United States Department of Agriculture	Natural Resources Conservation Service	5 Radnor Corporate Center, Suite 200 Radnor, PA 19087-4585

Subject: Archaeology -- Geophysical Assistance **Date:** 8 July 1998

To: David P. Doss
State Conservationist
USDA - NRCS
John Hanson Business Center
339 Busch's Frontage Road, Suite 302
Annapolis, Maryland 21401-5536

Purpose:
The purpose of this investigation was to provide ground-penetrating radar field assistance in an attempt to locate the grave site of Thomas Cresap, a prominent historical figure in Allegany County.

Participating Agencies:
Allegany Soil Conservation District
Cresap Society
Maryland Department of Natural Resources
USDA-Natural Resources Conservation Service
USDI-National Park Service

Principal Participants:
Sarah Bridges, Cultural Resources Specialist/Archaeologist, USDA-NRCS, Beltsville, MD
Ben Cooper, Conservation Planner, Maryland Department of Natural Resources, Cumberland, MD
Jim Doolittle, Research Soil Scientist, USDA-NRCS, Radnor, PA
Anne Lynn, State Biologist, USDA-NRCS, Annapolis, MD
Carl Robinette, Resource Soil Scientist, USDA-NRCS, Cumberland, MD
Steve Potter, Chief Archaeologist, USDI-National Park Service, Washington, DC
Francis Zumbrun, Forest Manager, Maryland Department of Natural Resources, Flintstone, MD

Activities:
All field activities were completed on 25 June 1998.

Equipment:
The radar unit used in this study was the Subsurface Interface Radar (SIR) System-2, manufactured by Geophysical Survey Systems, Inc. This unit is backpack portable and requires two people to operate. The use and operation of GPR have been discussed by Morey (1974), Doolittle (1987), and Daniels and others (1988). The SIR System-2 consists of a digital control unit (DC-2) with keypad, VGA video screen, and connector panel. The 400 and 200 mHz antennas were used in this investigation. The system was powered by a 12-VDC battery.

The GPR is a time scaled system. This system measures the time that it takes electromagnetic energy to travel from the antenna to an interface (e.g., buried cultural feature, soil horizon, stratigraphic layer, bedrock surface) and back. To convert the travel time into a depth scale, either the velocity of pulse propagation or the depth to a reflector must be known. The relationships among depth (d), two-way, pulse travel time (t), and velocity of propagation (v) are described in the following equation (Morey, 1974):

$$v = 2d/t$$

The velocity of propagation is principally affected by the dielectric permittivity (e) of the profiled material(s) according to the equation:

$$e = (c/v)^2$$

where c is the velocity of propagation in a vacuum (0.98 ft/nanosecond). The velocity is expressed in feet per nanosecond (ns). The amount and physical state of water (temperature dependent) have the greatest effect on the dielectric permittivity of a material. Tabled values are available that approximate the dielectric permittivity of some materials (Morey, 1974; Petroy, 1994). However, as discussed by Daniels and others (1988), these values are simply approximations.

Calibration trials were conducted at the site. The purposes of the calibration trials were to determine the velocity of propagation of electromagnetic energy through the soil materials, establish a crude depth scale, and optimize control and recording settings. A shovel blade was buried at a depth of 0.38 m (15 inches). The depth to this buried feature was used to estimate the velocity of propagation through the upper soil horizons. Based on the round-trip travel time to the buried shovel blade, the velocity of propagation through the upper part of the soil was estimated to be 0.0809 m/ns with the 400 mHz antenna. The dielectric permittivity was estimated to be 13.7. With a velocity of 0. 0809 m/ns, a scanning time of 50 ns provided a maximum observation depth of about 2 m.

Discussion:

Introduction:

Thomas Cresap was born in England. He received a land grant for Allegany County from the King of England. In 1740, he built a house near Cumberland, Maryland. Thomas Cresap was a Revolutionary War leader. He died in 1787. In the early 1800's , because of the threat of vandalism, Thomas Cresap's grave stone was believed to have been moved to a church cemetery. The actual grave was not moved and has remained unmarked. The grave is located in a pasture near the Chesapeake and Ohio Canal. The land is owned by the National Park Service.

Study Area:

The survey area is located on the crest of a ridge near Oldtown, Maryland. The survey area is located in a pasture owned by the National Park Service. The study area is located within a unit of Weikert and Gilpin channery silt loam map (Stone and Mathews, 1997). The shallow, excessively drained Weikert soil is a member of the loamy-skeletal, mixed, mesic Lithic Dystrochrept family. The moderately deep, well-drained Gilpin soil is a member of the fine-loamy, mixed, mesic Typic Hapludult family. Soils examined within the study area were members of the included Monongahela (fine-loamy, mixed, mesic Typic Fragiudult family).

Field Procedures:

A rectangular grid was established across the site (0.028 acres). The dimensions of the grid were 63 by 20 feet. The grid intervals were 3 feet (east - west) and 5 feet (north - south). The radar survey was completed by pulling the antennas along the 21 north - south trending grid lines. This direction was chosen because of the presumed orientation of the graves (east- west). This procedure provided about 420 feet of continuous radar imagery. Each radar profile was printed and reviewed for anomalies. One set of recorded radar profiles obtained with the 400 mHz antenna were processed using background removal and gain amplification.

Results:

Figure 1 is a representative radar profile from the site. The depth of observation (> 2m) was suitable for this investigation. The depth scale appears along the left-hand margin of the profile and is in meters. Several features are evident in this profile. The upper boundary of the C horizon is evident and has been highlighted. Several point reflectors (see B, C, and D) are evident in this profile. Based on field observations, these reflectors most likely represent rock fragments.

