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Tracing soil carbon cycle and the origin of needle fibre calcite

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Needle Fibre Calcite (NFC) is the most widespread habitus of terrestrial calcite. Several SEM (Scanning Electron Microscope) observations support the biological origin of the NFC: needles of calcite seem to be precipitated inside organic sleeves, which are interpreted as fungal hyphae acting as a mould (Cailleau et al., 2009 [1]). Different micromorphologies are observed corresponding to different stages of NFC evolution. In order to test the biogenic hypothesis, a new approach based on a systematic soil carbon tracing has been conducted. The aim was to define the source(s) of carbon incorporated in the NFC. Both organic and inorganic carbon pools were measured at the most accurate scale ever in a NFC study.

The negative value of NFC $\delta^{13}C$ (*ca* -9.56‰) is often interpreted as a biological signature. Tracing soil carbon over a year highlighted a gradient of ^{13}C fractionation from soil organic matter, to DIC, to secondary $CaCO_3$ (various morphologies of NFC). The host rocks (cryoclasts from Jurassic limestones) have a conventional marine limestone signature. This result emphasizes a complex behaviour of carbon that precludes the use of NFC $\delta^{13}C$ signature as an evidence for fungal influence. The NFC signature is close to the theoretical physicochemical $CaCO_3$ $\delta^{13}C$ values obtained using the physicochemical conditions of the studied soil (mostly in equilibrium with organic matter decay). Due to the fact that fungi are heterotrophic organisms, C from DIC does not transit through metabolic pathways. Consenquently, the NFC isotopic signature should not be influenced by an organic pathway. C uptake for biomass is separated from carbon absorption of DIC origin, which could be passive. In conclusion, ^{13}C investigations do not unequivocally demonstrate the biogenic origin of NFC. Other approaches, such as isotopic (^{87}Sr, ^{44}Ca) or multi-elemental methods have to be considered to prove the biological origin of NFC.

[1] Cailleau, G., Verrecchia, E.P., Braissant, O., Emmanuel, L. (2009) The biogenic origin of needle fibre calcite. *Sedimentology*, in press