” by K. A. Bogus et al.**

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We thank the referee for their very helpful comments on the manuscript. For each of the suggestions mentioned in the review, we now provide our responses.

1. “The authors relate their results and changes in proxies mainly to differences in bottom water oxygen. . . Particularly the OMZ transect may suffer from other factors as well: the oxic sediment is far more off shore than the anoxic and suboxic ones. Although the terrestrial OM input may be small, the sediment near Pakistan may be influenced by

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different (possibly terrestrial) mineralogies. Oxic sediments exhibit deeper bioturbation and oxygen penetration. Although  $< 1$  cm top sediments were used, bioturbated ones are mixtures of young and older material (several 100s of years), and therefore they experience much longer oxygen exposure times than less/no bioturbated anoxic sediments. Thus, how rapid are the changes observed and are they of similar periods of time? In other words, the authors should discuss other factors than oxygen as well.”

We initially sought to constrain the influence of factors other than oxygen by using and comparing the proxy signals from three different transects, as mentioned in the introduction. We agree with the reviewer that the resulting changes in proxy ratios are probably the result of composite factors, including those in the mentioned review (Cowie, 2005). Specifically, it is really a combination of oxygen-related factors that produce the changes in the proxies, including benthic activity (or lack thereof), oxygen concentrations, which contribute to the oxygen exposure time. Thus, this will be clarified in the revised manuscript.

Differences in the amount of terrestrial material minimally influence the proxy ratios, even along the oxygen minimum zone (OMZ) transect, as a result of the very low and similar amounts of long chain n-alkanes present in each sample. Low terrestrial input can also be inferred from the low amounts of total pollen grains in the samples; these data will be added to the Supplement. We cannot directly control for any effect of differing mineralogies, however, the similarities between the OMZ and below OMZ-seep trends suggest that any influence of mineralogy is likely to be minor.

2. “How was the quantification of the 1, 15 C30 and C32 diols and keto-ols conducted? They often co-elute, which fragment ions did the authors use?”

The quantification of the C30 1, 15-diols and keto-ols was performed by quantification of characteristic mass spectra fragments and then calibration to an internal standard. They were specifically the  $m/z$  387 and 328, for the diols and keto-ols, respectively, (after Versteegh et al., 2000) and the  $m/z$  130 of the 1-nonedecanol standard. This

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specific information will be included in the revised version of the manuscript, rather than simply stating, as we did, that the procedure followed Versteegh et al. (2010).

3. “Why were not always the C32 ones quantified? Do the authors also see trends in DOXI for the 1, 14 and 1, 13-diols/keto-ols.”

The C32 isomers were not always quantified because in the more oxic samples, the C32 diols were not present. As we were interested in changes in the diol oxidation index (DOXI) values, it was thus not possible to calculate this index for all of the samples in the three transects. This will be clearly stated in the revised manuscript. In terms of the 1, 14 and 1, 13-diols and keto-ols, these compounds have not been specifically used in a sediment alteration proxy, as the DOXI is specifically defined using the 1, 15-diols and keto-ols. Therefore, we did not discuss any trends related to their concentrations or use them in a ratio based on their concentrations.

4. “Alkenones are very abundant in Arabian Sea sediments, did they suffer from selective oxidation?”

The alkenones in our samples were overwhelmingly comprised of the C37 chain length. These have been reported as the most dominant alkenones in other Arabian Sea studies (e.g., Schouten et al., 2000) and the comparison between the tri- and di-unsaturated forms (C37:3 and C37:2, respectively) form the basis of the UK’37 (paleo)temperature proxy. Previous studies have shown that there may be an influence of selective oxidation on these alkenones, which affects temperatures reconstructed from the UK’37 proxy (e.g., Kim et al., 2009). However, due to the high sea surface temperatures of our sampling area, the tri-unsaturated ketone (C37:3) was not present in sufficient quantities to reliably determine the effect of selective degradation on the UK’37 paleothermometer.

5. “For the GDGT data: it would be useful to add the BIT indices as indicator of the terrestrial OM contributions.”

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We agree that the BIT (Branched and Isoprenoid Tetraether) index would be useful for indicating terrestrial input. However, as both the higher plant alkane (HPA) index and alcohol preservation index (API) have as their basis terrestrially derived components, the use of the BIT index for terrestrial input is redundant. If large changes in terrestrial input would be a contributing factor, the long chain n-alkanes, which are derived from plant leaf waxes, would demonstrate large concentration changes. Nonetheless, this is not the case as the n-alkanes exhibited low and stable concentrations (see Supplement). To corroborate this information, we will also include the concentration of total pollen grains in the Supplement.

6. “I would prefer to express concentration per gram TOC instead of per gram sediment as that reflects better preservation/degradation.”

Unfortunately, this is not possible as we were unable to measure total organic carbon (TOC) with the amount of material available. While it seems that normalizing the concentrations to TOC would provide a better indication of the preservation/degradation state of the sediments, it also has its caveats. The main problem is that TOC, as a bulk parameter, is composed of a large variety of components from many different sources that have varying degradation rates, so that its “degradation constant” is not actually constant. Therefore, it is ambiguous to use it as a reference material to assess degradation.

As the different specific components investigated have varying degrees of sensitivity to aerobic degradation, so does TOC in comparison with them. For example, Versteegh et al. (2010) found that while dinoflagellate cysts seem to be less resistant overall than TOC, alkanols and especially the alkanes are more resistant than TOC. In the case of a compound that is more resistant than TOC, the alkanes, the alkane/TOC would initially increase and then decrease again in a later stage of degradation while the reverse would be true for the dinoflagellate cysts in this example. Thus, for each compound/TOC value, two degradation states are possible which makes normalization to TOC doubtful for estimating degradation. Therefore, we concluded that presenting

our concentrations as normalized to a gram of sediment was sufficient.

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