Effects of Soil Moisture on Macropore Geometries

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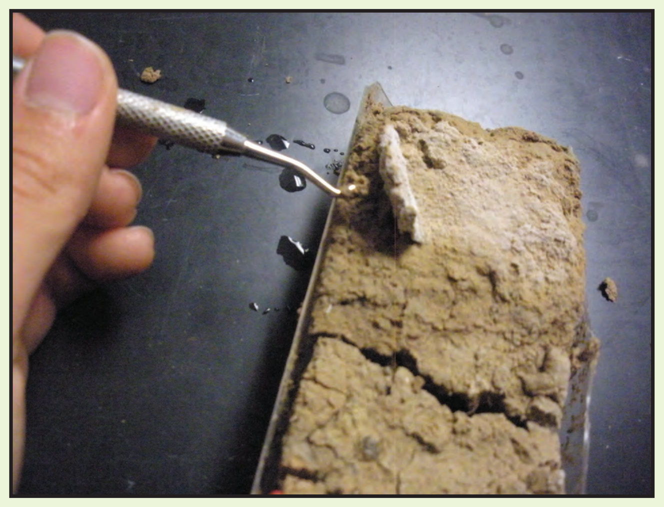
1. Macropores (large voids that can alter soil hydrology) are dynamic and can respond rapidly to changes in soil moisture content.

2. We sought to understand the response of quantitatively characterized macropore geometries (QCMGs) to changing volumetric soil water content (θ_v). To obtain QCMG data, we employed Mulitstripe Laser Triangulation (MLT) scanning.

3. A soil core was taken using a Giddings hydraulic corer from the KU Field Station in a Grundy series (fine, smectitic, mesic Oxyaquic Vertic Argiudoll).

4. Using a spatula, we split the core lengthwise and by depth sections.

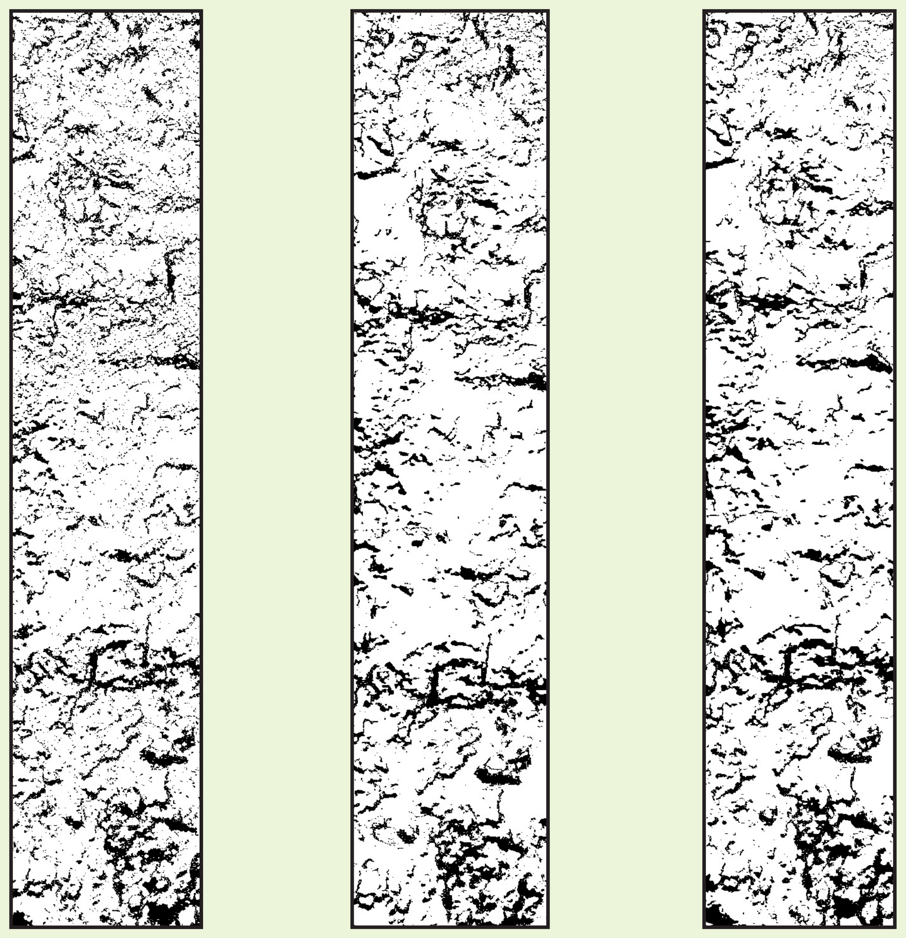


5. We wet the surface of each section and sprayed 1,1-difluoroethane on the split face to freeze a thin veneer which was peeled off to remove artifacts.

6. We wrapped half-sections of the core with cheesecloth and allowed them to saturate for 24 hours in a small basin filled with approximately 2 cm of water.

7. For each depth section, one half of the core was scanned using a MLT scanner while the other half was sampled at the same time for θ_v determination.

