

Review on “Inputs and processes affecting the distribution of particulate iron in the North Atlantic along the GEOVIDE (GEOTRACES GA01) section” by Arthur Gourain et al.

This manuscript presents and discusses the distribution of PFe, PAI, PMn and PP in the high latitudinal North Atlantic. The presented water column data is wonderful and I am looking forward to see the data published in the next GEOTRACES intermediate data product. We need more particulate data! However, the discussion is very detailed and long, but I am missing a straight storyline. The authors jump a lot between different topics and even present Ba data at the end of the manuscript, but a discussion is missing. The manuscript needs serious work, and I am suggesting major revision. My three main points are:

1. The authors conclude that higher PFe/PAI and PMn/PAI ratios are indicative for biogenic bound particulate Fe. I am missing the discussion of scavenged and authigenic Fe, that could also cause PFe/PAI ratios higher than that of crustal ratios. For my opinion, the authors should include the PFe/PMn ratio, where biogenic ratios (phytoplankton) are available in the literature.
2. The authors include a PMF model and conclude that variances in PFe are related to changes in the content of lithogenic particles. This is in contradiction to the authors conclusion of biogenic Fe, responsible for changes in PFe/PAI. This needs to be discussed more carefully!
3. There is an entire data set of barium excess concentrations at the end of the manuscript. I am not sure that this data is required for the conclusion of the author. If kept, please discuss the data!

Detailed comments are listed below.

With best regards,

Christian Schlosser

#### Abstract

Line 32: What is meant with “At most stations over the Western,...” and “..relative concentration..”? I cannot see how concentrations show a ubiquitous influence of crustal particles. Ratios maybe! However, be more precise.

#### Introduction

Line 78: Replace to “using the distribution of particulate aluminium, manganese, and phosphorous.” And remove sub-sentence “, to further.... .”

#### Methods

Line 90: Sentence too long, please split up.

Line 91: Missing bracket.

Line 97: Indicate Go-Flo company. “General Oceanics”

Line 100: 6mm sounds a bit thin for me. Kable must be wider.

Line 111: Replace “litters” by “liters”

Line 111ff: Filter cleaning and what kind of filters were applied, should be stated earlier. For instance, before how much volume was passed over them.

Line 113: Remove “-1” from “MΩ cm<sup>-1</sup>”

Line 118ff: I cannot follow, is this relevant?

Line 120: Replace “slide” by “dish”

Line 143: Please provide the values of blanks and limit of detection, maybe in Table 1 (Please also provide the standard deviation of your CRM analysis).

## Results

General comment 1: The result section needs to be shortened. You mention in line 277 that PAI and PMn and PFe are similar in IrB, IcB, WEB and IAP (in line 270ff that the Reykjanes ridge is similar to IcB). That is the entire stretch between Spain and Greenland! Please combine results! In addition, if I look at Figure 4, the distribution of PFe in LB seems very similar to the concentrations in IcB. I am suggesting to combine the results of open ocean regions and just include separate paragraphs of results from the three margins, Iberian, Greenland and Newfoundland margin.

General comment 2: You talk about different surface currents, please include them in Fig. 1

Line 184ff: Could just find ENACW in Figure 2. Please correct text or Figure 2.

Line 198: Remove “really”

Line 210: IB refers to IrB and IcB? Please mention that.

Line 218ff: There are five concentrations for 4 parameters!

Line 221: Please include the standard deviation of trace metals and PP hosted by small particles

Line 226: Please refer to transmissometry Figure.

Line 228ff: Sentence is hard to follow, please rephrase.

Line 233ff: Sentence “The highest...” does not tell anything new, remove! Since you explain results from the Iberian Margin, later referred to as (IM), please include IM in Figure 2.

Line 240ff: There is something wrong with that sentence!

Line 242: When it is really the case at “every stations” then there are no exceptions! Please rephrase.

Line 244: I do not understand what is meant here: “Particulate aluminium profiles matched the PFe profiles, with low median concentrations within the first 100m of 1.77 nmol L<sup>-1</sup> and 26 pmol L<sup>-1</sup> respectively. Then, concentrations increased with depth to reach a maximum close to the oceanic floor.” Did you mean 1.77nM Pal and 26pM PFe? Please provide values for bottom waters.

Line 258: Replace “progressive” by “gradual”. Again refer to transmissometry figure.

Line 315: You are mentioning lithogenic elements here. How do you know? I know concentrations are high, but before introducing your tool that differentiates between biogenic and lithogenic Fe, I would leave out such terms.

