

Interactive comment on “Biological weathering and its consequences at different spatial levels – from nanoscale to global scale” by Roger D. Finlay et al.

Anonymous Referee #2

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In General:

The authors of the paper propose a review of current (last 10 years) of advancement made in the understanding of biological weathering, specifically focusing on the boreal forest, in response to an interdisciplinary project called “Quantifying weathering rates for sustainable forestry.” This topic fits well the scope of BG and it is needed to help us move forward in this area of research.

The manuscript cites more than 200 references that span a wide range of topics from physical, chemical and biological approaches, and scales from nano-scale empirical studies to global scale modeling, and emphasizing an evolutionary viewpoint on biolog-

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ical weathering. However, I was disappointed seeing that about 1/3rd of the references are prior to 2009 and have been widely cited and reviewed in the past, thus these do not give “anything new” especially in some sections of the manuscript (see details below) and it also contradicts with the authors aim of summarizing the last 10 years of advancement.

The manuscript is a well-written review/summary of more than the last 10 years of biological weathering research with a heavy emphasis on mycorrhizae mediated weathering (which is the ecosystem in the boreal forest). However, there is no synthesis of the reviewed literature, there is no agreement stated on what is the current understanding, or state of this biological weathering in the boreal forest, and how it applies to sustainable forestry or simply how to move forward. The manuscript is a review, but it lacks a synthesis.

Regardless of great writing, it was not an easy read, because I could not find/follow the purpose of this manuscript, it presents a lot of data on both side of the arguments that contradict each other, which is fine, however, there are no directions, there is a lot of rambling on without focus – what is the underlying message? What do the authors want to achieve with this review? Key questions and knowledge gaps section is underdeveloped and it seems like it was an afterthought and stuck to the end.

In addition, I think that the title is misleading, as the review is really about weathering in the boreal forest. Most cited work was done by researchers related to the boreal or other forests (field), in the laboratory using mostly conifers and mycorrhizal fungi, and there are couple of “side topics” that seems to be out of place in this bigger scheme (for example, the hydraulic lift study for drought-prone ecosystems).

Some specifics:

Abstract and 1. Introduction – no specific comments.

2. Microscale/nanoscale observations of physical alteration of minerals: This section is

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heavily based on older findings and mention some new studies, but it is unclear what advances were made in the last 10 years – new techniques? New understanding of processes? Or just supporting previous findings? Or all above? It needs a refocus, and it can be shortened by about half and still convey the same message.

3. Biofilms and small scale microbial interactions with consequences at higher spatial scale: how are these differently categorized than the next section, which is about microbial and plant secretions? EPS, biofilm, oxalic acids etc. are secretions, are not? What are the consequences at higher spatial scale? Do we know? Or is it a challenge to scale things up? Again, what is the new advancement in the last 10 years? The section needs some clarifications and/or refocus.

4. Microbial and plant secretions – evidence from microcosms and mesocosms: long section – rambling on without focus, lots of info and data about various roles, functions, and processes of mycorrhizal fungi, but no other components of the ecosystem, and the hydraulic lift section seems irrelevant in the boreal forest. Bringing in drought may be something we want to think about as climate shifts, but it most likely causing larger problems in drought-prone parts of the world.

5. Systemic consequences of microorganism-mineral interactions in an ecological and evolutionary context: this is really important and interesting, however, it is too long, have some repetition – I am not sure why the 5.1. section is separated (elevated) from the rest of 5. – Weathering, nutrient acquisition, carbon allocation, and sequestration are the key elements of the evolutionary viewpoint – perhaps, this section could be rearranged and shortened to synthesize our current understanding of the evolution of plants and associated fungi in the context of carbon and nutrient cycling. Bob Berner did the pioneering work in this field with his carbon models, but it got a lot of attention in the last 10 years, so a focused synthesis would help us to identify future directions.

6. Methods using stable isotopes: The section is interesting, provide laboratory evidence of the usefulness of these techniques in addition to field studies, however, the

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last paragraph states that the “there is no clear evidence that processes observed at the laboratory-scale play a significant role in “soil-scale” mineral dissolution rates.” This indicates that laboratory studies are useless, why do we bother then? Is there anything we learned from the laboratory studies? Also, the last paragraph is a repetition of statements on page 12 lines 13-15.

7. Modelling of weathering in forest soils: this whole section is unfocused. It starts with the PROFILE and ForSAFE models, then it talks about information needs and possible improvements (in 7.1.) and then it returns to talk about a bunch of other models in too much detail without getting to a point. This section should synthesize what are the main outcomes of the different modeling approaches (probably in half of the length), and identify what is missing (information) and how to tackle the shortcomings.

8. Conclusions: I was expecting to find the key questions, knowledge gaps and future directions (or call for specific areas of research) in this section.

Figures: Not all necessary – Figure 1, 2, 4, 6, 7 do not add new information to the summary (synthesis) or not necessary to understand the text. Figure 9 and 10 are a good representation of specific examples for laboratory approaches. Figure 3, 5, 8, and 11 are great illustrations of processes and their interactions from small to large scales.

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