

We would like to thank the reviewer for their positive and constructive comments on this manuscript. Their time invested is greatly appreciated and certainly improved this manuscript.

Please find below point by point responses to the reviewers comments.

I found this to be an excellent paper which is certainly publishable, given that minor changes and some cuts are made. The study compares the particulate chemistry at a series of sites on the well-fertilised Kerguelen plateau with more remote sites that are poorly fertilised. The particulate chemistry is able to show that the Fe used for fertilisation originates from the re-suspension of shelf sediments and from fluvial and glacial sources derived from the Kerguelen Archipelago. This is an important finding some aspects of which need to be emerge more clearly. My main criticism is that the calculation in section 3.7 rests on the assumption that all particulate P is biogenic and this needs to be supported. What are the compositions of the rocks of Heard and Kerguelen Island- basalts can be high in P and may be an important source to the sediments? There may also be other non-biogenic sources. This calculation would require chemical and mineralogical data for the island rocks and the sediments for publication. In the absence of this data I would omit this section. The paper also tends to lose focus towards the end and removal of section 3.7, and also 3.9, would help to retain focus.

We considered the reviewers comments together with the second reviewers comments also regarding section 3.7 and rewrote this section and bolstered the calculation of biogenic Fe with correlations between biogenic Fe and fluorescence and dissolved oxygen. We have also listed the elemental molar ratios of Fe:P in Kerguelen Basalt and upper crust to show the factor of 1000 increase in pP within the suspended particles compared to these potential sources. We have cut section 3.9, together with figure 9 as these were minor parts of the paper and as the reviewer points out, their removal helps maintain focus. The new text regarding the biogenic Fe calculation in section 3.7 is as follows:

“If we assume that all particulate phosphorus (pP) is of biogenic origin, we can calculate the biogenic Fe fraction of the total Fe concentration by normalising to pP and comparing with published elemental ratios of Southern Ocean diatoms (Planquette et al., 2013). For the calculations we used the upper limit of Fe:P ($1.93 \text{ mmol mol}^{-1}$) reported by Twinning et al. (2004) for Southern Ocean diatom assemblages. Given that pP and POC are remineralised throughout the water column and are generated within the surface mixed layer, calculations of biogenic trace metals will only be valid within the surface mixed layer, as the concentration of pP and POC decreases strongly with depth. It should also be noted that Kerguelen Island basalts and upper continental crust can contribute particulate phosphorus concomitantly with pFe to the particulate pool. However the Fe:P ratio found within Kerguelen Island basalts and the continental crust is 12.8 and 25.8 (mol:mol) respectively (Gautier et al., 1990; Wedepohl, 1995). Thus, the factor of 1000 increase in pP within suspended particles compared to these rock sources indicates that this pP is likely produced *in situ* within the mixed layer from dissolved PO_4^- rather than supplied from rock weathering. Furthermore, within the upper 200 m of the water column, biogenic Fe correlates significantly with both fluorescence (Spearman's RHO $R = 0.518$, $P < 0.05$, $n = 30$) and dissolved oxygen (Spearman's RHO $R =$

0.507, $P < 0.05$, $n = 30$) confirming the autotrophic composition of the particles identified as high in biogenic Fe.”

Additional Comments below keyed to page and line numbers.

13392 line 14. What sedimentary records?

Thank you for noticing this, it is a mistake, I have changed the wording from “sedimentary records”, to “Antarctic continental ice records”.

The new text within the introduction is as follows:

“This limitation on the biological pump means that the Southern Ocean does not realise its full potential in transferring atmospheric CO₂ into the ocean interior; a result illustrated in Antarctic continental ice records over geological timescales and supported by modelling studies (Barnola et al., 1987; Bopp et al., 2003; Martin, 1990; Watson et al., 2000).”

13393 line 7. Needs dFe inside the bracket. Also important here to point out that dFe includes colloidal and nanoparticulate Fe (which may be only partially bioavailable) as well as aqueous Fe (which is probably all bioavailable).

Changed to include these suggestions

The new text within the introduction is as follows:

“Dissolved Fe (dFe < 0.2 μm) includes colloidal and nanoparticulate Fe, which may only be partially bioavailable, as well as soluble Fe (sFe < 0.02 μm) which is highly bioavailable (de Baar and de Jong, 2001). As a result, the larger particulate fraction (> 0.2 μm) is often less studied due to the perception that it has low bioavailability.”

Line 16. Better to write inside the bracket as follows (e.g. weathering products delivered by fluvial and glacial processes, resuspension of sediments and porewaters, : : :).

It is likely that the porewaters contain reduced Fe which is oxidised to nanoparticulate Fe (oxyhydr)oxides on entering seawater. This is the main source of potentially bioavailable Fe from re-suspension.

The MS was changed to include these suggestions

13394 line 5. Unclear, re-write this sentence.

Sentence has been reworded to:

“Blain et al., (2007) and Chever et al.,(2009) demonstrated that dFe fertilisation from the plateau increased primary production in the area.”

