

Biogeosciences Discuss., referee comment RC2  
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## Comment on bg-2021-112

Beth Orcutt (Referee)

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Referee comment on "Geochemical consequences of oxygen diffusion from the oceanic crust into overlying sediments and its significance for biogeochemical cycles based on sediments of the northeast Pacific" by Gerard J. M. Versteegh et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-112-RC2>, 2021

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### General comments

This manuscript describes porewater and solid phase profiles of oxygen, nitrate, manganese, cobalt, and nickel in oligotrophic sediment within the German nodule exploration block of the Clarion Clipperton Zone in the northern Pacific Ocean. The authors document variable profiles of oxygen, with fully oxic sediment profiles in relatively thin sediment profiles near seamounts and thicker sediment packages overlying presumed subsurface faults. The profiles of oxygen indicate diffusion from the seawater-sediment and the sediment-basement interfaces, indicating oxic conditions in basement in this region, as had been documented before. By contrast, thicker sediment packages away from these features exhibit zones of suboxic conditions where dissolved manganese increases from solid phase Mn oxide dissolution, which also leads to mobilization of cobalt. It is presumed that oxygen also diffuses from basement into deeper layers of sediment, but the coring depths were too shallow to confirm this. The main points of the manuscript are that: 1) the depth of oxygen penetration from the seafloor is somewhat uniform, the depth of oxygen diffusion from basement is more variable and suggests highly variable basement oxygen concentrations, 3) nitrification in sediment can lead to a nitrate source to basement fluids in some instances, 4) cobalt and other redox sensitive elements are remobilized due to suboxic conditions and do not reflect initial burial conditions.

While this manuscript is well written and based on a very impressive dataset, I was disappointed that the authors did not put the results into a larger context of what is known about sediment-basement interactions at other locations. The results are described in exquisite detail, but the discussion section lacks comparison of these profiles and their patterns to recent comparable studies from the equatorial Pacific (Wheat et al. 2019, DOI: 10.1029/2018GC007933) or the south Pacific Gyre (D'Hondt et al. papers) or from the western North Atlantic (D'Hondt and colleagues) or from the flank of the Mid-Atlantic Ridge (Orcutt et al., 2013; Wankel et al. 2015, Ziebis et al. 2012, Kiel Reese et al. 2018). For example, how do the authors claims about sediment nitrate being a source or sink to basement compare to inferences from these other studies, besides just the earlier work from Fisher and Wheat 2008? (Disclaimer that this reviewer is a co-author on some of the

work suggested for consideration and, thus, this suggestion may be viewed as a conflict of interest.)

I am also a bit perplexed by the inference of the oxygen concentrations at the sediment-basement interface based on this study. In Table 2, the inferred basement oxygen concentration at one site is likely higher than bottom water oxygen concentration in this region (note: this isn't reported in the paper, but looking at the CTD profiles in the cruise report, along with WOCE datasets, indicates a regional bottom water concentration closer to 200  $\mu\text{M}$ ). Likewise, extrapolating the nearly linear profiles to the inferred basement depth in other profiles leads to similarly perplexingly high concentrations. The discussion section on porewater oxygen does not address this issue.

Continuing the oxygen theme, the variable depths of the suboxic fronts are really intriguing to me. The authors state that the variability in the shallower front being related to variability in bottom water oxygen conditions. I am curious why the authors do not consider variable bioturbation impacts, a non-steady state phenomenon, also as a possible cause. The highly variable depth of the deeper suboxic front is also fascinating, and I'd like to see more discussion about that.

So, overall, I find this to be an interesting study, but I would like to encourage the authors to spend a bit more time putting the results in a larger context of what is known. Below I also highlight a few specific areas that need attention to improve clarity:

#### Specific comments

Line 95: I am not sure that the Fischer et al. 2009 and Ziebis et al. 2012 citations are appropriate references here for a comment about measuring oxygen in ocean drilling program cores, as these studies were on gravity core samples. More appropriate references would be D'Hondt et al. 2015 for the South Pacific Gyre and/or Orcutt et al. 2013 for North Pond, which are the only two drilling expeditions with porewater oxygen data.

Line 171: I think "nearly linear" might be the more appropriate phrase here, since some of the deeper oxygen profiles show some curvature in their profile below the minimum oxygen depths.

In the methods and/or acknowledgement section of the paper, the authors should state that the working areas are within the area contracted by the International Seabed Authority to the German Federal Institute for Geosciences and Natural Resources for exploration of polymetallic nodules.

Table and Figure comments:

- overall, there are several inconsistencies in the labeling of sites between tables and figures. please carefully check.

Table

- consider adding an additional column, or to modify the core name column, to indicate the "SM" and "F" categories of the cores used in the figure.

Figure 1.

- there seems to be a mismatch in the shapes used to indicate the various working areas in panel B compared to the zoomed-in panels. For example, panel B indicates WA-1 is a vertical rectangle shape, whereas the zoomed in panel indicates a horizontal rectangle shape. Also the seamounts shown in the zoomed in panels do not match the features indicated for WA-1 and 2 in panel B. Please clarify.
- consider using different colors and/or shapes to indicate the core locations being either "SM" or "F", to aid in understanding.
- Please indicate in the figure caption what software and datasets were used to create the bathymetric maps, or if the maps are already published. Also indicate what the contour spacing is, as it is hard to discern the small text in the figures.

Figures 2-4: consider using different symbol shapes, in addition to color, to distinguish between variables in plots. This can aid with interpretation for those with color sensitivities or when viewing printed in black and white.

Figure 4:

- panel a: should the label be "9KL" instead of "9SL"?
- panel c: should the label be "42SL" instead of "42KL"?