Archaeological Soil Chemistry in Cultivated Orange Groves

A Test Case from the Blueberry Site, Lake Placid, Florida

Zaida E. Darley, B.A.
E. Christian Wells, Ph.D.
Department of Anthropology, University of South Florida

THE PREMISE

One of the primary roles of archaeological resource managers is to locate and preserve cultural remains. For nearly a century, the technique to accomplish this task is the basic method of shovel testing. Over the years, archaeologists have investigated the accuracy of shovel tests to determine accuracy and effectiveness (e.g., Nance and Ball 1986). The results show that, although shovel tests have their shortcomings, including time and cost, this technique is the most effective for locating cultural materials. The purpose of this poster is to explore simple and inexpensive ways of using soil chemical analysis to supplement or, in some cases, supersede, shovel testing as a way to locate significant subsurface deposits.

Testing has revealed multiple temporal components including Archaic and Historic; the main period is Belle Glade.

Blueberry (8HG678) is an active orange grove in Lake Placid, Florida, with scattered areas of scrub habitats and wetlands. The site has been under constant cultivation for at least a quarter of a century. Combined with climate and the local soil environment, this has produced highly eroded inceptisols with pH = 5.64 (s.d. = 0.27).

The Florida Master Site File describes the soil at this site as Astatula-Paola-Tavares soil series.

A SIMPLE AND INEXPENSIVE METHOD

Below- We used a 1"-diameter hand auger probe to collect samples in the field.

Labor: approx. 2 min. per sample
Cost: $0.10 per sample

IN THE FIELD

Soil samples were collected across an east-west transect through the middle of the site. Two soil samples were collected 5 m apart in a north and south direction, creating a series of pairs. These pairs were collected approximately 25 m apart along the east-west transect. Each sample was collected using a hand auger probe ($25) from a depth of 20 cm. Each sample was placed in a sterile Whirlpak plastic bag ($0.10/ea.). A handheld Garmin 76S GPS device ($250) with an accuracy of less than 3 meters recorded the coordinates for every sample locus.

Cost: $1.23 per sample

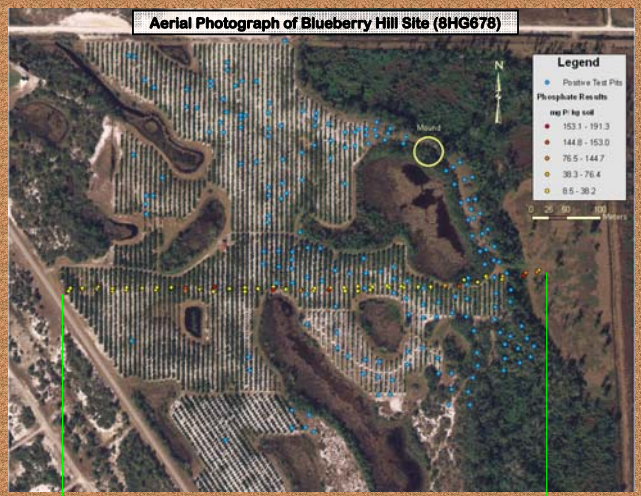
The soil is placed in a Mehlich II solution (left) to extract the phosphates and then filtered into clean vials.

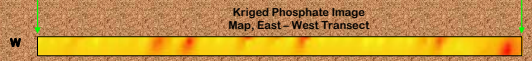
Filtered samples are placed in glass vials with a reagent pillow. The colorimeter (right) records the phosphate levels.

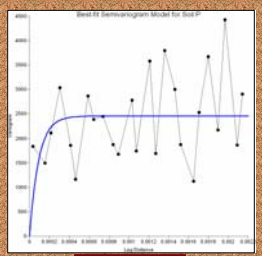
Labor: 5 min. per sample

IN THE LAB

To process the samples, we adapted the field procedure described by Richard Terry and colleagues (2000). Phosphates were extracted using a Mehlich II solution ($0.64/sample) and a PhosVer 3 reagent pillow ($0.26/sample). Two grams of soil were placed in a vial with 20 ml of the extraction solution and agitated for five minutes. The samples were then filtered into clean vials using ashless filter paper ($0.33/sample) Once filtered, the solution was placed in 10 ml glass vials and the reagent was added to the solution. The samples were shaken for one minute. After waiting roughly five minutes for the reagent to fully dissolve, the vials were recorded in a Hach DR 850 colorimeter ($890). After the startup cost of the colorimeter, each sample cost $1.23 to process.







Labor: 30 min.

