USDA United States Department of Agriculture

Natural Resources Conservation Service

Soil and Plant Science Division—Region 9

Southern Great Plains Region

Elemental Analysis Using Portable X-Ray Fluorescence Spectrometry (PXRF)

Purpose

The 9-LUB Soil Survey staff assisted in the identification, description, and classification of soil characteristics for a soil profile at the Texas Tech University Erskine Experimental Rangeland in Lubbock, Texas. Visiting professors Fujun Sun and Noura Bakr along with professors David Weindorf and Tommy Dang, and graduate student, Vung Pham, of Texas Tech University have devised a method to determine elemental content using portable X-ray fluorescence spectrometry (PXRF). This process allows the user to gather soil elemental information in the field.

Background Information

Portable x-ray fluorescence spectrometry is possible through a low-power, self-contained, x-ray gun which enables the user to make elemental determinations in specific spots in a soil profile, either in a soil pit or soil within a probe tube.

The PXRF uses visible, near infrared, reflectance spectroscopy to determine physical characteristics (pH), salinity, and the presence of individual elements. Vast improvements have been made in the precision and accuracy of the PXRF gun, making use of it in the field much more feasible.

Sampling pits representative of the benchmark Amarillo and Acuff series were dug. The pit faces were prepared and described using procedures outlined in the Kellogg Soil Survey Laboratory Methods Manual.

The Amarillo and Acuff series are deep, moderately permeable, soils weathered from eolian deposits. Both soils occur on nearly level to gently sloping plains. The Amarillo series is classified as a fine-loamy, mixed, superactive, thermic Aridic Paleustalfs. The Acuff series is classified as a fine-loamy, mixed, superactive, thermic Aridic Paleustolls. After describing each soil profile on its respective pit face, the horizon boundaries were marked using string and golf tees. This method was also used to create “cells”, or individual quadrants on the pit face, in which individual PXRF readings could be taken. Figure 1 shows the horizon boundaries of the pit face; the pit face marking the “cells”, or individual quadrants; by using computer graphics, the photos were merged, showing the relation between the marked cells and the soil horizon boundaries.

Key Outcomes

Using the PXRF gun, readings were taken within each cell, revealing the elements present within each location. An algorithm was used to compute the concentration of each element present within each “cell”, or individual quadrant. With further use of computer graphics, the results of elemental concentration were then displayed by cell as a layer overlying the photo of the pit face. The overlay shows the elemental composition within each cell in relation to soil depth and horizon (Figure 2). As an additional analysis, the correlation between certain elements found in the soil were determined.

Future Goals

This research introduces a much faster method to gather soil elemental information in the field, in contrast to current laboratory methods. In the future, the PXRF gun could be a new tool used by field soil scientists. For more information check out the following link, https://vimeo.com/297385740/3c258ef538

Figure 1. (center) NRCS soil scientists, Alain Basurco, Craig Byrd, and Todd Carr assisting Dr. David Weindorf describe the Amarillo soil profile. Using string and golf tees the horizon boundaries are outlined. The grid on the left shows the string and golf tees method used to create a lattice of cells on the soil profile face. PXRF readings were taken from the area with each cell using the self-contained PXRF x-ray gun. The grid on the right is a computer graphic overlay showing the "cells", or individual quadrants, in which individual PXRF readings were taken.

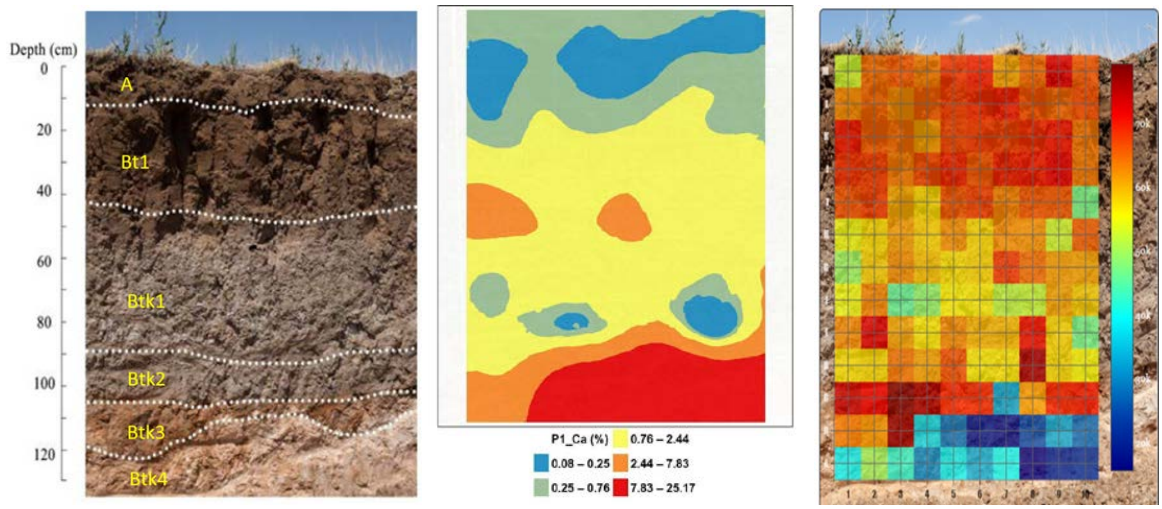

Figure 2. (left) The Acuff soil profile with graphic overlay of the soil horizon boundaries. (center) Example of the Acuff soil with corresponding mosaic showing the percent concentration of calcium throughout the soil profile. Notice the concentration of calcium is highest in the calcic horizon, visible in red, corresponding to the Btk3 and Btk4 horizons in the profile photo. (right) Elemental concentrations shown within each cell in relation to the soil profile. To the right of the graphic is a legend showing how the color relates to the concentration of the element within each cell.