What's in the pan? A characterization of Western Kentucky's fragipans

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What is a fragipan?

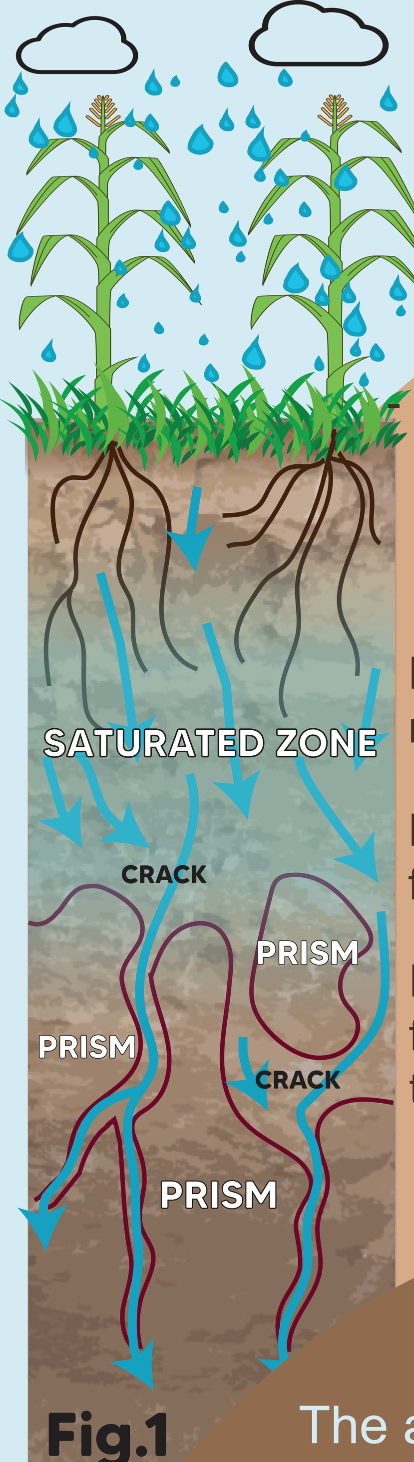

Fig.1

Fragipans are soil features found primarily in the aeolian soils of the southeastern + midwestern US

Fragipans prevent the downward movement of water and roots into the soil (Figure 1, left)

Extremely dense, brittle prisms block movement while coarse crack material surrounding the prisms serves as a preferential flow path

Root stunting caused by fragipans has been found to heavily decrease crop yields[2]

Perched water may occur above the fragipan, causing engineering problems that largely prevent development[3]

Study Area

The area of interest in this study is the western third of the state, particularly the Western Coal Fields physiographic province (Figure 2, below)

Fragipans are very common in W. Kentucky because of the aeolian parent material (eg. loess) that collects there.

Fig.2

Research Objectives

This study focuses on describing in situ fragipans in the Western Coal Fields of Kentucky to better understand their genesis, evolution, and pedogenic features.

RO1: Observe and characterize fragipans of different ages in situ from several sites in W. Kentucky

RO2: Create a profile of each fragic pedon that includes its chemical, mineralogical, and physical data

RO3: Evaluate "crack" and "prism" subunits discretely to better explain their formation

RO4: Examine the role of silica in the characteristic bulk density and brittleness of the fragipan

Field Methods

- 8 pedons in 7 counties were excavated, described, and sampled in the summer of 2019
- Sites were chosen with the help of KY NRCS based on previously mapped fragipan soil units and proximity to KY Mesonet weather systems
- Pedons were described in situ and the crack and prism subunits measured and sampled discretely (Figure 3, right)
- Bulk density and dating cores were collected at each site (optically stimulated luminescence and cosmogenic radionuclide analysis performed at NC State)

