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Comment on soil-2020-98

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Referee comment on "Aluminous clay and pedogenic Fe oxides modulate aggregation and related carbon contents in soils of the humid tropics" by Maximilian Kirsten et al., SOIL Discuss., https://doi.org/10.5194/soil-2020-98-RC1, 2021

Review of « Aluminous clay and pedogenic Fe oxides modulate aggregation and related carbon contents in soils of the humid tropics" by Kirsten et al. in Soil Discussions / soil-2020-98

Whatever the editor decision, congratulations to the lead scientist and all the team, as their study and the work done in the field and the lab contributed to the training of soil scientist and put on the table interesting data about mineralogical controls on OC content and aggregate size fractions

Studying aggregate size fractions and their resulting effect on soil OC content in a gradient of Fe oxides and aluminosilicates relative proportion, under two land use is very interesting and bring here important data to highlight the relative importance of these two minerals (typical of highly weathered tropical soils) in OM dynamics.

In my first very general comment, it seems that there is some overlap with the study published by the same first author Kirsten et al; 2021 "Iron oxides and aluminous clays selectively control soil carbon storage and stability in the humid tropics" Scientific reports , 11, 5076. To exemplify my point, here is the sentence in Kirsten et al. 2021 "*Clay minerals and pedogenic metal (oxyhydr)oxides are the most reactive soil mineral constituents controlling the long-term persistence of organic carbon (OC) in terrestrial ecosystems. However, their co-occurrence in most soils complicates direct assessment of their individual contribution to OC persistence.*" and the one from the abstract of the present submission: "*For weathered tropical soils, aluminous clays (kaolinite and gibbsite) and pedogenic Fe (oxyhydr)oxides (goethite and hematite; termed 'Fe oxides') have been suggested as important building units for aggregates However, as both secondary aluminosilicates and Fe oxides are part of the clay-sized fraction it is hard to separate, how certain mineral phases modulate aggregation, and what consequences this has for organic carbon (OC) persistence after land-use change*". If I understood well, here, the novelty is exclusively focused on how mineral phases modulate aggregate. As density fractionation was also described in Kirsten et al. 2021, I recommend the authors to clarify how the results of aggregates are new and add novelty compared to Kirsten et al. 2021. I mean here it makes sense to clarify this point as much as possible as aggregate size fraction and OC distribution in these fractions is one of the main control on soil carbon storage and stability in soils. So it makes me thinking that the data of Kirsten et al. 2021 must be presented, treated and interpreted together with the present data about

aggregation. In my opinion, it could be great to build your research question based on what you uncover in Kirsten 2021, because their results can be a solid foundation to this study. So summarizing and building on Kirsten 2021 in the introduction could serve to expose the novelty of the present study

I also recommend to clarify the results interpretation without comparing the two ecosystems, especially because the co-variable inducing OM changes due to land use and management practices. I am saying the bottom line of the study is to compare the two ecosystems, but the current presentation of results and data interpretation make it a bit fuzzy, confusing.

I know the sites and sampling, and some of the methodologies are already presented in Kirsten et al. 2021, but given the topic of the submitted study I strongly recommend the authors to make the site selection and soil sampling crystal clear to help the readers to understand how environmental factors are similar between the studied sites under forest (how is your vegetation homogenous) and croplands (especially here for agricultural practices).

Abstract:

- Line 27: could you please clarify what you mean by "positive feedbacks on soil carbon storage".
- Line 30: would it make sense to use either "aluminous clays" or "aluminosilicates for the sake of clarity? I would prefer "aluminosilicates".
- Line 37 should be clarify, a bit wordy
- Lines 38-41: I recommend to reword this sentence as this is not clear why you oppose formation of large macroaggregates and promoted OC storage and persistence
- Line 42: "low clay-high Fe" does not ease the reading. I would suggest to present it another way to read smoother
- Line 36: a bit awkward as mineral-organic interactions are part of the aggregation. How can you oppose them?

