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Soil organic carbon can be up-taken by plant roots and stored in plant biosilica: NanoSIMS and isotopic labeling evidences

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Plant biosilica particles called phytoliths contain occluded organic compounds (phytC). Over the last few years, phytC content, nature, origin, paleoenvironmental meaning and impact in the global C cycle has been the subject of increasing debate[1, 2]. Inconsistencies in phytC quantification were fed by the scarcity of in-situ characterization of phytC in phytoliths and by inadequate extraction methods[3]. Very recently, ^{14}C-AMS analyses of soil organic matter (SOM), amendments, plant tissues, atmospheric CO_2 and phytolith samples, evidenced that a small but significant pool of phytC is not photosynthetic but derived from old SOM[4,5]. From there, several investigations were started to go further into the characterization of phytC and the mechanisms in play behind old SOM absorption by plant roots and old SOM occlusion in plant biosilica. Here, we first reconstruct at high spatial resolution the 3-dimentional location of phytC and its C/N signature using 3D X-ray microscopy and Nano-scale Secondary Ion Mass Spectrometry (NanoSIMS). A pool of phytC appears homogeneously distributed in the silica structure and its C:N estimate is in the range of amino acid signatures[6]. Then, we use ^{13}C and ^{15}N-labelled amino acids monitored from an hydroponic solution to grass roots, stems, leaves and phytoliths to evidence that amino acids are absorbed as such by the roots and are concentrated in phytC rather than in the plant tissues. These findings strengthen and complement the ^{14}C evidences. Both of them dissuade attempts to use phytC as a proxy of plant C. Further, they open new avenues of investigation regarding the processes which drive SOM mobilization by plant uptake, for a better understanding of soil/plant interactions involved in the terrestrial C cycle.

[1] Santos et al. 2010. Radiocarbon 52:113

[2] Santos et al. 2012. Biogeosci. 9:1873

[3] Corbineau et al. 2013 R. Paleobot. Palyn. 197: 179

[4] Reyerson et al. 2013 AGU Fall meeting 2013 (1803125)

[5] Santos et al. 2014 AGU Fall meeting 2014 (B51A-0011)

[6] Alexandre, et al., 2014. Biogeosci. Discuss. 11, 14699 :14727.