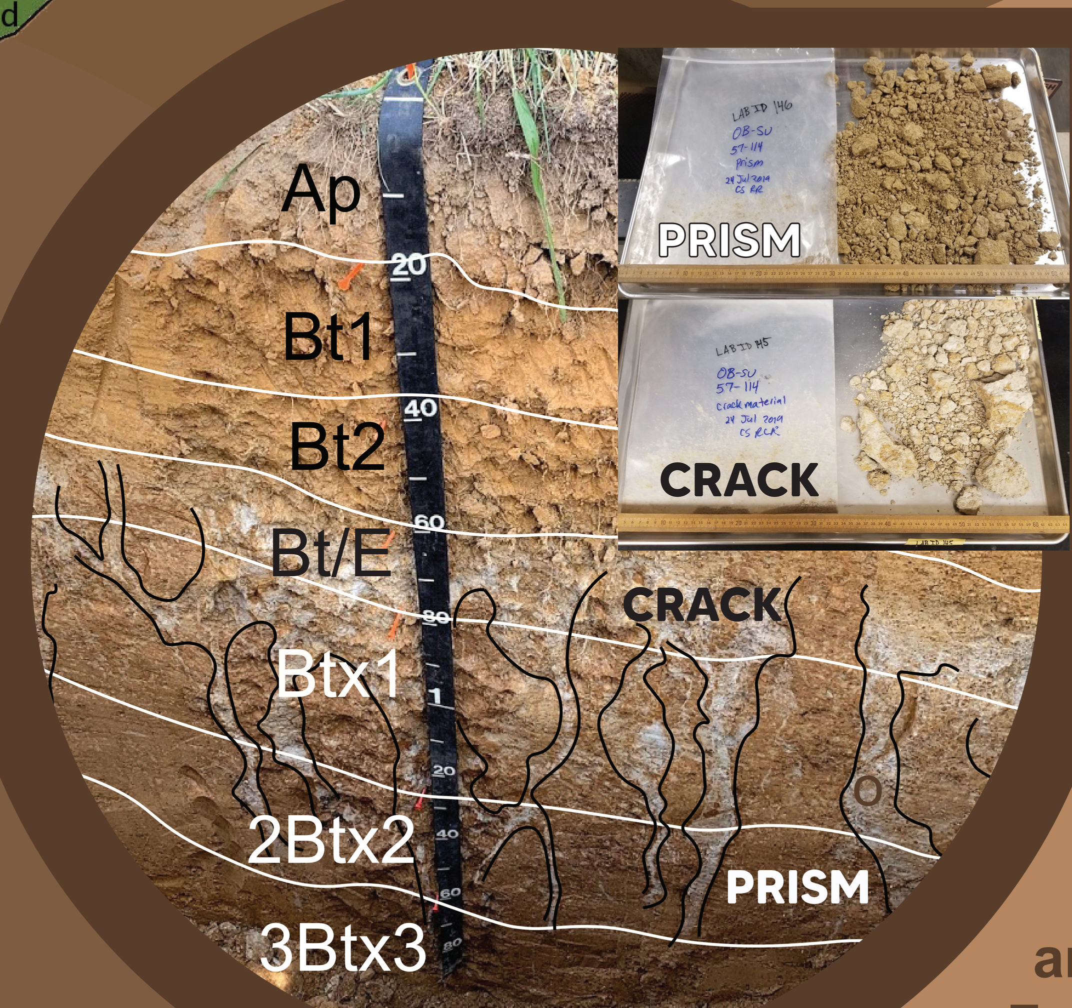

Fig.3 Pedons were first fully described, then fragipan horizons were split into crack and prism subunits and sampled separately for lab analysis. Drying samples from the same horizon can be seen at right.

