Dear Editor,

We sincerely thank you and the reviewers for the careful evaluation of our manuscript and for the constructive comments that greatly improved the clarity, depth, and scientific rigor of our work. Below we summarize the key changes made in response to the reviews.

First, we **refocused the manuscript** to emphasize the most robust and interpretable results. Following reviewer concerns about potential biases in the soil CO_2 efflux (SCE) measurements, and because SCE is complex to interpret in the context of our study (mixing organic and inorganic carbon dynamics), we removed all SCE data and shifted the paper's focus to three central topics: (1) plant biomass responses, (2) base-cation dynamics as indicators of inorganic carbon dioxide removal (CDR), and (3) the fate of trace metals. To complement these analyses, we added a **new soil leaching test** and corresponding figure to provide a more complete picture of base-cation and heavy-metal mobility.

Second, we **expanded the discussion** to provide deeper interpretation of key findings. We now include mechanistic explanations for biomass changes, the behavior of heavy metals such as Ni and Cr in different soil fractions, and the lack of detectable calcium accumulation in soil fractions/leachates despite basalt addition. We also clarify potential processes underlying biochar's positive effects on plant growth and metal immobilization.

Third, we substantially **improved data presentation**. All figures were redesigned to avoid overlapping elements, control data are now consistently included, captions are self-explanatory, and p-values and effect sizes are reported throughout the results. Methods were revised to explain why these amendment application rates were used, particle size distributions are included in the main text, soil texture was carefully determined and added, and the sequential extraction procedure is introduced in greater detail. Statistical analyses are now clearly identified as two-way or mixed-effects ANOVAs as appropriate.

Finally, to better reflect the revised scope, we **changed the manuscript title** from *"Increased soil* CO_2 *emissions after basalt amendment were partly offset by biochar addition in an urban field experiment"*

to
"Effects of basalt and biochar addition on base cations and trace metals in plants and soil in an urban field trial"

We believe these revisions address all major concerns, strengthen the scientific interpretation, and enhance readability. We thank the reviewers for their thoughtful guidance and hope that the revised manuscript meets the journal's standards for publication.

We understand that the removal of the SCE measurements may give the impression of reduced relevance. However, SCE measurements give only a rough indication of the soil C fluxes, as the different sources cannot be disentangled (at least not in the current experiment, as flux partitioning would require a specific setup; cf. Boito et al., 2025).

To compensate for this reduction in information in the manuscript, we did add new data from a leaching experiment that we performed to take into account the reviewer comments. **We believe these changes have strengthened (rather than weakened) our study as the new data consolidate the interpretation on the weathering rates and CO2 removal.**

Key novelties include:

- The revised manuscript now focuses on **base cation mass dynamics** across functional soil pools, using the established Tessier sequential extraction method. Because base cation mass balancing is increasingly seen as a valuable tool for assessing inorganic CO_2 removal potential in enhanced weathering (EW) (e.g. https://doi.org/10.5194/egusphere-2025-2740), we believe this provides significant and timely insight to the field. We added water-soluble base cation data through a new leaching test, allowing for more robust conclusions about cation fate and related CO_2 removal. Our findings offer new understanding of mechanisms that influence (or inhibit) inorganic carbon dioxide removal, which we consider highly relevant to the EW community.

- An additional value of our study lies in the **heavy metal analyses**, as heavy metals are the primary risk for real-world ERW applications.

- **Interactions between biochar and ERW on inorganic C sequestration and weathering are not well understood**. To the best of our knowledge, our experiment is the first field study to investigate ERW x biochar interactions on weathering and inorganic C sequestration with a full-factorial design.

With kind regards,
Arthur Vienne
on behalf of all co-authors

Reviewer 1:

Q1) This study conducted an interactive experiment to figure out the effects of basalt, biochar, and basalt * biochar on clover and mustard yield, soil chemistry and trace metals. They found most significant effect was caused by biochar addition rather than basalt, which differentiates with some results reported in some previous studies (Beerling et al., 2018, nature plants; Beerling et al., 2024, PNAS). The result that increased soil CO2 emissions with basalt addition were partly offset by biochar addition found in the present study is interesting.

We thank reviewer 1 for this constructive comment. We appreciate the acknowledgment of our findings.

Q2) But the deep analysis and discussion on results are scarce in this version, and the making of figures also needs to be improved. In figures, vertical lines overlapped for tree treatments, which is not easily recognized well.

We also thank the reviewer for pointing out the need for deeper analysis and clearer figures. In the revised version, we have expanded the discussion to provide more in-depth interpretation of the results, including the potential mechanisms behind biomass changes following basalt addition, and the fate of heavy metals. Furthermore, we have improved the figures by adapting their design to enhance readability; specifically, we adjusted the overlapping vertical lines for the three treatments to ensure that the results are more clearly distinguishable (see Figure 3 and 4).

Q3) In the main context, most results associated with trace metals, but the title of this manuscript only refer to the soil CO2 emissions. It is not very integrated.

We agree that the title should inform the reader about the effects of basalt and biochar amendment on our main results: changes of trace metals and base cations in plants and soilsBecause we decided to focus the manuscript on biomass, trace metals and base cations (because of potential bias in the SCE data, see Q21) We suggest the following change:

Previous title: Increased soil CO2 emissions after basalt amendment were partly offset by biochar addition in an urban field experiment.

New suggested title: “Effects of basalt and biochar addition on base cations and trace metals in plants and soil in an urban field trial”.

