A108 Forensic Soil Analysis of New Jersey State Parks Using a Combination of Simple Techniques and Multivariate Statistics

Jennifer Bonetti, BS, Cedar Crest College, 18 York Place, Kingston, NY 12401; and Lawrence Quarino, PhD, Cedar Crest College, Department of Chemistry & Physical Science, 100 College Avenue, Allentown, PA 18104*

After attending this presentation, attendees will realize that soil evidence is not utilized to its fullest potential in forensic science laboratories and that probative analysis of samples may not involve expensive or complicated instrumentation.

This presentation will impact the forensic science community by serving to provide a method of analysis for soil evidence that provides meaningful results, yet is neither time nor labor intensive.

Soil evidence is found in a large number and variety of criminal cases, yet it is often overlooked in forensic laboratories. Although there are a number of published techniques for testing soil evidence at an analytical scientist's disposal, it seems as though labs without access to a trained forensic geologist are left floundering when it comes to gathering useful information from soil evidence. Recently, emerging techniques have become more and more complicated leading to time and labor intensive methods that are simply not practical for the average crime laboratory. For this study, two simple yet effective methods, particle size distribution and pH measurements, were combined to generate a quick and easy method that can still be used to discriminate between samples from different locations by applying multivariate statistics such as a Principle Component Analysis (PCA).

Five samples at 50 feet intervals from one another were obtained for this study from 12 state parks distributed evenly across the state of New Jersey. The method employed for the particle size distribution was a modification of the method outlined by the Health and Physics program at the University of Nevada, Las Vegas[1]. Small aliquots (1.0-1.8g) were taken from each sample for the particle size distribution. These samples were treated with sodium acetate, hydrogen peroxide, sodium citrate-bicarbonate buffer with sodium dithionite, and sodium hexametaphosphate to remove all cementing and organic materials from the samples before using a wet sieving technique with mesh sizes of #10, #35, #60, #120, and #230. The Kolmogorov-Smirnov test, a nonparametric statistical test, was utilized to identify statistically significant differences between state parks based solely on the particle size distribution data. This curve-comparison test showed less than 35% of park to park comparisons to be indistinguishable (determined by a p-value greater than 0.05).

The pH measurements were carried out in triplicate in both water and 1M $CaCl_2$ using 1.0 grams of soil in 10mL of liquid and analyzed with an Accumet AB15 pH meter. The pH measurements for soil in water and soil in 1M $CaCl_2$ were analyzed separately using a Student's two-tailed t-test without assuming equal variance. In water, four of 66 park to park comparisons were not statistically significant while in $CaCl_2$, five of 66 park to park comparisons were not statistically significant. Only one park to park comparison was indistinguishable using pH measurements in both water and $CaCl_2$.

Using a 2D and 3D Principle Component Analysis (PCA) as well as a 2D and 3D Linear Discriminate Analysis (without prior PCA preprocessing), the 12 state parks could be viewed as clusters and discriminated. These results suggest that for general forensic comparisons, there is no need for complicated, time-consuming, and expensive methods. With the correct statistical analysis, simple conventional methods can be utilized and yield extremely meaningful results.

Reference:

1. Johnson WH. Soil Particle Size Analysis. UNLV Health Physics Program Laboratory Operating Procedure. 1996:1-16.

Soil Analysis, Particle Size Distribution, Multivariant Statistics

 ** Presenting Author*