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Beneath aggregate stability – quantifying thermodynamic properties that drive soil structure dynamics

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Soil aggregates are a figment of your energy input and initial boundary conditions, so the basic thermodynamics that drive soil structure formation are needed to understand soil structure dynamics. Using approaches from engineering and materials science, it is possible quantify basic thermodynamic properties, but at present tests are generally limited to highly simplified, often remoulded, soil structures. Although this presents limitations, the understanding of underlying processes driving soil structure dynamics is poor, which could be argued is due to the enormity of the challenge of such an incredibly complex system. Other areas of soil science, particularly soil water physics, relied on simplified structures to develop theories that can now be applied to more complex pore structures. We argue that a similar approach needs to gain prominence in the study of soil aggregates.

An overview will be provided of approaches adapted from other disciplines to quantify particle bonding, fracture resistance, rheology and capillary cohesion of soil that drive its aggregation and structure dynamics. All of the tests are limited as they require simplified soil structures, ranging from repacked soils to flat surfaces coated with mineral particles. A brief summary of the different approaches will demonstrate the benefits of collecting basic physical data relevant to soil structure dynamics, including examples where they are vital components of models. The soil treatments we have tested with these engineering and materials science approaches include field soils from a range of management practices with differing clay and organic matters contents, amendment and incubation of soils with a range of microorganisms and substrates in the laboratory, model clay-sand mixes and planar mineral surfaces with different topologies. In addition to advocating the wider adoption of these approaches, we will discuss limitations and hope to stimulate discussion on how approaches could be improved and made more useful for studying soil structure dynamics in the future.