Vertisols: Expanding Our Vision

Kathryn L. Watkins[1] and Briana M. Wyatt[1]

[1]Department of Soil and Crop Sciences, Texas A&M University

Texas A&M AgriLife Research

Texas A&M University Soil & Crop Sciences

Introduction

- Deeper understanding of crack formation and water flow in shrink-swell clays would greatly benefit agricultural industry, construction industry, and land restoration efforts.
- Vertisol soil cracking similar to that in Figure 2 can cause the following: cracked foundations; animals falling in cracks; damaging root systems; and puddling in large cracks.
- Texas' state soil, Houston Black series, is an example of a vertisol clay; they are found in the Blackland Prairie stretching across the central part of the state as seen in Figure 1.
- There are currently no established methods for accurately measuring or viewing soil cracks.
- We took X-ray Computed Tomography(CT) scans of saturated and dried vertisol clay cores to expand our vision of the patterns of crack formation.

Objectives

The goal of this project it to improve our understanding of water flow in vertisol clays, using X-ray CT scanning to quantify crack patterns and sizes in shrink-swell soils.

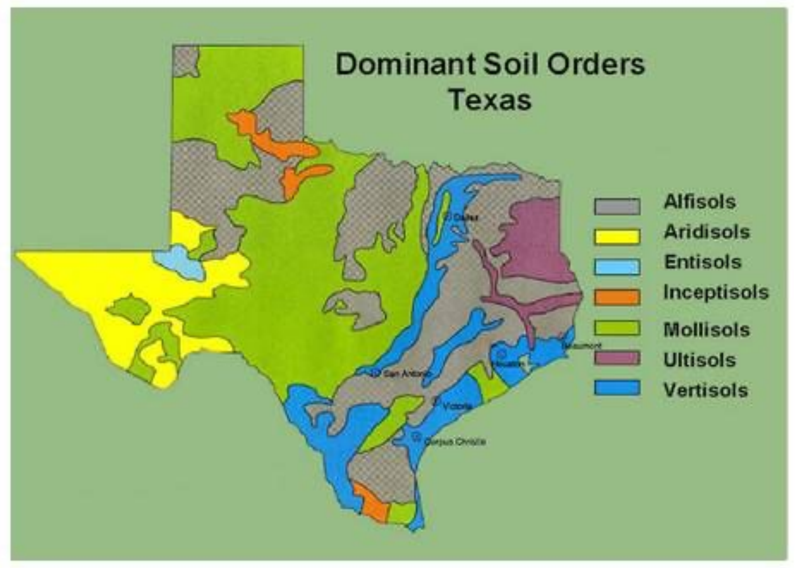

Figure 1. "Texas Soil Orders" nrcs.usda.gov

Figure 2. "Cracks in expansive soils" https://geology.com/articles/expansive-soil.shtml

Current Focus

- Calculating soil sample volume and changes in soil volume between corresponding dried and saturated soils
- Calculating gravimetric water content (Table 1) of each soil core using:

$$\theta_g = \frac{weight\ of\ wet\ soil\ (g) - weight\ of\ dry\ soil\ (g)}{weight\ of\ dry\ soil\ (g)}$$

- Calculating the bulk density ϱ_b for each soil core sample by dividing the mass of the sample in grams by the volume of the soil sample in cm^3
- Using image processing applications such as Blob3D and Quant3D, find the range of pore sizes and the size distributions to understand water flow in saturated and dried vertisol clays

Materials and Methods

Collection Sites

- Core 1: 30°32'52" N 96°24'48" W
- Core 2: 30°32'52" N 96°24'47" W
- Core 3: 30°32'51" N 96°24'48" W

Process

- After collection as seen in Figure 3,The cores were first saturated in the lab using 0.55 mmol Calcium Chloride
- We scanned the cores at the Computed Tomography (CT) Lab at University of Texas (Figures 4 & 5)
- The cores were then dried, and re-scanned (Figure 6)
- The scanner used was the North Star Institute Scanner System