We did not only measure base cations (also anions such as nitrate and phosphate were measured), yet emphasize on base cations in the title as base cation mass balancing is commonly used to calculate weathering rates and estimate inorganic C sequestration in EW.

Introduction

Q4) Lines 65 Why does biochar increase weathering rates of EW?

Biochar can increase the weathering rates of EW because it acts as a sink for cations, lowering their concentration in the pore water. This shifts the dissolution equilibrium of minerals, promoting further weathering according to the principle of le Châtelier (chemical equilibrium of elements).

See line 64: Synergies between both EW and biochar have been postulated; Biochar has been hypothesized to increase weathering rates of EW and reduce accumulation of trace metals in soil waters (Amann & Hartmann, 2019). The latter is expected to follow from metal sorption to biochar, reducing cation concentrations in soil water. According to the principle of chemical equilibrium, more base cations can consequently dissolve into solution. This way, sorption of base cations by biochar may increase rock dissolution. Nonetheless, in a mesocosm study, Honvault et al. (2024) did not detect any synergistic effects of biochar and basalt on CDR and therefore concluded that their effects were additive; however, data on this topic remain scarce.

Methods

Q5) Lines 95 How did authors decide the dosage of basalt and biochar?

40 t ha-1 was chosen as a high application rate for basalt for all fields of the EU horizon 2020 UPSURGE project. It is comparable to other recent EW research, in mesocosms or field studies (Anthony et al., 2025; Boito et al., 2025; Steinwidder et al., 2025). The biochar application rate (33 ton ha-1) is in range with values typically used in research (see Frequency distribution of biochar application rate in literature by (Liu et al., 2013)). We clarified this in Line …:

Basalt treatments received an equivalent of 40 t basalt ha-1 while biochar was added at an application rate of 33 t ha-1, in range with typical application rates in other studies (Anthony et al., 2025; Boito et al., 2025; Liu et al., 2013; Steinwidder et al., 2025).

Q6) Lines 120 Please briefly introduce how to distinguish cations in four different consecutive fractions using the sequential extraction scheme of Tessier et al. (1979).

We elaborated on the meaning and methodology of these sequential extractions in line 126:

Soil-bound cations were extracted twice using the sequential extraction scheme of Tessier et al. (1979). In this sequential leaching protocol, we distinguish (base) cations in four different consecutive fractions: the exchangeable, carbonate-, (hydr)oxide- and SOM-associated fractions. In the exchangeable soil pool, cations are bound to negatively charged surfaces of clay minerals or SOM and can be extracted with a weak salt solution (e.g. 1M $BaCl_2$). The carbonate pool consists of minerals such as $CaCO_3$, with its carbon typically reported as soil inorganic carbon (SIC). Quantifying carbonate-associated base cations can help circumvent common challenges related to carbon heterogeneity and the detection of relatively small SIC shifts (Kelland et al., 2020). Carbonates are extracted with acidic acetate solutions. In the reducible soil pool, base cations are linked to Fe- and Mn-(hydr)oxides and are extracted with 0.04M $NH_2OH.HCl$ in 25% acetic acid. Finally, in the oxidizable pool, cations are associated by stronger bounds to SOM or sulfides and are extracted with acidic H_2O_2 solutions. Tessier's sequential extractions were also used in recent EW studies (Boito et al., 2025; Niron et al., 2024; Steinwidder et al., 2025; Vienne, 2025).

Results:

Q7) Line 235 delete "observed"

Thank you for noticing this language error that was overlooked. As the discussion on SCE has been deleted from the manuscript (see Q21), this sentence was deleted.

Discussion

Q8) Figure 3, I do not understand the decreased ΔCa in four soil fractions with basalt addition after 550 days compared with the initial sampling time. If the basalt is weathered, Ca should be released, resulting in an increase of ΔCa over time.

Indeed, Ca release from basalt weathering would be expected to increase ΔCa over time. However, we did not observe a significant positive *basalt × time* effect for Ca in any of the four assessed soil pools. Similarly, Ca leaching via rainwater was not enhanced in basalt-amended soils (see newly added *Figure 5C*).

Although no clear evidence of weathering was detected in this experiment, this does not necessarily indicate the absence of weathering or Ca release. It is plausible that Ca became incorporated into soil fractions not captured by the applied extraction method (for instance, within newly formed or recrystallized mineral phases (e.g., crystalline clays)). Recent studies have demonstrated Ca incorporation into secondary clay minerals during enhanced weathering processes (see, e.g., https://www.sciencedirect.com/science/article/pii/S0883292725001817).

The lack of detectable changes in Ca across the extracted soil pools could therefore reflect either: (i) limited basalt weathering over the 550-day experimental period likely influenced by the coarse particle size of the basalt, its high content of slowly dissolving albite, and the alkaline soil conditions that reduce the dissolution of more reactive pyroxenes and olivines; or (ii) the redistribution of released Ca into secondary minerals or strongly bound pools that are not accessible via the Tessier extraction scheme. In the latter case, Ca may have precipitated as Ca-bearing clays (e.g., Ca-montmorillonite), making it undetectable in the operationally defined fractions used here, even if weathering occurred.

This interpretation is consistent with previous observations of clay-like material (including precursor clays and protoclays) formed in Northern Irish basalts similar to the one used in this experiment (Cox et al., 2017).

