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Interactive comment on "Turning sunlight into stone: the oxalate-carbonate pathway in a tropical tree ecosystem" *by* G. Cailleau et al.

Anonymous Referee #4

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The idea that a tree species in a tropical area with acidic soil can produce large amounts of carbonate is fascinating, and important mechanism in understanding all aspects of the global carbon cycle. More work into this topic is needed, and a mechanistic understanding of this process would be very valuable. "Turning sunlight into stone: the oxalate pathway in a tropical tree ecosystem" attempts to elucidate some of the particular fluxes of carbon and calcium between trees, downed wood and litter, soil, soil solution, and calcified tree tissues in the live tree. The authors propose a model based on field observations and C isotopes of various compartments involved in the system. The proposed model provides an interesting way of visualizing the complex system involved and provides the foundation for further mechanistic studies.

There are several aspects of the paper that should be clarified that may require a

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significant re-writing of the manuscript. The conclusions stated in the paper may not be justified based on the evidence given in this study.

General Comments:

1) The objectives of the study are unclear, and are not well linked to the data that were collected. The below excerpts are the objectives that were stated. However, these are vague. How will the data collected specifically test a hypothesized model?

Intro Question: Does this system work with only the presence of oxalate (supplied by an oxalogenic tree) and soil oxalotrophic bacteria, as observed in Petri dishes, or do other key players need to be involved to make this system an efficient carbon sink?

Objective: Consequently, the aim of this study is to document and challenge our present-day knowledge about the oxalate-carbonate pathway involved in tropical settings. For this purpose, we propose to use microscopic and petrographic investigations, as well as stable isotopic measurements, to test the previously hypothesized model elaborated from experimental data obtained in the laboratory and described by Braissant et al. (2004).

Question in Discussion As a consequence, it seems that this system is unable to work only with both the oxalogenic tree and the soil oxalotrophic bacteria. So how does the system really work? Where does the transformation of oxalate into carbonate take place? To answer these questions, fluxes of matter are described and discussed using all observations made from the field to the microscopic scale.

2) The study needs more context. The previous papers by Braissant and other mentioned should be reviewed in more depth, and used to highlight what gaps are missing in our understanding of this system. It would also be useful to have more context about the study site, climate, soil C:N, soil pH etc.

3) More information about how this system is important in carbon cycling would help justify its importance. How common are trees that have this process? How much of

the C sequestered by these trees ends up in carbonate? What is the approximate residence time of the carbonate?

4) The isotope data is not clearly related to each other between the pools measured. The tree tissues are the most depleted (-24 per mil), with the Ca-oxalate from live tissues and the burned Ca-oxalate also very depleted (-19 to 17 per mil). In contrast, the Ca-carbonate samples measured were less depleted (>-10 per mil) and more similar to CO_2 signature of the air (-6 to -8 per mil). While the isotope measurements were meant to clarify the pathway of carbon from trees to soil, these data do little to satisfy. It's not obvious to me from this data that the C in Ca-carbonate is from C in Ca-oxalate. Could the authors identify two clear end members? Could another isotope (18O?) or marker be measured for a mixing model?

Specific Comments:

P 1078 L19 agents l 21 agents P1079 lL20. Potential C sink of what magnitude? Section 2 P1080-1081. Why not include more of an ecosystem perspective here about C sink potential? P1081 L19 binoculars? Do you mean hand lens? P1081 why mention these other sites, but be vague about what you did there? P1082 L6 Do you have a citation from the bromoform method? Or is this the first time anyone has done it? Can you provide some validation for this method? P1083 methods for Ca-oxalate separation. Same problem with validation. Any citations or evidence that this works? After precipitation of Ca-oxalate, how much of the sample was C from oxalate, versus some other source of C? It's not clear that you removed the other C compounds for isotope analysis. P1084 section 4.2–the purpose of the X-ray diffraction on these particular samples is not clear to me. Haven't previous studies identified Ca-oxalate already in these tissues? The second sentence about Ca-carbonate in former roots does not seem to fit in this section. I think clarification and more details are needed. P1085 L3 "there is no evidence of dissolution of these crystals". Explain. In the figure caption you state that "Oxalate crystals (blue arrows) are embedded in the amor- phous silica, which postdates the oxalatization." The reason for your interpretations here are not

