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Earth System
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Interactive comment on "Rolling stones; fast weathering of olivine in shallow seas for cost-effective CO_2 capture and mitigation of global warming and ocean acidification" *by* R. D. Schuiling and P. L. de Boer

Anonymous Referee #2

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Mitigation of climate change and ocean acidification is a serious and important issue and evaluation of possible mitigation strategies is urgently needed. Hence given the significance of the issue, thorough and careful scientific research is required to test the feasibility of the various proposed mitigation approaches.

Unfortunately, when it comes to thorough and careful scientific research, Schuiling and de Boer's study falls short (detailed below).

In order to seriously evaluate fast weathering of olivine as a possible mitigation strategy,

I recommend the authors conduct research following the three steps outlined below.

(1) Conduct a comprehensive study of laboratory experiments to determine (and disentangle) chemical and mechanical weathering rates under various environmental conditions. This includes studying the effects of temperature, solution chemistry, mechanical parameters, various grain sizes etc. The results of the experimental study should be published in a peer-reviewed journal, for instance, Chemical Geology or Geochimica et Cosmochimica Acta. Note that the quality of the experimental data alone would have to be high enough to warrant publication.

(2) Conduct a comprehensive field study to demonstrate that the findings obtained in the laboratory experiments apply to typical settings found in nature. The results of the field study should also be published in a peer-reviewed journal.

(3) Based on the results of the laboratory and field study, conduct a comprehensive carbon cycle modeling study to test whether or not fast weathering of olivine on a global scale is a feasible and effective strategy for mitigation of climate change and ocean acidification.

Unfortunately, the content of the current ms is inadequate to draw any conclusions about the proposed approach.

Experiment.

The authors suggest spreading of olivine in shallow marine environments (i.e. in seawater). However, the experiments were carried out in tap water. Because of the fundamental differences in the ionic composition of seawater and tap water, tap water is inappropriate for the dissolution experiments if the target is open marine environments.

The experiments were conducted in 250 ml flasks filled with tap water open to the atmosphere (similar to batch experiments: solution chemistry drifts over time). Such experiments bear no significance to the open marine environment where seawater is continuously exchanged with the surroundings (bulk chemistry is essentially constant

during dissolution). Batch experiments are inappropriate for the dissolution study if the target is open marine environments.

The results show a rapid increase of pH to high pH values (> 8.7) during the first day (Table 1) but a decrease between day 1 and day 4 (both fine and coarse). First, such high pH values are not encountered in seawater. Second, the pH drop indicates that other processes have affected the experiments such as precipitation of other minerals (Mg and Si concentrations decrease!). As a result, the experimental setup is inappropriate to study the dissolution of olivine if the target is open marine environments.

The critical quantity in determining chemical and/or mechanical weathering rates under various environmental conditions is the dissolution rate. Dissolution rates are typically measured in units of mol/area/time in order to normalize the results. Schuiling and de Boer do not report dissolution rates in units of mol/area/time or similar units. As a result, (even if an adequate experimental setup was used), it would be impossible to compare their results to other published studies of olivine dissolution (e.g. Oelkers, Chem Geol, 2001 and many other studies which have not been cited in the present ms). More importantly, without normalized dissolution rates, it is impossible to quantify olivine weathering under different environmental settings and provide estimates of the efficacy of olivine weathering as a mitigation strategy on a global scale.

No attempt at all was made to quantify the mechanical effects from the rotary table top shaker. It is hence impossible to evaluate the mechanical weathering effects as simulated in the laboratory relative to those encountered in reality in nature.

In summary, the scope and design of the laboratory experiment is inadequate to study the weathering of olivine and evaluate its potential as a possible mitigation strategy. The content of sections 3, 4, and 5 are based on the inadequate experiment presented in Section 2. Sections 3, 4, and 5 are hence unpublishable.

As a result, I recommend rejection of the manuscript. In my view, the quality of the study is insufficient for submission to a peer-reviewed scientific journal.

Interactive comment on Earth Syst. Dynam. Discuss., 2, 551, 2011.