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# *Interactive comment on* "Weathering by tree root-associating fungi diminishes under simulated Cenozoic atmospheric $CO_2$ decline" *by* J. Quirk et al.

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General Comments

This paper provides a very thorough and detailed experimental design addressing the mechanisms of biological weathering as a function of atmospheric CO2. This laboratory investigation provides an excellent justification for the need for such studies based on previous global-scale modeling work. Mechanistic studies such as this are very capable of illuminating specific processes operating at the scale of mycorrhizal root-symbionts. Such specific bio-mineral interactions are lost at larger scale investigations. The authors are to be commended for developing such a meticulous and unequivocal

investigation, especially in choosing a range of [CO2]a concentrations reflecting that of the last 35 Ma. I also like how the authors have been able to correlate weathering mineral surface features with fungal hyphae, refuting previous reports of certain features being purely of abiotic origin.

Specific Comments

(1) Early in the Abstract, and elsewhere, the importance of terrestrial Ca-Mg-silicate chemical weathering as being responsible for the sequestration of atmospheric CO2 in marine carbonate bedrock is emphasized. This is an important point and I'm pleased it is explicitly stated by the authors. However, the biological weathering of muscovite, a K-silicate mineral, is then addressed. Wouldn't biotite have been the more applicable mica to include? There is also a very large literature on biotite weathering, including both experimental and field-based studies to which the results of this study could be compared. (2) Following item (1), the inclusion of basalt in the study is very appropriate. However, basalt can exhibit a relatively complex mineralogy with solid-solutions for olivine and pyroxene, and variable proportions of glass which can also have varying compositions. Previous research has shown the glass to be most reactive material in basalt. Can any additional specific information be provided regarding specific phases in the basalt that are weathering? (3) The results of this study certainly support global carbon cycle models, even though nanoscale processes operating in soils are addressed. An inherent assumption of this paper is that soils developed on Ca-Mg-silicate bedrock contain significant quantities of weathering minerals. In saprolitic landscapes which dominate the Earth's surface the soils may be relatively thin (<30 cm of a 5-10+ m-thick regolith) and composed of highly leached material containing relatively few reactive minerals. The most reactive minerals would have been chemically weathered/dissolved at or near the saprolite-bedrock interface, presumably dominated by inorganic processes. If true, then any biological weathering in the soil would exert relatively little influence on solute budgets at the watershed-/landscape-scale (4) Following item (3) above, Section 2.7 (Canopy transpiration) contains numerous as-



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sumptions that allow the hyposphere results of this study to be scaled up to a global weathering model. Assumptions include stoichiometries of nutrient uptake to support NPP, respiration and GPP rates based on simple multipliers, calculation of organic acid exudation by EM hyphae using GPP, dimensions of the hyphosphere, etc. Furthermore, the geometric surface area of the basalt is used, with any estimate of mineral "reactive" surface area always being fraught with errors. I realize references are provided in some cases, but the potential sources of error here are very large and only propagate with further calculations. If the authors are confident in these values, then more justification is needed. As written, making such a large jump in scale may be met with a great deal of skepticism by the readers. (5) I realize this may be beyond the scope of the present study, but after completing such a rigorous and thorough study is it possible to relate the findings to present-day/near-future climate change? For example, there is some evidence in Fig. 1 that the influence of [CO2]a on biological weathering my reach a steady-state above $\sim$500 ppm.

Technical Corrections

(1) In section 15781, line 7, the phrase "...35 Ma ago..." is used. Including the word "ago" is redundant as "Ma" reflects time before present.

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Interactive comment on Biogeosciences Discuss., 10, 15779, 2013.