United States Department of Agriculture

Natural Resource Conservation Service

160 East 7th Street
Chester, PA 19013-6092
610-490-6042

Subject: Archaeological Investigation near Oxford, Maryland, November 14 & 15, 1994

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To: Jeri Berc
State Conservationist
USDA-NRCS
John Hanson Business Center
339 Busch's Frontage Road, Suite 301
Annapolis, Maryland 21401-5534

Purpose:
Human bones from Native American burials had been exposed along an eroding bluff near Oxford, Maryland. The site had been examined by the Maryland Historical Trust (MHT). Based on MHT findings and unless additional remains are found at this site, no further fieldwork has been planned for this site. However, concerns have been expressed for the need to halt further bank erosion. At the request of the MHT, the National Soil Survey Center (NSSC) and the NRCS staff in Maryland agreed to provide ground-penetrating radar (GPR) field assistance to help characterize the site and discern whether additional burials are present within the site.

Participants:
Tyler Bastian, Archaeologist, MHT, Crownsville, MD
James A. Doolittle, Soil Specialist, NRCS, Chester, PA
Beth Cole, Archaeologist, MHT, Crownsville, MD
Dennis Curry, Senior Archaeologist, MHT, Crownsville, MD
Richard Hughes, Chief, MHT, Crownsville, MD
Maureen Kavanagh, Archaeologist, MHT, Crownsville, MD
Susan Langley, Archaeologist, MHT, Crownsville, MD
Darrin Lowery, Contract Archaeologist, Talbot County, MD
Anne M. Lynn, State Biologist, NRCS, Annapolis, MD

Activities:
Field work was completed on 14 and 15 November, 1994.

Study Site:
The site was located in a cultivated field, in an area of Sassafras sandy loam, 2 to 5 percent slopes, moderately eroded [1]. near the town

1. Reybold, William. 1970. Soil Survey of Talbot County, Maryland. USDA - Soil Conservation Service. U. S. Government Printing Office. Washington, D. C. pp. 84.

of Oxford. Sassafras is a member of the fine-loamy, siliceous, mesic Typic Hapludults family.

In the representative profile of Sassafras soils, the texture of the surface and subsurface layers are sandy loam. The upper part of the substratum is sand and loamy sand. These materials are fairly resistive and did not limit the choice of antennas or the depth of observation. However, within depths of 2.4 m and in the lower part of the scanned substratum, layers of silt loam and silty clay loam restricted the depth of observation. Within the surveyed area, these medium-textured layers occur at increasingly shallower depths with increased distances from the escarpment and in lower-lying positions of within the landscape.

Equipment:
The ground-penetrating radar unit used in this study was the Subsurface Interface Radar (SIR) System-8 manufactured by Geophysical Survey Systems, Inc. Components of the SIR System-8 used in this study were the model 4800 control unit, ADTEK SR 8004H graphic recorder, power distribution unit, transmission cable (30 m), and the models 3110 (120 mHz), 3105 (300 mHz) and 3102 (500 mHz) antennas. The system was powered by a 12-volt vehicular battery.

A range of 60 nanoseconds (ns) was used in this investigation. A metallic reflector was buried at a depth of about 18 inches and used to determine the velocity of signal propagation through Sassafras soil. Based on the scaled depth to this reflector, the estimated velocity of propagation was 0.062 m/ns, the dielectric constant was 19.9, and the maximum depth of observation was 2.4 meters. Considering the dryness of the observed soil profiles, values for the velocity of propagation and the dielectric constant are suspected of measurement errors and the depth of observation is believed to be slightly greater than estimated.

The system radiates a conical beam and scans a footprint area beneath each antenna. The footprint area is considered circular and can be approximated by the formula:

$$2 \sin^{-1} (1/e),$$

where e is the dielectric constant of the scanned materials (19.9). In this medium, the calculated beam-width for the antennas would be about 6°. The estimated beam diameter would be about 5 and 10 cm at depths of 50 and 100 cm, respectively. It is important to stress that all antennas (500, 300, and 120 mHz) will vertically profile columns of soil having similar horizontal dimensions. Often, field investigators have mistakenly believed that the physically larger 120 mHz antenna scans a larger footprint area than the smaller 300 or 500 mHz antenna.

The 300 and 500 MHz antennas provided superior resolution of subsurface features. However, subsurface horizons and features were

more easily interpreted on the radar profiles obtained with the 120 MHz antenna.

Field Procedures:
Prior to the arrival of the GPR unit, an irregularly shaped, rectangular grid had been established across the site (about 0.8 ha) by the staff of the MHT. The maximum dimensions of the grid were 120 by 70 m. The grid interval was 5 m. The grid extend inland from the bluff overlooking the Tred Avon Creek. Radar traverses were completed along each east-west trending grid line (15) with the 120 MHz antenna.

