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Faculty of Geosciences

Nederlandse Organisatie voor Wetenschappelijk Onderzoek

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

Introduction

Soil water repellency (SWR) biomarkers are defined as hydrophobic organic compounds causing SWR, which originate from vegetation and microbes. Free lipids and ester-bound biopolymers (cutin and suberin) are usually seen in the aliphatic part of soil organic matter. To investigate the effects of fractions/compounds on SWR and to identify the SWR-biomarkers and their origin, a sequential extraction and hydrolysis approach is applied.

Methods and materials

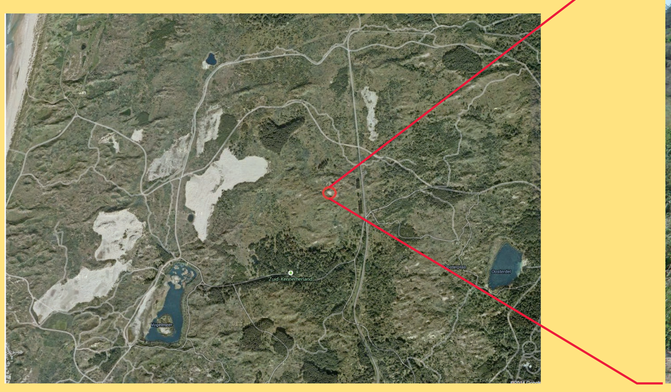

Figure 2. WDPT (Water Droplet Penetration Time) measurements in the field.

Figure 1. The left photo shows our field site locates in the national park of Zuid-Kennenmerland on the western coastal line of the Netherlands (the red circle points the sampling location). The right photo shows the zoomed sampling area, soils were collected from profiles (0-25 cm) under various vegetation at different depth.

Sequential extraction procedure

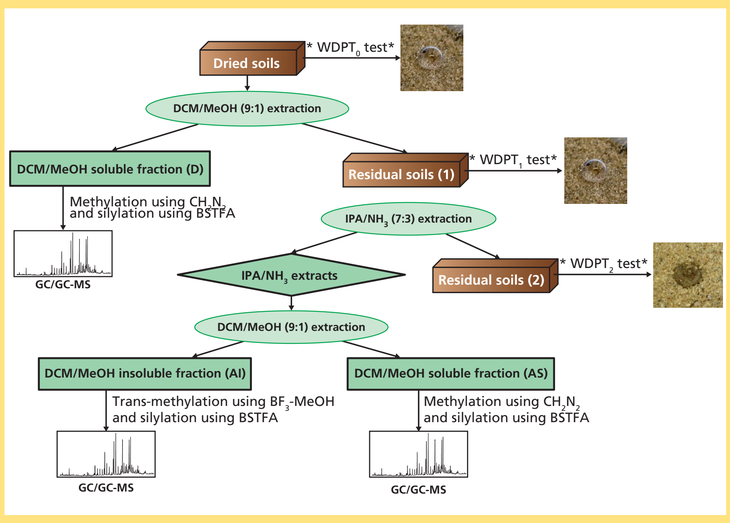

Figure 3. A simplified diagram of the whole sequential extraction and hydrolysis approach and WDPT measurements in the lab

SWR changes

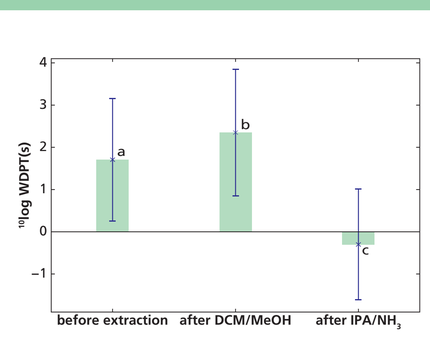

Figure 5. Mean values (^{10}log WDPT) of SWR before extraction, after DCM/MeOH extraction and after IPA/NH_3 extraction. Error bars mean standard deviations of ^{10}log WDPT for all soils. Different letters indicate significant differences between treatments at $P < 0.05$

SWR increases after DCM/MeOH extraction when a part of the hydrophobic compounds are removed from the soils. SWR dramatically decreases and even disappears after IPA/NH_3 extraction. Figure 7 shows the possible explanation for the SWR changes.