We discussed this in Line 305: Hence, the absence of an accumulation of base cations in any of the four extracted soil pools as well as in the leachates implies either no detectable basalt weathering within 550 days or redistribution of released base cations such as Ca into secondary minerals or strongly bound pools not accessible by the Tessier extraction scheme. Limited weathering may have occurred as the utilized basalt had a relatively coarse particle size. Moreover, 62% of the basalt was identified to be albite, a mineral with a low weathering rate (approximately 10^$^{-12}$ mol/m^2/s at pH 8, (Palandri & Kharaka, 2004)) and the 31% pyroxene minerals present also have a relatively low weathering rate at pH 8 (augite for example also dissolves at a rate of ~10^$^{-12}$ mol/m^2/s at pH 8). Nonetheless, there was also 6% olivine present in the rock feedstock, for which we expect a weathering rate of ~10^$^{-10}$ at this pH. We cannot exclude the possibility that leaching of air-dried topsoil as done here underestimates field leaching (e.g., via preferential flows and limited cation extraction efficiency in air-dried topsoil).

In addition, base cations may have been scavenged by newly formed clay minerals. Ca could for example have precipitated as Ca-montmorillonite, making it unextractable with the Tessier protocol, even if weathering occurred. In other words, secondary oxides and clays may have formed but gone undetected if they were retained in a residual soil fraction resistant to extraction (Steinwidder et al., 2025). Clay-like material (including precursor clay minerals and protoclays) were previously identified in natural Northern-Irish basalts similar to the one used in this experiment (Cox et al., 2017). Recent studies have suggested the potentially significant production of secondary minerals and associated degassing of bicarbonate (Iff et al., 2024; Niron et al., 2024; Steinwidder et al., 2025; Vienne et al., 2025).

Q9) Lines 260 With basalt addition, Ni showed significant accumulation in both the reducible fraction and the oxidizable fraction associated with soil organic matter (SOM), while Cr increases were confined to the reducible fraction. Why do Ni and Cr have different response to basalt application?

Thanks for this interesting observation.

Chromium in soils is mostly present as Cr(III), which strongly sticks to iron oxides, especially when the soil is not acidic. In soils made from basalt (like those in Northern Ireland), iron oxides are the major materials that capture and hold chromium, making it hard for chromium to move into water or be taken up by plants. This means chromium is not very available in these soils unless the environment becomes more acidic or there is a lot of organic matter, which can help release both iron and chromium from these complexes.

Nickel, on the other hand, also attaches to iron oxides but more loosely compared to chromium. Because nickel's chemistry allows it to react more easily with organic materials and it carries a different charge, it is more likely to move through the soil, especially when organic acids are present. The fact that nickel was found more in organic-bound forms (oxidizable fraction) after adding basalt suggests nickel tends to form associations with organic matter, while chromium remains firmly attached to iron oxides (reducible fraction). As a result, both metals are mostly held in stable forms, which lessens their immediate risk to plants.

We added this to the discussion, line 330:

Chromium in soils is predominantly present as Cr(III), which has a strong tendency to adsorb or co-precipitate with iron oxides, especially at alkaline pH (van Raffe et al., 2025). In natural basaltic soils, Fe-oxides are known to be the main Cr scavengers (Sun et al., 2022). Acidity and organic acids can however promote leaching of these Fe-Cr-oxides. In natural basaltic soils in Northern Ireland (soils overlying the Antrim basalts, similar to the basalt used in this study), the availability of Cr in the soil was however extremely low due to the high stability of Cr bound to Fe-oxides (Cox et al., 2013, 2017).

Similarly, Ni also associates with Fe oxides (Xu et al., 2007), but is likely to have a relatively higher tendency to leach from these oxides compared to Cr due to its different chemical behavior. Ni(II) has a smaller charge compared to tri- or hexavalent Cr and ability to react with organic ligands increases its mobility (Barałkiewicz & Siepak, 1999). The higher accumulation of Ni in the oxidizable fraction following basalt addition thus likely reflects this affinity for organic complexes, while Cr remained predominantly in the reducible fraction indicative of its immobilization in Fe-Cr-oxides. These distributions indicate that the added metals were largely sequestered in more stable pools, reducing their immediate bioavailability to plants.

Q10) For plant biomass, why do plants have different response to basalt and biochar addition? Biochar application increased plant biomass, why? Are there any correlations between plant biomass and nutrient contents? Why do harvest 1 and 2 of mustard have different responses to biochar addition?

For basalt addition, there was no significant biomass increase. Biochar, on the other hand, significantly increased biomass of both clover and mustard plants. The increase in mustard biomass after biochar amendment in our study may (in part) be due to a P-fertilization effect, as mustard aboveground biomass-P increased significantly and our digestate-derived biochar had a relatively high P_2O_5 content (40.6 g/kg). Also biochar showed lower trace metals in aboveground biomass, while basalt did not show this effect. The reduction of toxic trace metals may also have stimulated biomass. We add correlations between aboveground biomass yield and nutrients as supplementary figures Fig. S12 and S13.

