Assessing the Effects of Biochar, Saturation Methodology, and Particle Size on Hydraulic Conductivity

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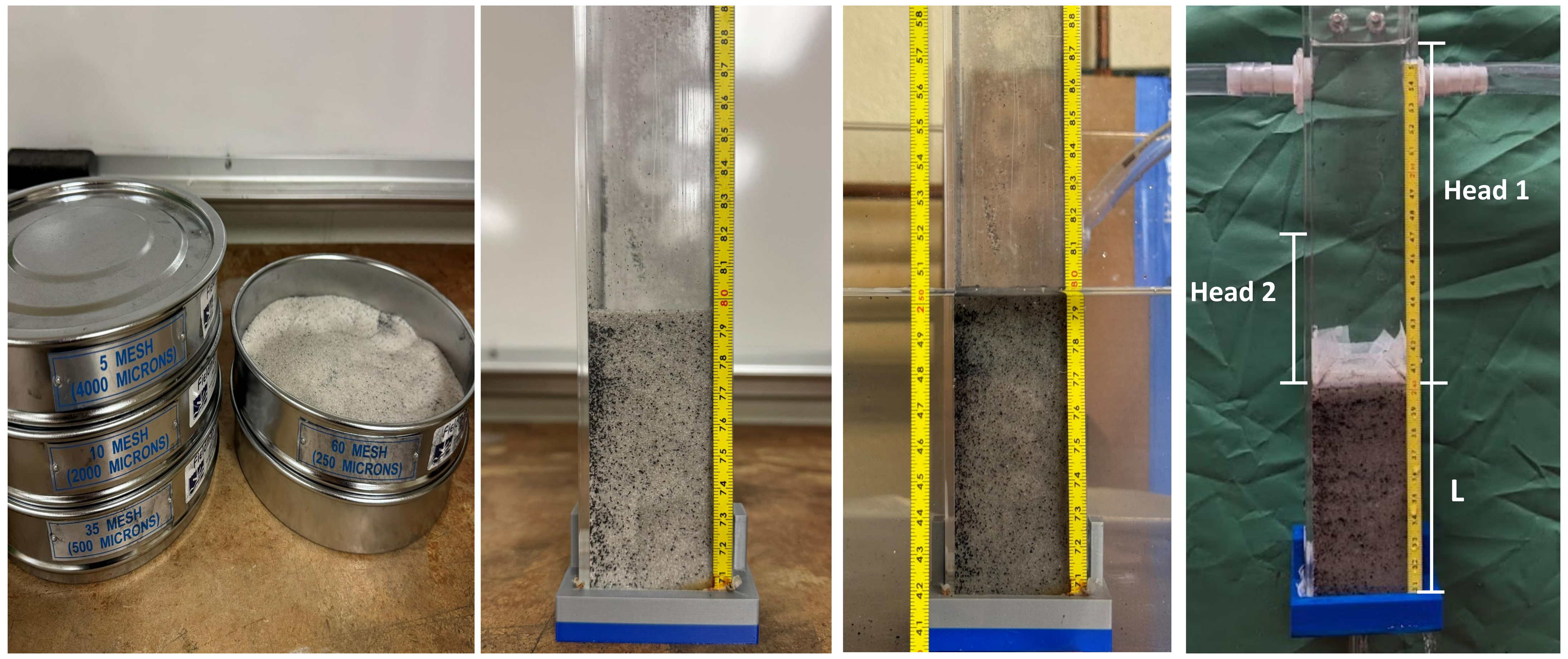
Abstract

Biochar is charcoal intentionally produced for different uses such as agriculture and carbon sequestration. Biochar addition to soil has agricultural benefits because the biochar can increase water available for nutrient delivery to plants. These benefits, however, are only valuable as long as the biochar remains in place. To improve assessment of hydrologic benefits, we conduct hydraulic conductivity experiments of biochar-soil mixtures with the primary goals (1) to understand how hydraulic conductivity varies with different biochar mass concentrations, saturation methods, run time, and particle size and (2) evaluate the role of biochar migration in hydraulic conductivity changes. Hydraulic conductivity describes how easily fluid flows through sediment pore space. In our current experiments, we observe changes in hydraulic conductivity in experiments, however there is no visual indication of biochar movement. We however hypothesize that the movement of biochar is driving the hydraulic conductivity changes over time by migration resulting in decreasing pore space and increasing water retention. We are continuing to collect more hydraulic conductivity data to finalize how its values evolve. The next stage in our research is to develop a methodology for measuring magnetic susceptibility during experiments hydraulic conductivity tests which may be able to track biochar migration through material properties rather than visual inspection.

