Genesis, Mineralogy, and Micromorphology of Vertic Soils in Southeastern Kansas

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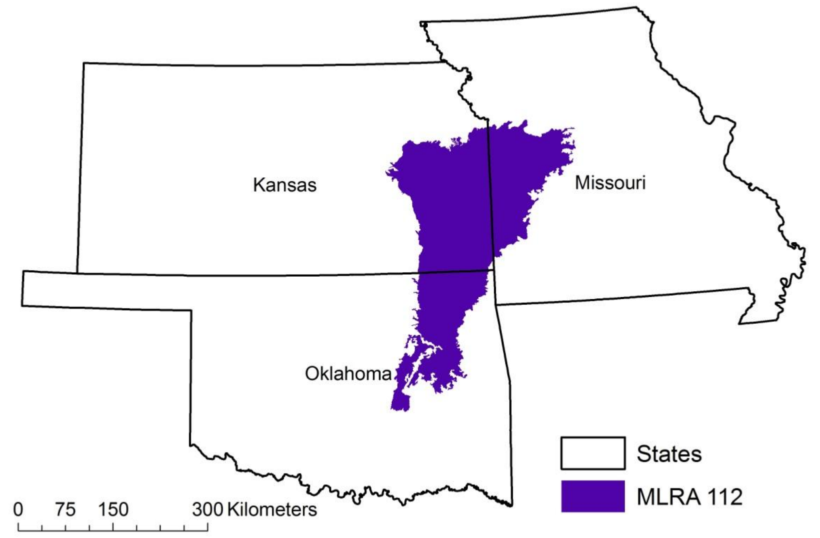
Introduction

Many of the soils in the Cherokee Prairies region of southeastern Kansas are characterized by high clay contents and high shrink-swell potentials. These vertic properties and claypan characteristics cause soil management to be difficult and pose problems for agricultural, environmental, and engineering uses. The objective of this study is to determine the clay mineralogy and genesis of claypan soils having a range of vertic characteristics.

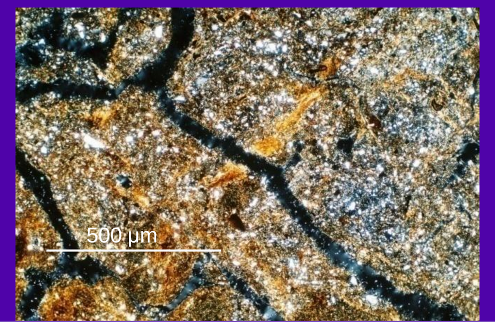
Site and Methods

The study area is the Cherokee Prairies Major Land Resource Area. This area is characterized by gently sloping to rolling, dissected plains. Common parent materials are loess or re-worked loess, old alluvium, and residuum derived from marine shales and limestones. Ten pedons representing eight soil series that exhibited a range of vertic properties were sampled and described in the field. Clay mineralogy for selected horizons was determined by X-ray diffraction. Soil thin sections were analyzed, and various other soil physical and chemical data were collected in the laboratory.

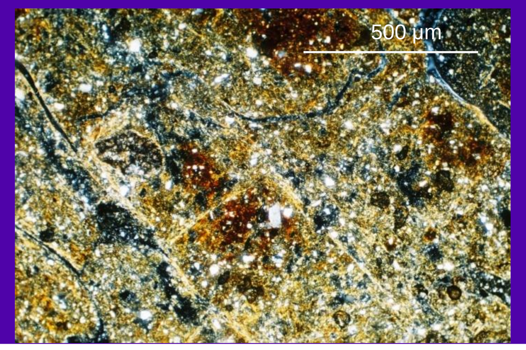
Clay minerals were identified as follows:
- •Smectite – 14Å Mg25, 17Å MgEG, 18Å MgGLY
- •Vermiculite - 14Å Mg25, 14-17Å MgEG, 14Å MgGLY
- •Kaolinite – 7.1Å (collapses with K550 – data not shown)
- •Clay Mica – 10Å
- •Quartz – 4.26Å
- •Goethite – 4.18Å
- •Lepidocrocite – 6.26Å
- •Feldspars – 3.12-3.28Å