For Mustard:

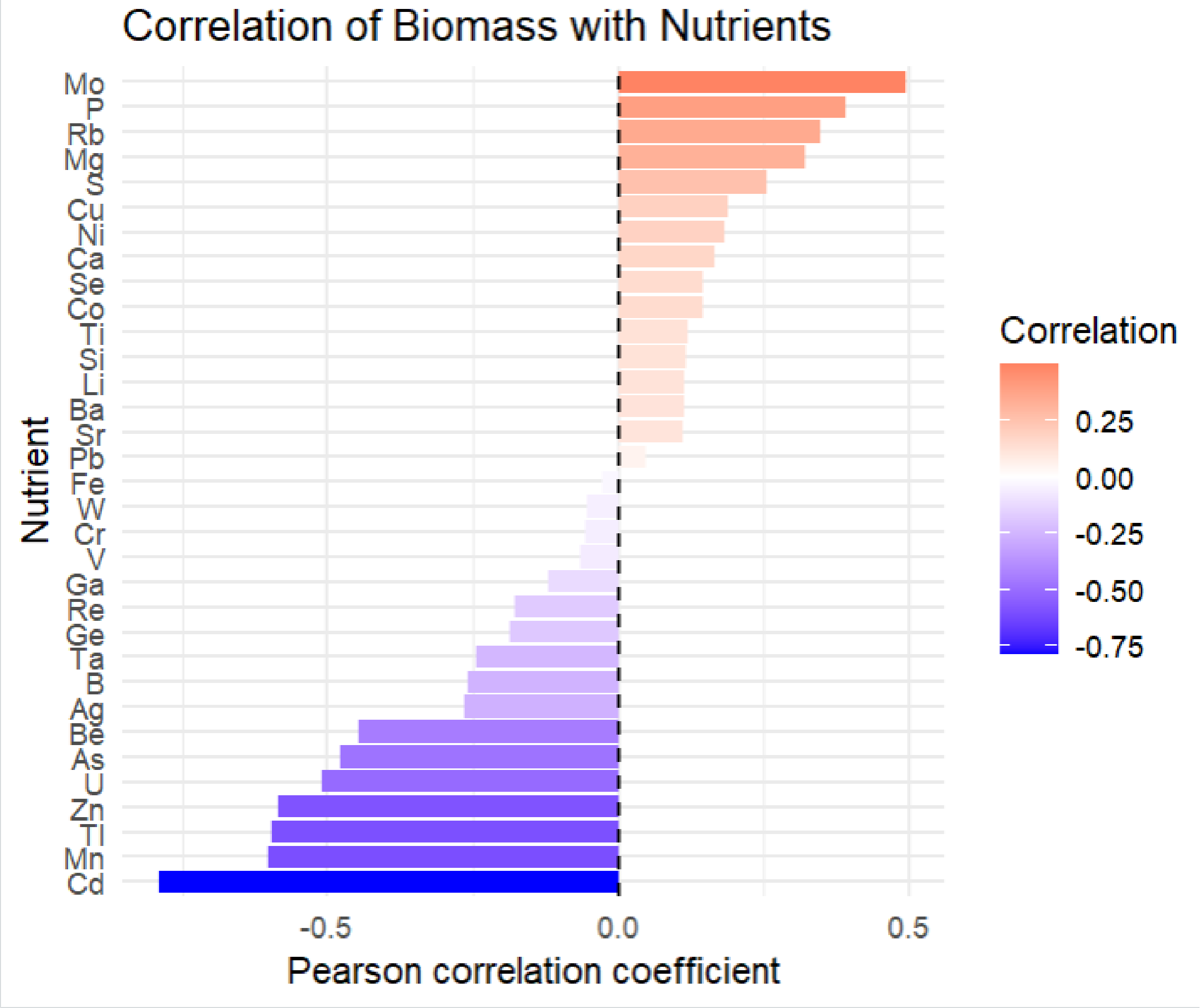
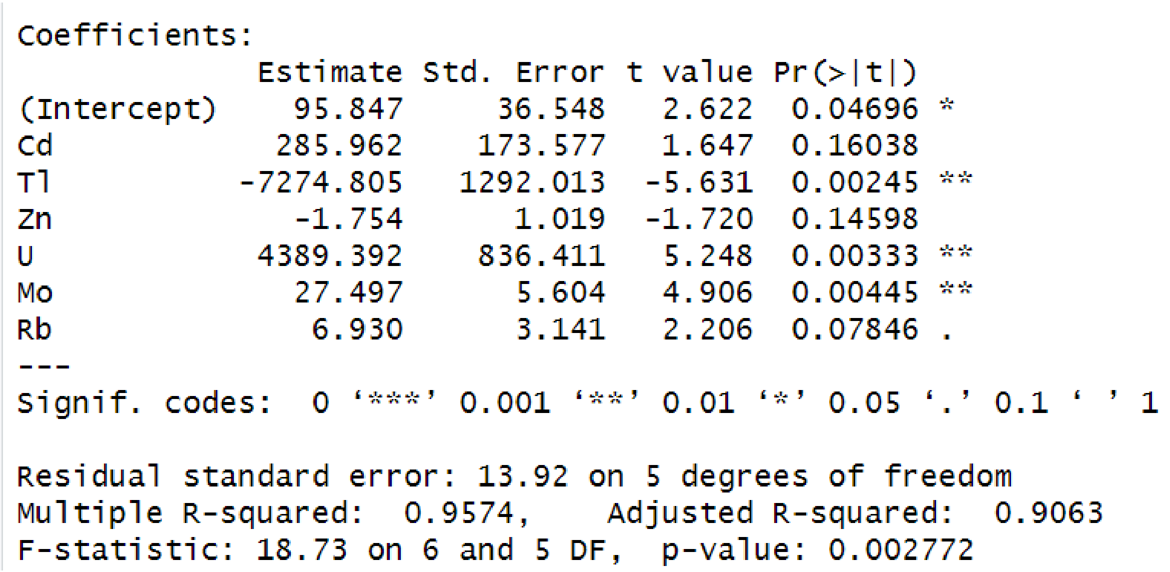
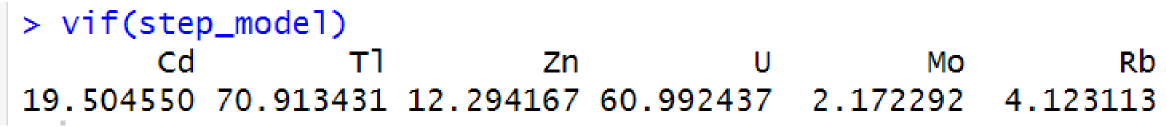


Fig. S12: Correlations for mustard aboveground biomass and aboveground biomass elemental composition.Using stepAIC regression, we then attempted to make a predictive model based on the 10 elements with the largest absolute value of correlation. The model we get (output below) was significant for some variables, yet the vif factor was too high, pointing towards a multicollinearity issue.



