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Do microbes destabilise old soil organic matter after fresh substrate addition?

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The input of fresh organic matter to soil may stimulate microbial activity and alter soil carbon storage by enhancing mineralization of native soil organic carbon (SOC). Assessing the age of sequestered SOC utilised by stimulated microbes is a major challenge as the destabilisation of old SOC would be much more damageable for the overall carbon budget than the mobilization of recent SOC. Here, we investigated the microbial populations sequentially activated after the addition of a labile substrate. We questioned wether they have distinct metabolic potential and we characterised the age of the native SOC they mineralised.

We used C3-C4 soils from Congolese Eucalyptus plantations that were previously under savannah: old (C4) and recent (C3) SOC exhibited different delta 13C. Soils were amended with glucose and incubated for one week. To partition respiration sources, the delta 13C of CO_2 was continuously recorded using a tuneable diode laser spectrometer (TDLS). To characterise active microbial populations, this was combined with phospholipids fatty acids (PLFA) analyses and potential metabolic activities measurements after two and seven days of incubation.

A peak of glucose mineralization occurred after 17 hours of incubation. After the peak of glucose consumption, over-mineralization of native SOC occurred for some days, first affecting the recent C3 SOC, and later the old C4 SOC. Before this peak, some decomposer populations with a strong feeding preference for recent SOC were triggered by glucose addition. They were likely responsible for glucose consumption but also for the subsequent enhanced mineralization of recent C3 SOC. They were then out-competed by slower communities preferentially utilising the old C4 SOC and displaying a high potential for degrading P- and N- containing substrates. As nitrogen enrichment of old soil organic matter is a general feature, we postulated that nitrogen exhaustion in the poor soil solution was responsible for the succession of microbial communities and the change of SOC pool utilisation.
Our results demonstrated the role of soil microorganisms as drivers of SOM dynamics. They pointed out the necessity to assess the age of over-mineralised SOC when investigating the balance between SOM formation and mineralisation.