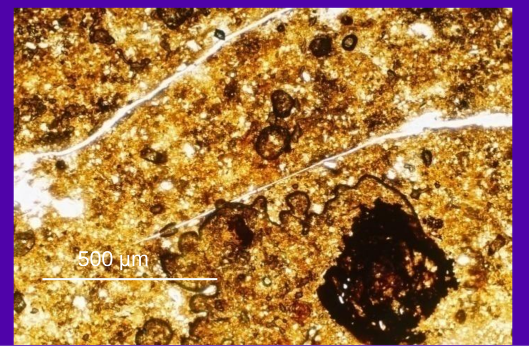
Results



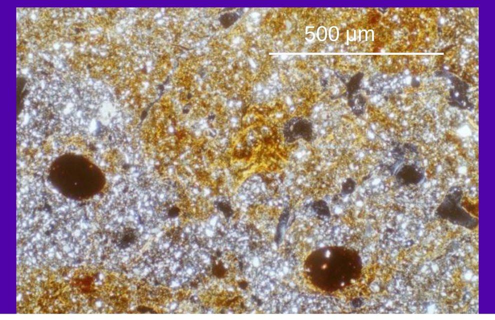
Woodson, Bt1, XPL
Distorted, embedded argillan separated by a planar void.



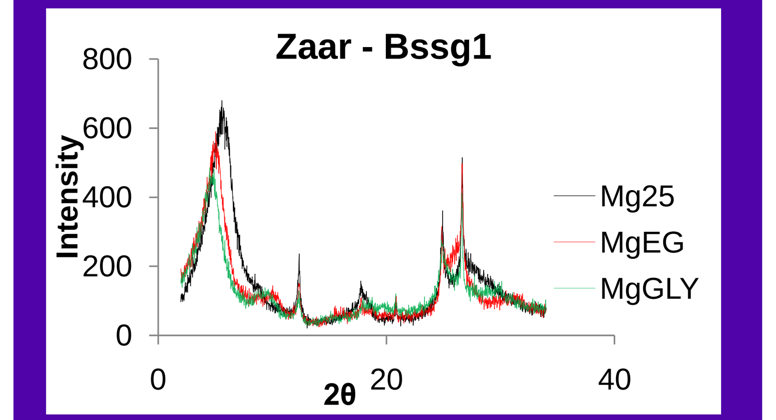
Woodson, Bt2, XPL
Cross striated b-fabric. Long linear zones of oriented clay due to shear stress.