Figure 3. Sample collection using slide hammer

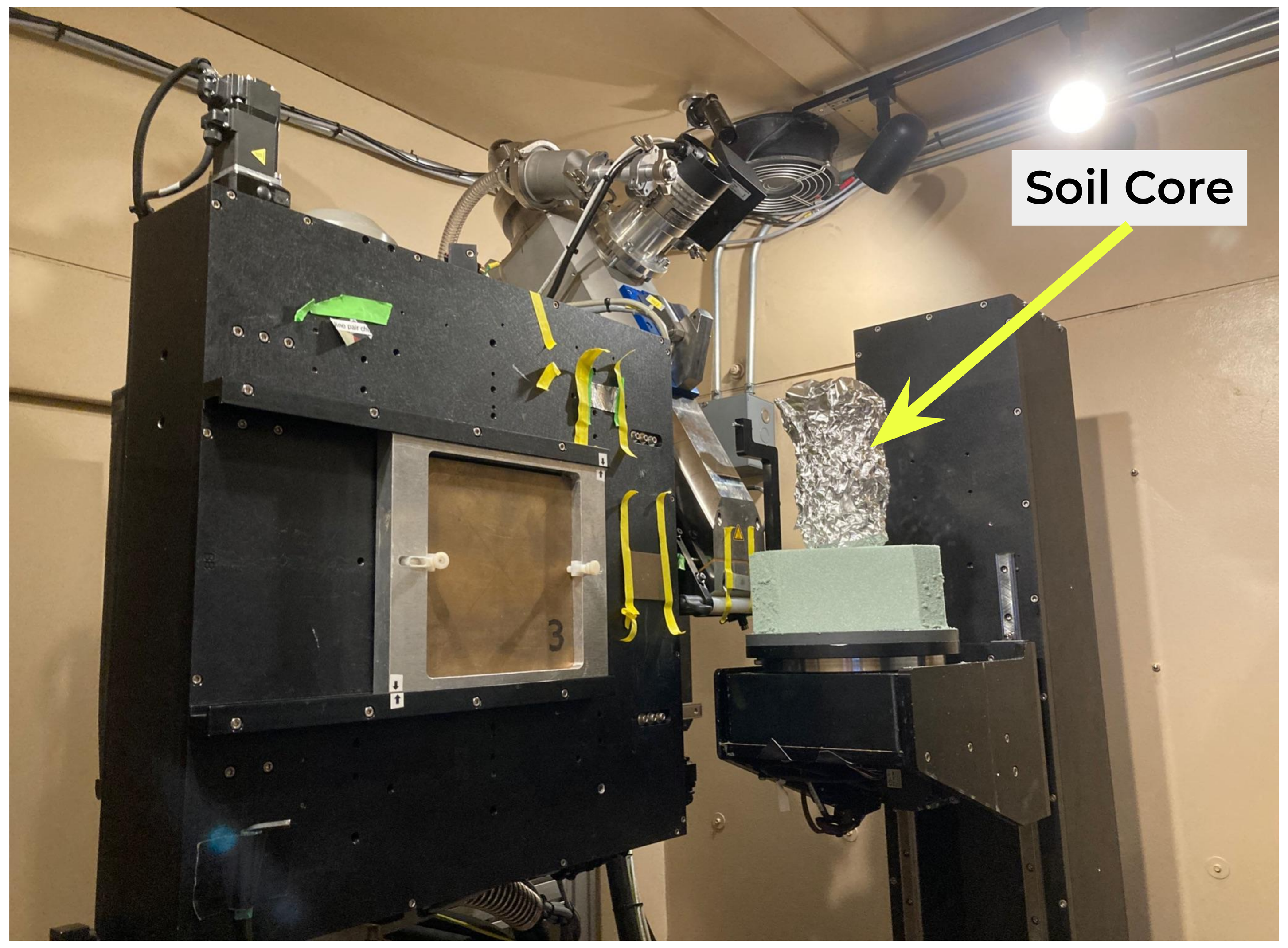

Figure 4. Soil core inside the North Star Institute (NSI) Scanner System at University of Texas CT Lab

