

## “Perspectives on the misconception of levitating soil aggregates”

submitted by Garland et al.

In the paper provided, the authors set out to try on two conflicting views on soil structure – solid and pore perspectives. In my opinion, they almost succeeded, as they provided a simple and, most importantly, viable abstraction to describe the delineation of the different functional zones within soil structure (which are actually aggregates) (*Figure 3*). This is the most important and strongest takeaway of this paper. Also, despite the simplicity and brevity of Section 3, I would like to emphasize its value for those readers who may wish to develop the topic of soil structure. Especially, I would like to highlight the validity of the thesis "a more holistic assessment must inevitably consider multiple complementary approaches". I have some suggestions and questions regarding the terminology and the wholeness of the proposed approach, which do not lessen the value of proposed MS. The MS contains the necessary novelty, and is written quite logically. Therefore, it can be accepted after a moderate revision. See my general and specific suggestions below.

### General comments

Since the authors set out to try on two groups of researchers, it would be nice to see explicitly which of the main theses presented by both sides the authors find useful, and some arguments regarding the non-contradiction (L81) (in a general sense, I agree with you). For example, the authors do not use or discuss the definitions given in previous articles (*Vogel et al., 2022; Yudina and Kuzyakov, 2023*). As Prof. Vogel correctly points out in the preprint comments "*the wording has a significant impact on our perception*".

You need to better disclose what you mean by "do not necessarily need to have a distinct physical boundary" (L21) without jeopardizing the use of the term "aggregates" (which is actually what Prof. Baveye immediately appeals to in his comment to the preprint). In my understanding, this is analogous to applying the concept of soil types at the landscape scale, and trying to identify corresponding to different soils areas. It is also often impossible to distinguish *distinct* physical boundaries between them (as well as between other environmental bodies characterized by gradual transitions). Because many phenomena in nature are continuous, they don't know how to have sharp boundaries. However, we nevertheless use such abstractions and more than successfully. Accordingly, I don't think the word "distinct" is quite appropriate here. Because the distinctness will be achieved due to the conditions that we will set (real, i.e. experimentally affecting the soil, or virtually, i.e. modeling the processes).

From L136-138, it is not entirely clear what the authors' position is – whether they consider size, shape, etc. characteristics important for aggregates. Moreover, from L138-139 it appears that the authors take an operational approach – aggregates are what is distinguished in such and such a way. This to some extent contradicts the authors' position that aggregates exist as natural entities (L89), and the aggregate size differs (L141-143, L209). Please clarify your point.

I think it will be important to emphasize that the delineation of boundaries between aggregates according to the presented conceptual scheme on *Figure 3* (L108-125) will 1) strongly depend on the available instrumental capabilities (which pores and type of contacts are detectable), 2) and, accordingly, have different significance depending on the type (hierarchy) of the aggregates that the task is to delineate. If we are talking about the experimental application of your approach (that looks promising). For example, at a rather good resolution of tomographic imaging (of the order of the first  $\mu\text{m}$ ), we do not see pores, which can actually constitute a meaningful fraction (see Gerke et al., 2021). Accordingly, if one is trying to apply what the authors suggest to research, the question arises as to how it should be used. It would be good to reveal this point to a greater extent within the Section 3 of MS.

I find the argument against inter- and intra-aggregate pore space (L97-101) as interesting, but in need of refinement. It highlights the weak side of the paper – you do not explicitly discuss the hierarchy of soil structural organization. But actually discussing it (e.g., here L182-185). In my opinion, without this abstraction (as pores belonging to different dynamical parts of the structure), as well as without the concept of non-aggregated mass (which you do not use except L165 during describing t0 and beyond), presented approach does not look quite complete. Likely such abstractions would have improved the description in the L161-188.

### Specific comments

L9 It's not very correct to write “soils and land-use types” with “and”, because they are different kinds of things; land use type has no aggregation, only soils

L27 what is the difference between solids and aggregates? voids and pores? – It's not clear what the point of listing alternative terms here is. Please, try to use terms more strictly within the whole text of the MS.

L55 temperate → temperature

L66 “the unrealistic boundary conditions of isolated aggregates” conditions for what, modelling? or boundary conditions for isolation of aggregates?

L70 probably, the relevant works where this is said should be cited at the end of this sentence

L95-97 it will be good to put this argument to the abstract, as this is one of the important foundations on which your proposal is built; however, it is not clear for me what you mean here – “at spatial scales relevant for most soil mechanistic investigations”. Please, clarify. E.g., microaggregates having size of several-tens-hundreds  $\mu\text{m}$  and surrounded by micro- and mesopores are relevant for rheological behavior.

L98 “if aggregates do not need to be physically separated” → prefer to write “cannot be surrounded on all sides by pores”. Because you actually make an excellent point that the physical boundary can be not only the pore, but also various types of contacts between solids.

L109 “the different soil particle fractions (i.e. sand, silt and clay)” → the term “soil particle fractions” is not strict enough – as for the soil texture fractions it would be more accurate to write “soil particle size fractions”. If you mean them. According to the bracketed text, you do. However, it would be more logical and consistent with the rest of the text to specify simply «soil solids» instead of this term referring to soil texture rather than soil structure. Please, clarify this.

L138 “Instead ... “ – I cannot agree with this sentence in any way, because if aggregates are natural formations of soil, their size and other characteristics are determined by soil processes, but not by methods used.

L152 “Aggregates do not need to be separated by distinct physical boundaries.” would be better named → “Types of physical boundaries between the aggregates”. Pores and different types of contacts between soil solids are physical boundaries. Our task as researchers is to define correctly the boundary conditions for different types of aggregates.