8. Images from the NextEngine™ software (ScanStudio) were imported to ImageJ for macropore quantification.



Saturation | 24 hours | 48 hours

8.1 These figures represent a time sequence of one drying core section.

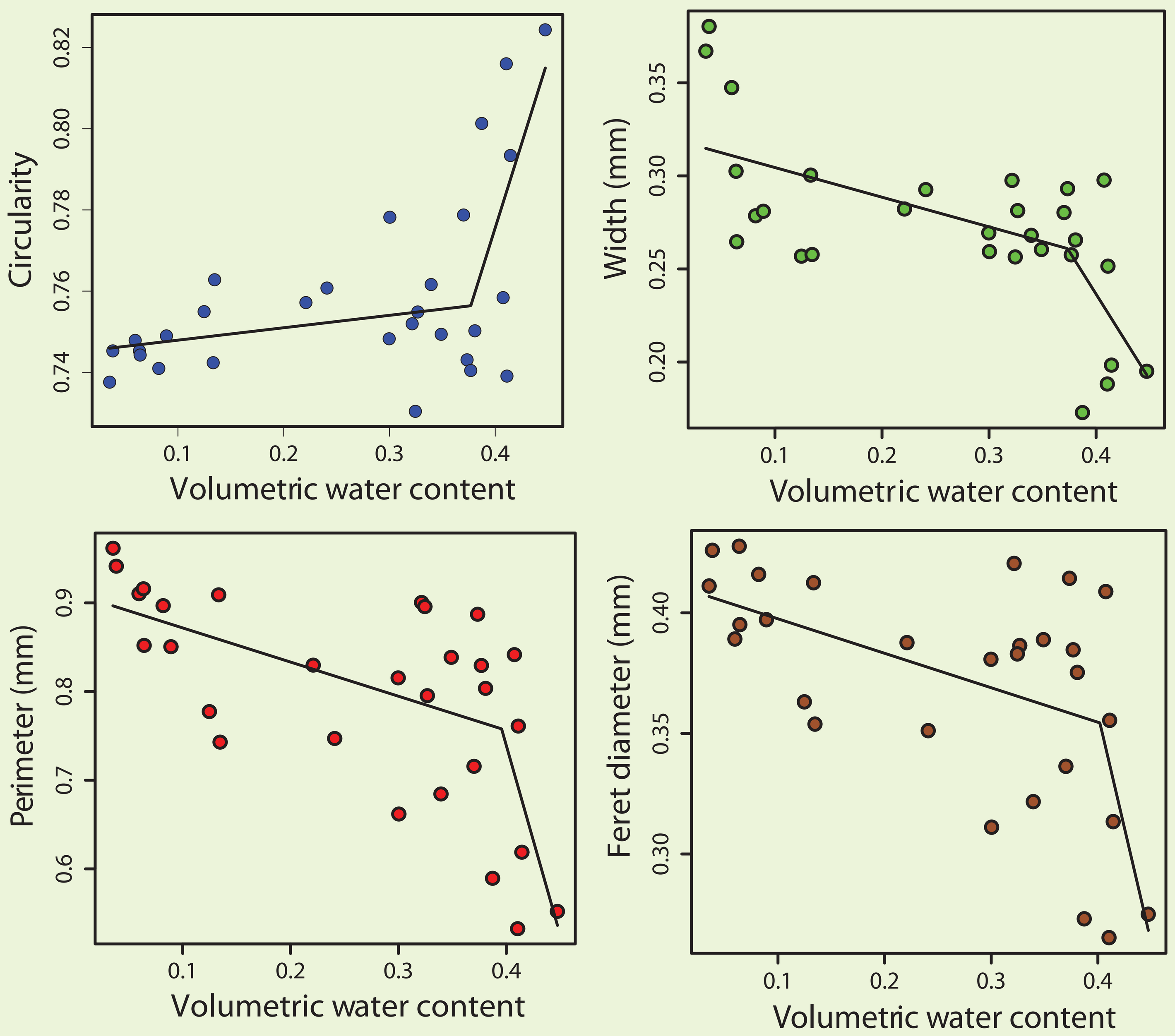
8.2 We observed that the rates of QCMG change were independent of a macropore's specific depth zone. Therefore, we focused on a simple QCMG versus θ_v relationship.

9. Using particle analysis in ImageJ, we acquired 5 specific QCMGs: area, perimeter, bounding-box width, feret diameter, and circularity.

9.1 Mean metric values were highly skewed toward larger pores. Median values of each metric were used for a more accurate representation of central tendency for each depth section.

9.2 The solid yellow line represents the linear regression line for each relationship, while the solid and dotted blue lines signify the moving average and upper/lower quartiles.

10. We generated piecewise linear regressions for each of the length metrics (perimeter, width, and feret diameter) and the shape metric (circularity). Additionally, we predicted the breakpoint between the two linear models fit to the data.



10.1 Interestingly, the breakpoint (θ_v value that describes the boundary between the two linear regression domains) is strikingly similar for each of the graphed metrics, averaging about 0.39. To the left of the breakpoint, the rate of QCMG change declines substantially.

QCMG	Model P -Value[1]	Breakpoint (θ_v)
Circularity	0.023	0.377
Perimeter	0.132	0.396
Width	0.239	0.373
Feret diameter	0.179	0.402

[1] Corresponds to the null hypothesis that the data can be described by a single linear regression model.

11. Macropores appear to change from circular to more linear shapes with decreasing θ_v.

12. As a macropore becomes more linear, changes in length metrics become increasingly negligible. This trend is evidenced by the rapid change of the linear metrics early in the drying process. The widening of a pore may have a larger effect on area than perimeter, bounding-box width or feret diameter.

13. Once the water content has reached the breakpoint ($\theta_v \approx 0.39$) in this soil, we can expect to see little change in length QCMGs. This suggests that the effect of antecedent soil moisture conditions on preferential film flow will be minimal over the normal range of field water content.

Acknowledgments

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