Genesis of Aridic Argiustolls of Western Kansas

Kansas State University | Department of Agronomy

Michelle Scarpace[1], Michel D. Ransom[1], DeAnn Presley[1], Gerard Kluitenberg[1], Skye Wills[2]

[1]Kansas State University, Dept. of Agronomy; [2]USDA-NRCS-National Soil Survey Center

USDA United States Department of Agriculture

Introduction

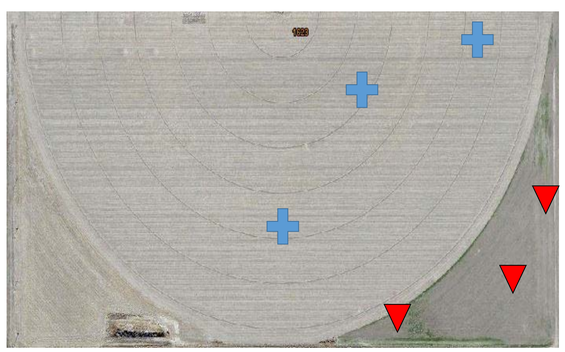
- Inherent properties- remain stable regulated through ClORPT
  - What happens when humans alter ClORPT? Can inherent soil properties be dynamic?
- Central concept of argillic horizon (Soil Survey Staff, 2014)
  1. Increase with depth in clay content
  2. Orientation of clay
- Both concepts need to be formed through **illuviation**
  1. Leaching of carbonates
  2. Dispersion and illuviation of clay
- However, clay increases and orientation from in-situ weathering can exist
  - Weathering of mica, feldspar, shrink-swell action
- How do these argillic horizons form in Keith soils?
  - Studies show irrigation does affect illuviation (Ricks Presley et al., 2004)

Objectives

- Analyze the processes that form soils in western Kansas
- Understand how long-term irrigation affects clay illuviation processes and the distribution of calcium carbonate

Methods

- Keith fine-silty, mixed, superactive mesic Aridic Argiustolls
  - Climate: 350-600 mm of precipitation/year
    - **Irrigation adds 300-600 mm/year**
  - Organisms: agriculture production (corn)
  - Relief: nearly level to gently rolling hills
  - Parent Material: Peoria Loess
  - Time: Stable landscape (loess <20,000 YBP)
- Four sites mapped as Keith 1-3% slopes
- Described 6 pedons per site- 3 irrigated, 3 non-irrigated
- Particle Size Analysis (PSA) of each horizon to a depth of 2 m
  - PSA method: Pipette method (Soil Survey Staff, 2004; Kilmer and Alexander, 1949)
- Thin sections of subsoil for soil micromorphology
  - Prepared by Texas Petrographic Services Inc.
  - Examined using a petrographic microscope and terminology of Stoops (2003)
- Statistical analyses:
  - Paired t-test with four blocking factors and twelve replicates of irrigated and non-irrigated

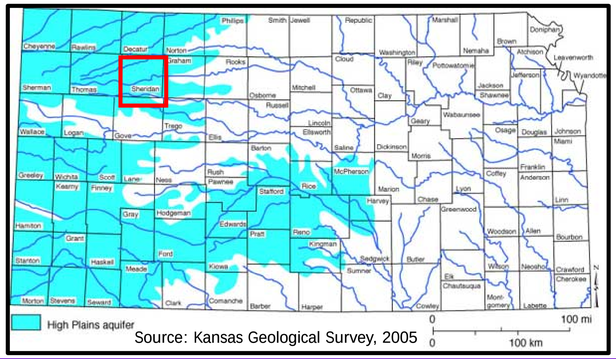


Sampling location of irrigated pedons and Ap horizons

Sampling location of non-irrigated pedons

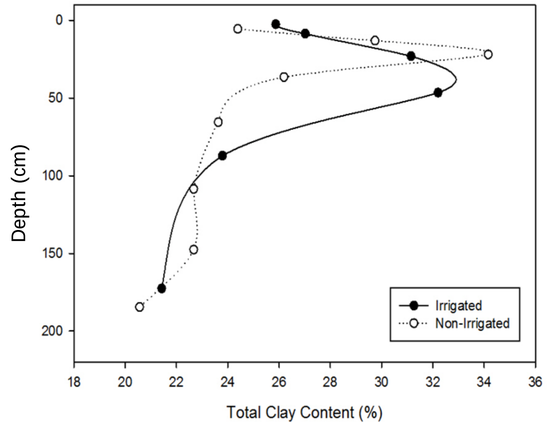
Methods

Map of High Plains aquifer within Kansas, outlining Sheridan County.