Method

1) Sieve Biochar + Sand **2) Pour Mixture** **3) Saturate** **4) Measure change in head**



5) Calculate the hydraulic conductivity

$$K = ln(H_1 - H_2)\frac{L}{\Delta T}$$

Refining Our Methodology

To determine how different variables affected the mobility and hydraulic conductivity of biochar, we adjusted out methods to isolate specific variables.

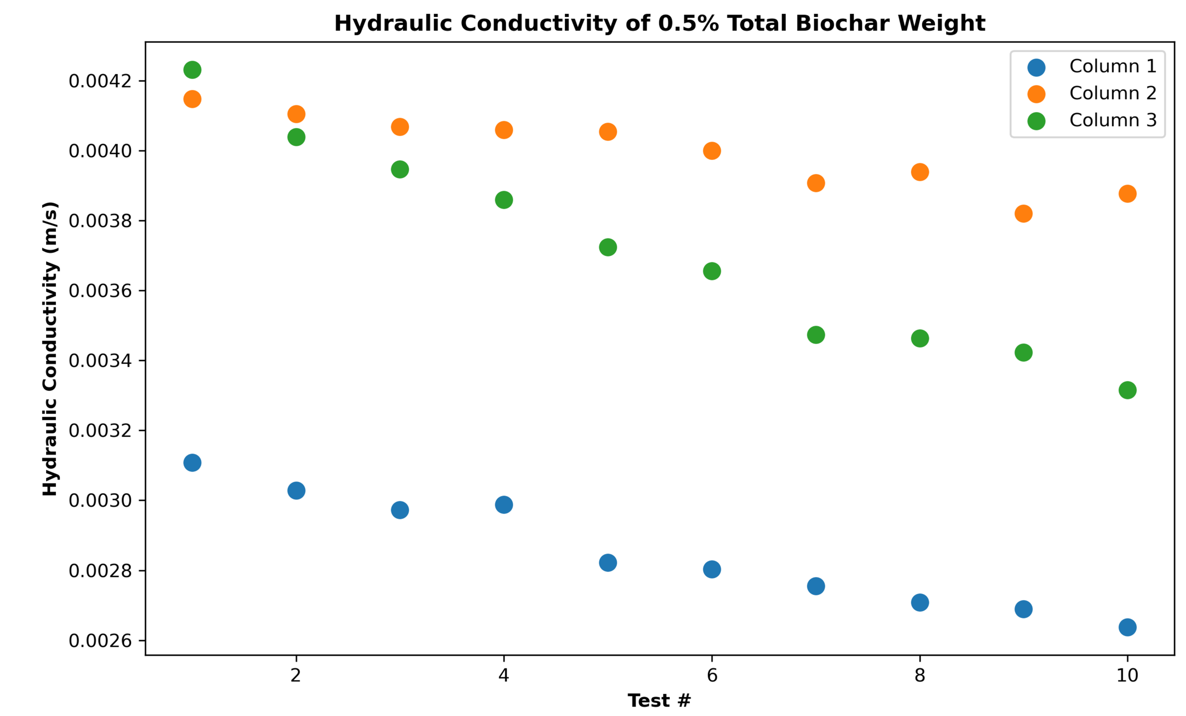
Isolated Variable	Methodology
1. Biochar Concentration	1. Conduct tests on 0.5, 0.75, 1.0, and 1.5 percent total biochar weight, saturated, same particle size (250 µm)
2. Saturation Method	2. 0.5 and 0.75 percent total biochar weight, same particle size, unsaturated
3. Particle Size	3. 0.5 and 0.75 percent total biochar weight, saturated, particle size greater than 250 µm

