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Tracing the origin of the remarkably stable organic Carbon in plaggic Anthrosols

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Until the invention of chemical fertilizers around 1900 AD, stable manure was used for centuries to fertilize poor sandy soils throughout large areas of North-Western Europe. The manure was produced in stables and consisted of a mixture of stable straw, animal (mainly sheep) droppings and sods. In spite of the abandonment of this agricultural practice over a century ago, the elevated organic C in the resulting plaggic Anthrosols still remains. Its remarkable stability is difficult to explain by the reigning paradigm of sorptive preservation and physical occlusion alone, and may be linked to unique combination of straw, heath sods and sheep manure that constituted the manure added to the land each year. Therefore, a key first step to study the dynamics and preservation of soil organic carbon (SOC) in these systems is to reconstruct the SOC input and subsequent (selective) preservation thereof.

Previously we showed that preserved plant derived n-alkanes and n-alcohols can serve as biomarker indicative of past vegetation cover and C input in soils (1). To study C input and subsequent SOC dynamics in Plaggic Anthrosols (2) we used a combination of such biomarkers and fossil pollen to examine the input of stable fillings used to produce plaggic manure in the plaggic horizon of several Plaggic Anthrosols. Pollen of Calluna was observed in all spectra of the plaggic horizons, biomarkers of Calluna only in the youngest. This suggests that large scale Calluna sod application only took place in last stages of the plaggic agricultural system, while other stable fillings were used before (2). However, even if other fillings than Calluna sods were used, sheep grazing occurred at least since the early Middle Ages. This means sheep droppings were always part of stable manure, and input of C, including biomarkers, via digestive tracts of animals must be taken into account. The favorite food of sheep are grasses, but at the end of the season when grasses become scarce, they also consume Calluna shoots. The question then arises: where did the Calluna biomarkers from the sheep droppings in the older parts of the plaggic horizons go? Did they not survive the digestive tract of sheep? Was Calluna derived C preferentially degraded in the soil? And what does this mean for the turnover of SOC in these old manured soils now and under future climate or land-use change?

In our presentation we will discuss these questions and their potential answers using our previously mentioned analyses of the molecular dynamics of SOC in Plaggic Anthrosols (2), combined with the results of on-going research where we analyze biomarker and pollen compositions of present day sheep droppings collected during one annual seasonal cycle.

References

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2) Van Mourik, J.M., Wagner, T.V., De Boer, J.G. and Jansen, B., 2016. SOIL, 2, 299–310.