Following interpretations, additional traverses were completed along the north and south sides of grid lines 165 and 167.5 north, and along the south side of grid line 170 north. Along these lines, additional survey flags had been inserted in the ground at 1 m intervals. The 500, 300, and 120 mHz antennas were used for this part of the investigation. Following radar interpretations, five shallow, exploratory pits were excavated by MHT personnel. The purpose of these pits were to verify radar interpretations.

Interpretations:
Even under favorable site conditions (i.e. dry, coarse-textured soils) the detection of a buried cultural features with GPR can not be guaranteed. The detection of buried cultural features is affected by (i) the electromagnetic gradient existing between a cultural feature and the soil, (ii) the size, shape, and orientation of the buried cultural feature, and (iii) the presence of scattering bodies within the soil.

Unless the radar antenna passed directly over a bundle burial, it was considered unlikely that GPR would detect skeletons. Most bones are too small and not directly detectable with GPR. However, it was anticipated that GPR would discern evidence of disturbed soil conditions within grave shafts, concentrations of artifacts buried with a corpse, or chemically altered soil materials (or red ocher) which often directly surrounds a burial rather than the bones themselves. It is the abrupt truncation and obliteration of soil horizons within the grave shaft that makes most graves and some cultural features detectable with GPR. However, with the passage of time, the signs of disturbances may be erased by natural soil-forming processes or management practices.

Cultural features are difficult to distinguish in soils having numerous rock fragments, tree roots, animal burrows, or stratified and segmented soil layers. These scattering bodies produce undesired subsurface reflections which complicate radar imagery and mask the presence or identity of buried cultural features. Under such conditions, "desired" cultural features can be indistinguishable from the background clutter. The investigated area of Sassafras soils had numerous scattering bodies, many believed to be rock fragments, burrows, and segmented horizons.

In the search for buried cultural features with GPR, success is never guaranteed. Even under ideal site and soil conditions, small, buried cultural features are often missed with GPR. The usefulness of GPR for site assessment purposes depends on the amount of uncertainty or omission that is acceptable.

Results:
Radar profiles identified the locations of numerous point reflectors and a large area which was assumed to have disturbed features. Shallow pits were excavated near two, distinct, point relectors. The objects producing these distinct reflections were identified as a small, buried metallic implement and a large rock fragment.

After a cursory review of the radar profiles, an area having what appeared to be obliterated soil horizons was recognized and located in the field by the participants. Coincidentally, this area of disturbance was adjacent to the point on the escarpment where the bones had been exposed. On the radar profiles, the "disturbed area" appeared to be bounded by truncated soil horizons and was characterized by the absence of distinct subsurface images. Exploratory observations made within this area produce faint and inconclusive evidence of disturbance. Soils within the "disturbed area" appeared to be darker brown with coloration changing across an observable boundary. A few fragments of charcoal were observed within the "disturbed area." However, within the "disturbed area," no artifacts were interpreted from the radar profiles or found within the exploratory pits.

Conclusions:
Results from this survey were inconclusive and did not provide evidence supporting the presences of additional burials. Although unique and identifiable graphic signatures were noted in an area immediately adjacent to the location where exposed bones had been observed, these patterns may reflect natural processes of deposition and/or erosion rather than the effects of artificial disturbances. Without more supporting data, the location of these patterns near the burial site is considered fortuitous.

Ground-penetrating radar techniques have been used infrequently on prehistoric, Native American sites. This field study provided an opportunity to improve interpretative skills and to assess the appropriateness of GPR techniques on these sites. Further studies are needed and recommended to improve NRCS ability to assess subsurface cultural features at similar sites.

This field investigation provided an opportunity for members of NRCS and MHT to exchange information and to work together to resolve a common problem.

All graphic profiles were turned over to Dennis Curry of the MHT for further analysis.

It was a pleasure to work with Anne Lynn and the staff of the Maryland Historical Trust. I thank you for this opportunity.

With kind regards,

James A. Doolittle

O. D. Ashford, Director, NNTC, NRCS, Chester, PA
A. J. Dornbusch, Director, MNTC, Lincoln, NE
M. J. Kaczor, Cultural Resource Specialist, ESS Div., NRCS, Washington, D.C.
J. R. Culver, Assistant Director, Soil Survey Div., NSSC, NRCS, Lincoln, NE
C. S. Holzhey, Assistant Director, Soil Survey Div., NSSC, NRCS, Lincoln, NE