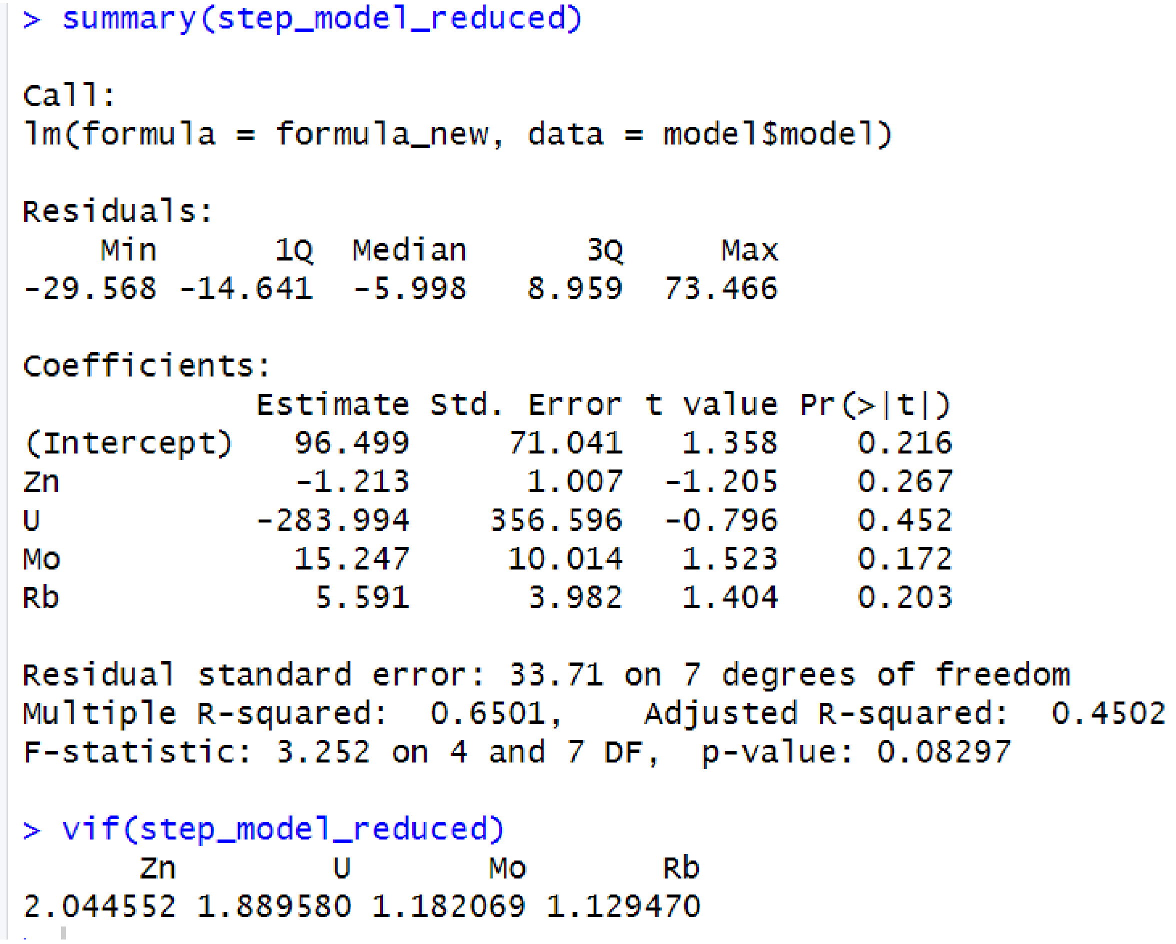
```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)    95.847     36.548   2.622  0.04696 *
Cd            285.962    173.577   1.647  0.16038
Tl          -7274.805   1292.013  -5.631  0.00245 **
Zn             -1.754      1.019  -1.720  0.14598
U            4389.392    836.411   5.248  0.00333 **
Mo             27.497      5.604   4.906  0.00445 **
Rb              6.930      3.141   2.206  0.07846 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 13.92 on 5 degrees of freedom
Multiple R-squared:  0.9574,    Adjusted R-squared:  0.9063
F-statistic: 18.73 on 6 and 5 DF,  p-value: 0.002772
```



```
> vif(step_model)
       Cd        Tl        Zn         U        Mo        Rb
19.504550 70.913431 12.294167 60.992437  2.172292  4.123113
```

