Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2020-130-AC2, 2020

Biogeosciences Discussions

Interactive comment on "Reviews and Syntheses: Ironing Out Wrinkles in the Soil Phosphorus Cycling Paradigm" *by* Curt A. McConnell et al.

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Received and published: 26 June 2020

Dear Dr. Kirkby, Thank you for your incisive review of the MS. We hope to address all your comments here. We will include your suggestions in the revised manuscript.

Dr. Clive Kirkby, Referee 2 (R2)

R2: "While the authors mention methodological and analytical discrepancies it is done in just a couple of lines. Do the authors think it is really important or not so important, and why. While it is pretty obvious why Pi is generally poorly correlated with soil C do the authors think soil C is poorly correlated with Po because of the unnamed methodological or analytical discrepancies or someother, perhaps unknown, reason."

Authors: We believe investigating the methodological and analytical discrepancies in

stoichiometry measurements to be an important pursuit. As stated in Kirkby et al. 2011, C:Po ratios can vary widely across studies (Table 7) employing different P measurement methods (extraction, digestion, or ignition). However, C:Po ratios also varied within studies applying the same methodology thus Kirkby et al. 2011 briefly explored some potential explanations for this weak correlation. We will address these mechanisms below and in more detail in the revised MS.

Kirkby et al. 2011 hints to varying Po forms and abundances as a possible driver of the variation in C to Po ratios: "... P is found in many organic compounds and the proportions vary in different soils (e.g. Turner et al., 2003a, 2003b). The major organic P compounds are the inositol phosphates (up to 50% of total OP), which contain neither N nor S but are generally considered to be associated with the soil heavy fraction component (Borie et al., 1989; Dalal, 1977)." This is a point we mention in line 180 and 366-67 of the review, on which we will expound more in the revised MS. Additionally, evidence of variable phytate abundance and mineralization is covered in section 2.1.3, but a more direct connection to the soil C to Po stoichiometry will also be made.

Another explanation mentioning diverging C:P ratios also appears in Kirkby et al. 2011: "differences in how microbes enzymatically attack OP vs N or S could also play a substantial role but we consider a detailed discussion on these issues beyond the scope of this paper". We comment on this in line 367-69 and more generally in section 2.1.3 and 3.1, but the relationship between enzymatic Po hydrolysis and soil stoichiometry will be stated more explicitly in section 2.2.

Mentioned later in our review are the differing mechanisms of stabilization of Pi and Po. Phosphate groups can control the sorption of Po, and some Po substances do not have to pass through the microbial biomass and can therefore be directly stabilized in the soil. An example of this would be phytate. Its recalcitrance and resulting abundance in some systems would yield a higher soil C:P ratio when compared to a similar system with a lower phytate abundance.

We will add more explicit connection between provided mechanisms and their effect on soil C:P stoichiometry: âĂć Variable phytate abundance can affect SOM stoichiometry of soil. If more abundant in one soil, the C:P ratio could be higher than that of another with lower phytate abundance. âĂć The prevalence of P-driven mineralization can affect the C:P ratio of the soil through preferential mineralization of P and not C.

Overall, it is difficult to ascribe a relative importance to each mechanism potentially controlling the decoupling of Po and C. However, we can describe the mechanisms that potentially explain this decoupling. When assessing if P cycling pathways or methodological difference explain this decoupling, we are inclined to say that both likely are at play (methods are described briefly in Kirkby et al. 2011 sec. 2.2), but that the review of P cycling mechanisms strongly suggests that no stability in this ratio should be expected. Rather, we should understand its controls.

R2: “While obtaining such a measurement is probably expecting too much it might be worthwhile seeing if forest soils and top soils in no till agriculture (which generally have high fungi:bacteria ratios) can be modelled differently to soils that are often cultivated (which often have lower fungi:bacteria ratios).”

Authors: It would be interesting to follow this line of thinking, and it would be natural to explore the scenarios proposed by the reviewer in a focused study. While we think that this falls outside the scope of the review, it does fall in the scope of topics that should be explored further and we will incorporate this suggestion it in the review.

R2: “The difference in fungal and bacterial C:P ratios may help to explain differences in P driven Po mineralization compared to C-driven Po mineralization in different soils”

Authors: Yes, this could be a very useful area of study and the relative abundance of fungi and bacteria (as R2 stated previously) is a worthwhile topic of investigation. Exploring fungi:bacteria ratios and the differences in their respective C:P ratios may reflect differences in P vs. C-driven mineralization and potentially, soil C:Po ratio discrepancies.

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