Data and Potential Results

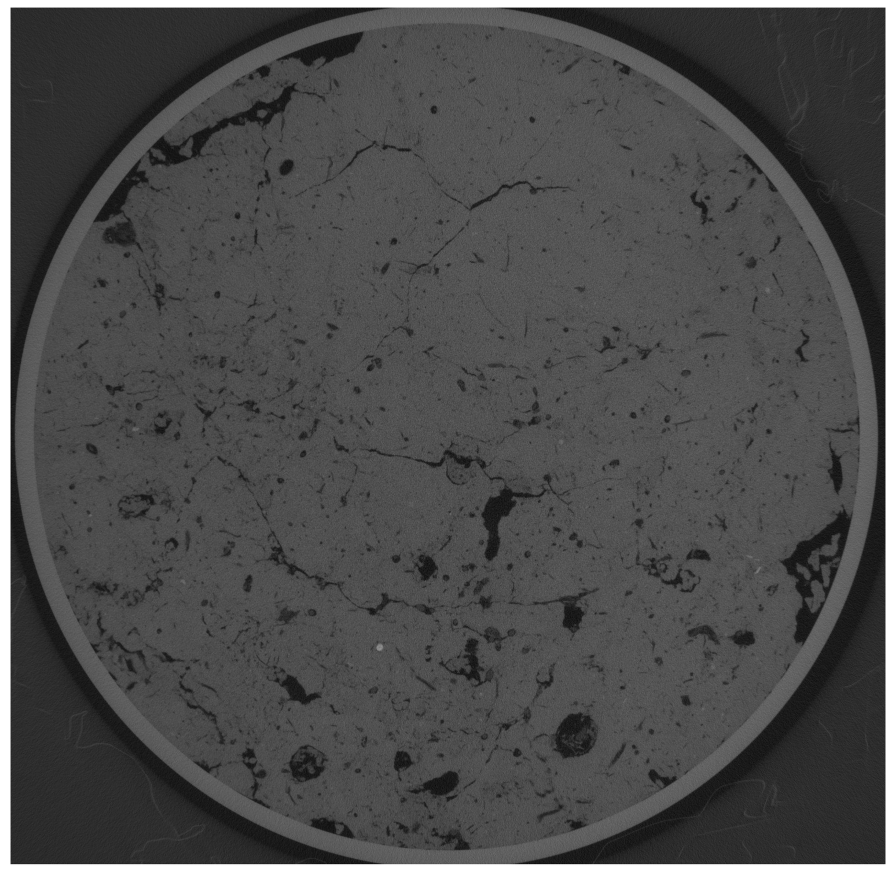

Figure 5. Saturated Core 3 Slice 968

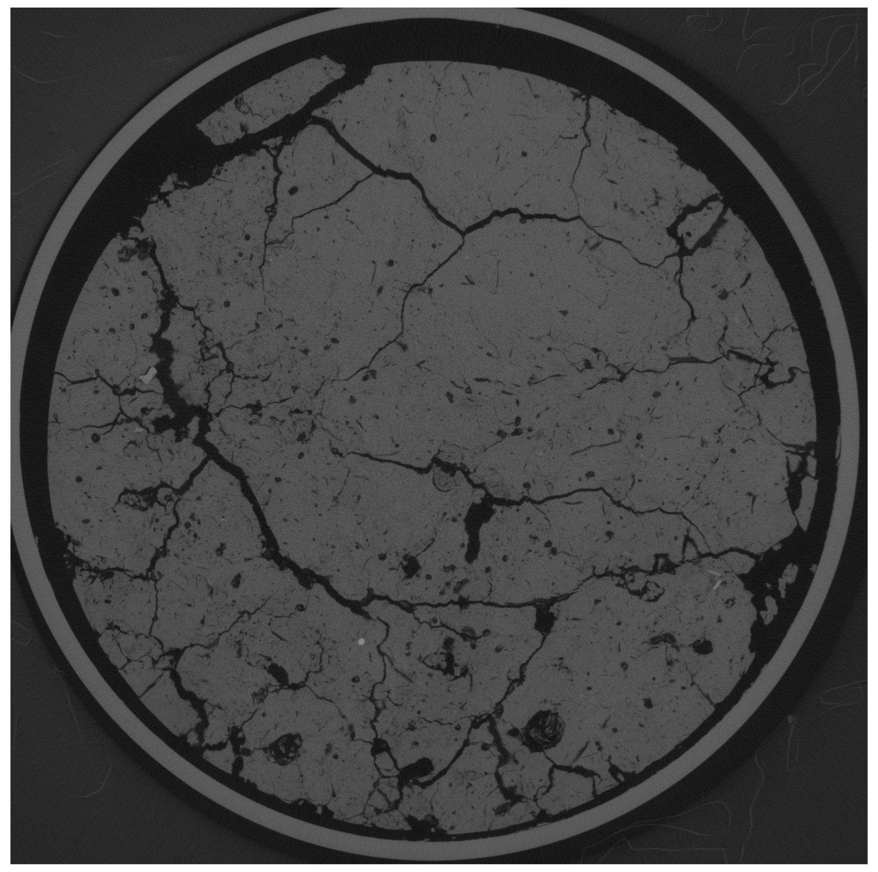

Figure 6. Oven-Dried Core 3 Slice 1000

	Gravimetric Water Content θ_g (g g^{-1})	Bulk Density ρ_b (g cm^{-3})
Core 1	0.255	1.642
Core 2	0.235	1.692
Core 3	0.261	1.600

Table 1. Gravimetric Water Content and Bulk Density Values for Cores 1, 2, and 3 with bulk density being at time of sampling

Challenges

- It's difficult to line up the slices of wet and dry cores
- There are image processing constraints due to data size (about 15GB per core scan)
- The crack dimensions of the wet cores are difficult to measure due to their small size

Future Work

Next steps include grinding each soil core to prepare for and run particle size analysis, as well as to continue image processing of the X-ray CT scans.