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The role of hydrophobic organic compounds in causing soil water repellency: current hypotheses and actual evidence

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Water repellency is widely accepted to be caused by hydrophobic organic compounds, which represent only a fraction of the total soil organic matter (SOM) content. Recent research has demonstrated that neither total SOM content, nor the amount of common hydrophobic (or partially hydrophobic) compounds always relates well to soil water repellency. Cases exist where wettable and hydrophobic soils of otherwise comparable characteristics contain similar types and amounts of hydrophobic compounds, and hydrophobic compounds extracted from wettable soils have been shown to induce hydrophobicity in clean wettable sands. This raises the question, what factor(s) in addition to the presence of hydrophobic compounds controls the occurence of water repellency in dry soils. In this contribution, a brief review of current hypotheses and existing evidence is given and a summary of our recent work addressing the above question is presented.

Our recent approach to understanding this phenomenon has been two-fold: a) the measurement and chemical characterisation of the organic content of soils; and b) modelling of soil water repellency by studies of acid washed sand (AWS) coated with organic compounds found in soils. Here we bring together data from both types of experimental work, and discuss the results in the light of current ideas on water repellency in soils.

Quantitative measurements and chemical characterisation of organics found on wettable and non-wettable sandy soils are presented. Techniques used include: TOC and DRIFT analyses, extractions, and GC and GC-MS analyses. These experiments show what is on the soil and in what quantity; they do not show which compounds, or what chemical properties or interactions, are important. To investigate the effect of functional group, molecular shape and packing efficiency on soil wettability we have studied the effect of applying organic compounds, such as found on soils, to AWS at different loadings. Compounds used included: linear and branched alkanes and esters, long chain saturated and unsaturated (cis and trans) acids, long chain amides, and sterols. Compounds with a strongly polar functional group caused repellency, those bearing less polar groups did not. Acids and alkanes were also applied as mixtures, which generated higher repellency than the acids alone. Studies with cis and trans unsaturated acids suggest that molecules which "pack" well are more effective in causing repellency than those that do not.

The results suggest that the chemical factors which influence soil water repellency are similar to those which control the stability of interfacial films formed by organics at liquid/liquid, and air/liquid, interfaces.