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immediately obvious. P1085 Optical observations. Lots of studies have looked at images of Ca-ox crystals, could you emphasize here what is new-found information? Or be more clear about observing Ca-oxalate, versus Ca-carbonate versus silcates. And how do you know which is which from the images? P 1085 L20. Explain Fig 3c also. The front of calcitization looks interesting, and how does it related to the Ca-ox you saw dissolving? P1087 L10-12 this information should be in methods. P1087-1088 C isotopes section. It is not clear why these particular samples were measured and the purpose of the measurement and the comparisons made. Why were averages taken? P1087 L18-19 which site is this sample from? P1087 L 23 the average you calculated was based on which 11 samples? You report only 3 sample from Biga above. The average of the four values above does not equal -7.9. P1087 L 24 which site was the soil from? P1088 L15 It's not obvious that there is a fractionation occurring when oxalate oxides during incineration if you are not reporting the isotope value before burning. At Biga the Ca-ox isotope value you report is already depleted and was -19 per mil. P1088 L16 Or are these values the isotope values before incineration? Clarify. If so, why were the Ca-ox values from Biga so different? P1089 L5-6 What do mean that the system is unable to work with both the oxalogenic tree and the soil oxalotrophic bacteria? And how does this relate to wounds and oxalate dissolution in the tree tissues? Close attention to language and clarity is needed. P1089 L5-9 More questions are being asked in the Discussion. The questions of your research should be clear before now. P1089 L17 "In addition, at this step, oxalic acid excretion by roots is also a possible source.." This sentence seems out of order and should come after the following sentence. Also, not sure what you mean by "at this step" P1089 L10 "Milestones" does not seem to be the appropriate word for this section. P1090 L6-7 this sentence isn't very scientific. . . can you cite something to back this up? Or either quantify or give a caveat to "always" P1090 L2-15 This paragraph is muddled. It sounds like termites do three things 1) consume wood tissue and release carbonates as they eat the surrounding wood, and 2) cause more of the tree to release more organic matter in general to the soil (like big slabs of wood) and 3) there is some association between termites and more carbon-

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ate production of the tree. I'm not sure if that is entirely correct? P1090 L18-L25 The writing in this section needs improvement to better guide the reader. The visualization jumps from live trees, to soil, back to live trees, back to soil and back to trees. P1091 L1 "Lumberjacks" is a colloquial term, not sure it's appropriate. Maybe try "those who harvest" P1091 L11-19 "must be the result" of diffusion process of carbonate.... I'm still not clear how carbonate stays in solution in the sap and then precipitates at a certain point. L13 authors write "(and eventually Ca2+)" though, I cannot see why there is a time lag in Ca2+ uptake and movement in xylem sap. It seems that the arrival of Ca2+ would initiate Ca-carbonate precipitation, so what is here in parentheses is actually quite important and should be elaborated on. P1091 L20-P1092 L1-10 Some of the above comment is addressed here, although not very clearly. Is there a time-lag in Ca2+ in the xylem, or are both carbonate and Ca ions continually present but precipitation happens under dry conditions? These two sections need to be clarified and improved in writing. P1093 L13-15 This paragraph does not have any interesting information in it. Delete or explain. P1093 L25-27 There must be several alternative explanations that you did not address. P1094 L8. This is first time you mention "DIC" ... what do you mean by DIC? P1094 L7 "confirms" is too strong language P1094 L10 clarify language here and in the rest of the paragraph. There are two processes that change with depth, 1) CO2 in the soil decreases with depth and 2) oxalate concentrations from the tree decreased with depth. Are you saying that these two processes have opposite effects on DIC concentrations? P1094 L22 what do you mean by variations? P1095 section 5.4 It is less of a concern to define the tree itself as a micro-ecosystem than to describe the importance of this study to a larger ecosystem. For example, how much C is involved when you include the tree density of the larger ecosystem? How much of the tree's C sequestration via photosynthesis ends up in calcite versus more rapidly decomposing pools? P1096 L4-11 The conclusions may not be appropriate in that there is little clear mechanistic data in this study that sufficiently describes the functioning of this system. There is a proposed model, but I don't think that the pathways between measured pools were either illustrated/quantified/described with data as

evidence.

General comment: Throughout the manuscript and especially the figures, you use all the terms: carbonate, calcite, CaCO3 and DIC. Please minimize the use of multiple words that mean the same thing. If there is a specific reason you are using one word over the other, you may want to explicitly alert the reader to the reason.

Fig 6 This figure is not well described in the text. How do you know that this is a sequence of events? Again, not always clear about whether this is happening in live wood, or in dead wood within the soil or both.

Fig 5 and Fig 7 Figure 7 is much more complicated. Can it be used instead of Fig 5, but first take the time to explain all the fluxes between the pools? Are all the same processes represented in both figures?

Fig 7 "Photosynthesis CO2 uptake d13C $\sim$ -6 to -8 per mil" was this measured? It's not mentioned in the methods. Is this the signature of CO2 in the air or of plant tissues?

Why just the isotope data from Biga? How does this related to the isotope data from the other sites? Can you add data (ex. From the wound secretion) from the other sites to fill in some of the missing pools, as an estimation?

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/8/C397/2011/bgd-8-C397-2011-supplement.pdf

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