Introductin:

- Line 61: I suggest to change "reacting" by "associating"
- Line 64-65: reading this sentence makes me thinking – how does it make sense to think aggregation processes in soils could be associated with one unique mineral phase? As long as soil is multiphase, it seems pretty reasonable to assume aggregation is explained by interactions between various phases. While I fully understand the need to better understand how proportion between minerals play a role in aggregation. Maybe, the sentence here needs to be rephrased.
- Lines 83-86: In addition could you please clarify how you isolate the OM content and quality between your sites? This is neat the idea to choose sites with identical mineralogical context. But OM quantity and quality play also a role in aggregation, so that it could make sense to explain whether this variable is also similar between studied sites.
- Line 92: need to precise here what you mean by "to which extent aluminous clay and

pedogenic Fe oxides" do you mean, the proportion? The type of oxides and aluminosilicates?

M&M

- Line 141: I am aware fractionation methods are time consuming but could the authors explain why they do not investigate aggregate size under 250µm and also why the authors do not measure oxalate-extractable and DCB-extractable Fe and Al in each fractions, so that to be able to have direct relationships between type of mineral in aggregate fraction and its contribution to the OC pool.
- Regarding the specific extraction, it is not clear how the authors can relate aluminous minerals to oxalate-extractable Al which is very specific to short-range ordered minerals. Authors refer to Kirsten et al. 2021 for the method to determine aluminous clay based on DCB extraction and textural analysis. It could help to summarize here how they proceed, especially because all interpretations in the paper depend on this quantification.
- I recommend this paper to be self-sufficient concerning the description of site location. As authors are dealing with aggregate processes, it is crucial to ensure all soil characteristics are strictly identical sites, except of course for the gradient in Fe and Al phases content. It could be helpful also to get some words explaining a bit what is behind the scene with regard to the mineralogical changes. What is the soil-forming processes and factors responsible for these changes?

Results

- Line 250: which one takes over – mineralogical combination or land use?
- Lines 269-271: ok it makes sense, I am just wondering how agricultural practices can affect aggregate stability compared to less managed forest ecosystem. This is pretty well documented and in your study I am wondering if Fe and Al phases can take over land use management when studying parameters such as aggregate stability. I am thus wondering if it makes sense to compare the two ecosystems. What do you think about interpreting the controls of mineral phases on aggregated inside each ecosystems without venturing into comparison between ecosystems.
- Line 286: how can you directely associate a variation in soil OC content to mineral constituents as land use and management practices can significantly affect OC. Again I would separately present the results for the two ecosystems, forest and cropland
- Line 295: linked to my previous comment (line 286) it is pretty confusing to read that ">4mm aggregates this was significantly modified by the mineralogical combination" while OC input and quality (together with the way OM is processed in these two highly contrasting ecosystems) can also play a key role

Discussion

- Line 326: what do you mean by "did not result in entirely different"
- Line 333-335: ok, it is the observation you did concerning your results, but how can you explain soils need a mineral phase take over the other one to promote aggregation. I am curious to learn a bit more here, maybe with the help of the state-of-the-art knowledge already published in this research field?
- Line 341: I am definitely uncomfortable with the study of land use effect on aggregate distribution through the lens of mineralogical variations. I think on top of mineralogical differences, the land use and management practice explain all the differences with regard to aggregate and OC distribution between forest and cropland.
- Line 348: to be able to say that higher Fed/Al ratio control aggregate formation, I think you have to ensure there is no other effect concerning agricultural practices. I mean here: how are you sure that tillage, crop rotation, cover crops… are identical between your studied croplands?
- Line 385-386: it is part of the introduction, and what you are presenting from Kirsten could help to introduce your research question by presenting it in the introduction, in order to streamline the presentation of your objectives, and their novelties compared to Kirsten 2021
- Line 398: taking into account land use changes as an explaining variable, compared to mineralogical changes is a bit "adventurous".
- Lines 433-434: I agree but I think it could make better sense to only study the effect of mineralogical changes for each ecosystems, separately. It will help the reader to better catch your message regarding the role of Fe/Al ratios on aggregation formation for either forest ecosystem or croplands
- Lines 435-437: I am afraid I do not understand your last conclusion sentence. Need to be rephrased, IMO.