Lab Methods

Chemical extracts were used to create a profile of each horizon's metallic character. Extracts used include:

citrate-bicarbonate-dithionite (amorphous forms of iron, aluminum, and aluminosilicates)

sodium pyrophosphate (organic bound aluminum and iron)

ammonium oxalate (organometals, SRO of Fe-oxyhydroxides, SRO alumino-silicates, and manganese)

Other chemical methods include pH & EC analysis, LOI for carbon storage, and C:N analysis

Physical laboratory methods include chromameter analysis, PSDA by pipette, and BD determination

Results + Discussion

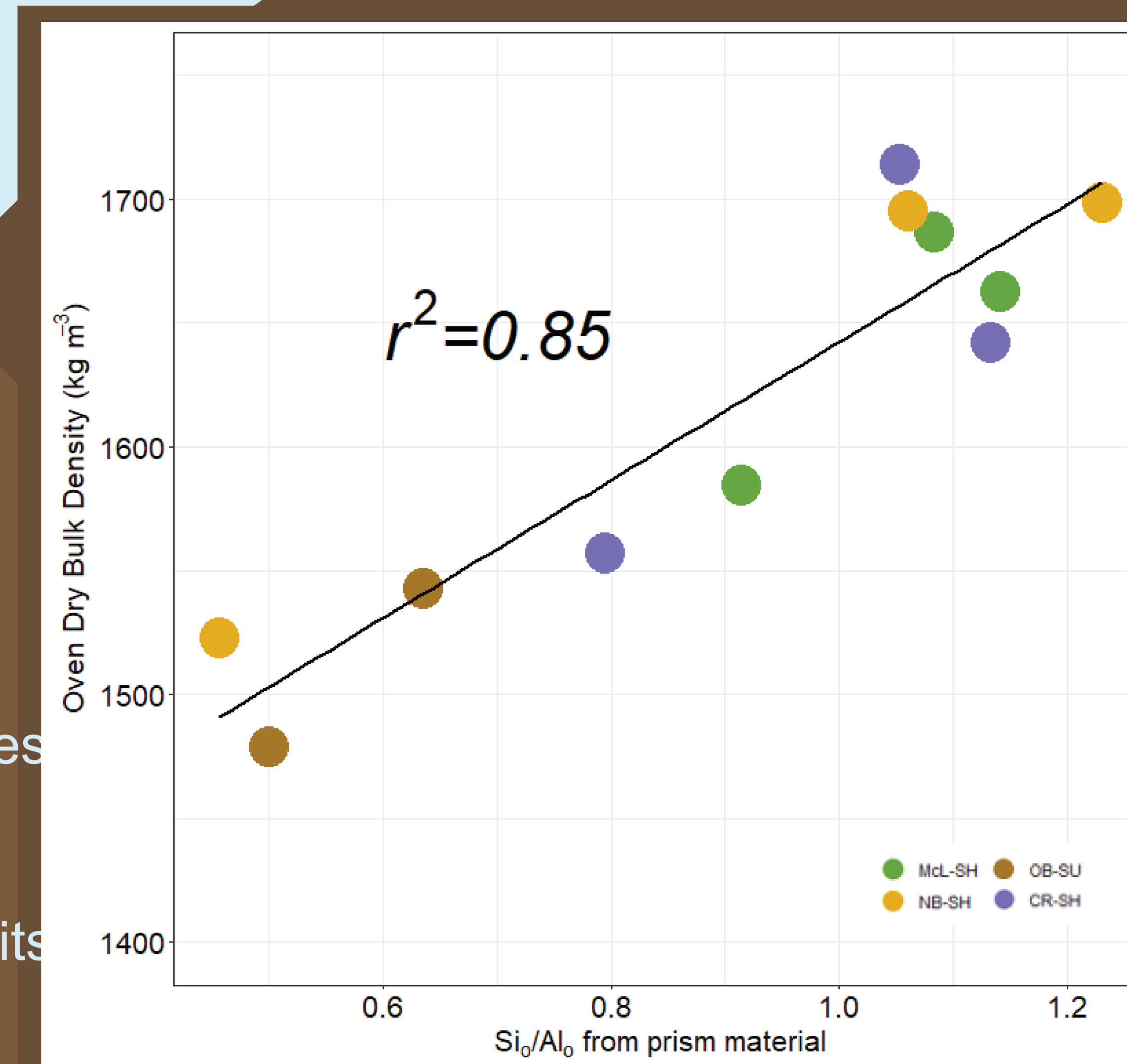

Fig.4 This figure shows the ratio of ammonium oxalate extractable Si:Al v. the bulk density of the fragipan prism. It was found that the most dense prisms (McL-SH and NB-SH) were also those with the most Si. This indicates that Si is a major component in the characteristic density of the fragipan

