

bg-2012-378 review

Storage and stability of organic carbon in soils as related to depth, occlusion within aggregates, and attachment to minerals

General comments:

This study has provided enormous data of stock and stability of soil organic carbon along soil profile from diverse sites by using density fractionation and combined methods, and the data can be used to draw conclusions for soil organic matter stabilization at large scale. This manuscript is generally well written and lots of efforts have been invested to put massive data together. However, this manuscript would be easier to understand when objectives of the study in “introduction are stated clearly, the “materials and methods” section are elucidated especially for the data used to make figures, the “results” section present in figures are reconstructed to make the whole story easy to catch the main points, and the “summary” section are stated explicitly and concisely.

Specific comments:

Abstract and Introduction:

In the “introduction” section, there are not clear and concise statements of the objectives of this study from beginning.

Lines 30-31, this manuscript does not fully discuss how soil type and parent materials affect SOC stock and stabilization. As far as I understand, it discussed how SOC stock and stabilization differed among soil horizons and among soil with different contents of Fe/Al oxides.

Lines 36-37, what is the exact meaning of liens 36-37, especially ”reflect plant functional types in soil profiles not subject to plowing”?

Line 39, how did authors draw the conclusion that “fossil C derived from the geogenic ...”? What is the evidence/data/citation of fossil C in this study?

In lines 57- 59, what are the references of this statement?

Lines 102-103, I do not quite understand the sentence and suggest to rewrite it.

Line 118, I suggest to delete “In summary” in this line, since this is the not final section of this manuscript.

Materials and methods:

Lines 154-158, what is the measurement for root biomass along soil profile?

Line 161, please state which soil fraction was used to determine mineralization rates of soil OC, bulk soil or fLF, or oLF, or HF.

The mineralization incubation lasted for 20 days in the study. Are 20 days long enough for the majority of soil labile OC respired? Therefore, how can normalized CO₂ respired rates over 20 day be used to indicate stability of OC?

Lines 173-174, please specify how the calculation of “mass of C evolved per container and hour was calculated by taking the pH-dependent solubility of CO₂ in the soil water into account”.

Lines 220-222, what I understand from the sentence is that the dry combustion of samples at 450 °C for 16 hours can remove carbonate. While, is 450 °C high enough to remove carbonate efficiently? What are citations to support this method?

Line 234, where are soil samples from 5-10 cm? Are they missing?

Line 235, what do “these samples” refer to? Please clarify which samples were missing and which samples were analyzed. I am lost here.

Lines 234-235, please specify how we can know that density fractionation showed no contribution of fossil C.

Results:

I suggest to restructure the results section. The main points of this study are the stock and stability of three soil fractions (fLF, oLF, and HF) along soil profiles from sites with different vegetations and parent materials. As a reader, firstly I would like to see the results of stock (in terms of OC concentration or contents) and of stability (indicated by C/N, $\delta^{13}\text{C}$, ^{14}C , and mineralization rates) for three soil fractions along soil profile. Then I would be interested in how the stock and stability differ among sites with different vegetation and parent materials.

Please definite terms and their units for mineralization rates in the “Materials and methods” section at first, and then use the terms consistently in the “results” section, such as “specific mineralization rate” and “OC normalized CO₂-release rates”.

In lines 271-272, why only the data from cropland sites and the ploughed grassland site were selected to be shown in Figure 2?

In lines 361-362, how were the contributions of organic layers to the total CO₂ evolved calculated? No description can be found from the method section.

Lines 372-374 should be moved to the “Materials and methods” section.

Discussion:

In lines 402-403, this sentence just shows the results without discussion (lines 402-403), and so would better being moved from discussion.

In lines 405-412, it is confusing that which OC is more important contribution to LF-OC, fossil C or geogenic C. In addition, what are the evidence/data of the contribution of fossil C to LF-OC in 3/12 sites?

Lines 418-420, why can the authors state that the results support roots are more stable and important for soil OC formation? The results of this study show the relations between root mass and fLF-OC and oLF-OC rather than HF-OC, which do not support the statement above.

In lines 440-441, what is the evidence of the statement “there seems to be a similar situation at our topsoils” (Tables? or Figures?).

In lines 450-453, the sentence is too long without even a comma. Short sentences would make reading easier.

In lines 453-454, it would be better to say that “little or no relation between mineral indicators and OC can be expected when available binding sites at mineral surfaces are not limited”, because limited factors are always the driving factors and can cause changes of dependent variables. However, the availability of binding sites at mineral surfaces does not indicate that mineral indicators are limited factors.

Lines 494-495, I did not see the reasons of put this sentence here.

In lines 501-503, it does not make much sense that “correlations between CO₂-release rates and OC in all three density fractions suggest that OC in all three fractions turns over fast enough to ...”. First, what is this “CO₂ release rate”, absolute or relative rates? I did not see the relations between fast turnover of OC and significant contribution to mineralization rates. The CO₂ evolved might be due to large amounts of labile OC in soil fractions rather than fast turnover of small amounts of soil OC.

In line 503, what is the “respiration rate”, absolute or relative rate?

In lines 507-508, the statement is not new and commonly accepted, why repeat it here?

In line 519, it does not make sense that “... which is the prerequisite for degradation of mineral-bound”. What is the exact meaning here?

In line 520, which type of correlation is between OC-normalized CO₂-release rates and bulk sample Δ14C, positive or negative? Moreover, how can the negative correlations for samples from 10-20 cm be used to draw the conclusion for samples at larger scale? Deeper soils may refer to soils in horizons deeper than 20 cm.