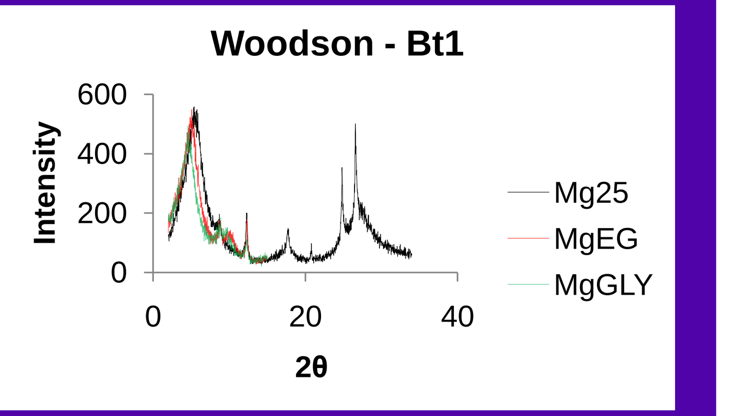


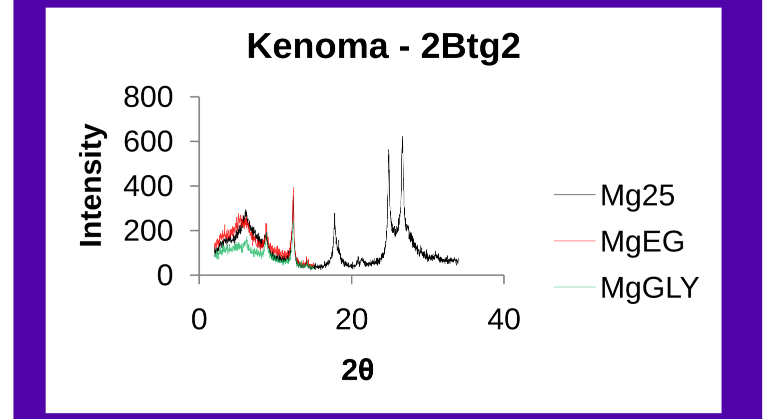
Summit, Bt2, PPL
Slickensides or planar voids caused by shear failure. Fe-Mn nodule.

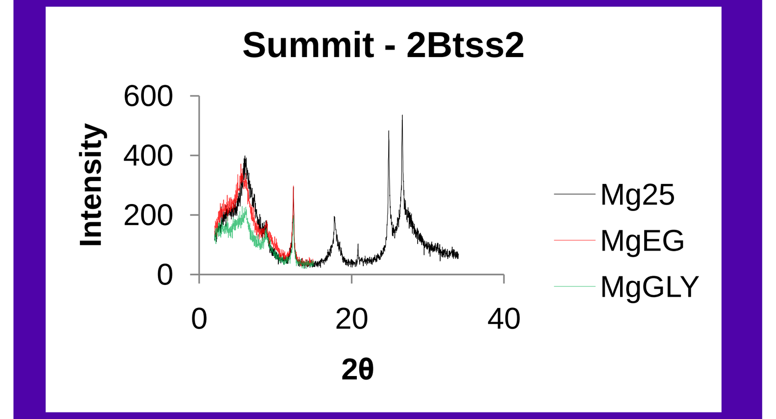


Kenoma, Bt1, XPL
Distorted, embedded argillan and silt coating or infilling. Fe-Mn nodules.









Zaar S05KS205002
Fine, smectitic, superactive, thermic Aeric Endoaquert

Horizon	Depth (cm)	Field Description of Clay Films	Field Description of Slickensides	pH (1:1 H20)	% Total Carbon	% Clay	Texture	COLE	Abundance of Clay Minerals (semi-quantitative)
Ap	0-13	—	—	6.9	1.65	46.7	SiC	0.113	Smectite-4, Kaolinite-2, Clay Mica-1, Quartz-1, Feldspars-1
A	13-28	—	—	7.4	0.81	56.8	SiC	0.135	—
BA	28-56	—	2% continuous pressure faces	7.8	0.63	56.1	SiC	0.143	Smectite-4, Kaolinite-2, Clay Mica-1, Quartz-1, Feldspars-1
Bg	56-84	—	1% continuous pressure faces	8	0.64	53.1	SiC	0.141	—
Bssg1	84-106	—	3% continuous	8.1	0.78	48.8	SiC	0.144	Smectite-5, Kaolinite-2, Clay Mica-1, Quartz-1, Feldspars-1
Bssg2	106-142	—	5% continous	8.2	0.54	46.6	SiC	0.13	—
Bssg3	142-163	—	15% continous	8.3	0.37	48.4	SiC	0.122	Smectite-5, Kaolinite-2, Clay Mica-1, Quartz-1, Feldspars-1
Bssg4	163-212	—	10% continous	7.9	0.24	50.6	SiC	0.125	—

