

## ***Interactive comment on “Soil andic properties as powerful factors explaining deep soil organic carbon stocks distribution: the case of a coffee agroforestry plantation on Andosols in Costa Rica” by Tiphaine Chevallier et al.***

### **Anonymous Referee #2**

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Comments on SOIL-2019-14: “Soil andic properties as powerful factors explaining deep soil organic carbon stocks distribution: the case of a coffee agroforestry plantation on Andosols in Costa Rica”

This manuscript reports very interesting results on a highly relevant topic, and the results are based on a large number of soil profile / horizon samples; however, it has room for improvements, both in terms of data evaluation/presentation and writing.

Subsoil OC storage is of top priority in global soil research, and volcanic soils, although

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covering a rather small fraction of the land surface, play an important role in global soil OC storage. This study nicely relates the pedogenic development of volcanic soils to their capacity to store OC not only in the topsoil or top 1 meter, but down to 2 m depth, and shows that the mineralogy (i.e. halloysitic vs. short range order) plays a key role in OC stabilization and storage down to 2 m depth. This in itself warrants publication.

The study further explores the use of MIRS to differentiate between the above-mentioned mineralogical groups and to predict resulting effects on soil OC contents and stocks. The presented K-means clustering (Figs. 2 and 3) shows that such differentiation seems possible based on MIRS, albeit not with a sharp line of separation but rather including a “transition” population in between the two clusters. The further prediction of OC contents, bulk density and OC stocks from MIRS spectra seemed to yield accurate results, which shows the potential of this approach for rapid estimation of OC stocks in volcanic soils.

In my opinion, the manuscript currently has several shortcomings, which could all be addressed in a thorough revision: (1) The English is generally comprehensible, but would strongly benefit from revision (with the help of a native speaking soil scientist). (2) The abstract currently does not include any results or conclusions. The study has produced many interesting results, and the authors definitely should include the main results and conclusions in the abstract. (3) The term “andic properties” is not used correctly throughout the manuscript (incl. title, abstract, and esp. in lines 165-175). Andic properties are clearly defined in US soil taxonomy and WRB, and these definitions should be used when claiming that a certain horizon has andic properties or not. The authors have analysed several properties that are specifically important for Andosols (e.g. Alp or Sio or (Alp-Alp)/Sio) but are not “andic properties” per se nor are they requirements for the classification of “andic properties”. The authors are advised to be very rigorous in their use of clearly defined terms such as “andic properties”, as a misuse of such terms may spread and perpetuate in literature. (4) The accuracy of the developed prediction models was determined by LOO-cross validation using the whole

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dataset, if I understood it correctly. While LOO-cross validation is a valid approach for a dataset of independent samples, there may be issues when depth samples of the same profiles (in this study up to 10 depth samples per profile) are included in the dataset. The validation would be much more convincing if it was truly out-of-sample, i.e. using different profiles for calibration and validation, respectively. One way around this could be to perform “LOO-cross validation” leaving out not only one horizon but one entire profile at a time. Alternatively, 75% of the studied profiles could be used for calibration and 25% for validation. Still, the samples of this study originate from a very small (0.9 km<sup>2</sup>) watershed; the authors need to be aware that even if their models yield accurate predictions for this study area, this may be an indication that similar approaches might work elsewhere, but the parameterized models cannot necessarily be applied directly to other volcanic soils.

Additional comments L198 and elsewhere: “correct” is not the appropriate term for describing the model prediction; “accurate” would be more appropriate. L199: Fep is not shown in Table 1. L204-205: What about ferrihydrite? (Fe is not contained in allophane and imogolite) L204-205: delete “and not to specific vibrations. . .” till end of the sentence. L225-226: To my understanding, Alp/Alo ratios of 1 and higher indicate that (almost) all of the amorphous Al is in the form of organic complexes; but still the authors find 16% allophane in these soils. How can this discrepancy be explained? L234: Did the authors observe nano-spherule structures? If yes, how? L278-280: The second half of this sentence should be rephrased for more clarity. L367: maybe better to replace “weathering” with “formation” L371-378: Rephrase for more clarity. Which are results of this study, which are general statements based on references? L374: replace “would occur” with “occurred” L375: replace “thus” with “likely”; “absorption” or “adsorption”? L398: should be Table 8, not 7. L405-410: If OC stocks are compared to other studies, the depth to which OC stocks were analysed in those other studies needs to be listed, and the comparisons need to address potential differences in depth. L439: “thickness of the young andic A horizon” or “thickness of andic properties”?

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Tables and Figures Tables and Figures need to be numbered in the order of their appearance in the text. Figs. 2, 3 and 4 could be combined into one 3-panel figure. Fig. 6 does not have a legend, and I think this figure is not really necessary and could be deleted. Fig. 8d: It seems that there are 2 populations with very different slopes, (roughly) corresponding to the 2 mineralogical groups (halloysitic vs. short range order). Could the different slopes be related to different Fe forms (with different capacity to stabilize OM) in these two types of materials? Fig. 10a: Please use the same abbreviations in the legend as in all other figures. Tables 5, 7 and 8: Please explicitly state in the caption if these tables show statistics of the predicted or measured values (I assume the latter). In Tables 7 and 8, please add the number of replicates (n).

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