In lines 542-545, what is the exact meaning of this sentence?

Summary:

In line 561, it is strange to say that “the distribution of OC over density fractions”.

In lines 562-567, it is a very long sentence. Short sentences would make reading easier.

In lines 571-573, what is the evidence of transfer of fLF-OC or oLF-OC to HF-OC? Are the correlations among decomposition rates of fLF-OC or oLF-OC to HF-OC the evidence? The correlations among decomposition rates of OC in three fractions indicate that amounts of labile OC in three fractions are linked. However, such link does not mean the OC transfer from one fraction to another, and might mean the properties of OC in three soil fractions. So, I cannot see the transfer from fLF-OC or oLF-OC to HF-OC.

In lines 573-574, the statement does not make sense. Please clarify.

What is the title for the third points in the “Summary” section, since there are titles for other points?

In lines 582-584, please explain how HF- associated OM in topsoils prone to be replaced by freshly produced reactive organic compounds.

In lines 592-593, is it necessary to say that “OC in the LF represents fresh, unprotected OC”? It is widely accepted.

In lines 595-596, there should not be further discussion of the unsolved problem in “Summary” section. Summary is expected to be concise.

The results from the study show no or weak correlations between mineral properties and OC. So, how was the statement in lines 602-604 developed?

Figures:

Figure 1: The last sentence in figure caption belongs to the results or discussion section.

Figure 2: Rescale x-axis of OC graph, OC-to-TN ratio graph, and δ¹³C and make graphs easier to read.

Please clarify the unit of OC g kg^{-1} . Does it refer to $\text{g kg (bulk soil)}^{-1}$ or $\text{g kg (soil fraction)}^{-1}$?

Is the large value in the graph of OC-to-TN in Carlow outlier or not? If the point is outlier, why plot the point in the graph?

Why only the data from the four sites were selected to make this graph? Three sites are the agricultural ecosystems and one is the grassland ecosystem. I cannot see the reasons of selecting these four sites.

Figure 3: Why put these two graphs into one group? Although the two graphs are all about soil OC in different soil horizons, the data of soil OC stocks and total soil respiration are for samples from soil depth by different criteria. In addition, y-axis for the right graph is total soil respiration, but its unit is $\text{g CO}_2 \text{ m}^{-2} \text{ day}^{-1}$. Since the variable is indicated by per day, does it make sense to label it as “total...”? How was total soil respiration calculated? Was it calculated by dividing cumulative CO_2 evolved over 20 days by the area of plastic container used for incubation? If so, the values do not make much sense because the area of plastic container is artificial, and the CO_2 evolved data cannot be compared to incubation results of other studies neither.

Figure 4: Are data in two graphs the average values or not? Please clarify.

Figure 5: Please specify the calculation of relative contribution per layer. What is the denominator? No description can be found in the Materials and methods section.

Figure 6: Are the values in two graphs the average? If so, where are the standard errors bars? Perhaps, figure 6 can be replaced by a table or text to demonstrate the main point that root biomass was correlated with fLF-OC and oLF-OC at the top 0-10 cm, considering that many figures were used in this manuscript.

Figure 7: “0-10 cm” on top of the figure should be deleted since it is in the figure caption. What is the unit of x-axis, $\text{g (?) kg}^{-1} (?)$? Please clarify. Are the values in the graphs the average? If so, where are the standard errors bars?

Figure 8: “0-10 cm” on top of the figure should be deleted since it was in the figure caption already.

Why are the letters “Ca” in 2 graphs in this group? Are the letters used to highlight the outlier? If the data are outliers, why the outlier should be present?

Figure 9: “0-10 cm” on top of the figure should be deleted since it was in the figure caption already. The values of x-axis (OC loading in terms of $\text{g HF-OC g}^{-1} \text{ clay}$ and $\text{g HF-C g}^{-1} (\text{Fe}_d + \text{Al}_o)$) are too high, are they correct? Are the values in the graphs the average? If so, please add standard error bars.

Figure 11: The values in the right graph are too high, is the unit of x-axis of the right graph correct?

Figure 12: CO_2 evolved during incubation have been found to be positively correlated with initial soil OC in many studies. I did not see the reasons of using graph to show this relation. If the graph was to show different slopes of regressions between CO_2 evolved with initial soil OC, tables or text can be used to achieve this. Otherwise, this graph can be deleted considering that there are already many figures in this manuscript.

Figure 13: This graph showed relations between CO_2 evolved and OC of different soil fractions. The results suggest that each fraction has easily degraded OC. What will be the multi-regression between CO_2 evolved and OC of fLF, oLF, and HF? The multi-regression results might tell the different contributions of OC of each soil fraction to CO_2 evolved.

Figure 15: “10-20 cm” on the top should be deleted since it is in figure caption already. In addition, why only the data of samples from 10-20 cm were reported here?

Figure 16: Why do the arrows from fLF to oLF and from oLF to HF mean? There are no straightforward hierarchical relationships among OC of the three soil fractions. So, the arrows between them would be misleading.

Technical corrections:

Format error, in line 267 it should be 3.1.1, in line 309 it should be 3.1.2, and in line 338 it should be 3.1.3.

In line 277, “Fig. 1, 2, 3a” should be “Figs. 1, 2, 3a”.

In lines 278 and 317, “largest” should be “the largest”. Again, in line 317, “smallest” should be “the smallest”.

In line 535 “OC with and the OC-to-TN”, delete “with.”

In line 577, use the same format as in lines 569, 585, 591, etc..

In line 585, is there supposed to be a period at the end following “soil profile”?

In line 594, “carbon” should be “C”.