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I. Introduction

Ground Penetrating Radar, or GPR, survey was completed by The LAMAR Institute and a team from Valdosta State University on January 13, 2010 on portions of two urban lots in Valdosta, Lowndes County, Georgia. Preliminary results of the remote sensing project, which included GPR, soil conductivity, and magnetometry, were presented at the 2010 meeting of the Georgia Academy of Science (Thieme et al. 2010). Magnetometer and ground penetrating radar data also show anomalies in many of the same areas, but there are a number of differences in the results from the different sensors which merit further investigation.

The present report details the findings of the GPR survey. It describes four GPR sample blocks that were placed on the two lots. The survey was successful. Excellent radar reflections were obtained in each of these samples. Several of the anomalies that were identified by the remote sensing survey were investigated by a Valdosta State University archaeological field school. The results of those excavations are concurrently being produced by archaeologists and geoarchaeologists Marvin Smith and Donald Thieme at Valdosta State University.

The study area, known variously as the Smith house and the Masonic Lodge, is located at the intersection of North Patterson and West Hill streets in Valdosta, Georgia (Figure 1).

Figure 1. Project Location.
II. Research Methods

Ground Penetrating Radar, or GPR, uses high frequency electromagnetic microwaves to acquire subsurface data. The device uses a transmitter antenna and closely spaced receiver antenna to detect changes in electromagnetic properties beneath them. The antennas are suspended just above the ground surface and the antennas are shielded to eliminate interference from sources other than directly beneath the device. The transmitting antenna emits a series of electromagnetic waves, which are distorted by differences in soil conductivity, dielectric permittivity, and magnetic permeability. The receiving antenna records the reflected waves for a specified length of time in nanoseconds (ns). The approximate depth of an object can be estimated with GPR by adjusting for electromagnetic propagation conditions.

The GPR sample blocks in this study area were composed of a series of parallel transects, or traverses, spaced 50 cm apart, which yielded a two-dimensional cross-section or profile of the radar data. These samples are termed radargrams. This two-dimensional image is constructed from a sequence of thousands of individual radar traces. A succession of radar traces bouncing off a large buried object will produce a hyperbola, when viewed graphically in profile. Multiple large objects that are in close proximity may produce multiple, overlapping hyperbolas, which are more difficult to interpret.

The GPR signals that are captured by the receiving antenna are recorded as an array of numerals, which can be converted to gray scale (or color) pixel values. The radargrams are essentially a vertical map of the radar reflection off objects and other soil anomalies. It is not an actual map of the objects. The radargram is produced in real time and is viewable on a computer monitor, mounted on the GPR cart. These raw data are later processed in the laboratory to provide additional interpretive information.

GPR has been successfully used for archaeological and forensic anthropological applications to locate relatively shallow features, although the technique also can probe deeply into the ground. The machine is adjusted to best probe to the depth of interest by the use of different frequency range antennas. Higher frequency antennas are more useful at shallow depths, which is most often the case in archaeology. Also, the longer the amount of time (ns) the receiving antenna is set to receive GPR signals, the deeper the search.

The effectiveness of GPR in numerous environments on the North American continent is widely variable and depends on solid conductivity, metallic content, and other pedo-chemical factors. Generally, Georgia’s coastal plain soils have moderately good properties for its application.

GPR signals cannot penetrate large metal objects and the signals are also significantly affected by the presence of salt water. Although radar does not penetrate metal objects, it does generate a distinctive signal that is usually recognizable, particularly for larger metal objects, such as a cast iron cannon or man-hole cover. The signal beneath these objects is often canceled out, which results in a pattern of horizontal lines on the radargram. For smaller objects, such as a scatter of nails, the signal may ricochet from the objects and produce a confusing signal. Rebar-reinforced concrete, as another
example, generates an unmistakable radar pattern of rippled lines on the radargram. The equipment used for this study consisted of a RAMAC/X3M Integrated Radar Control Unit, mounted on a wheeled-cart and linked to a RAMAC XV11 Monitor (Firmware, Version 3.2.36). A 500 megahertz (MHz) shielded antenna was used for the data gathering. MALÅ GeoScience’s Ground Vision (Version 1.4.5) software was used to acquire and record the radar data (MALÅ GeoScience USA 2006a).

