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Water Shedding Properties of Oil Impregnated Hydrophobic Soils

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Hydrophobic soils and sediments have gained significant interest in soil science due to negatively influencing biomass production and as drivers of landslides and enhanced erosion. Whilst natural and fire-induced soil water repellency have been studied, little work has considered how the sediment-water interaction with naturally occurring hydrophobic sediments might change in the presence of oil. Recent advances in materials physics have shown bio-inspired slippery liquid infused porous surfaces (SLIPS) and lubricant impregnated surfaces (LIS) can produce super slippery surfaces with excellent water shedding properties. Here we apply this new understanding to the physics of soil water repellency and address how the presence of oil, whether from contamination or otherwise, might influence water infiltration. We hypothesise that oil impregnating a hydrophobic soil may create stable oil coatings and/or layers that create soil surfaces resistant to water infiltration and with enhanced run-off of water. Using monolayers of sand, silt and clay particles treated with a commercial hydrophobising agent and silicone oil, we created model (oil-free) hydrophobic and oil impregnated hydrophobic soils. Static water contact angles and droplet sliding angles were used to classify their degree of hydrophobicity and ability to shed water. Our results show that in the absence of oil, model hydrophobic soil surfaces with particle sizes below 63μm are superhydrophobic with water droplet contact angles above 150 degrees. In the presence of oil, we observed a sediment-based SLIP/LI surface on particle sizes below 63μm with water contact angles of 90 degrees and droplet sliding angles of below 5 degrees. We also achieved reduced sliding angles compared to the oil-free surfaces, and a conformal layer of oil on all particle sizes. These results support our hypothesis that SLIPS/LIS may occur in natural soil systems. These results have implications for soil water repellency, oil clean up from soil and for processes occurring in other sedimentary environments caused by both naturally occurring and anthropogenic contamination of oils.