

Identifying Soil Profile Weathering Status Using Portable X-Ray Fluorescence Spectrometry



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INTRODUCTION

- Soil chemical weathering under natural conditions is one of the essential processes for sustainability assessment of agriculture and land use, as well as for the identification of acid sensitive regions through the estimation of critical loads.
- Most surface exposures in Louisiana consist of Quaternary (Pleistocene and Holocene) sediment. Holocene deposits, including alluvium of the Mississippi, Red, Ouachita, and other rivers and smaller tributaries, and coastal marsh deposits, occupy about 55% of the surface, which leads to unusual difficulties in field description and subsequent determination of chemical weathering status.
- Hypothesis
 - Immobile elements stay and mobile elements move, vertically or horizontally.
 - The enrichment of immobile elements and depletion of mobile elements on the upper part of a soil profile reflects its weathering status, and possibly age.
- The major objectives of this part are to:
 - characterize chemical weathering in terms of vertical variations in different profiles and spatial differences in fields based on PXRf readings,
 - compare the calculated chemical weathering rates based on PXRf readings and other methods, and
 - rationalize the cause of the variations.

MATERIALS AND METHODS

- Published dataset (detailed chemical data of 21 pedons) in "Impact of Climate and Parent Material on Chemical Weathering in Loess-derived Soils of the Mississippi River Valley", by Muhs et al. 2001 (Figure 1).
- Nine pedons from Louisiana, 3 from Rapides Parish, 3 from St. Landry Parish, 3 from Iberville Parish (Figure 2).



Figure 1 Pedon locations of the published dataset

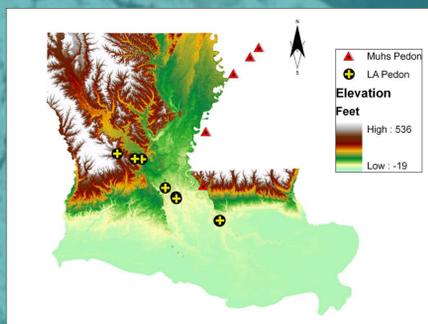


Figure 2 Locations of the Louisiana pedons

Elements examined:

- Zirconium (Zr): generally recognized as immobile element
- Titanium (Ti): low weathering rate and mobility, primarily inherited from parent materials
- Potassium (K): low to moderate mobility
- Variables: Ti/Zr and K/Zr, normalized Ti/Zr and K/Zr

RESULTS

- A common trend was found in all pedons: both Ti and K were depleted substantially in the upper ~60 cm.
- The degree of depletion was closely related with the intensity of weathering; the pedons in the south experienced more depletion than those in the north.
- As expected, K showed greater mobility than Ti.