The general area of desired GPR survey coverage was dictated by Valdosta State University’s research design. This area was four locations surrounding three sides of a standing wood frame building, tentatively identified as the Smith House site. Upon arrival at the site, the RAMAC X3M Radar Unit was set up for the operation and calibrated. Several trial runs were made on parts of the site to test the machine’s effectiveness in the site’s soils. Machinery settings and other pertinent logistical attributes included the following:

**Machine Settings**
- Time Window: 80.7 ns
- Estimated Signal Velocity: 60 m/microS
- Number of Stacks: 4
- Number of Samples: 632
- Antenna: 500 MHz shielded
- Sampling Frequency: 7462 MHz
- Antenna Separation: 0.18 m
- Radargram Spacing: 50 cm

Minor adjustments to the GPR equipment were made in the field during the data collection phase. The time window that was selected allowed data gathering to focus on the upper two meters of soil, which was the zone most likely to yield archaeological deposits relating to human burial. Additional filters were used to refine the radar information during post-processing. These include adjustments to the gain. These alterations to the data are reversible, however, and do not affect the original data that was collected.

The radar information was displayed as a series of radargrams. Output from the survey was viewed using the GroundVision software program developed by MALÅ GeoScience, which provided preliminary information about the suitability of GPR survey in the area and the effective operation of the equipment. Easy 3D software (Version 1.3.3), also developed by MALÅ GeoScience (2006b), was used in post-processing the radar data and 3-D imaging. This entailed merging the data from the series of radargrams for each block. Once this was accomplished, horizontal slices of the data were examined for important anomalies and patterns of anomalies, which were likely of cultural relevance. These data were displayed as aerial plan maps of the sample areas at varying depths below ground surface. These horizontal views, or time-slices, display the radar information at a set time depth in nanoseconds. Time-depth can be roughly equated to depth below ground.

The GPR data from the present study was further processed with more robust imaging software, GPR-Slice (Version 7.0), developed by Dean Goodman, is recognized as the world leader in GPR imaging (Goodman 2010).

The survey was accomplished by the LAMAR Institute researcher, Valdosta State University staff and students—Can Denizman, Jason Giddens, Gregory Kashkin, Evan Snow and Don Thieme (Project Director). Weather conditions at the time of the survey were cool and clear.

A local site grid was established for the project. Coordinates for this grid were based upon setting an arbitrary N 100 m, E
100 m for the project grid at: Lat: 30 deg, 50 min, 23.4816 sec, Long: 83 deg, 16 min, 55.1244 sec. Expressed in UTM coordinates (NAD(WGS)84, the E 100, N 100 datum is at E 281757.67, N 3144082.89. Data was collected from four grid blocks, which were designated GPR Blocks A-D. Each is described below.

**GPR BLOCK A**

A total of 45 radargrams, which totaled 1.44 kilometers of linear radar data, was collected within this block (Figure 2). GPR Block A measured 32 m (grid) North-South by 22.5 m (grid) East-West. Radargrams were collected from East to West and data collection progress was from South to North. The Vegetation consisted of a grassy lawn with lightly scattered trees and shrubs. GPR Block A corresponds to Grid 4, cited in other aspects of this study. The northwestern corner of Grid 4 is located at grid coordinates E 69.000, N 165.000.

