An exploration of pore structure through MicroCT scans

Mathematical metrics of individual pore structure

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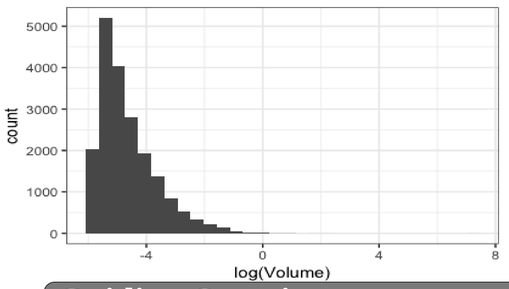
Motivation:

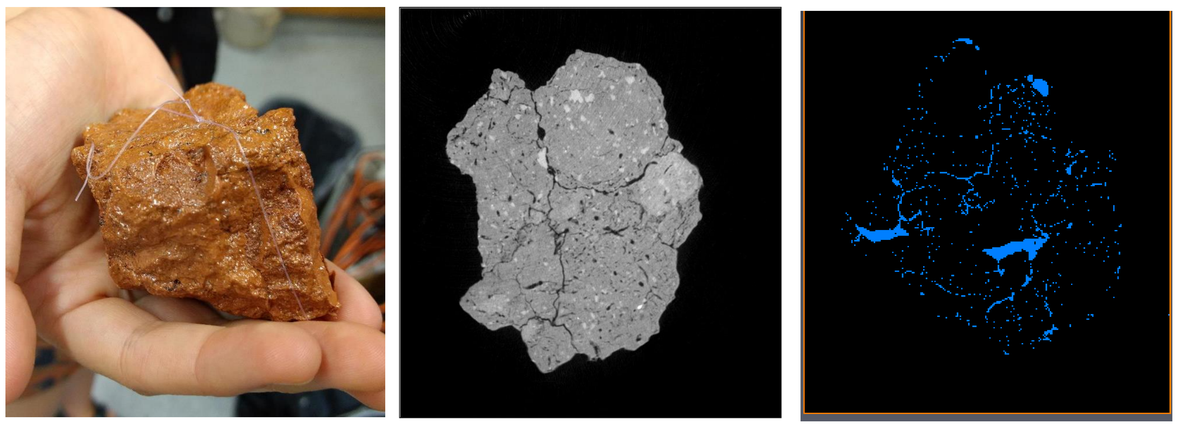
Soils are a porous medium, in which pores are the voids in soil which can be up to 50% of the volume of soil. Pores dictate the movement of fluids through soil and reflect biology, mineralogy, and land use history. Macropores (those studied here, as the scanner had resolution of 30-70µm) are conduits through which water and gas rapidly flow. I am interested in the structure of these pores, their regularity and heterogeneity

Aggregates: From 0-275 cm (A through BC horizons) in hardwood, replanted pine and agricultural land uses in Kanhapludults in the South Carolina Piedmont at the Calhoun Critical Zone Observatory



Basic metrics:

-Volumes were log normally distributed (left)
-Mean voxel size (resolution) was 55µm
-Aggregates had a mean porosity of 40%, as determined by bulk denisty



Each aggregate (left) was scanned on the Nikon XT H 225 ST MicroCT scanner at Duke SMiF. These were then transformed into slices (center), which were analyzed in Avizo 9.1.1 to extract the pore structures (right). The MicroCT scanner analyzes samples 3-dimensionally, as opposed to traditional two-dimensional analysis of analyzing soil structure.

Guiding Questions:

1-How does pore size distribution change with depth and land use? Does it follow a regular mathematical structure?
2-How are pores oriented? Are they all generally oriented in the same direction?
3-How sensitive is this technique of assesing porosity?

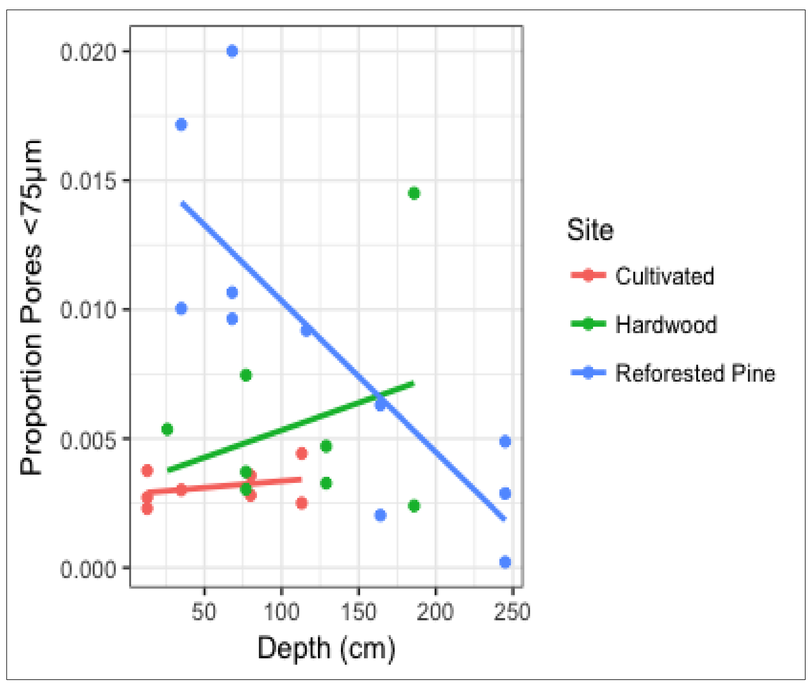


Figure 1 (Question 1):