13395 line 11. I am not familiar with this methodology but would not expect that you could combust nylon and polyester. Is this correct as written?

No it is not correct, this was a typographical error which has been changed to show that only the QMA filters were combusted.

The methods section has been changed as follows:

“The ISPs were fitted with 142 mm quartz micro fibre (QMA) (Sartorius) filters with 53 µm Petex pre-filters and 350 µm polyester supports. QMA filters were pre-combusted to remove particulate organic carbon and then acid-washed with Seastar Baseline™ HCl and rinsed with copious amounts of ultra-pure water according to the methods outlined in the GEOTRACES sample handling protocols handbook (Cutter et al., 2010). The pre-filters and supports were carefully acid washed and rinsed with copious amounts of ultra-pure water before use.”

13399 line 5. Fig. 2 seems to show that the southern waters are colder but less salty. Check this.

While it is true that there is some localised salinity variability in Figure 2, particularly near the Le Claire rise, the overall surface salinity north of the polar front is illustrated in blue (~33.7) and south of the polar front is green (33.9). In a small area downstream of the Le Claire rise this trend seems to be reversed, however this could be either bad data or inter-annual variability in the position of the polar front.

line 25. Write ‘contain recycled Fe’. Delete a form of.

Done

13400 line 7. Clarify that these are molar ratios here and in the Tables.

Thankyou for noticing this. All ratios are molar ratios except for the Kerguelen Archipelago Basalts listed in Table 2 from the Doucet et al 2005 reference. We have updated this table with the molar ratios of Kerguelen Island basalts from Gautier et al 1990 and also included the upper continental crust ratios of Wedepohl 1995. On reviewing the reference used as an end-member for Kerguelen Island Basalts we decided that the work of Gautier et al 1990 was more appropriate as the work of Doucet et al 2005 focuses on a less common subset of Kerguelen island high MgO basalts and Picrites.

13401 lines 8-14. Start with R2 and move these lines to the end of the paragraph – a more logical order to fit the following discussion.

Done, text changed as follows:

“The reference station (R-2) has a bottom depth of 2528 m and is characterised by low surface Chl a concentrations (Lasbleiz et al., 2014) and nutrient concentrations characteristic of HNLC waters (Blain et al., 2014). Station F-L is approximately 313 km northeast of Kerguelen Island with a bottom depth of 2690 m and represents the northern PF. Station F-L is downstream of Kerguelen Island, with the PF delivering waters that originated near station R-2. In this case, the waters crossing Station F-L have interacted with both the plateau and shallow coastal waters of Kerguelen Island. In contrast, station A3 is located over the Kerguelen Plateau and has a bottom depth of 527 m, making it the shallowest station sampled for trace metal analysis of suspended particles and one of the most

likely to be influenced by resuspension of shelf sediments (Fig. 1). The proximity of the station to Heard and Kerguelen Island (roughly half way between the two) means that fluvial and glacial runoff may also drive fertilisation at this site. However, the hydrography of the area dictates that waters which previously interacted with upstream Heard Island are a more likely source to A3 than downstream Kerguelen Island (Park et al., 2008)."

13404 line 22. Briefly explain how Al was lost preferentially and why you think processes involved occurred here.

We are unclear on what is needed here as we go on to discuss this in detail in the following paragraph, citing Shigemitsu et al. (2013).

13406 line 5. The Schroth paper found that 2-3% of the total Fe (not of all the rock flour) could be leached by distilled water. This is a dFe measurement and may not all be bioavailable (see above).

We agree that clarity is needed on this point. We have changed the text to the following:

"Furthermore, it has been shown that 2 – 3 % of the Fe within glacial rock flour can be leached into the dissolved size fraction (< 0.2 µm) with ultrapure water, a large proportion of which should be bioavailable (Schroth et al., 2009)."

Line 7. Not quite correct. Write as follows- 'this dFe is leached from nanoparticulate Fe (oxyhydr)oxides in glacial rock flour (Raiswell et al., 2010, Raiswell 2011)' The 2011 reference is DSR v.58, p.1364.

Done, text changed to:

"It is thought that this dFe is leached from nanoparticulate Fe (oxyhydr)oxides in glacial rock over time (Raiswell, 2011; Raiswell et al., 2010) following an exponential decay, so it is possible that this source could be excluded from the < 0.2 µm dissolved fraction, but included in the 1-53 µm particulate fraction presented here."

Line 20. See above. The assumption that all P is biogenic needs to be thoroughly justified or else this section should be left out. Even if you can justify this assumption the paper is starting to lose focus here and would be improved by leaving out this section.

See previous comment, we have now redrafted this section with justification and supporting correlations.

13408 line 19. Delete et al. This is the DSR 2011 reference.

Done

Section 3.9. I cannot see that you need this section and the paper would keep its focus better without this section. The relevant sentences from this section could be put elsewhere.

Agreed, we have now removed section 3.9 and figure 9 to maintain focus.