Goals

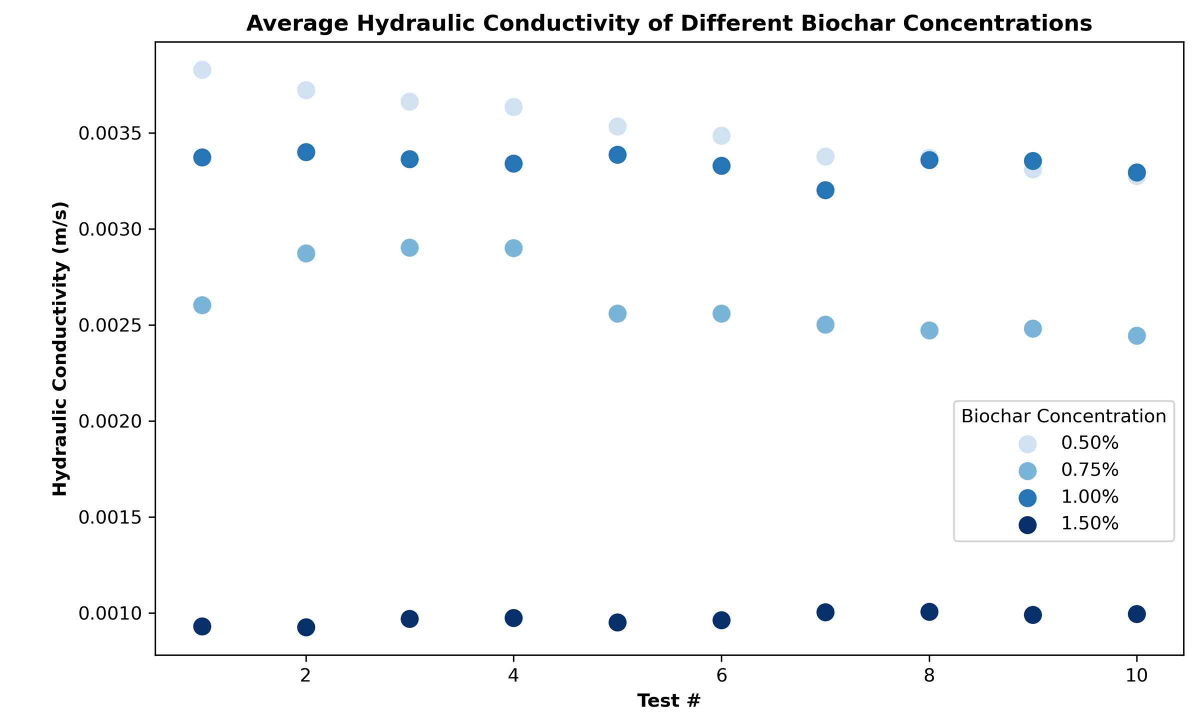
- Understand how biochar movement affects the hydraulic conductivity over time
- Determine how the saturation method, particle size distribution, and biochar concentration contribute to biochar mobility