Results & Discussion

Soil characteristics vs. SWR

Figure 4. SWR as a function of (a) soil pH and (b) ^{10}log TOC before extraction. Soil pH negatively relates to SWR, and ^{10}log TOC has a positive relation with SWR, but both are significant

GC traces of the D, AS and AI fractions

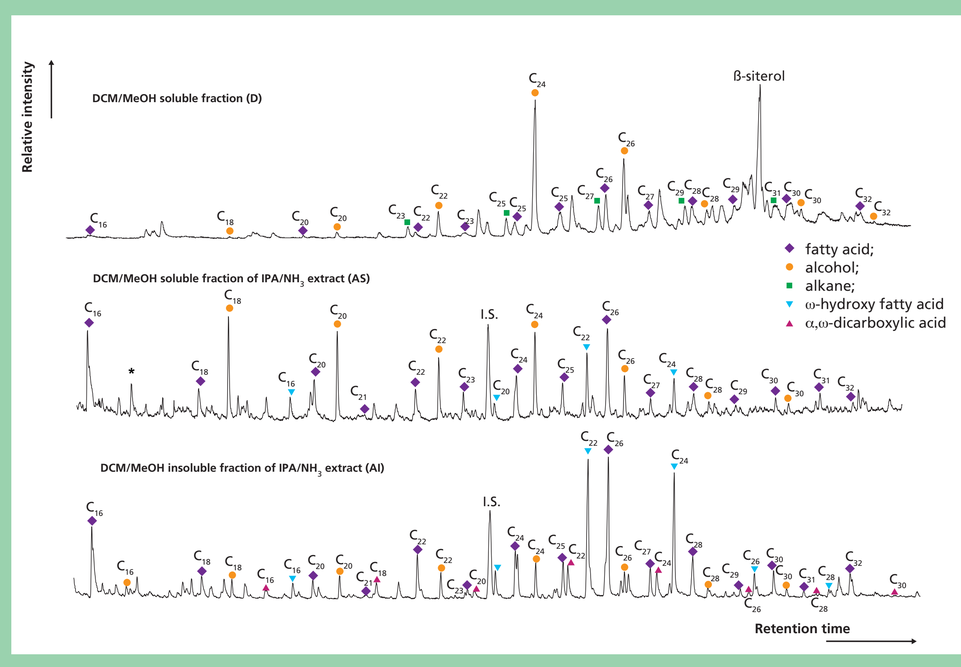

Figure 6. Gas chromatograms of D, AS and AI fractions from one soil (Ah1 horizon under oak).
I.S. – internal standard
*.- contaminant
Cn indicates chain length

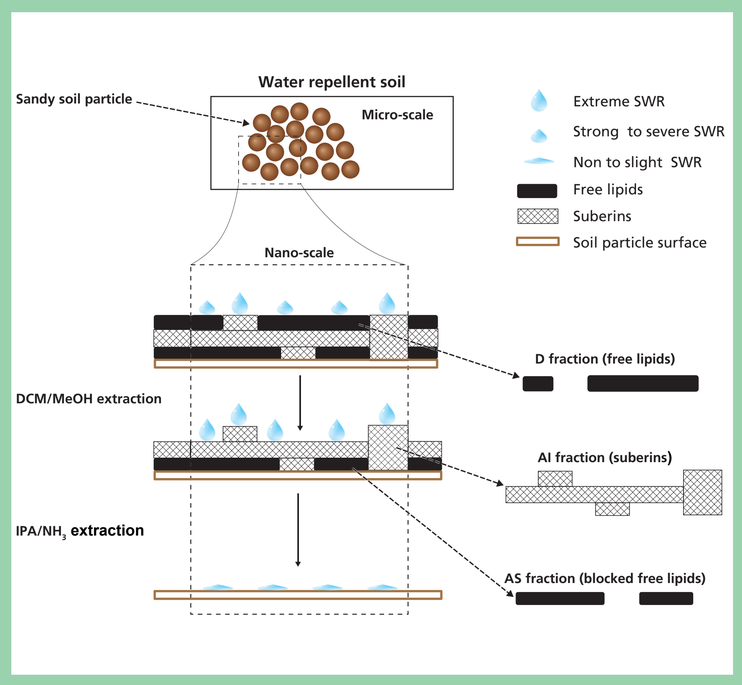

Figure 7. Simplified conceptual diagram of behaviour of the D, AS and AI fractions on a soil particle surface and their relation to SWR

D fraction: the even-over-odd predominance of fatty acids and alcohols and odd-over-even predominance alkanes suggest they are from plant (leaves) waxes.
AS fraction: the physically protected free lipids from plant waxes and hydrolysed suberin-derived compounds.
AI fraction: suberin-derived components from roots.

Conclusions

- TOC has a significant liner relation with SWR
- Only a small fraction of TOC is responsible for SWR
- Leaf waxes and roots both induce SWR
- Although leaf waxes are more abundant, root compounds have a stronger impact on SWR