

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

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Referee 3

A “sink” is not timeless, but one has in mind that materials “disappear” from the system for a period of time. Therefore it would be interesting to know how long these carbonate features remain in the (acid) soil after decay of the tree. Is this a question of months, years or decades? Some information on climate, especially precipitation, vegetation, etc. would help to evaluate this.

Authors' answer : This is a very interesting point. If an average C sink rate (as calcium carbonate) was calculated (see Cailleau et al. 2004), the residence time of these carbonates, at this moment, is only discussed based on available literature (most of

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it from Retallack publications, e.g. Retallack 1990 Soils of the past : an introduction to paleopedology). He suggests a soil carbonate residence time up to 100'000 times longer than organic matter. Nevertheless, some recent research we have conducted in Burkina Faso shows that the soil carbonate residence time below the first 10 cm could be in the order of magnitude of 5000 yr.

To be added in P 1081 in section 3.1

At Biga site, mean annual temperature (MAT) is 24.5°C the mean annual rainfall (MAR) is 1500 mm/yr. 5 dry months occur in this semi-deciduous forest from the Guinean domain. At Kani site, MAT is estimated as equal to Biga site, MAR is 1300mm/yr and there is 6 dry months occurring in this gallery forest from the Sudanian domain. At Massangam area (include Massangam, Machatoum, and Mankaré sites) MAT is 23°C and MAR is 1800 mm/yr. These sites take place in gallery forest from the Guinean domain. The studied soils mainly belong to the reference soil group Ferralsol (WRB 2007).

There remains also the question in how far new carbonates are formed in this cycle. The authors mention as source of calcium weathering of silicates, rain and dust (§5.2.2). In Ferralsols the amount of Ca⁺⁺ contributed by weathering is practically negligible (are it really Ferralsols/Oxisols? No real information is given). Moreover the dust might in many cases contain carbonates (any information on the composition of the dust in this region?). So the real “sink” is probably extremely limited.

Authors' answer : We agree that calcium pool in such soils are small and to sustain such an important C sequestration rate, Ca must be stored somewhere and it probably does function under a fully “direct logistics flow” but more on existing pools. First, the studied soils belong to the typical Ferralsol (WRB 2007) and oxisol (USDA 2006) groups. Secondly, as far as the calcium cycle is concerned, the calcium is considered to be mainly stored in the biomass as it is typical of tropical forests. This is presently

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under investigation. Concerning the “real sink”, there is carbonate neither in the basement (Cailleau et al. 2004) nor in the dust (Stoorvogel et al 1997). Consequently, the quantified secondary carbonate pool and its concomitant C sink are real and unlimited.

P.1079 L 4 : defined replaces define

Page 1084, line 12: underlying soil. Generally the term underlying is used for a soil covered by colluvium, constructions, etc., not a soil below a tree.

Authors' answer : We agree, "soil beneath" can be used.

P1084 L12 : on the soil beneath replaces on the underlying soil

Page 1085, it would be most useful if an estimation of the size of the oxalate and carbonate crystals was given. For carbonates the table mentions that they form mostly micritic fabrics. Are it pure or impregnative nodules, with sharp or diffuse boundary? If other fabrics are present, please describe them, as this might be useful to recognise such accumulations in other soils. Although this is not the aim of the paper, it could be an important contribution to pedology.

Authors' answer : the referee will find most of the requested information in our Catena publication (Cailleau et al., 2005).

Page 1089, line 11: underlying?

Authors' answer : We agree, "soil beneath" can be used.

P1089 L11 : to the soil beneath replaces to the underlying soil

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Page 1090, the aqueous soil solution does not only contain carbonate ions from oxalate oxidation, but also from rain, dust, and microbial and root action.

Authors' answer : carbonate ions resulting from the oxalate oxidation are present in the aqueous soil solution where they can be mixed with soil DIC.

Page 1093, First Fig. 6 is mentioned, only later Fig. 5. This is not logic.

Authors' answer : Figure 5 is mentioned on page 1092 L7 whereas, Figure 6 is mentioned for the first time on page 1093 L7.

Page 1098, Dambrine et al.: seems not mentioned in the text.

Dambrine et al. deleted in reference section

Fig. 2: the sharp peaks for amorphous constituents need some explanation.

Authors' answer : In the bark diffractogram, the dome-like shape (diffraction around 20-25 angle 2θ) dominated by a wide peak (around 22 angle 2θ) is typical of organic matter mixed with partially crystalline and “amorphous” unidentified silica observed in thin section. As the baseline is not subtracted, the organic matter emphasizes the dome shape.

Fig. 4A: a higher magnification would be more suitable.

Authors' answer : we think that this picture gives the context and a more magnified photomicrograph would reduce its interest.

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Fig. 6: caption not clear. The drawing contains 3 phases (I, II and III) which are not explained in the caption.

Caption modification:

Fig. 6. Temporal occurrence of major events often observed related to the iroko oxalate-carbonate pathway. Three steps can be distinguished: Step I: "initial" state before any noticeable event happening to the seedling. Step II: Oxalatization is the first step observed related to both photosynthetic activity and concomitant organic matter flux to the soil. Whewellite is synthesized in the bark and the wood tissues. If wounds occur on the trunk, oxalotrophic bacteria contamination can initiate oxalate consumption. However, this process seems minor and the process becomes really efficient only after the release of a large amount of oxalate crystals into the soil. This last step requires an important flux of Ca-oxalate-bearing organic matter. At this stage, the process can be enhanced through termite feeding and saprophytic fungi. In the soil, oxidation of calcium oxalate by soil oxalotrophic bacteria starts and leads to the release of carbonate ions. Step III: These ions, present in the soil parent solution (i.e. as DIC), are pumped through the roots and can locally precipitate as calcium carbonate in the wood tissues (in the vascular system, or as a calcite pseudomorphosis on neighbouring tree tissues). Silicification is interpreted as synchronous to calcitization. Nevertheless, it remains unclear if amorphous silica appears after oxalatization.

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