Kenoma S05KS133003
Fine, smectitic, superactive, thermic Typic Epiaquert

Horizon	Depth (cm)	Field Description of Clay Films	Field Description of Slickensides	pH (1:1 H20)	% Total Carbon	% Clay	Texture	COLE	Abundance of Clay Minerals (semi-quantitative)
Ap	0-20	—	—	5.9	2.05	22.1	SiL	0.018	Kaolinite-3, Smectite-2, Quartz-2, Clay Mica-1, Feldspars-1
Bt1	20-32	30% continuous	—	5.6	1.48	53.3	SiC	0.117	—
Bt2	32-49	30% continuous	5% continuous	6	1.31	55	SiC	0.125	Kaolinite-3, Smectite-3, Quartz-2, Clay Mica-1, Feldspars-1
2Btg1	49-80	20% continuous	—	6.4	0.29	43.5	SiC	0.051	—
2Btg2	80-97	20% continuous	2% continuous	6.8	0.29	44.2	SiC	0.051	Kaolinite-4, Smectite-3, Vermiculite-2, Clay Mica-2, Quartz-1, Goethite-1, Lepidocrocite-1
2Bssg1	97-133	40% continuous	2% continuous	7	0.33	44.5	SiC	0.044	—
2Bssg2	133-159	20% continuous	20% continuous	7.1	0.33	50.4	C	0.057	Kaolinite-4, Vericulite-3, Smectite-2, Clay Mica-2, Quartz-1, Goethite-1, Lepidocrocite-Tr
2BC	159-188	—	1% discontinuous pressure faces	7.3	0.25	43.4	SiC	0.062	—

Summit 09KS207001
Fine, smectitic, thermic Aquertic Argiudoll

Horizon	Depth (cm)	Field Description of Clay Films	Field Description of Slickensides	pH (1:1 H20)	% Total Carbon	% Clay	Texture	COLE	Abundance of Clay Minerals (semi-quantitative)
Ap	0-18	—	—	6.0	4.95	32.3	SiCL	—	Kaolinite-4, Smectite-3, Clay Mica-2, Quartz-2, Vermiculite-1, Hydroxy-Interlayered Mineral-1
A	18-29	—	—	6.2	2.66	39.4	SiCL	—	Kaolinite-4, Smectite-3, Clay Mica-2, Quartz-2, Vermiculite-1, Feldspars-Tr
Bt1	29-53	30% continuous	—	6.4	1.52	45.9	SiC	—	Smectite-3, Kaolinite-3, Clay Mica-2, Quartz-2, Vermiculite-1, Feldspars-Tr
Bt2	53-103	10% continuous	25% continuous	6.7	0.62	50.0	SiC	—	Smectite-3, Kaolinite-3, Clay Mica-2, Quartz-2, Vemiculite-1, Feldspars-1
2Btss1	103-135	40% continuous	20% continuous	7.0	0.60	52.4	SiC	—	Smectite-3, Kaolinite-3, Vermiculite-2, Clay Mica-2, Quartz-1, Feldspars-Tr
2Btss2	135-177	20% continuous	5% continuous	7.4	0.32	54.6	SiC	—	Vermiculite-3, Kaolinite-3, Smectite-2, Clay Mica-2, Quartz-1
3Btkss	177-210	70% continuous	50% continuous	7.4	0.00	59.0	C	—	Vermiculite-4, Kaolinite-3, Smectite-2, Clay Mica-2, Quartz-1

Relative Peak Size: 1-very small 2-small 3-medium 4-large 5-very large

Summary and Conclusions

•Vertic properties were identified in the field or in thin section for all pedons.

•Zaar and Woodson pedons were dominated by smectite while other soils exhibited a more mixed clay mineralogy.

•Zaar showed the strongest vertic properties while Woodson and Parsons expressed the weakest.

•Fluctuations in moisture status may not be large enough to cause more significant soil movement and cracking within the highly smectitic Woodson pedon.

•Results show that dominance of smectite is not a key requirement for limited shink-swell in claypan soils of this region because soils of mixed mineralogy with relatively high contents of kaolinite, vermiculite, and clay mica had significant vertic properties.

•Clay illuviation occurs at a rate great enough for the development of clay films and an argillic horizon in all but the Zaar pedon.

•Vermiculites and high charge smectites are relatively common and may contribute to K^+ and NH_4^+ fixation.

•Results from this study will be provided to the USDA-NRCS for use in future soil survey updates.