

## ***Interactive comment on “The silicon stable isotope distribution along the GEOVIDE section of the North Atlantic Ocean” by Jill N. Sutton et al.***

**P. Grasse (Referee)**

pgrasse@geomar.de

Received and published: 8 May 2018

### Review

The silicon isotope distribution along the GEOVIDE section of the North Atlantic Ocean  
Jill N. Sutton et al.

The manuscript by Sutton et al. shows the dissolved silicon isotope ( $\delta^{30}\text{dSi}$ ) distribution along the GEOVIDE section in the North Atlantic Ocean. The authors present 10 Stations along the transect. The data is of high quality and intercalibrated according to GEOTRACES protocol. Samples in the upper 500 m could not be measured due to low DSi. The manuscript discusses in detail the influence of water masses on the  $\delta^{30}\text{dSi}$ . However, some parts of the water mass discussion need to be improved.

C1

The discussion would benefit from a plot with water mass end members to identify all sources and possibly other processes influencing  $\delta^{30}\text{dSi}$  in intermediate and deep waters. The manuscript is overall very good and suitable for Biogeosciences, but needs revision (medium) to improve the discussion section. Please find my comments below.

#### Abstract:

P1 L12: I think the information that low DSi samples could not be measured does not necessarily need to be in the Abstract. I think it would be more important that this information is mentioned in the methods or results part.

#### Methods:

P3 L20: Mesh size of the AG 1 X8 resin? P4 L20: Please check the equation. Shouldn't it be 26/24 Mg or 25/24Mg? P5 L15: It seems the manuscript Garcia-Ináñez et al. is already accepted.

#### Results:

P6 L5: Please include one sentence about the DSi concentrations in the upper 500 m and that the samples could not be analyzed.

P6 L8: I would add some information to describe the DSi and  $\delta^{30}\text{dSi}$  in more detail. E.g. St. 1 and St. 13 already increase at 1000 m depth.

P6 L18: Please give the exact values of the lowest  $\delta^{30}\text{dSi}$  (0.95 ‰ to 0.98 ‰). I think these very low  $\delta^{30}\text{dSi}$  values are actually quite interesting and need some more attention. See my comments below.

Discussion: P7 L13: The constant offset between the data set from Brzezinski and Jones and de Souza et al., must be indeed a measurement artifact. However, the offset between your data set and de Souza is partly bigger than 0.2 ‰ and samples of the GEOVIDE section do not seem to plot on a straight line between DSi and  $\delta^{30}\text{dSi}$ . It looks that the data clusters as some samples show a wide range in  $\delta^{30}\text{dSi}$  (1 ‰ to 1.7

C2

‰ at nearly similar concentrations (approximately 40  $\mu\text{mol}$ ) and at low DSi (appr. 12  $\mu\text{mol}$ ) where  $\delta^{30}\text{dSi}$  ranges from 1.25 ‰ to 1.7 ‰. That could indicate that other sources or processes influence the waters of your study compared to the open ocean stations in de Souza et al., and Brzezinski and Jones. I think it would be helpful to modify figure 4. First of all, you should make your data more visible (e.g., bring your data to the front, use a light color for the already published data). You could try to group your data. e.g., only use open ocean stations vs. stations close to landmasses. Colorcode the stations or samples that are characterized by specific water masses. It would also be helpful to add water mass end members, e.g., AABW, which brings a light source from the south 1.2 ‰ (0.01 DSi; Souza et al. 2012). That could show additional processes that influence your deep-water masses e.g. at St. 1 and St. 13. Generally, I think it is interesting, that you see such light  $\delta^{30}\text{dSi}$  values and it should be discussed in more detail. According to your intercalibration with de Souza et al. (Fig. 6) and your results from the intercalibration study Grasse et al. (2017) your  $\delta^{30}\text{dSi}$  data agrees very well within error (0.1 ‰ 2sd). Therefore, a water sample of 1 ‰ together with slightly higher DSi compared to de Souza et al., might indicate that further remineralization influences the  $\delta^{30}\text{dSi}$  composition. Such low (or even lower, 0.6 ‰) values are typically associated with much higher DSi of 130 to 150 micromol in the Pacific and (Reynolds et al. 2006, de Souza et al., 2012, Grasse et al., 2013) at DSi concentrations (even though I know that some people doubt some of the  $\delta^{30}\text{dSi}$  deep water values in the North Pacific). However, Grasse et al. 2016 observed  $\delta^{30}\text{dSi}$  values of 1.1 ‰ in bottom water of the Peruvian shelf ( $\sim$ 40 micromol), which were influenced by pore waters from the sediment and remineralization at the sediment-seawater interface (Ehlert et al., 2016). Not necessary an effect you observe, but if not dissolution at the seawater-sediment interface or in the water column influences your  $\delta^{30}\text{dSi}$ , you could also have admixture with a distinct water mass that brings in a very light  $\delta^{30}\text{dSi}$  signature (e.g., a water masses from Iceland? I am not so familiar with the water mass circulation in the Atlantic, but it seems that the NEADW can pick up its signature here?). Additionally, the circulation is quite sluggish, or? Therefore, you can have a trapping effect? I do not

