Geophysical Research Abstracts
Vol. 16, EGU2014-3471, 2014
EGU General Assembly 2014

A sequential extraction and hydrolysis approach to understand the chemical nature of soil water repellency

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Soil water repellency (SWR) biomarkers (SWR-biomarkers) are defined as hydrophobic organic compounds in soils causing SWR and originating from vegetation or microbes (Doerr et al., 2000). Free lipids and ester-bound biopolymers (cutins and suberins) are usually seen in the aliphatic part of soil organic matter (SOM) (Nierop, 1998). The method of sequential extraction can divide hydrophobic compounds into individual fractions with different characteristics.

We aim to find out the SWR-biomarkers in soils within different fractions, investigate the effects of fractions on SWR and link them to their original sources. To extract free and ester-bound lipids from sandy soils, DCM (dichloromethane)/MeOH (methanol) and IPA(isopropanol)/NH_3 were used in sequential steps. As a result, three fractions were obtained during these sequential experiments: a DCM/MeOH soluble fraction (D), a DCM-MeOH soluble (AS) fraction of IPA/NH_3 extracts and its insoluble (AI) fraction. To date, research was limited to (organic) extractable fractions only. To investigate the DCM-MeOH insoluble part of IPA/NH_3 extracts they were depolymerised by trans-methylation using BF_3-MeOH. All fractions were analysed by gas chromatography-mass spectrometry.

After DCM/MeOH extraction, water repellency of 80% of the soils studied increased while SWR of the other soils remained at the same level. Straight-chain fatty acids, alcohols and alkanes were the main compound groups in the D fractions. The distribution of fatty acids (C_{20}-C_{32}) and alcohols (C_{20}-C_{32}), both of which with an even-over-odd predominance suggest their source were higher plants, and so did the odd-over-even predominated alkanes. After extraction by IPA/NH_3 , most soils became non-repellent. Both fatty acids (C_{16}-C_{32}) and alcohols (C_{16}-C_{30}) with an even-over-odd predominance were also found in the AS fractions, whereas no alkanes were detected. There were four main component groups identified in the AI fractions: fatty acids, alcohols, ω-hydroxy fatty acids and α,ω-dicarboxylic acids. Aside from fatty acids and alcohols, the latter two compound groups were considered as the main groups of monomers released from suberins. Therefore, suberin-derived compounds were most abundant in the AI fractions suggesting that plant roots could be the main source of AI fractions. We will present some of the relations between fractions/compounds and SWR to show that this approach may be an effective tool to improve our understanding of SWR mechanisms.

We present relations between fractions/compounds from SOM with SWR to determine SWR-biomarkers. By assessing the origin of these biomarkers, we are able to understand how SWR is formed and in which circumstances they are mainly from leaves or roots (i.e. cutin or suberin).

References:

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