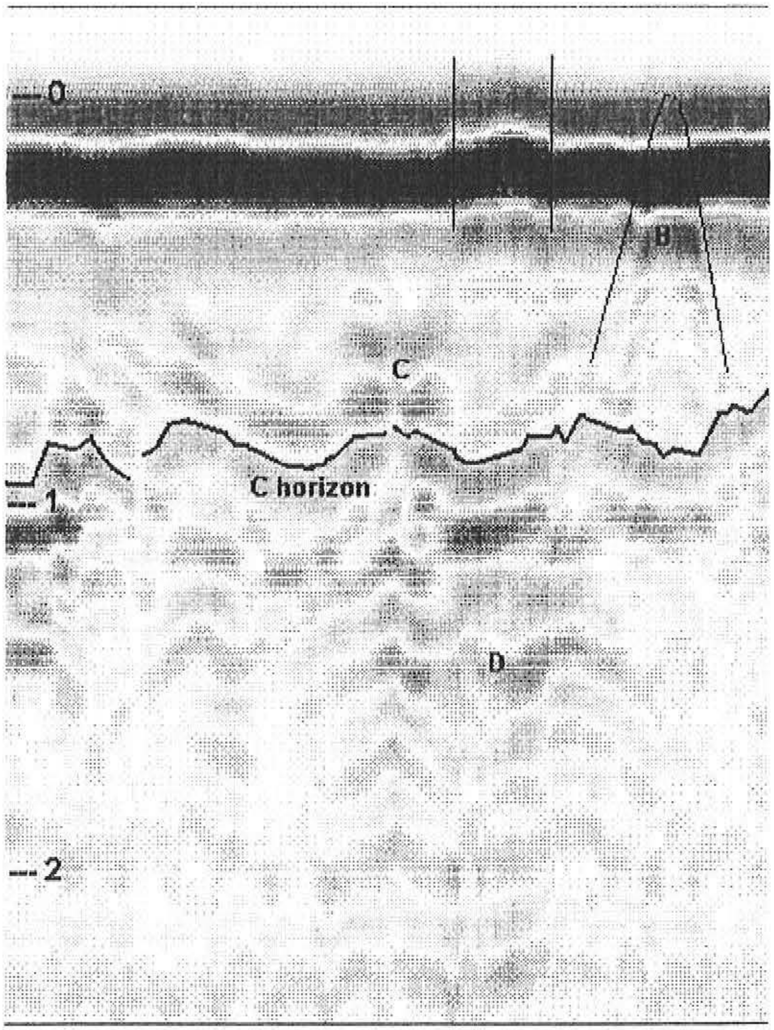

Figure 1 - Representative radar profile from an area of Monongahela soil.

Two features, believed to be the base of a head stone and a kneeling stone, were located and identified by archaeologists during field investigations. Two radar traverses passed between these features. In Figure 1, this area has been bordered by vertical lines and labeled "A". On the radar profile, the soil surface appears to rise in this area. This phenomenon has presumably been produced by denser surface materials. In Figure 1, a shaft-like feature appears to underlie the outlined area.

This could be interpreted as a grave shaft. Bevan (1991) noted that it is more likely that GPR will detect the disturbed soil within a grave shaft, a partially or totally intact coffin, or the chemically altered soil materials that directly surrounds a burial rather than the bones themselves. Killam (1990) believes that most bones are too small and not directly detectable with GPR. This author noted that the disruption of soil horizons makes most graves and some cultural features detectable.

I do not believe that the radar has detected a grave shaft. The large number of rock fragments in these soils makes the detection of a grave shaft improbable. In addition, with the passage of time, the signs of disturbances have most likely been erased by natural soil-forming processes. I believe that the feature (see "A" in Figure 1) represents the reverberated echoes from a near surface feature.

Interpretations are sometimes based on the conspicuous surface features rather than from the imagery appearing on radar profiles. Once these interpretations have been made, supporting subsurface imagery are often visualized or fantasized. Foundation walls that are not deeply buried can produce low, linear ridges. Soil materials used to fill a grave shaft or an excavation often settle, leaving an obvious depression. In some areas, such as at this site, burials are outlined with borders of rock fragments or other objects. Based on observable features, archaeologists identified the most probably burial site of Thomas Cresap. In a representative radar profile from the presumed burial site, the GPR did not provided supplementary, subsurface information. Therefore radar interpretations of the grave site are viewed with deep skepticism.

Conclusions:

In the search for buried cultural features with GPR, success is never guaranteed. Even under ideal site and soil conditions, buried cultural features will be missed with GPR. While the radar did not provide clear evidence of the grave site of Thomas Cresap, the results of the radar survey did not refute the interpretations made by archaeologists.

It was my pleasure to work in Maryland and with members of your fine staff.

With kind regards,

Jim Doolittle

James A. Doolittle
Research Soil Scientist

cc:

Sarah Bridges, Cultural Resource Specialist/Archaeologist, USDA-NRCS, Mid-Atlantic Interdisciplinary Resource Team, 11710 Beltsville Drive, Suite 100, Beltsville, MD 20705

Jim Brown, State Soil Scientist, USDA-NRCS, John Hanson Business Center, 339 Busch's Frontage Road #301, Annapolis, MD 21401-5534

Jim Culver, Acting Director, National Soil Survey Center, Federal Building, Room 152, 100 Centennial Mall North, Lincoln, NE 68508-3866

Elmer Dengler, District Conservationist, USDA-NRCS, 11602 Bedford Road NE, Cumberland, MD 21502

John Kimble, Supervisory Soil Scientist, USDA- NRCS, National Soil Survey Center, Federal Building, Room 152, 100 Centennial Mall North, Lincoln, NE 68508-3866

Ann Lynn, State Biologist, USDA-NRCS, John Hanson Business Center, 339 Busch's Frontage Road #301, Annapolis, MD 21401-5534

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