SOIL Discuss., referee comment RC1
https://doi.org/10.5194/soil-2020-92-RC1, 2021

Comment on soil-2020-92

Anonymous Referee #1

Referee comment on "The role of geochemistry in organic carbon stabilization against microbial decomposition in tropical rainforest soils" by Mario Reichenbach et al., SOIL Discuss., https://doi.org/10.5194/soil-2020-92-RC1, 2021

The manuscript aims to determine the effects of soil parent material and landscape position on soil organic carbon contents and retained by the mineral matrix in tropical soils, which is a very relevant issue to be considered in understanding soil carbon turnover and biogeochemical processes, especially in areas with limited available information as in the studied area. While the manuscript is well organized and written, I identified the following shortcomings that need to be addressed to improve the clarity of the paper:

1) The authors use the term “organic carbon stabilization” in the title and in many other parts of the manuscript. It could be stabilization against decomposition, temperature, erosion, dispersion, oxidation, or all these together. However, the authors do not provide a context in which the word "stability" is used.

2) In the introduction (section 1.2 Environmental and geochemical controls on SOC dynamics in tropical forests), you never talk about very important environmental controls such as temperature, moisture, pH, redox potential, and oxygen diffusion. You should explore the optimum conditions (e.g., temperature and moisture) for enzymatic activity in the tropics, which ultimately will determine organic matter decomposition rates.

3) It is not clear in your hypothesis ii, the proxy for the amount of “stabilized” SOC. Is it the carbon content adsorbed on clay minerals? Does it also consider the carbon occluded in microaggregates that are physically stable against dispersion?

4) How many soil profiles were sampled? What is the classification of these soil profiles that you sampled? It needs to be shown in the methods section “2.2 Study design and soil sampling”.

L22: I think you meant “changes in hydraulic conditions”.

L23/24: What is “fossil organic carbon (FOC)”? Is it defined by a specific organic compound (e.g., polycyclic aromatic hydrocarbon) or by a certain “age” (e.g., >10000 years)? The authors should define “fossil organic carbon” when they first mentioned it in the abstract.

L29: What depth interval are you considering for this observation about SOC stocks? 0-20

cm, 0-50 cm, 0-70 cm, 0-100 cm?

L66: What do you mean for "stabilize C in the soil"? stabilize against decomposition? For how long? 100, 1000, 10000 years?

L66-68: Please, provide the reasoning for why pyrogenic carbon may remain in the soil for centuries. Does it have to do with the following? The degradation of condensed aromatic carbon compounds is an energy-demanding process. For degradation to occur, the biological capacity for specific degradation pathways must exist in the soil [Baldock et al., 2004]. It is likely that certain microorganisms can produce the (costly) enzymes required for pyrogenic carbon degradation and their presence or absence from soils is thus a crucial control on pyrogenic carbon accumulation. However, images of fungal hyphae encasing charcoal particles in soils [Hockaday et al., 2007] indicate that fungi can very well decompose pyrogenic carbon.

L69: Are you sure that the word "recalcitrant" is the best one to describe what you meant here? Maybe using terms like "long turnover times" may help you to overcome this issue. I highly recommend the authors to read the following publications for further ideas and suggestions:

Mikutta, R., Kleber, M., Torn, M.S. and Jahn, R., 2006. Stabilization of soil organic matter: association with minerals or chemical recalcitrance?. *Biogeochemistry*, *77*(1), pp.25-56.

Kleber, M., Nico, P.S., Plante, A., Filley, T., Kramer, M., Swanston, C. and Sollins, P., 2011. Old and stable soil organic matter is not necessarily chemically recalcitrant: implications for modeling concepts and temperature sensitivity. *Global change biology*, *17*(2), pp.1097-1107.

L116: Define "geogenic carbon"? Is it the same as "fossil carbon"?

L117: You said "more active microbial communities". However, you didn't conclude the comparison. Is it more active than what or where?

L140: Check the concordance of the preposition "on" and the verb "affect" in this sentence: "our current understanding on how geochemistry and topography in highly weathered tropical soils affects SOC stocks and stabilization mechanisms is still limited"

L225: What method did you use for "texture" determination? Hydrometer, pipette?

L248: Did you subtract the rock fragment to calculate SOC stocks?

L329: Please, check if this statement is necessary: "For non-valley positions, pyrophosphate extractable oxides (0.02 to 1.93 mass%) and oxalate extractable oxides (0.32 to 2.33 mass%) were low compared to DCB extractable oxides". Assuming that DCB extracts most of the oxides (including oxalate and pyrophosphate extractable oxides), then, DCB extractable oxides will always be the highest regardless of the landscape position.

Figure 3. It would be helpful if we know the soil types. Are they all ferralsols? Or the soils derived from "mafic" parent material are lixisol and nitisol as well? Also, it would be nice to see in another figure and table the average clay content as a function of soil depth in each group: mafic, felsic, mixed.

L539: Iron concretions are found, but I am not sure about aluminon concretions. Check whether all these soils contain Fe-concretion or nodules because these concretions are not always found even in microaggregates.

L540: The citation Martinez and Souza, 2019 is actually from 2020. Check it in other parts of the manuscript.

L543: Check the following publication to obtain more information about the effects of soil depth and texture on carbon retention in Ferralsols. They may help you with new insights and allow comparisons with your data. Soil depth and texture seem to regulate the content of carbon retained by the mineral matrix in Ferralsols. Make sure you addressed it in the discussion.

Souza, I.F., Almeida, L.F.J., Jesus, G.L., Kleber, M. and Silva, I.R., 2017. The mechanisms of organic carbon protection and dynamics of Câ□□saturation in Oxisols vary with particleâ□□size distribution. *European Journal of Soil Science*, *68*(5), pp.726-739.

Souza, I.F., Almeida, L.F., Jesus, G.L., Pett-Ridge, J., Nico, P.S., Kleber, M. and Silva, I.R., 2018. Carbon sink strength of subsurface horizons in Brazilian oxisols. *Soil Science Society of America Journal*, *82*(1), pp.76-86.