![Radargram Plan of GPR Block A (0,0 m point is in southeast corner).](image)

**GPR BLOCK B**

GPR Block B measured 9 m North-South by 12-32 m East-West. A total of 18 radargrams, which totaled 480 meters of radar data, was collected within Block B (Figure 3). Radargrams were collected from West to East and data collection progress was from North to South. Shrubs hindered data collection in the southeastern part of the grid, which accounts for the irregular coverage. GPR Block B corresponds to Grid 3, cited in other aspects of this study. The
northwest corner of Grid 3 was at E 82.000, N 134.000. The GPR grid extended to the south of this grid approximately 5 m more than the areas covered by EM-38 and Magnetometry. Field conditions were similar to Block A with grass, shrubs and small trees.

GRID BLOCK C

GPR Block C measured 4-30 m North-South by 6 m East-West. A total of 12 radargrams, which totaled 334 meters of radar data, was collected within Block C (Figure 4).
GRID BLOCK D

GPR Block D measured 7.5 m North-South by 33 m East-West. A total of 16 radargrams, which totaled 503 meters of radar data, was collected within Block D (Figure 5). Radargrams were collected from West to East and data collection progress was from North to South. GPR Block D corresponds to Grid 1, cited in other aspects of this study. The northwest corner of Grid 1 was at E 93.500, N105.000. The field conditions consisted of grass and shrubs and a cement walkway and granite curbing.
Figure 5. Radargram Plan of GPR Block D (0,0 m point is in northwest corner).
III. Results

The GPR survey of the Smith House site in Valdosta yielded favorable results. The radar signals were strong and they revealed information about subsurface anomalies at all parts of the study area. The findings in each GPR Block are described below.

GPR BLOCK A

Block A was the largest sample block in the survey. It covered most of a vacant lot that was situated immediately north of the lot containing the Smith house. Several utility lines were noted in the GPR data within Block A. Numerous other small radar anomalies also are apparent in the various plan maps. The function of these anomalies remains undetermined. Several of these, which are elongated and curvilinear, probably are radar reflections created by large tree roots. No obvious structural patterns were noted in the GPR data.

On the western end of Block A a buried zone is evident in the GPR profile from about 60-80 cm below ground. This zone may represent a filling episode relating to the modern construction just west of the project tract. It is illustrated in Figure 6.

Figure 6. Block A, Radargram 45, Showing Buried Zone at About 60-80 cm Depth.

Figure 7 shows a plan view of Block A at 6-10 ns Time Depth. Figure 8 is a plan view of Block A at 36-40 ns.
An overlay map of Block A is shown in Figure 9. Several strong radar anomalies are apparent in this view. One of these is a diagonal line, which likely relates to a utility line, or possibly a sewerage drain line. The strong radar reflections on the western (upper) end of this sample are enigmatic, but they may represent an area with wetter soils, or possibly an area of refuse disposal. The strong radar reflections on the northern (right) side are probably related to the fill foundation of a recent building on the adjacent lot. The eastern one-half of Block A contains many GPR anomalies in the overlay view, and some of these probably relate to previous historic occupation on this city lot.
GPR BLOCK B

Block B was located immediately to the rear (north) of the Smith house. A representative radargram (Radargram 55) from Block B is shown in Figure 10. Numerous strong radar reflections are visible in this view, which may represent cultural features.

Two plan views of Block B are shown in Figures 11 and 12. They reveal several large oval anomalies. These may represent privies, wells or trash pits. The first view is from 23-27 ns depth. The next view of Block B is from 57-60 ns depth. Some of the anomalies seen in the previous view remain visible. A large anomaly is visible in the second view, however, that was not apparent at upper depths.
An overlay map of Block B is shown in Figure 13. It reveals a heavy concentration of radar reflections in the east-central portion of this block. A probable (but poorly defined) utility line or ditch is apparent in the western section of Block B. Interestingly, the large anomaly observed in the previous view is less obvious in the overlay view.
GPR BLOCK C

Block C was located immediately to the west side of the Smith house. A representative radargram (Radargram 72) is shown in Figure 14. This view contains a very large, strong radar reflection approximately 7 m in extent, which is also apparent in plan view. The top of this strong reflection is approximately 60-70 cm below ground surface.
Despite the relatively small size of this sample, Block C yield most intriguing GPR results of the four grids. A large oval to sub-rectangular radar reflection is visible on the east-central portion of the grid in Figure 15 at 14-17 ns depth. This feature measures approximately 10 m north-south by (at least) 3 m east-west. It likely continues to the east towards the house and beyond the GPR coverage.