When we only allow predictors with a vif < 5, no significant links, (including not with P) can be made using our relatively small dataset. In conclusion, yes there are correlations between biomass and nutrients but no robust models or predictions can be made based on our dataset. Making a model with e.g. only P would be cherrypicking.



```
> summary(step_model_reduced)

Call:
lm(formula = formula_new, data = model$model)

Residuals:
    Min      1Q  Median      3Q     Max
-29.568 -14.641  -5.998   8.959  73.466

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   96.499     71.041   1.358    0.216
Zn            -1.213      1.007  -1.205    0.267
U           -283.994    356.596  -0.796    0.452
Mo            15.247     10.014   1.523    0.172
Rb             5.591      3.982   1.404    0.203

Residual standard error: 33.71 on 7 degrees of freedom
Multiple R-squared:  0.6501,    Adjusted R-squared:  0.4502
F-statistic: 3.252 on 4 and 7 DF,  p-value: 0.08297

> vif(step_model_reduced)
      Zn        U       Mo       Rb
2.044552 1.889580 1.182069 1.129470
```

For Clover:

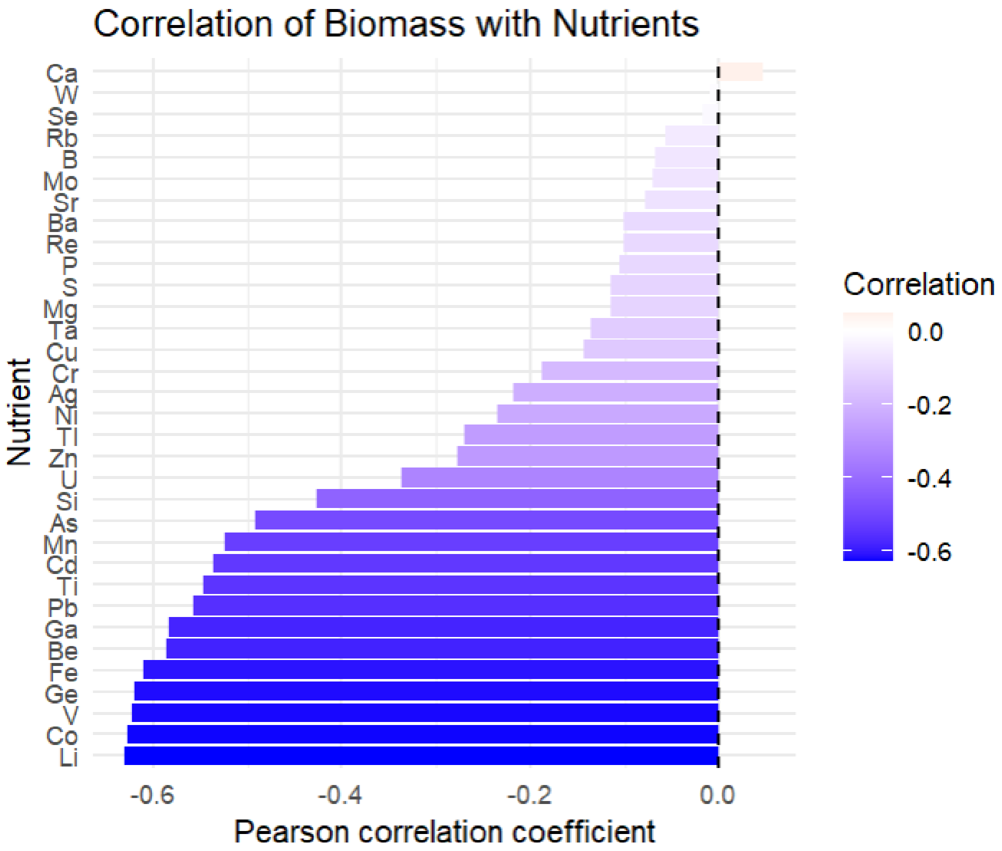


Fig. S13: Correlations for clover aboveground biomass and aboveground biomass elemental composition.

The temporal variation in biochar response of mustard could be due to seasonal variation (as harvest 1 encompasses the period of november→may, while harvest 2 is from may →november). However, the temporal variation was observed only for treatment Bi, not for the combined biochar and basalt treatment. If only seasonal variation played a role, we would expect to find this effect in both treatments. The reason for this temporal fluctuation of biomass in treatment Bi thus remains unclear.

We discuss these nutrient and biomass changes, in line 367: Biochar, on the other hand, significantly increased biomass of both clover and mustard plants. The 67% increase in mustard biomass after biochar amendment in our study positively correlated with Mo, P, Rb, Mg and S in aboveground biomass, while it negatively correlated with Cd, Mn, Tl, Zn and U in aboveground biomass (**Fig. S12**). The biomass increase may (in part) be due to a P-fertilization effect, as mustard biomass-P increased and our digestate-derived biochar had a relatively high P_2O_5 content (40.6 g/kg) and phosphates in biochar-amended soil leachates significantly increased. For clover, there was an inverse correlation between aboveground biomass Li, Co, V, Ge and Fe and aboveground biomass. We expect that lower amounts of toxic trace metals were taken up by clover in the biochar treatments. Nonetheless, we could not find robust models in which aboveground biomass was predicted by significant changes in aboveground biomass elements for both crops. It is possible that interactions with belowground nutrient dynamics, which were not captured in this study, played a role.

Q11) For SCE, for acidic soils, EW may increase pH, and thus increase SOC decomposition, but the soil pH in this study is 8.22, which is quite alkaline. Basalt addition significantly increased SCE, why?

Due to the change of focus of the manuscript and exclusion of the SCE data (see Q21), this remark no longer applies.