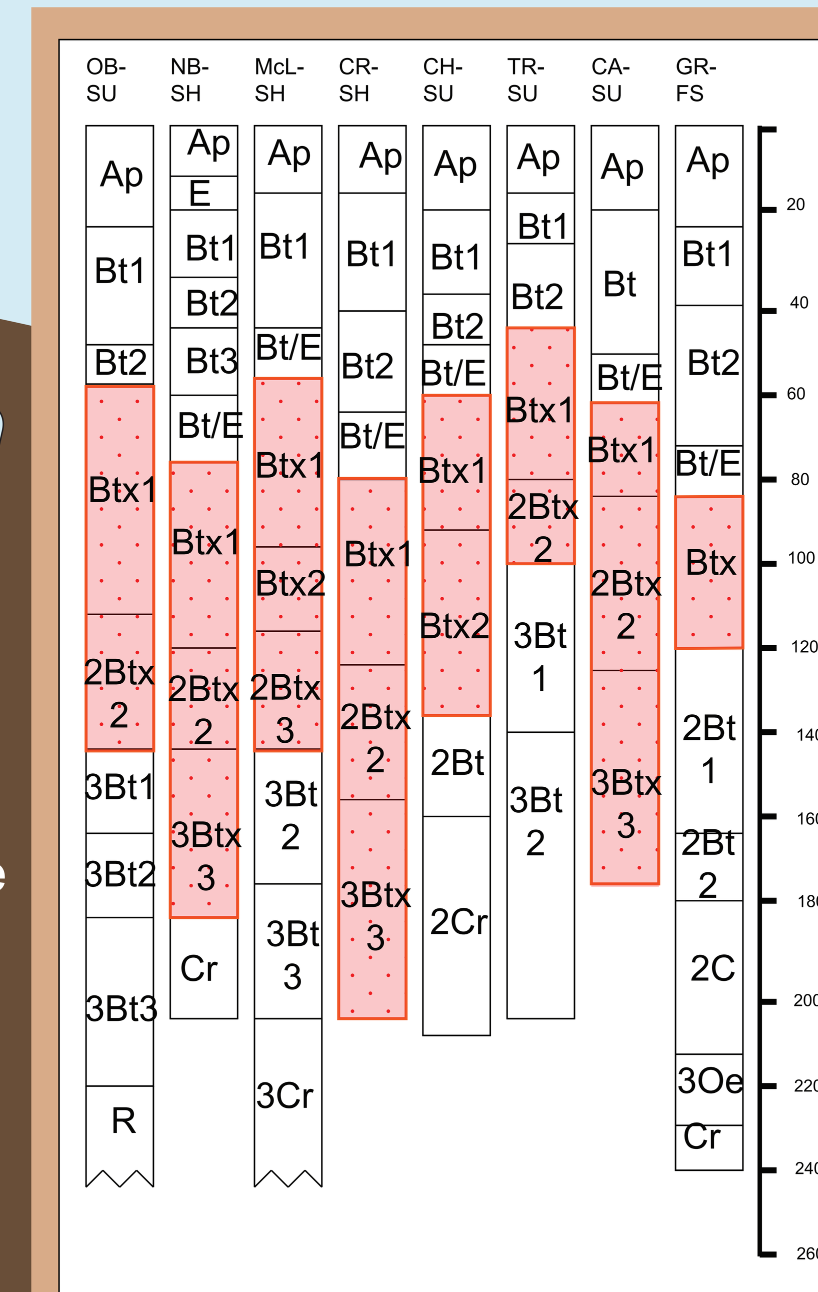

Fig.5 Fragic horizons (red) began at less than 100 cm from the soil surface in every case, making them agronomically important. In most cases, the fragic soils had several parent materials.