### C3

want, that you go too much into detail into the Pacific seawater  $\delta^{30}\text{dSi}$  distribution and I also see that some of the values are identical within error, but I would like to have a better explanation why not all of your data does fall on the line for DSi versus  $\delta^{30}\text{dSi}$ .

P7 L8: Please give the values (low, high) for the study by de Souza et al.

P7 L25: please mention here (or at least above) the absolute  $\delta^{30}\text{dSi}$  values from the study of de Souza et al. for comparison with your values. The range can be similar, but that does not necessarily mean, that the  $\delta^{30}\text{dSi}$  are identical.

P10 L8: Please also explain, why the uppermost sample at station 26 has such high  $\delta^{30}\text{dSi}$ .

P11 L5: Please mention the stations you are talking about. High  $\delta^{30}\text{dSi}$ ? Value? What values?

P11 L10: What are the  $\delta^{30}\text{dSi}$  values in the Labrador Sea? Please make clear that it is subducted surface water.

P11 L24: Please give me the station number and depth that makes it much easier to follow and understand your discussion.

P11 L25 Doesn't NEADW has high DSi? Here I am getting confused, isn't the NEADW influencing the eastern deep waters? At least according to Fig 4. in Garcia-Ibanez et al.? Please check the Garcia-Ibanez paper for water masses; it seems that there are some discrepancies, most likely as a result of the review process of the manuscript.

Figures: Fig.2 I do not think that the Figures has to be in the Paper. In my opinion, it is enough to mention in the text, that all samples fall on the mass-dependent fractionation line.

Fig4: Can you please adjust the y-scale from 0.5 ‰ to 2 ‰. Please add the studies indicated by different color directly to the legend. Would be good to modify the figure (see comments above)

### C4

Fig. 5: It is quite tricky to distinguish the colors of different water mass types. You could only name the dominant water mass in the figure. Similar to Garcia-Ibanez et al. (Figure 4). Can you replace section distance with longitude?

References: de Souza, G. F., Reynolds, B. C., Johnson, G. C., Bullister, J. L., & Bourdon, B. (2012). Silicon stable isotope distribution traces Southern Ocean export of Si to the eastern South Pacific thermocline. *Biogeosciences*, 9(1), 4199–4213.

Grasse, P., Ehlert, C., & Frank, M. (2013). The influence of water mass mixing on the dissolved Si isotope composition in the Eastern Equatorial Pacific. *Earth and Planetary Science Letters*, 380, 60–71.

Grasse, P., Ryabenko, E., Ehlert, C., Altabet, M. A., & Frank, M. (2016). Silicon and nitrogen cycling in the upwelling area off Peru: A dual isotope approach. *Limnology and Oceanography*, 61(5), 1661–1676.

Ehlert, C., Doering, K., Wallmann, K., Scholz, F., Sommer, S., Grasse, P., et al. (2016). Stable silicon isotope signatures of marine pore waters – Biogenic opal dissolution versus authigenic clay mineral formation. *Geochimica Et Cosmochimica Acta*, 191, 102–117.

Reynolds, B., Frank, M., & Halliday, A. (2006). Silicon isotope fractionation during nutrient utilization in the North Pacific. *Earth and Planetary Science Letters*, 244(1-2), 431–443.

---

Interactive comment on Biogeosciences Discuss., <https://doi.org/10.5194/bg-2018-165>, 2018.