Reviewer 2: This study compares the impacts of basalt amendment for enhanced weathering (EW) and biochar addition on soil cation release, dissolved inorganic carbon, soil organic matter, plant biomass, and heavy metals released into soil and plant biomass. It is a timely study, as we need more information on these two carbon dioxide removal (CDR) strategies, and whether their co-application supports the conjectured synergistic effects. However, in its current form, I cannot recommend this manuscript for publication and recommend a major revision.

We thank Reviewer 2 for the detailed and supportive comments. An important concern was raised in Q21 regarding SCE. We agree that potential gradient limitations in the measurement chamber could introduce biases during such long measurement periods. Consequently, we decided to remove the Soil CO_2 flux measurements from the manuscript and to adjust the focus of the manuscript toward: (1) biomass responses, (2) base cation monitoring to estimate inorganic CDR, and (3) the fate of trace metals.

To strengthen this revised focus, we performed an additional soil leaching test (in which one Kopecky ring volume of soil was leached with a fixed volume of rainwater; methodology now added to the Methods section) to assess the effects of basalt, biochar, and basalt × biochar treatments on base cation and heavy metal leaching. This new analysis supports and expands upon our earlier speculations regarding soil leachates, providing a more complete picture of base cation and heavy metal dynamics. We have added a new figure presenting these soil leaching results (Figure 5 in the revised manuscript).

Major concerns and comments:

Q12) The main limitation of this study, in my view, is that it does not estimate the carbon sequestered by EW. One could argue that this was not an objective of the paper, but without knowing how much EW actually took place, it is difficult to interpret whether the magnitude of the CO_2 efflux under basalt application has any real significance, or what the heavy metal results mean. Even better would have been to present a carbon budget for the duration of the experiment. Furthermore, the way soil CO_2 fluxes are presented makes interpretation difficult. They are referred to as "soil CO_2 emissions," but in fact the measurements include both autotrophic root respiration and heterotrophic respiration. As a result, the fluxes alone do not tell us much, especially since no information on root biomass is provided. What if basalt stimulated root growth and the observed efflux is mainly plant-driven? As it stands, we are left with multiple possible explanations and a great deal of speculation.

We used soil CO2 emissions as the sum of rhizosphere and heterotrophic respiration. We could only speculate on changes in rhizosphere respiration based on aboveground biomass. Due to the complexity, it is difficult to separate soil CO2 emissions in these two components in the field, we refer to Boito et al., (2025) who did this recently in mesocosms. Because of the speculative aspect of the SCE results along with the point made by reviewer 2 in Q21, we decided to withdraw the

SCE data from our manuscript and focus on basalt & biochar effects on base cations, trace metals and biomass.

Q13) The overall presentation of results and graphs needs significant improvement. The choice of overlapping bar graphs is uninspired and difficult to follow. Units on the axes are not properly formatted. Table and figure captions are not self-explanatory (e.g. the abbreviation SCE in Fig. 7 is not explained). The results section also needs more detail and context. For example, instead of simply stating at line 187 that “Basalt significantly increased soil exchangeable Ca,” it would be far more informative to give the percentage increase and the p-value. That way readers can understand the magnitude of effects without constantly having to check the figures. This should be done consistently throughout the results section.

We have made significant efforts to improve figures, making sure that all error bars are separated and that the captions are self-explanatory. Effect sizes were added throughout the result section, for non-significant trends, P-values were added. For significant effects, we refer to the p values in figures or tables, and always mention that the change was significant.

For example:

Line 258: Basalt did not increase any of the measured elements in soil leachates (**Figure 5**). In contrast, basalt even tended to decrease leachate Ni (p=0.06, -29%, **Figure 5H**) and Zn (p=0.08,-35%, **Figure 5I**).

Line 277: In clover plants, Ti, V, Fe, Ga and Ge significantly decreased after biochar amendment (with -60%, -61%, -63%, -63%, -57% respectively, **Figure 7**).

Q14) Data analysis and presentation are inconsistent across figures. For some variables, results are shown as differences of basalt, biochar, and their combination relative to the control (Figs. 3–4). For others, data for all four treatment combinations are presented. Why this difference? It is not explained in the methods, and it is not clear what statistical analysis was applied in these cases. It does not appear to match what is described in the statistics section.

We adapted figures to consistently include the control and now show data (non-normalized for the control values) also in Figure 3 and 4. All the statistical analyses were done with datasets including the control treatments, the earlier exclusion of controls in Fig.3 and 4 was intended to improve visualization of treatment effects, yet we agree that it is better to present control data consistently across all figures and therefore also include it in Figure 3 and 4 now.

Q15) Basalt particle size distribution should at least be briefly described in the main methods. The fact that the basalt used was relatively coarse is important, as it could explain the weak effects on plant growth and trace metal release. It also deserves a short mention in the discussion.

We added the basalt size fractions to the main text and incorporated it in Table 1. The basalt may have had limited weathering due to its relatively coarse particle size. Moreover, we discuss relatively slow mineral dissolution of albite, which was the major mineral in this basalt. We also nuance that the pH >8 and that minerals from the pyroxene- and olivine-group weather faster at more acidic soil pH.

We make these nuances it in the abstract, discussion and conclusions:

Abstract, line 21: Weathering of the relatively coarse, albite-rich basalt may have been limited in the alkaline soil, and/or the weathering products were retained in soil pools not accessible to the extraction scheme.