ON THE COMPUTER

To understand the distribution of P at Blueberry, we used kriging, an empirical model that makes use of spatial dynamics to interpolate unknown values based on known values. Kriging is based on the assumption that the variables between two known points follow a stochastic process, which is characterized by a semivariogram model. A semivariogram model predicts the spatial correlation between two points in such a way that allows the degree of correlation to change according to the spatial arrangement of the samples. Points that are near each other have a certain degree of spatial correlation, but points that are widely separated are statistically independent.

For the current study, we used the computational software program, Surfer, version 8.01 (manufactured by Golden Software, Inc. for $599) to construct an anisotropic exponential semivariogram model (scale=2450, length=0.00011, anisotropy ratio=2, angle=156.4, no nugget effect) using log base-10 standardized extractable soil P data (mg/kg), based on the equation in Cressie (1991:61), $\gamma(h) = C[1-e^{-h}]$. We fitted this theoretical model (blue line) to the experimental model (black line), which is derived from the soil chemical data, for interpolating unknown values in our study area, that is, to predict the chemical concentrations at unsampled locations.

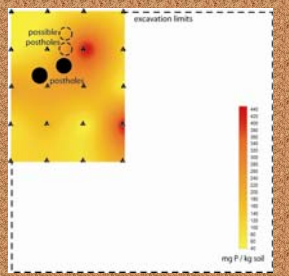
LOOKING FOR SITE BOUNDARIES

Knowing the distribution of phosphates can help in locating the extent of human occupation at a site, which often extends beyond macroscopically visible features and artifact deposits (Wells 2004). We plotted the kriged data on a regular xyz grid, which we overlayed on a plan view base map of Blueberry. The result is a visual probability map of P as it changes over space. The map shows that the deposition of P is variable across the transect, but concentrates in two spots. The P concentration to the east represents a dark anthrosol at the site that was heavily occupied by human settlement over a long period. The P concentration to the west, however, is in a location that shovel testing indicated was devoid of cultural materials. Had we only relied on the positive/negative outcomes from shovel testing, we would have incorrectly concluded that the extent of the archaeological site was much smaller than it appears to be based on our soil chemical assessment.

FINDING HUMAN ACTIVITY AREAS

In addition to its use for detecting site boundaries in the absence of macroscopically visible artifacts or features, soil P chemistry can be used in conjunction with artifact and feature data at smaller scales for understanding the location and nature of activity areas (Wells and Terry 2007). The photo on the right shows a kriged image map of a test unit excavated at the eastern edge of the site, which yielded evidence for postholes and a domestic assemblage of artifacts. Soil P chemistry helped to identify activity loci that can be targeted for further investigation.

Test Unit # 3 phosphate results from the northwest corner of the 2 m x 2 m unit. Triangles are the samples taken and the circles represent possible postholes features.



The picture on the left is Test Unit #3. The stratigraphy shows signs of an over-thickened mollic epipedon. Jeff DuVernay and Zaida Darley (right) are collecting samples from this test unit.

THE BOTTOM LINE

This technique is an inexpensive way to supplement shovel testing. The small sink hole where surrounding shovel tests did not recover artifacts shows high phosphate levels. We recommend that this area needs further investigation.

Summary of labor and cost for the transect:
2 h (field), 5.5 h (lab), 0.5 h (computation/writing)
Initial startup cost: $1764
Cost per sample: $1.33

ACKNOWLEDGMENTS

Anne Reynolds, property owner and founder of the KVAHC
David Butler, principal investigator of investigations at Blueberry Hill
Earthmovers Archaeological Consultants, LLC
Jeff DuVernay, University of South Florida

REFERENCES

Cressie, Noel A.C. (1991) *Statistics for Spatial Data*. Wiley, New York.
Nance, J.D., and B.F. Ball (1986) No Surprises? The Reliability and Validity of Test Pit Sampling. *American Antiquity* 51(3):457-483.
Terry, R.E., P.J. Hardin, S.D. Houston, S.D. Nelson, M.W. Jackson, J. Carr, and J.J. Parnell (2000) Quantitative Phosphorus Measurement: A Field Test Procedure for Archaeological Site Analysis at Piedras Negras, Guatemala. *Geoarchaeology* 15(2): 151-166.
Wells, E. C. (2004) Investigating Activity Patterns in Prehispanic Plazas: Weak Acid-extraction ICP/AES Analysis of Anthrosols at Classic Period El Coyote, Northwest Honduras. *Archaeometry* 46(1):67-84.
Wells, E.C., and R.E. Terry, editors (2007) Advances in Geoarchaeological Approaches to Anthrosol Chemistry, Part II: Activity Area Analysis. Special Issue of *Geoarchaeology* 22(4).