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The distribution of organic material and its contribution to the micro-topography of particles from wettable and water repellent soils

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Organic coatings on mineral particles will mask the physic-chemical properties of the underlying mineral surface. Surface images and force measurements obtained using atomic force microscopy (AFM) provide information about the nature of and variability in surfaces properties at the micro- to nano-scale. As AFM technology and data processing advance it is anticipated that a significant amount of information will be obtained simultaneously from individual contacts made at high frequency in non-contact or tapping mode operation.

For present purposes the surfaces of model materials (smooth glass surfaces and acid-washed sand (AWS)) provide an indication of the dependency of the so–called AFM phase image on the topographic image (which is obtained synoptically). Pixel wise correlation of these images reveals how the modulation of an AFM probe is affected when topographic features are encountered. Adsorption of soil-derived humic acid (HA) or lecithin (LE), used here as an example for natural organic material, on these surfaces provides a soft and compliant, albeit partial, covering on the mineral which modifies the topography and the response of an AFM tip as it partially indents the soft regions (which contributes depth to the phase image). This produces a broadening on the data domain in the topographic/phase scatter diagram. Two dimensional classifications of these data, together with those obtained from sand particles drawn from water repellent and wettable soils, suggest that these large adsorbate molecules appear to have little preference to attach to particular topographic features or elevations. It appears that they may effectively remain on the surface at the point of initial contact. If organic adsorbates present a hydrophobic outer surface, then it seems possible that elevated features will not be immune from this and provide scope for a local, albeit, small contribution to the expression of super-hydrophobicity. It is therefore speculated here that the water repellency of a soil is the result of not only of particle surface chemistry and soil pore space geometry, but also of the micro-topography generated by organic material adsorbed on particle surfaces.