Geophysical Research Abstracts
Vol. 20, EGU2018-3825, 2018
EGU General Assembly 2018

The origin of organic matter in plaggic Anthrosols based on pollen and biomarkers analysis

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Previously (1,2) we showed that biomarker analysis, i.e. using preserved plant derived lipids as molecular fingerprints indicative of e.g. past vegetation cover or soil organic matter input, is a valuable proxy to read the soil's archives in combination with palynology and absolute dating techniques. In these studies we compared biomarker spectra with fossil pollen spectra, using the premise that biomarkers are released from onsite plant species and pollen originate both onsite and offsite. However, even though plant lipid based biomarker have been studied and used for many years, fundamental questions still remain (3).

Studying plaggic Anthrosols (2) we used biomarkers to indicate stable fillings used to produce plaggic manure. Pollen of Calluna was observed in all spectra of the plaggic horizon, biomarkers of Calluna only in the youngest. Consequently, we concluded that contrary to the existing paradigm, farmers applied Calluna heath sods only in the latest stages of plaggen agriculture. However, sheep grazing occurred at least since the early Middle Ages. This means sheep droppings were always part of plaggic manure, and input of biomarkers via digestive tracts of animals must be taken into account: an input route hardly ever considered in biomarker based vegetation reconstructions (3).

The favorite food of sheep are grasses, but at the end of the season when grasses become scarce, they also consume Calluna shoots. The absence of Calluna biomarkers in all but the youngest part of the plaggic horizon suggests biomarkers may not survive the digestive tract. We tested this by analyzing present day sheep droppings collected during one annual seasonal cycle for biomarkers and pollen. In the pollen spectra of the sheep droppings, Calluna and Poaceae were always both clearly present. Surprisingly, the biomarker spectra of sheep droppings were dominated by Calluna suggesting preferential preservation rather than decomposition during passage through the digestive tract. This gives rise to the following intriguing question: Where did the Calluna biomarkers in the older parts of the plaggic horizon go? Possibly biomarker input via sheep droppings is negligible when compared to direct input via the heath sods. Alternatively, passage through the digestive tract may have made the biomarkers vulnerable to subsequent degradation in the soil.

Using this case study we will discuss opportunities and limitations of biomarker analysis in environmental reconstructions in a broader sense, focusing on future directions of research to further establish this valuable technique.

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3) B. Jansen and G.L.B. Wiesenberg (2017). Opportunities and limitations related to the application of plant-derived lipid molecular proxies in soil science, SOIL, 3, 211–234.