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Biogeosciences Discussions

Interactive comment on "Iron biogeochemistry across marine systems at changing times – conclusions from the workshop held in Gothenburg, Sweden (14–16 May 2008)" *by* E. Breitbarth et al.

Anonymous Referee #2

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General Comments on Paper as a whole: The authors seem to liken the workshop to the Amsterdam workshop used to compile Turner and Hunter's 2001 book, though I was not under the impression that the size or scope of this workshop was similar to the Amsterdam workshop. The authors state that it is not meant to be an in depth review of marine biogeochemistry, rather it is supposed to be a synthesis of interdisciplinary knowledge. With that in mind, I found it a bit confusing that the paper was prepared in 6 seemingly stand alone sections, and seemed to stray from the stated objective. I also found the "at changing times" part of the title to be somewhat misleading/confusing.

After reading the paper, I feel that it would be more appropriate to replace "at changing times" with something along the lines of ": progress from the past decade." With that said, I see a great deal of value in this paper because it is a great resource to update researchers about the work that has been performed over the past decade or so. With an ever increasing body of literature, it has become nearly impossible for researchers to keep up with all relevant journals, particularly in a field as broad as Fe biogeochemistry. By looking at the excellent reputations and the breadth of expertise of listed authors, it is clear that a great deal of work went into synthesizing this document, and that the workshop certainly had lively and worthwhile discussions on the topics listed in the 6 sections. Because this paper was not an exhaustive review (though I do believe the authors did a very good job), it is not appropriate to nitpick about the specific content/citations. Therefore, my comments are general, and I have structured them according to the overall structure of the paper, which was comprised of six standalone sections. Comments on individual sections Section 1. Natural Iron Fertilization I believe that the authors have done an excellent job explaining our current understanding of Fe addition to the open ocean via dust deposition. Advancements in sampling and data density in space and time are discussed, but the authors are quick to note that many of the parameters are poorly constrained, which allows for proper context of the published data. In a paper such as this, I also find it useful when the authors provide advice for better constraining parameters (e.g. Al measurement in dust traps as a tracer). In my opinion, section 1.2 does an excellent job pointing out that there are other potential Fe fertilization sources (e.g. volcanoes, sea ice, extraterrestrial dust, eddies, lateral transport) that have received much less attention than dust deposition. Again, in section 1.2, the authors point out that many parameters are poorly constrained and offer their advice on how to advance the field. Overall, it was a very effective section.

Section 2. Artificial Iron Fertilization As a reader, I do not understand the overall objective of section 2, and I think it will require a fair amount of reworking to clarify things. In this section, the authors glance upon a wide range of topics surrounding Fe biogeochemistry in the ocean (history of the Fe hypothesis, how mesoscale enrichments are

performed, origins of Fe in surface waters, greenhouse gas production following enrichments), but provide very little review of the actual results of the dozen or so mesoscale enrichments. Personally, I find the introductory paragraph of this section to be either unnecessary or misplaced. If the authors insist that a brief history of Fe importance in marine systems is warranted in a paper like this, I believe that it should be included in a general introduction, not following a section where episodic Fe fertilization events in HNLC regions has already been discussed. As for the brief discussion of geoengineering, I think that this type of paper needs to be careful when expressing concern of using artificial Fe fertilization for global warming remediation. If the authors believe that these concerns must be voiced, I think that it is only appropriate to do so after prefacing the concerns with a summary of the relevant data.

Section 3. Fe inputs into coastal and estuarine systems Overall, I have no major comments for this section. In my opinion, general results are appropriately summarized in the review article, and the reader is pointed to references for more detail. As I mention earlier, it would be easy to nitpick about what should be included in the review type article, but I think that this section is great as is.

Section 4. Colloidal Fe and organic matter I am also very pleased with this section overall, much for the same reasons as in section 3. I think that the citations are appropriate, and the section reads well. I also believe that the authors were correct to raise the point that oceanographers have been using operational definitions for dissolved/particulate/colloidal Fe, for the sake of simplicity; but that advances in technology (filtration and otherwise) now allow us to use more precise definitions. I comment more on this later.

Section 5. Linking biological processes to Fe chemistry Upon reading this title, I was concerned, because I was not sure how it would be addressed using our current understanding, without overspeculation. However, after reading the section, I was very satisfied with the way that the topic was handled and would not change much. The different Fe uptake models, adaptations to Fe stress and biological feedbacks, were

quickly outlined, with appropriate citations directing the reading for more detail. The authors included a section highlighting our changing understanding of Fe redox chemistry in natural waters. I was particularly pleased that the authors included a section that talks about how analytical improvements have been critical in advancing the field. This is the one thing that I believe requires more discussion/expansion, and perhaps its own section. It cannot be overstated how critical the ability to reliability measure Fe in the field has been to advancing our understanding of spatial and temporal variability. Application of highly advanced techniques are also discussed in this paper, with appropriate citations, though I do think it would be useful to summarize the new information that has been learned by using these techniques. Furthermore, the paper should state that the field needs to continue developing new methods and designing elegant experiments to link Fe chemistry to biological processes. With the discussion of new methods, I believe that the authors are omitting one key thing: autonomous methods and sensor technology. With capabilities associated with Ken Johnson's group at MBARI, it is conceivable to automate some of these methods to the point where they can be autonomously deployed. Furthermore, there has been a fair amount of work bridging marine Fe chemistry and novel sensor technology. I am aware of two papers that have come out in the past few years aimed at developing biosensors to measure Fe in natural seawater. The author list of both papers includes both chemists and oceanographers, and both papers are a great example of cross-discipline research that this paper suggests is imperative. While it is not my understanding that these methods are to the point where they are ready to be deployed on buoys, both methods were used in the field and have potential to give oceanographers about speciation as well as concentration. These types of new measurements could also help with an issue raised in section 4, where the authors brought up the need to better define fractions of Fe (e.g. dissolved, particulate. . .)

Lam, C. K. S. C. C.; Jickells, T. D.; Richardson, D. J.; Russell, D. A. Anal. Chem. 2006, 78, 5040–5045.

Roy, E.G. Jiang, C., Wells, M.L. Tripp, C. Anal. Chem. 2008, 80, 4689-4695

6. Iron and Climate Change My overall thoughts on this section are favorable. With a topic like this, it would be easy to get carried away with hand-waving speculation. The authors do a good job weaving plausible hypotheses with the few data that exist in the field regarding ocean acidification, biological feedback mechanisms and physiological triggers/adaptations, and then tie in probable effects on Fe biogeochemistry due to changing temperature and pH. I do not think that there are enough published data to address this issue any more than the authors already have, but I do not believe that they overspeculated.

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