## Discussion

Line 323: I would also include run-off, which is probably similar to your “melting ice shelves” but more precise. In addition, why sea ice must have melted recently to be a source for PFe. And what do you mean with biological pool? However, please be careful what you state here as source, for instance, lateral mixing is not per se a source, just when PFe loaded waters are advected offshore. Please be more precise!

Line 350ff: How barite formation refers to remineralisation of PFe. Explain! In addition, what inputs and processes are discussed below!

Line 365: Equation 2: I am pretty sure that the \* should be -.

Line 367: Another possibility might be that lithogenic particles from the Iberian shelf are advected offshore. In addition, the NAC is located further west [D J Reynolds et al., 2016]. Authors need to come up with a better idea, than dust!

Line 375ff: This paragraph needs an overhaul! From fronts, via isobaths and isotherms (not shown) to blooms and LSW. It is really hard to follow this paragraph. In general I would have wished the authors explained differences in PFe/PAI ratio and PFe lith% over the entire transect and not just WEB and IAP.

Line 384ff: Figure 8: The approach fingerprinting water masses with trace metals such as Fe and Mn would be nice, if it actually works. Other than NEADW and MW, other water masses have a higher Fe/Al ratio but they are very variable. In this case it is vital to check that the water mass difference is significant. I am suggesting performing a student t-test!

Line 400-409: You just repeat yourself, please remove!

Line 414ff: I am not convinced that the different Fe/Al ratio is driven by different sediments. Where are the elemental ratios of the sediments, just because a sediment is muddy does not proof anything. Further Shelley et al. (2017) showed that dust particles along the GA01 section are mainly from the higher latitudes and not from North Africa. Later on you mention biogenic contribution, you have not introduced this term, and now everything higher than the 0.21 is biogenic. This is questionable, what is with scavenging, authigenic FeOOH formation ect.

Line 425: I am not convinced that using a Mn/Al ratio from the upper crust, is helpful tracking sediments. Sediments can have a much higher ratio then the upper crust (eg. Sediments on the shelf of South Georgia 0.0066, Schlosser et al 2018 ). A higher Mn/Al ratio would change your figure 10 entirely. I am suggesting to apply the Mn/Al ratio of sediments from the different regions. In addition, the transmissometry data in figure 10 need to be cited earlier!

Line 490: I am again not convinced that just biological uptake was responsible for elevated Fe/Al ratios. Scavenging and authigenic precipitation would do the same job. You need SEM data to convince me!

Line 547ff: What do you mean with "oxido-reductive transformation". I know this term from microbiology classes, but in sediments? I am agreeing, dead biology sinks and settles on the seafloor. However, organic material is quickly remineralised and released Fe will oxidize quickly forming oxyhydroxides. FeOOH precipitate as single particle or form a coating around sediment particles. This will increase your Fe/Al ratio too, and I think even more pronounced than biogenic Fe, which in comparison to lithogenic particles stores just a small amount of Fe. This small quantity will be strongly obscured by lithogenic Fe. Everything below line 548 is highly speculative. If you would like to track biogenic Fe, you should use the Fe/Mn ratio, ratios are provided by *T-Y Ho et al.* [2003]. His Fe/Mn ratio for phytoplankton is ~ 1.7, lithogenic particles have a significantly higher ratio (upper crust ~50 and sediments ~ 70), indicative for the formation of authigenic Fe.

Line 620ff: Any explanation for Fe depleted particles and aerosols, respectively? Anthropogenic?

Line 636: I would check the Fe/Mn ratio too!

Line 650: Now we are back to PFe/PP and not anymore PFe/nonlith/PP. This is all very confusing. It is an interesting approach using PP, but what are numbers actually tell us. It would be better to show first how much nonlithogenic Fe is in the top 100 m and plot PP as well in a diagram. By looking at picture 3. PP is similarly high in IrB and LB, changes in PFe/PP are then mainly driven by PFe, but what does it actually mean.

Further on, you show nice plots using Ba excess data (Fig. 13 & 14), but there is not a single word towards the end of the discussion. There is more work needed!!

## References

Ho, T.-Y., A. Quigg, Z. V. Finkel, A. J. Milligan, K. Wyman, P. G. Falkowski, and F. M. M. Morel (2003), The elemental composition of some marine phytoplankton, *J. Phycol.*, *39*, 1145-1159.

Reynolds, D. J., et al. (2016), Annually resolved North Atlantic marine climate over the last millennium, *Nature Communications*, *7*, 13502.