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Charcoal's physical properties are key to understanding its environmental behavior

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Charcoal is a highly porous, low density material whose physical properties play a key role in its soil behavior and its environmental fate. In considering biochar, some of its most sought-after environmental effects are a result of its physical characteristics, not its chemical or biological properties. For example, the ability of biochar to retain soil water is widely attributed to its porosity. However, charcoal physical properties are so poorly understood that they are sometimes not characterized at all in the current literature.

Here we outline a suite of basic physical properties of charcoal and the likely environmental effects of their variations, with a focus on the interactions between charcoal and water. The most basic physical property of charcoal, its particle size, likely plays a role in its ability to alter the rate of drainage in soils. Particle morphology is also relevant, affecting how particles of soil and char can pack together. Bulk densities of charcoal and soil mixtures can be used to generate a simple estimate of the efficiency of char-soil packing.

Charcoal density is an additionally important property and can be measured in a number of ways. Density almost certainly controls the tendency of chars to sink or float, and to erode or remain on the land surface. However, charcoal density can vary by almost a factor of 10 depending on the measurement technique used. We discuss two simple techniques available for measuring char density and the value of information provided by each approach.

Finally, we report a simple, fast technique to measure total char porosity, including all pores from nanometers to 10s of micrometers in size. Porosity is at least one of the key controls on the ability of biochar to improve plant-available water, and techniques to measure it have previously been limited to the smallest fraction of pores (N2 sorption) or have required expensive, hazardous procedures (Hg porosimetry). We show that char porosity varies primarily as a function of feedstock and secondarily as a function of pyrolysis conditions.