<75µm pores correlated with depth across land uses

The smaller pore categories (<2000µm) correlated to the different land uses and depths (p<.001, in an anova). Pine and hardwood consistently had more small pores. Pine showed consistently different patterns from the hardwood stands with depth. For pores >2000µm the two predictors were insignificant.

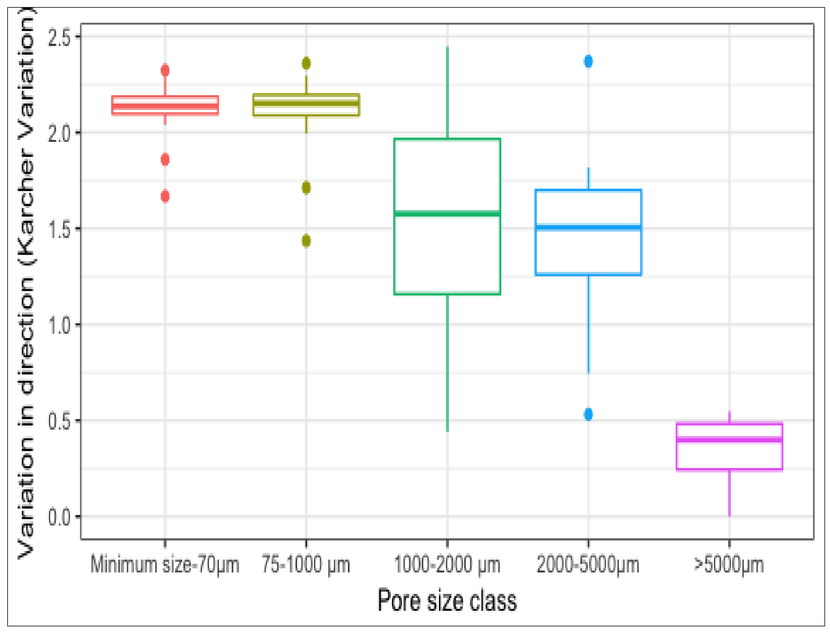


Figure 2 (Question 2):

Variation of the orientation of pores by size, 0 being most consistent, 2.5 being random.

The orientation of pores did not correlate with land use or depth however size of pore (divided into five classes) highly determined the regularity of orientation (p<.001)

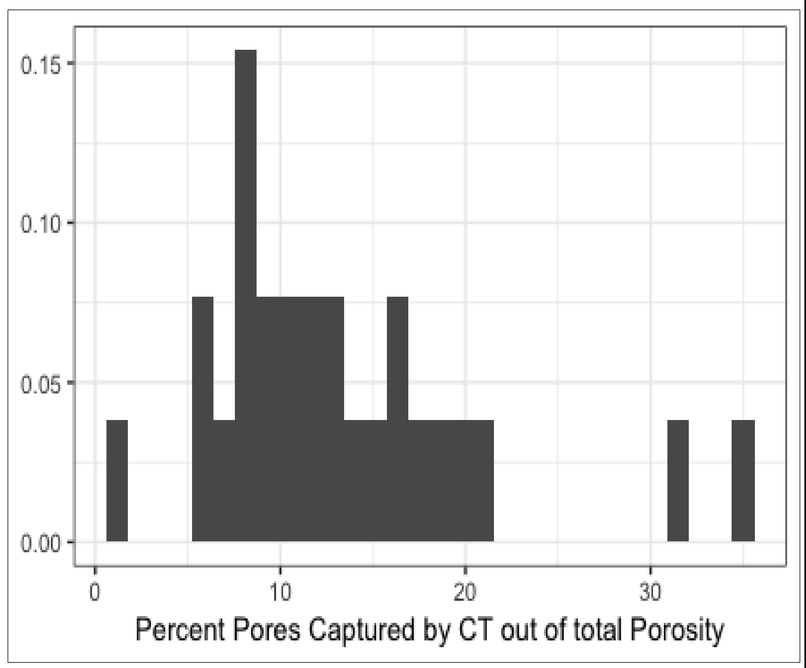


Figure 3 (Question 3):

Percentage of pores captured by CT scanner

Captured on average 17% (±7%) of pores. However, this did not correlate with size of clod, site of sampling or depth in a linear model.

Acknowledgements:
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