Climate of the Past Discussions

Clim. Past Discuss., author comment AC1
https://doi.org/10.5194/cp-2021-50-AC1, 2021
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

Reply on RC1

Jakub Witkowski et al.

Author comment on "North Atlantic marine biogenic silica accumulation through the early to middle Paleogene: implications for ocean circulation and silicate weathering feedback" by Jakub Witkowski et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2021-50-AC1, 2021

Reviewer comment: As mentioned in the text, 49 Ma corresponds with the possible onset of Northern Component Water. The 49-47 Ma gap in BN silica deposition is intriguing. Witkowski et al. (2020, Fig 5) show a 47 Ma end of widespread chert deposition in the deep North Atlantic. Why would biosilica deposition shift from the shelf to the deep sea? This is discussed more thoroughly in Witkowski et al. (2020), but I believe a review of this discussion is warranted.

Response: The 49-47 Ma gap in BN silica deposition is actually a hiatus, so we are unable to reconstruct the events that took place through this time period. The actual timing of peak chert/porcellanite occurrences in the Atlantic presented in Witkowski et al. (2020, Palaeo3 556: 109896) is slightly different to what the Reviewer is suggesting. Peak chert/porcellanite frequency coincides with the Early Eocene Climatic Optimum, from 53 to 49 Ma rather than the interval up to 47 Ma. Also, in the Palaeo3 paper referred to by the Reviewer, we show that both the siliceous sediments that underwent diagenesis to chert/porcellanite and those sediments that retain their original biosiliceous composition occur along continental margins. Thus, there is really no distinction between "deep-sea" and "shelf" sites in the dataset compiled for the Palaeo3 paper. Finally, considering the high proportion of neritic diatoms in the Blake Nose siliceous plankton assemblages, in the Palaeo3 paper we proposed that neritic siliceous plankton production must have been higher than that in the pelagic settings, even though biosiliceous sediments are sparse on the North American margin. We assume that by "biosilica deposition shift from the shelf to the deep sea" the Reviewer is alluding to the widespread occurrence of diatom-rich sediments in pelagic settings from the Late Eocene onwards. We believe at least part of the reason for this may have been associated with diatom evolutionary events that took place through the Paleogene, including the radiation of holoplanktonic species, as discussed by Sims et al. (2006, Phycologia 45: 361-402).

Reviewer comment: Figure 4 –Biosilca and CaCO3 flux is pulsed in the equatorial Pacific, as would be expected due to changing climate driven productivity gradients. Narrow vs. broad band of equatorial flux.

Response: The lack of a productivity gradient context in the discussion is referred to below, in the response to the Reviewer's comment regarding line 449.

Reviewer comment: Line 407 –high diatom to radiolarian ratios in BN sediments. What

about diatom to sponge spicule ratios? Were these done? Could sponge spicules contributed to biosilica percent.

Response: As explained in the text (lines 423-424), no attempts were made to quantify the contribution of sponge spicules to the reconstructed biogenic opal flux. The reason is chiefly pragmatic: counting and identifying sponge spicules was beyond the scope of both the present study, and the Witkowski et al. (2020, Palaeo3 556: 109896) paper mentioned by the Reviewer, in which Blake Nose radiolarian:diatom ratios were discussed. Secondly, to our knowledge, no quantitative studies on sponge spicules from the Blake Nose cores have been performed thus far, and consequently, we were not able to use published data. Finally, several recent studies, both specifically focusing on sponge contribution to total silica flux globally, and on silica biomineralization, point to declining contribution of sponges to total silica flux that is probably synchronous with diatom expansion in the late Mesozoic (Conley et al., 2017, Frontiers in Marine Science 4: 397; Maldonado et al. 1999, Nature 401: 785-788). Sponge spicules are therefore unlikely to have made a significant contribution to opal flux at Blake Nose through the early Paleogene. A related issue is silica preservation. Silica dissolution occurs in the water column, at the sediment-water interface, and within the sediment, hence the concern as to whether biogenic opal concentrations and/or fluxes have been compromised by silica dissolution (as stated in lines 45-47, deep-time reconstructions of opal flux are founded on one central premise, that opal comprised in the studied sediments has not undergone significant dissolution). Although some attempts have been made (Warnock & Sherer, 2015, Continental Shelf Research 102, 1-8), there is currently no reliable, quantitative measure of siliceous plankton preservation in sediments, and the basic indicators of silica dissolution are chert/porcellanite and zeolite (clinoptilolite) occurrences. We have stressed in the text (lines 146-147, 297-298 in the original submission) that chert occurrences are rare in the Blake Nose cores, and that in some intervals diatom preservation can be considered pristine (lines 300-301). We therefore assume that extensive diatom silica dissolution has not occurred, which would lead to preferential preservation of the more dissolution-resistant sponge spicule silica over the more dissolution-prone diatom and/or radiolarian silica. Thus, our conclusion is that a significant contribution of sponge spicule silica to total opal flux in the Blake Nose cores is unlikely. As explained above, the best we can offer is to put still more emphasis on this issue in the revised manuscript, for instance by including the explanations given above in an expanded version of the paragraph starting in line 407.

Reviewer comment: Line 449 –diminished BN silica fluxes at 42-38 Ma –imply diminished nutrient supply? How about increased productivity gradients? Explained beginning of line 470

Response: Indeed, the discussion on the reasons for Atlantic to Pacific biogenic opal flux fractionation included in the original submission is focused predominantly on seafloor biogenic opal preservation – but, as explained in the response to the previous Reviewer comment, preservation is only one of the key factors that could potentially compromise an opal flux reconstructions. The Reviewer is right that productivity context is not presented sufficiently well, and that a productivity gradient should also be discussed. As such, discussion of possible mechanisms for altering biogenic opal flux in the Atlantic and Pacific will be better incorporated into the revised manuscript.

Reviewer comment: Line 78 –flat continental relief –Does this imply reduced rates of terrestrial runoff?

Response: Yes, Misra & Froelich (2012, Science 353: 818-823) and Froelich & Misra (2015, Oceanography 27: 36-49) invoke reduced rates of terrestrial runoff (due to inferred flat continental relief) to explain the broad low in lithium and strontium isotope records spanning the late Paleocene and early Eocene subepochs.