Identifying the Possible Control of Clay Mineralogy of Soils in Some Southern US States over the Fluctuations in Potassium

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Introduction

- Soil potassium (K) exists in solution, exchangeable, and non-exchangeable forms that are in dynamic equilibrium with each other.
- The majority of total K budget in soils is controlled by K-bearing silicates such as illite and other mica, interstratified illite-smectite (I-S), and K-feldspars.
- The extent to which K is fixed in the phyllosilicates capable to host it (illite, I-S, smectite) depends on the exact type of clay mineral, their cation-exchange capacity, mineral charge density, the degree of interlayering, the moisture content, the concentration of K^+ ions, the concentration of interlayer cations, and the pH of the ambient solution.

Objective

- Determine the relationship between K retention in soils and its clay mineralogy.

Materials and Methods

Potassium quantification and fixation

- Pre-plant soil samples were collected at the 0 - 15 cm, 15 - 30 cm, or 0 - 30 cm depths for selected soils.
- Soil samples were analyzed for their plant available K concentration using Mehlich III method at the Texas A & M AgriLife Research Center, Lubbock, TX.
- Potassium fixation test was conducted following the incubation method (Galvak et al., 2005). This was done at the Texas A & M AgriLife Research Center, Lubbock, TX.

Clay separation and X-Ray Diffraction (XRD) Analysis

- Dried soil sample was gently crushed using mortar and pestle.
- Deionized water was added to samples, ultrasound and centrifuged.
- Samples were allowed to settle for 24 hours.
- The supernatant was discarded following which a dropper was used to collect sub-samples onto glass mount slides.
- Sub-samples were air dried on glass mounts.
- Glass mount samples were analyzed using a Rigaku® Miniflex II Desktop XR diffractometer (U = 30kV, I = 15mA; CuKα radiation) to obtain the clay phases present.
- Preliminary results showed the presence of mix–layered minerals. Thus, samples were glycolated and re-run on the XR diffractometer to identify the dominant phases of the mix-layered minerals that were present.
- Clay fractionation and XRD analysis were done at the Texas Tech University Department of Geosciences.

Results

Table 1: Characterization of the study soils.

Location	Soil depth (cm)	K (ppm)	Percent K fixation
Lamesa, TX	15 - 30	278	60
Lubbock, TX	15 - 30	319	48
Suffolk, VA	0 - 15	79	58
Wharton, TX	0 - 30	45	-