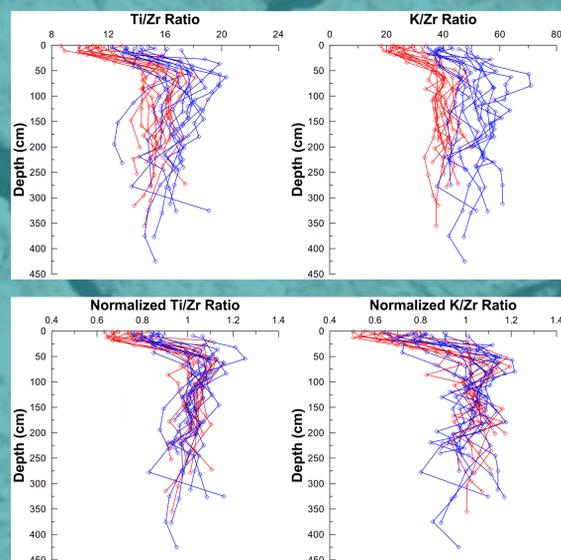
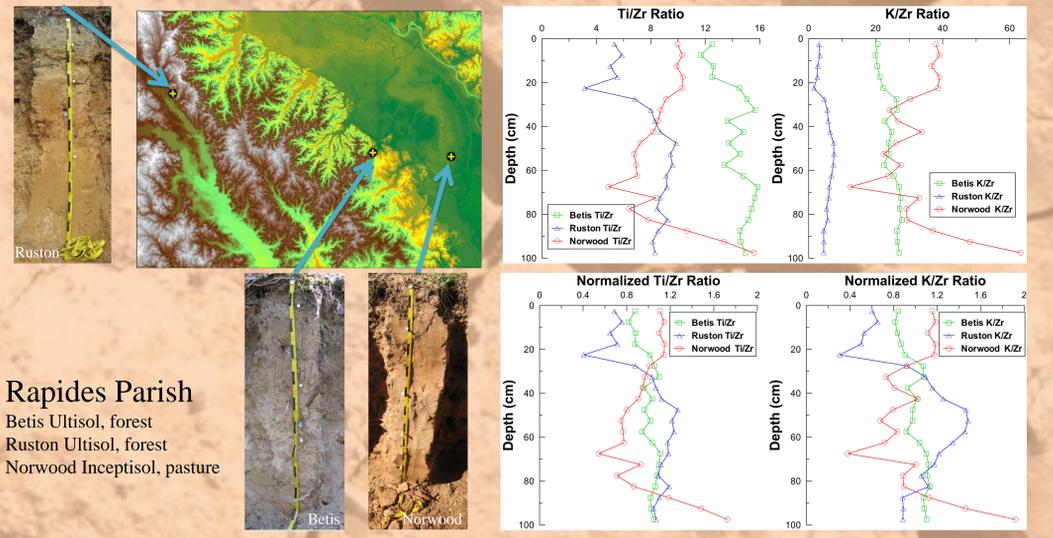
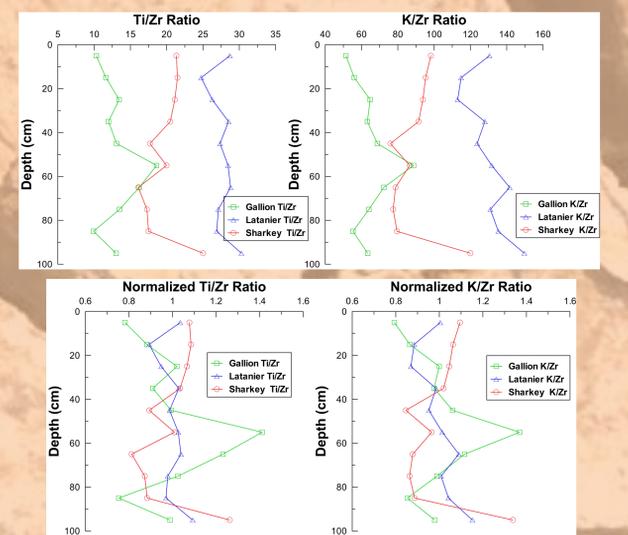


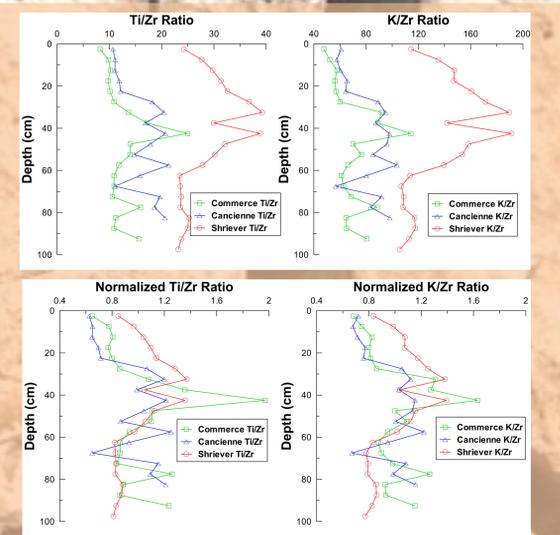
Figure 3 Vertical distribution on Ti and K in the pedons of Muhs dataset



St. Landry Parish
Gallion Alfisol, WRP,
Latanier Vertisol, wetland forest
Sharkey Vertisol, cropland



Iberville Parish
Commerce Inceptisol, cropland
Cancienne Inceptisol, cropland
Shriever Vertisol, cropland



CONCLUSIONS

- Titanium is more mobile than expected.
- Relative depletion of mobile elements in approximately upper 50 cm can be found in aged soil profiles.
- The degree of relative depletion depends on the mobility of the elements.
- Apparent depletion was found in two Ultisols, one Alfisol, two of three Inceptisols, and two of three Vertisols.
- Cultivation (tillage) expedites the process of weathering and/or vertical movement of the elements in soil profiles.
- PXRf was proven as a rapid and effective tool to provide soil weathering information.