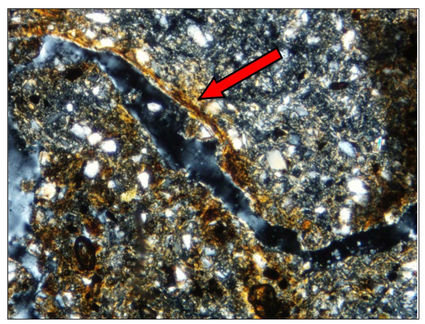


Results and Discussion

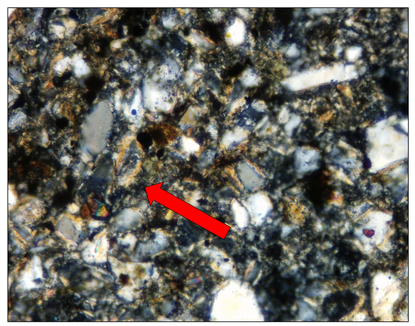
Total Clay Content (%) of Selected Pedons from Site 2



Evidence of Clay in Thin Sections



Clay coating along void, illuvial argillan. 10x, CPL
Non-Irrigated pedon Bt2
Frame length= 560µm

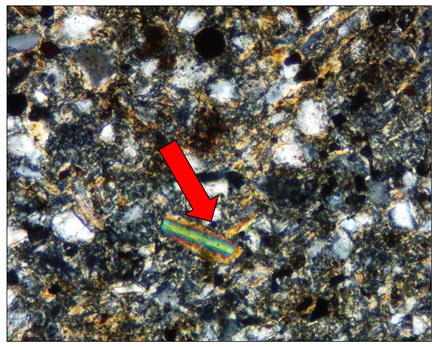


Grain argillans, stress feature coating grains 10x, CPL
Non-irrigated Bt1
Frame length= 560µm

- There were no significant differences in clay illuviation and calcium carbonate distribution between irrigated and non-irrigated soils
  - No differences in laboratory characterization data (Clay content % and FC:TC) and thin section analyses
- Other soils found in mapped areas of Keith 1-3% slopes:
  - Ulysses fine-silty, mixed, superactive, mesic Aridic Haplustolls
  - Richfield fine, smectitic, mesic Aridic Argiustolls
  - Kuma fine-silty, mixed, superactive, mesic Pachic Argiustolls

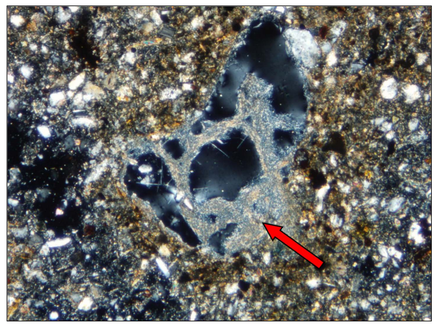
Results and Discussion

Formation of Argillic Horizons



- In situ weathering of mica minerals is the main cause of clay increases in the subsoil
- Stress due to shrink-swell in soils
  - Monostriations and pressure faces described in thin sections
- **Management did not affect these processes**

Evidence of Calcium Carbonate



- Pedogeneic carbonate superimposed on clay material
  - Goes against normal illuviation processes
- Suggests a younger PM (Bignell Loess) was deposited and could be inhibiting clay illuviation
- Bignell Loess found in 8 pedons with a thickness of 25-69 cm

Conclusions

- Irrigation does not affect clay illuviation or calcium carbonate distribution
  - T-test revealed no significant differences
- Two reasons for this:
  1. The addition of a younger PM
  2. Presence of map unit inclusions at every site
- Although all soils were the same map unit, the taxonomic differences in soils could explain results from this study
- In DSPs studies, what is defined as a 'similar soil' can greatly affect the results

Inherent properties can have a greater impact on soil change and prevent soil properties from changing over a human time scale.

References

Ricks Presley, D., M. Ransom, G. Kluitenberg and P. Finnell. 2004. Effects of thirty years of irrigation on the genesis and morphology of two semiarid soils in Kansas. Soil Sci. Soc. Am. J. 68:1916-1926.

Acknowledgments

Special thanks to USDA-NRCS employees who made this project possible: Chad Remley, Dale Younker, Tom Cochran, Ryan Still, Laura Bricknell and Tanya Allemang.
We thank Ed Goetz, Ron Bixeman, David Shippers, Delmer Kaiser, Dan Schultz, Dan Ochs and Greg Haffner for allowing this project to be conducted on their property.