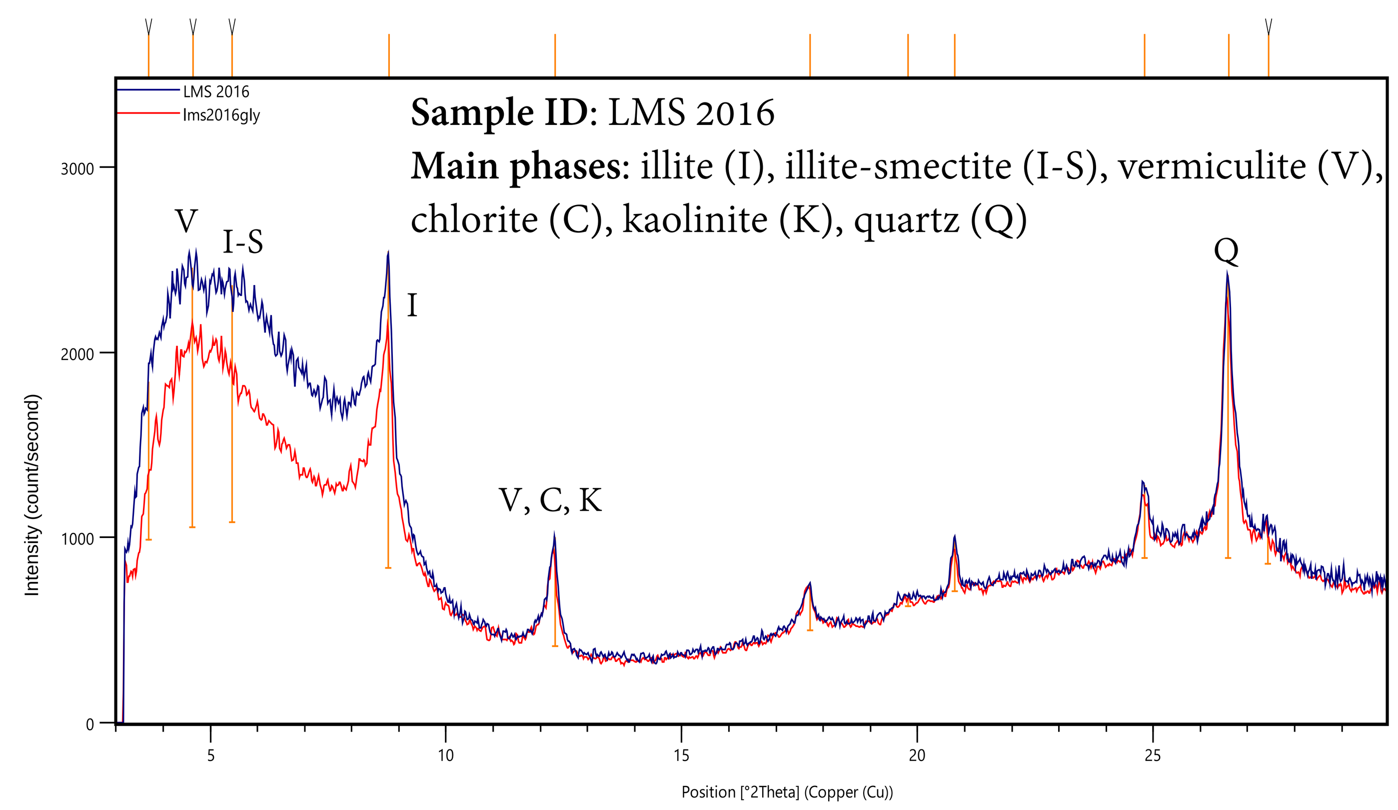

Figure 1: XRD of the raw clay fraction (blue) and the glycolated (red) clay fraction of the Lamesa soil.