Discussion: line 307: Limited weathering may have occurred as the utilized basalt had a relatively coarse particle size. Moreover, 62% of the basalt was identified to be albite, a mineral with a low weathering rate (approximately 10^$^{-12}$ mol/m^2/s at pH 8, (Palandri & Kharaka, 2004)) and the 31% pyroxene minerals present also have a relatively low weathering rate at pH 8 (augite for example also dissolves at a rate of ~10^$^{-12}$ mol/m^2/s at pH 8). Nonetheless, there was also 6% olivine present in the rock feedstock, for which we expect a weathering rate of ~10^$^{-10}$ at this pH.

And in the conclusions, line 418: The alkaline soil (pH ~8.2), coarse basalt particle size and high albite content may have constrained basalt effects and detectability of the weathering in our experiment.

Q16) Soil texture is also important. Simply describing it as a "clayey sand" is not enough to allow proper interpretation of results.

We did additional texture measurements for the control soil. We found that the texture could be identified as 'Loamy sand ' (0.07: 20.82: 79.13 clay:silt:sand). And added the methodology of texture analysis also to Table 2. "Textures were derived from the control soil particle size distribution, measured using a mastersizer 2000 with a Hydro 2000G sample dispersion unit."

Q17) Introduction: synergies have indeed been postulated, but the introduction should give a clear picture of the state of the art. There is already at least one study (Honvault et al. 2025) that looked at this and generally found additive rather than synergistic effects. This work should be mentioned.

Thank you for this suggestion. We have now incorporated this reference into the introduction as well. Specifically, we added:

Line 68: Nonetheless, in a mesocosm study, Honvault et al. (2024) did not detect any synergistic effects of biochar and basalt on CDR and therefore concluded that their effects were additive; however, data on this topic remain scarce.

We also compare each topic of discussion with this reference:

Line 354: In contrast with the hypothesis postulated by Amann & Hartmann (2019) and in agreement with Honvault et al. (2024), this suggests that the effects of basalt and biochar on soil base cations are additive rather than synergistic (Honvault et al., 2024). The soil texture in the soil utilized by Honvault et al. (2024) was similar (sandy loam), yet we expect higher weathering in their study as pH (in KCl) was only 5 and 66% of their basalt had a more reactive pyroxene mineralogy, with only 18% of relatively slower dissolving albite. Nonetheless, the synergy on weathering was also absent in the study by Honvault et al., (2024). Besides this study, we are not aware of other studies that investigated the fate of weathering products in the soil after co-application of basalt and biochar, so more research is needed to confirm this finding.

Line 380: While biochar effectively stimulated biomass production, we did not observe any synergistic effect between basalt and biochar in promoting biomass production. Similarly, Honvault et al. (2024) reported no significant interaction when cultivating wheat, although they noted a positive trend in total plant biomass.

Line 404: Biochar reduced plant trace metal uptake, but no synergistic effect with basalt was observed. This aligns with the findings of Honvault et al. (2024), who observed no synergetic reduction in trace element uptake from basalt when co-applied with biochar. In our study, adding basalt on top of biochar did not further decrease trace metal uptake. Whereas Honvault et al. (2024) reported increased uptake with basalt under more acidic conditions, our alkaline soil likely already immobilized trace elements from basalt, and biochar did not modify this effect.

Q18) Line 81: "Because the SCE model had a positive skew" — what exactly does this mean? Do you mean the data were heteroscedastic?

This comment no longer applies, as SCE was removed from the manuscript.

Q19) Lines 82–83: you tested the main effects of two categorical variables and their interaction. This is not multiple regression. Even if you used lm in R to extract fitted coefficients of categorical/factor variables, what you actually ran is a two-way ANOVA, right?

It is indeed an ANOVA, in the code we first do an lm (or lmer with repeated measures) and then an anova. For variables only measured once in time, it is a 2-way anova. For variables repeatedly measured in time there are more than 2 factors (basalt, biochar and time), then we refer to it as a multiple anova. Rephrased in the method section,

line 198: For measurements that were not repeated in time (i.e., biomass and plant elemental concentrations, leachate elements), we applied a multiple linear regression and a two-way anova using the lm and aov function in R and assessed the basalt, biochar and the basalt x biochar interaction effect. For measurements that were repeated in time (LOI and elemental soil data from sequential extractions and leachate pH, EC and DIC), a mixed linear model was constructed with basalt, biochar, time and their interactions as fixed factors and plot number as a random factor using the lmer function from the lme4 package, after which a multiple anova was done using the anova function from the car library in R. If the interaction effects (biochar x basalt, basalt x time or biochar x time) were not significant, a new model without the non-significant interaction effect was applied.

Q20) It is not very clear when the basalt and biochar amendments were added relative to the onset of the cultures. Please clarify.

Basalt and biochar were added on the date of amendment, just before seeding of the crops.

Added in line 102: Clover plots were seeded with *Trifolium pratense* at 4.5 g/m^2, while Mustard plots were seeded with *Brassica juncea* at 2.0 g/m^2. Seeding took place immediately after soil amendments.

Q21) Soil CO_2 flux measurements require a more thorough methodological description. I assume this was done by accumulation rather than open flow? How was the 1-hour duration chosen? This is quite long, and longer is not necessarily better. If accumulation continues too long, the increase becomes non-linear due to CO_2 gradient limitation, which can bias flux estimates depending on how the curve is fitted.

Soil CO_2 flux measurements were indeed done through accumulation. We fully agree with this critical point, potential gradient limitations in the measurement chamber can cause biases with such a long measurement duration. Therefore we decided to not use the soil CO_2 flux measurements anymore and restrict the focus of the manuscript to 1)biomass responses, 2) base cation monitoring to estimate inorganic CDR and 3) the fate of trace metals.