Fig.6 Oxalate extractable Si v. fragipan prism diameter suggests that there is a positive relationship between silicon content of the prism and the size of the prism. The size of the fragipan prism indicates its degree of pedogenic development. This suggests that as fragipans develop, silicon become more concentrated within their prisms. Our three largest prism fragipans (McL-SH, OB-SU, and CR-SH) also had the highest concentrations of silica in their respective prisms.

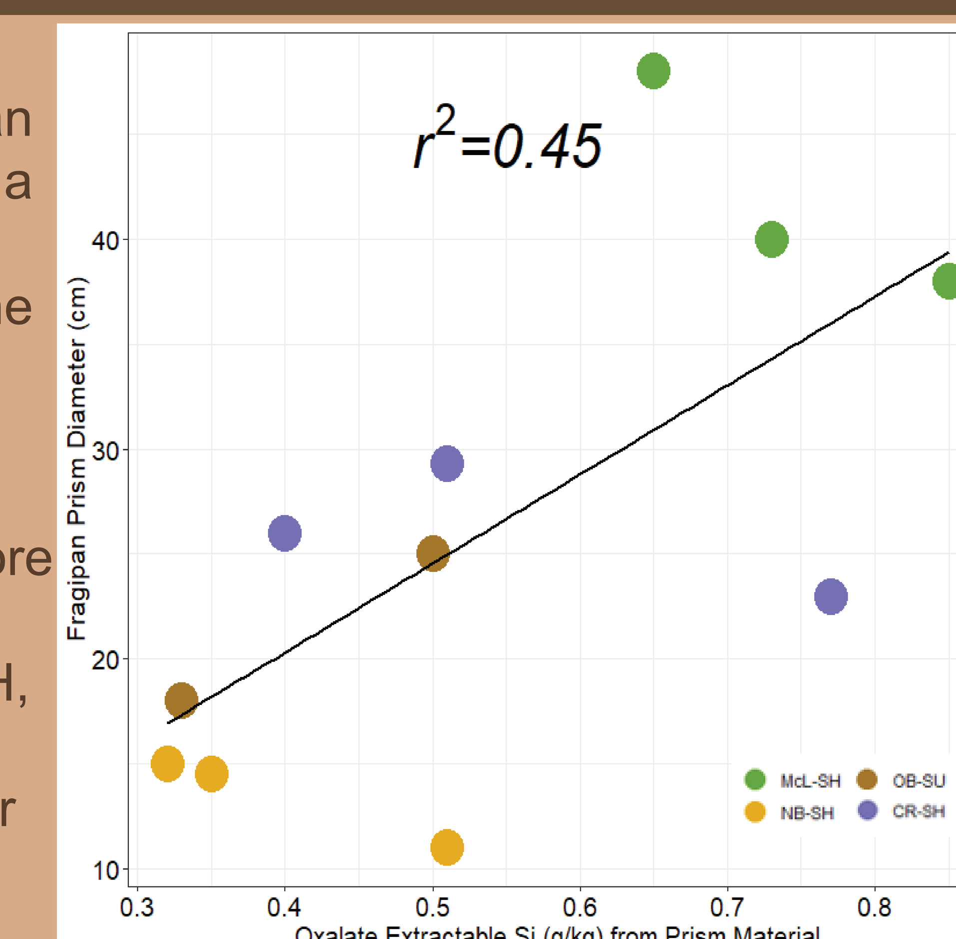

Fig.7 Though these figures may look like mirror images, they are indicating evidence of lithologic discontinuities in fragic soil. Fragipans often occur in loess over another parent material, and this is reflected here. The pedons start out extremely silty but become much more sandy with depth, indicating loess over sandstone or limestone residuum.