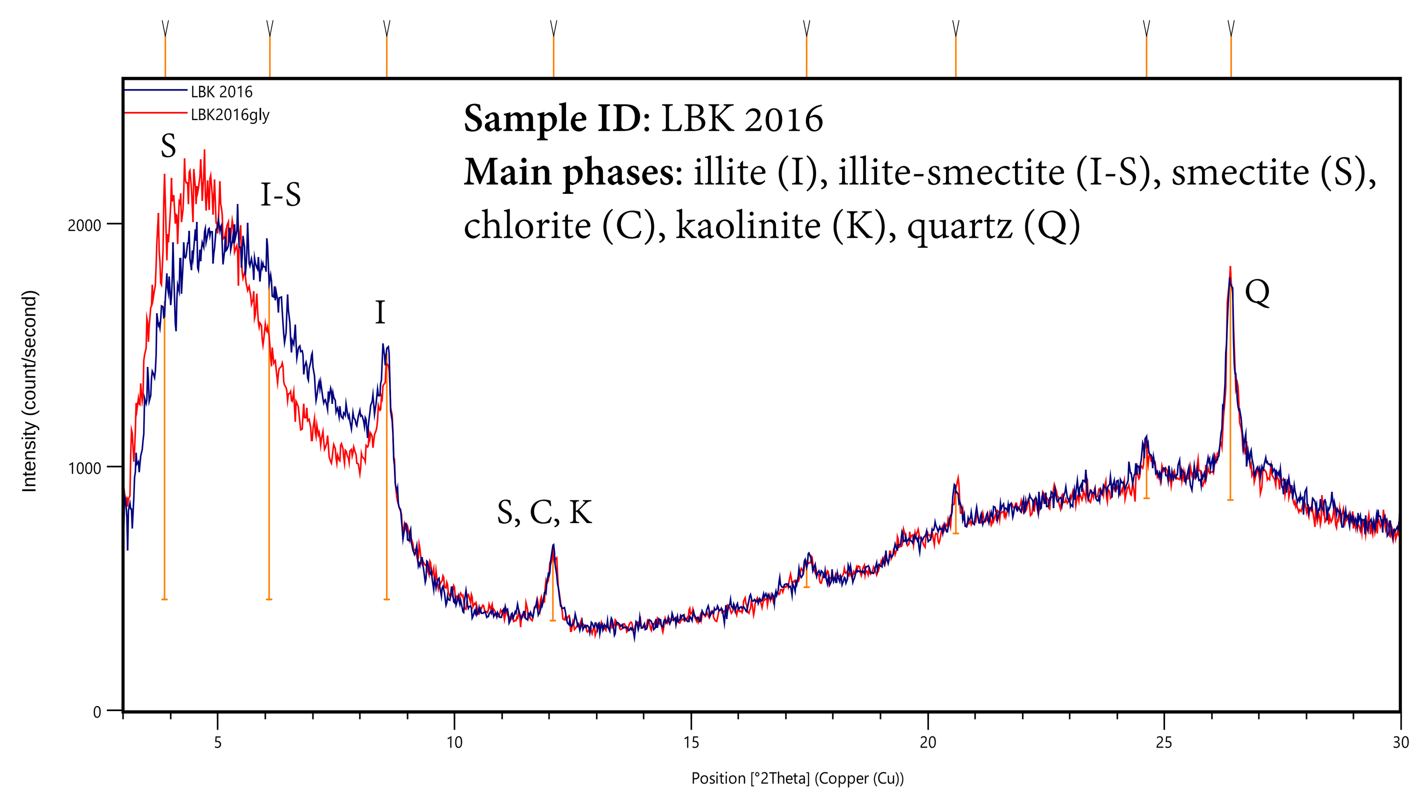

Figure 2: XRD of the raw clay fraction (blue) and the glycolated (red) clay fraction of Lubbock soil.

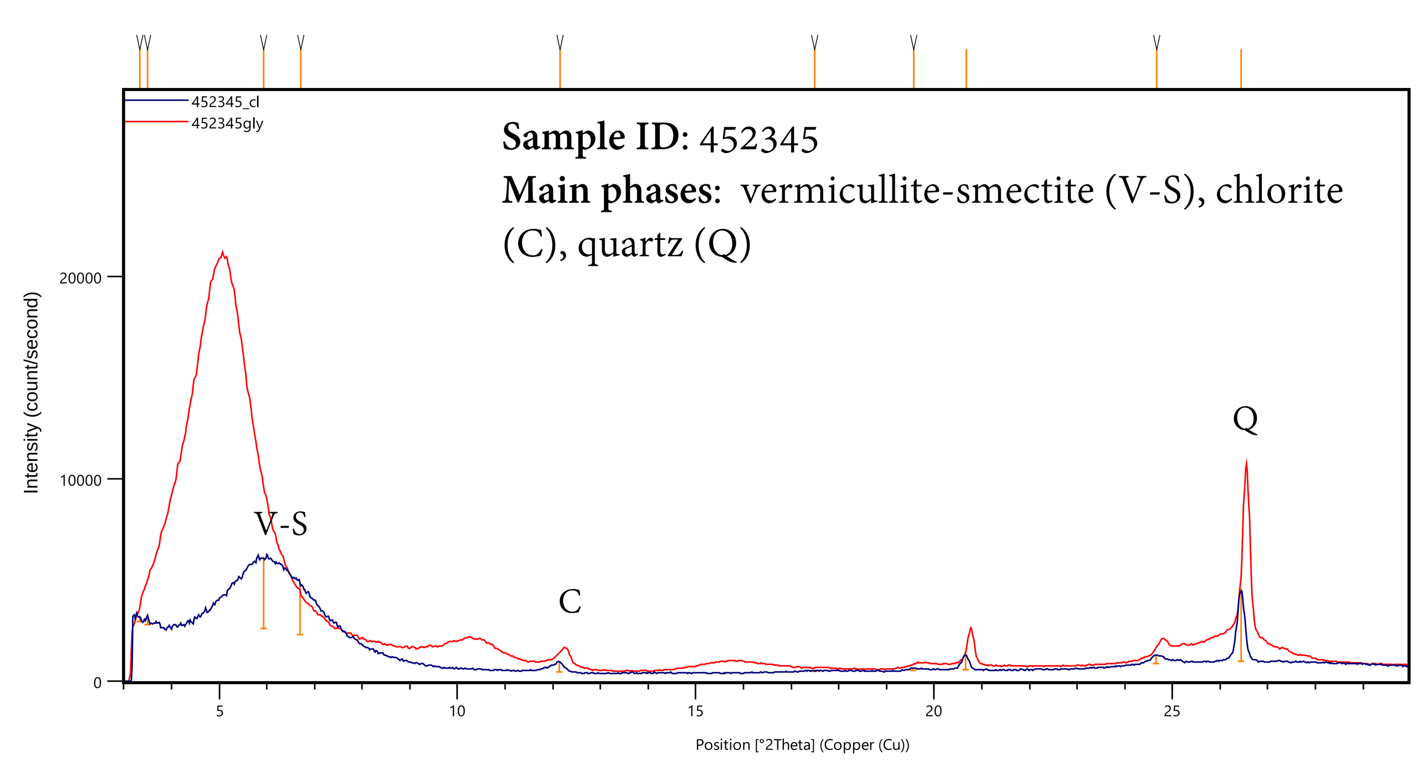

Figure 3: XRD of the raw clay fraction (blue) and the glycolated (red) clay fraction of the Suffolk soil.