Results

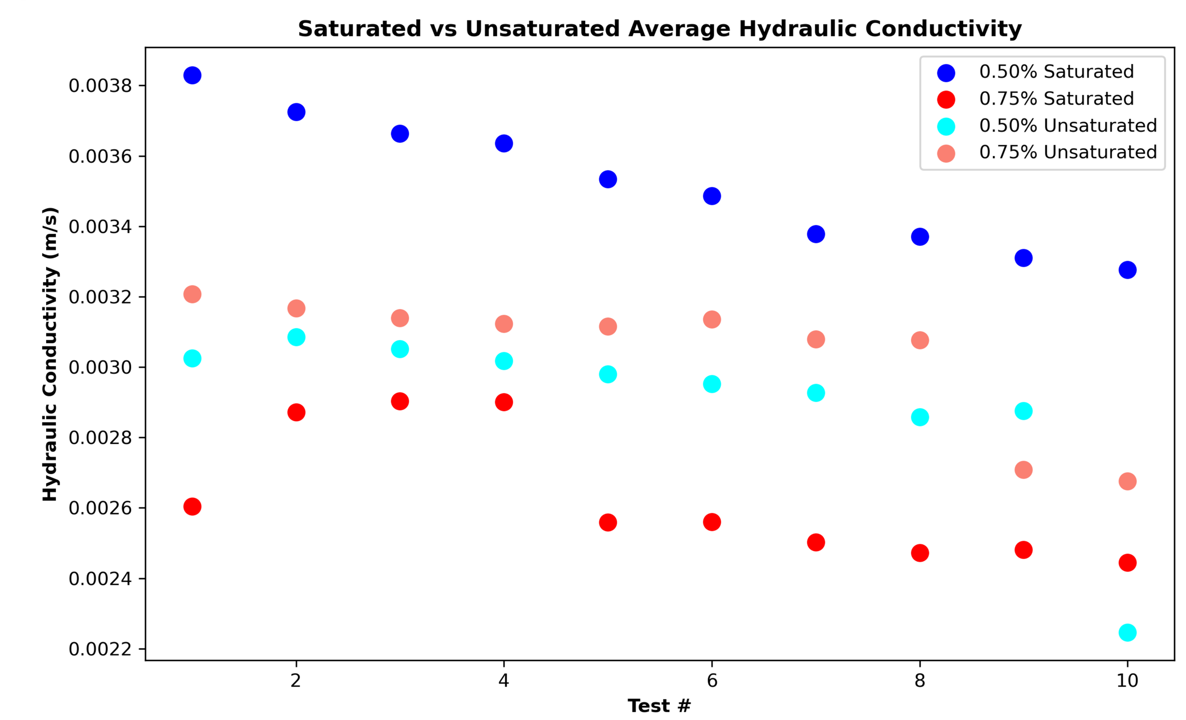
1A



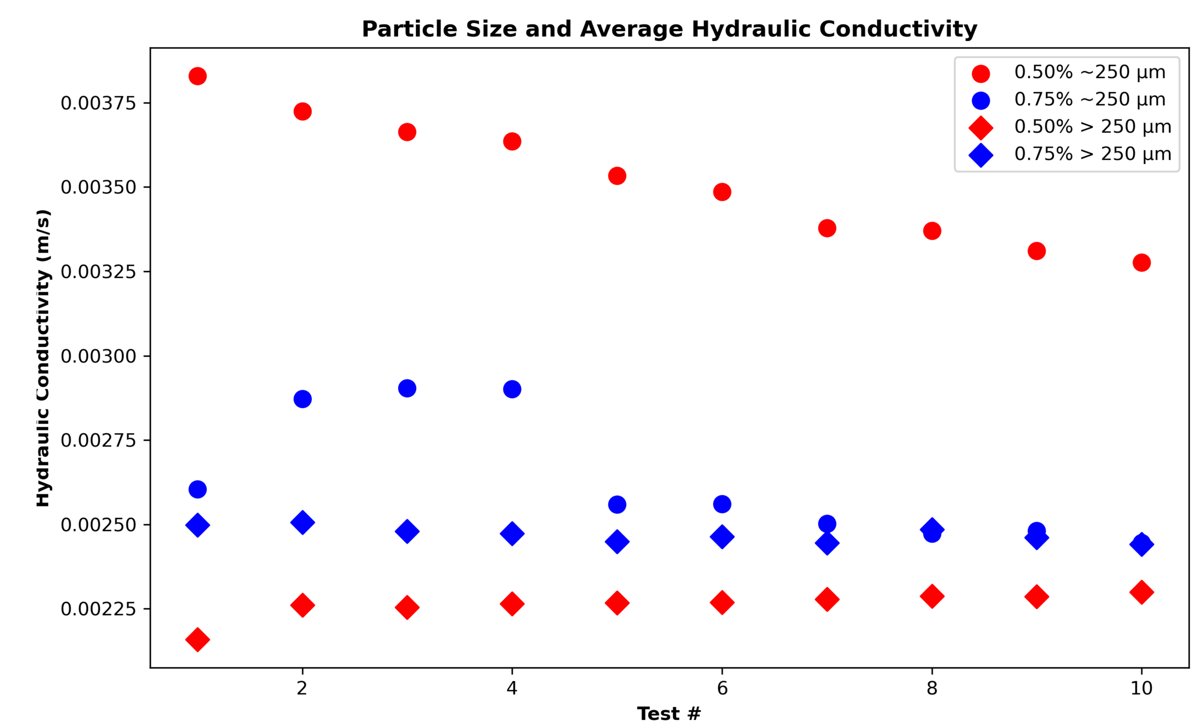
1B



1C



1D



(**1A**) Hydraulic Conductivity of 3 separate columns of 0.5% Total Biochar weight, saturated, with particle size ~65 µm. (**1B)** Comparison of hydraulic conductivity averaged over each test for 3 columns per concentration (0.5%, 0.75%, 1.0%, 1.5%).). (**1C**) Averaged hydraulic conductivity of 0.5% and 0.75% total biochar weight of columns saturated for 24 hours (red and blue) and unsaturated columns (cyan and salmon). (**1D**) Averaged hydraulic conductivity of 0.5% and 0.75% total biochar weight with particle sizes of ~250 µm (circles) and greater than 250 µm (diamonds

Path Forward

1. Experiment reproducibility for constant and falling head tests, isolating the saturation technique
2. Analyze hydraulic conductivity and biochar distribution in column to determine if there is biochar movement and what is the driving factor
3. Model magnetic susceptibility response for migrating biochar and use to design magnetic susceptibility experiment system