The previously described oval radar anomaly is not visible in plan view at 58-62 ns depth, although strong radar reflections remain on its northern and southern parts (Figure 16). Another strong linear anomaly is visible in this view, although it may be related to construction activity on the adjacent Georgia Power Company facility.

Figure 15. Aerial View of GPR Block C at 14-17 ns.

Figure 16. Aerial View of GPR Block C at 58-62 ns.

An overlay map of Block C is shown in Figure 17. It reveals concentrations of radar
reflections in the previously described “large oval”, as well as a concentration of strong reflections on the northern end of the sample.

**GPR BLOCK D**

Block D was located in the front (east) yard of the Smith house. A representative radargram (Radargram 80) is shown in Figure 18. A series of buried utility pipes or lines are evident in the upper strata and other soil disturbances are visible at greater depths. Some of these soil disturbances may be associated with the utility line construction. These modern features are also apparent in plan view.

![Figure 17. Overlay View of GPR Block A.](image-url)
Figure 18. Block D, Radargram 80, Exhibiting Utility Lines and Other Disturbances.

Four north-south oriented utility lines are clearly visible in plan view the GPR data in the upper zones (6-10 ns), as shown in Figures 19 and 20. Three of these are closely spaced and are aligned with the orientation of the concrete front walkway to the leading from Gordon Street to the house.
A plan view of Block D at greater depth (49-53 ns) shows no evidence of the cluster of three utility ditches but the western (lowermost) utility trench is still evident (Figure 20). An area of disturbance is also clearly visible in the eastern (upper) end of the sample block. This disturbance is likely related to the street infrastructure.

An overlay map of Block D, shown in Figure 21, reveals the four previously described utility lines. Another diagonal line, which also may be a utility ditch, is visible in this view. A series of small, segmented, radar anomalies are visible in the eastern (upper) third of the sample block, which were not evident in the individual plan views, as are two large “blob” anomalies in the western (lower) portion of
the overlay map. The function of these radar anomalies is presently unknown.

Figure 21. Overlay View of GPR Block D.
IV. Summary Interpretations

The GPR survey of the Smith house site in Valdosta provides another layer of remote sensing data that can be used to understand the past human activity on this historical property. The GPR survey coverage totaled 2,757 meters of radar data, or approximately 1,275.5 m², which was collected along 91 radargrams in four grid blocks (A-D). As expected, the GPR equipment detected many utility lines that criss-cross the property. These features may have very limited archaeological value and their definition by the survey may actually help the archaeologists to avoid needless (and potentially hazardous) excavation in these areas. Several other potential targets are suggested in the GPR data. The most curious feature is the large oval feature, just west of the house, in Block C. Its age and function is undetermined at present, but it would be an excellent target for archaeological exploration. This feature extends approximately 10 m north-south but is fairly narrow on its east-west axis. The several large oval anomalies in Block B also may be interesting targets for archaeology, since they may be pit, privy or well features that possibly contain sealed deposits of artifacts associated with the earlier site occupants. When the GPR data is combined with the other data layers, a more complete picture of site occupation and historic land use should emerge. A composite view of the four GPR samples at 21-25 ns depth is shown in Figure 22.

Figure 22. Composite View of GPR Blocks A-D, Smith House Site (21-25 ns Depth).
References Cited

Goodman, Dean


MALÅ GeoScience USA


Thieme, Donald M., C. Poppeliers, D. Elliott, M. Smith and C. Denizman