

Response to Reviewer Comment RC5

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This manuscript presents biogeochemical evidence for microbially accelerated weathering and provides valuable data for improving measurement, reporting, and verification of carbon dioxide removal (CDR). However, several key conclusions appear to extend beyond the direct evidence provided by the dataset. The differences in pH, DIC, SIC, TIC, and exchangeable base cations between the control and microbially treated soils were not statistically significant overall, although some differences appeared at specific soil depths. Given the inherently slow timescale of silicate weathering, the relatively small magnitude of the observed changes raises the question of whether the incubation conditions (e.g., temperature and duration) were sufficient to detect measurable differences in CDR within the timeframe of the laboratory experiment. In addition, the basis used to compare the control and treatment should be clarified. For example, it would be helpful to specify whether the reported concentrations were normalized by dry soil mass, soil bulk density, or extract volume. These issues should be addressed before the conclusions regarding CDR can be robustly supported.

We appreciate the reviewer's feedback. It's true that in this study, bulk soil measurements including pH, DIC, and SIC did not indicate a clear treatment effect. There are several factors that may have limited our ability to detect significant differences in bulk soil weathering. The reviewer correctly mentions incubation conditions (e.g., time and temperature). Additionally, reduced plant biomass and lower soil $p\text{CO}_2$ (the source of acidity for weathering) compared to natural soybean systems may also limit the magnitude of the treatment effects.

Although the bulk soil response did not indicate significant treatment effects, the patterns suggest the experiment may have been underpowered. Given our previous work indicating MP1-amendments are associated with increased weathering and soil SIC accumulation (e.g., Timmermann et al., 2025 and Yang et al., 2026) in different soils, we were interested in whether the sequential selective extractions would be more sensitive to small changes in available base cations associated with silicate weathering.

The sequential extraction results indicate: (1) small but significant differences in some carbonate, exchangeable, and reducible pool base cations and (2) when taken together, these differences indicate an increase in bioavailable cations in the microbial treatment compared to the control treatment. While the effect sizes remain small, the observed differences are consistent with our current understanding of microbially accelerated

weathering, providing a new line of evidence that increased silicate dissolution underlies the changes in available base cation pools.

In response to this and other reviews, we have updated the statistical methods used for testing treatment effects (please see our response to reviewer comment RC1 for more detail. Additionally, we've clarified units reported in all figures and tables. To the specific question of units, the native units for solid-phase concentrations are mass per dry weight soil. For leachate fluxes the corresponding units are mass per volume solution. In some cases, for example when calculating the mass balance across different measurement phases, we report base cation abundance as the mass of the cation per column or per depth increment. For solid phase measurements, that means multiplying the measured concentrations by the corresponding dry weight of soil or in the case of leachate, multiplying the measured concentration by the volume of leachate collected.

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