Results cont'd

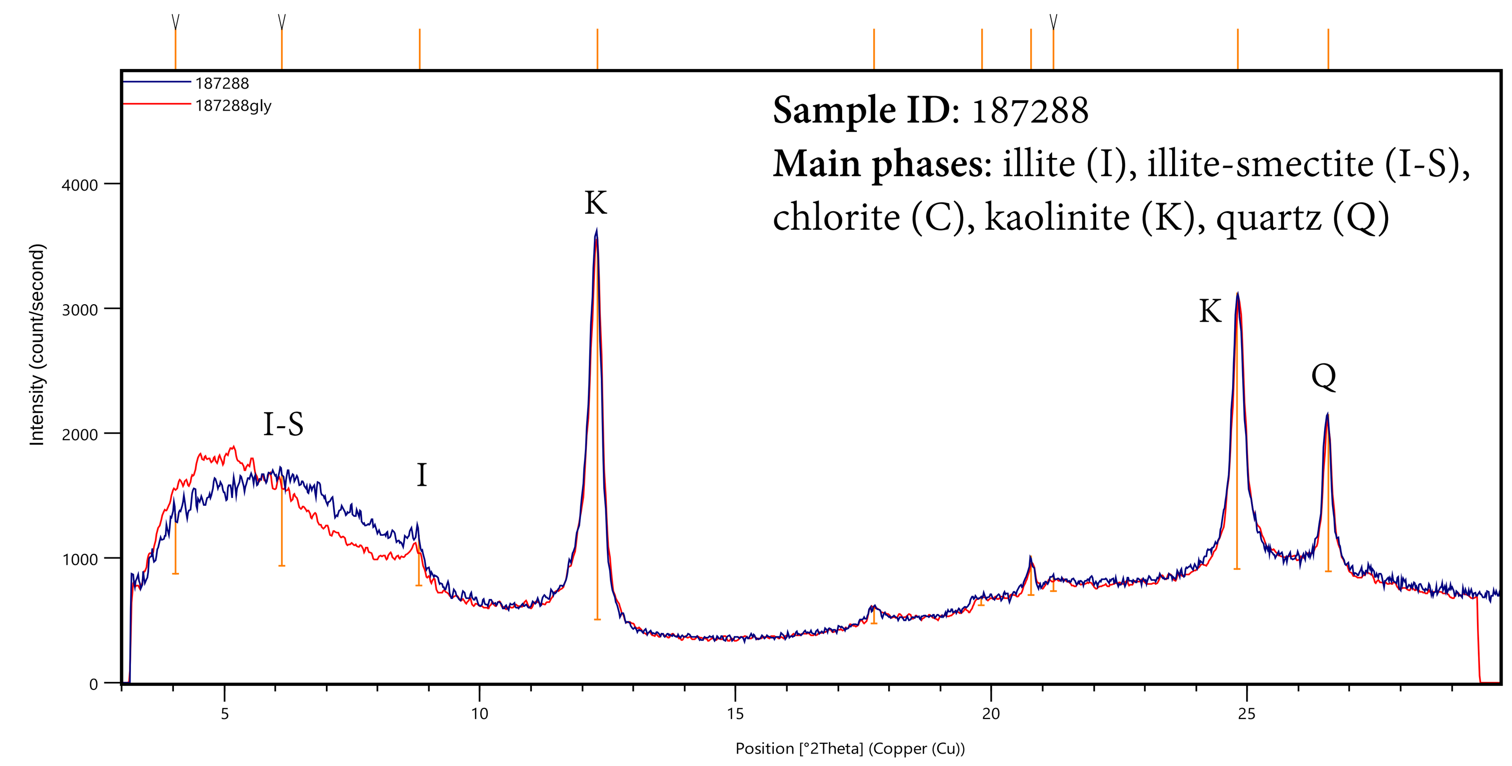

Figure 4: XRD of the raw clay fraction (blue) and the glycolated (red) clay fraction of the Wharton soil.

Discussion

- Soils in the Lubbock area are of the Acuff series, Lamesa are of the Amarillo series, Wharton are of the Lake Charles series, and Suffolk is of the Suffolk series.
- There seems to be a relationship between the K extraction results (table 1) and the XRD results (Fig 1 - 4). The findings are that the soils with greater K concentration have the illite and I-S phases being dominant.
- The Wharton soil show only a minor illite and I-S content thus explaining a low K concentration (Fig. 4).
- The fixation percentage in the Lamesa and Lubbock soil are high due to the presence of high K concentrations and the presence of I-S phases. A fixation test on the Wharton sample will confirm the complete relationship between the K content, and amount of K fixed in the current study.

Conclusion

- The higher the I-S phases of the clay fraction, the greater the total K. This shows that the I-S serve as storage for the soil K and their conversions is the main parameter controlling K dynamics in the soils.

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