Response Letter

Dear Associate Editor,

Thank you for your comments on our manuscript. We appreciate the time and effort in providing your valuable feedback. Here are our point-by-point responses to these comments.

General comment: I thank our two expert reviewers for insightful comments and suggestions, and the authors for their responses. Overall, the manuscript is suitable to be considered for publication upon major revision in line with the reviewer comments, author responses, and my additional comments below.

Response:

We thank the associate editor for the generous comment.

Major comment 1: In support, and in addition, to the feedback from both reviewers, I recommend that the authors include the following revisions with regard to the experimental treatments:

Abstract - Consider addressing the TA issue in the abstract, as it stands to be a leading question for any reader.

Response:

Thank you for pointing it out. We have added a new sentence in the abstract "Olivine and slag powders were of similar grain size, but the amount of added olivine needed to be much higher than the steel slag because less alkalinity is released by the olivine than the steel slag over the 3 weeks experiment." (Line 18).

Major comment 2: Methods - Unrelated to the disparate TA outcome, please provide more context for the choice of the intended treatments. The text is currently limited to "The total alkalinity released per amount of mineral powder added was much higher for the slag powder than the olivine powder in our preliminary test trials. So, three microcosms were enriched with 100 g of olivine powder, three microcosms with 2 g of steel slag powder". This does not provide any context for how those levels were selected or what change in TA was targeted and why. It would be worth including the test trial data (L132) as a supporting document.

Response:

Thank you, the data we are referring to is part of another project so we cannot show it here (part of it is currently under review). Our goal was to set up two reasonably realistic amounts for different minerals for potential coastal field applications, under consideration of their alkalinity release potential. We have added the following text in the discussion 4.2 to better express how the treatments were designed: "The amount of olivine and slag powder added to the treatments differed significantly (100 g of olivine powder were added while only 2 g of slag powder were added to the 53 L microcosms). Our rationale for these different mass additions was to yield somewhat similar amounts of detectable alkalinity enhancement in the dissolved phase, since we already knew from tests before the experiment that slag elevates alkalinity faster than olivine. However, olivine was less efficient in

releasing alkalinity than we had anticipated so that even a 50-fold higher additions of olivine (in mass) did not compensate for this difference. As such, our experiments are associated with an “apples and oranges issue” in that our perturbation with minerals and associated OAE differs. We argue that an adjusted addition of minerals depending on the alkalinity enhancement rate would be consistent with what OAE practitioners may do under real-world conditions. Presumably, OAE deployments may have to adjust the amounts of minerals to detect alkalinity enhancement in the dissolved phase for verification purposes. Nevertheless, to account for the “apples and oranges issue”, the following discussion mainly relates the observed environmental effects with the alkalinity enhancement achieved over the course of the study.”

Major comment 3: Discussion - The TA outcome from olivine was an unexpected result, but a result nonetheless and it is not discussed. Please include some discussion of this issue. What might have caused the unexpected low dissolution of olivine? Were there methodological differences in the preliminary trial and the experiment? How do the changes in TA observed in the preliminary trials and in the experiment compare to previous olivine experiments or its theoretical dissolution potential? Section 4.1. does not address this nor reference previous work.

Response:

Thank your for your comment. The comparative inefficiency of olivine dissolution is indeed interesting. However, we do not have the data available here to make a meaningful contribution as to why the inefficiency occurred. Experiments in our lab and other labs have shown that multiple variables affect dissolution rate. For example, in a study we are currently preparing for publication we found that larger grain sizes, surprisingly, dissolved faster. Also, interaction with sand and the amount of stirring were observed to be a big factor. We think our study adds a lot to the environmental assessment of olivine but provides limited insights into dissolution rates. Thus, we would prefer not to speculate about this here without having the substance for it, especially in light of the publication on olivine dissolution we are currently preparing.