IDENTIFICATION OF UNMARKED GRAVES AT TWO HISTORIC CEMETERIES IN GEORGIA

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DETECTION OF UNMARKED GRAVES USING GPR

The two field investigations summarized in this paper both involve detection of unmarked graves in historic cemeteries using ground-penetrating radar (GPR). Figure 1 indicates the location of the Sunset Hill Cemetery in Valdosta (“SH”) and of the Dickson-Rainey Burial Ground south of Macon (“DR”) on a map of the state of Georgia. Both the physical conditions and land use of the two sites are quite different, one being an abandoned family burial ground on a former farm in the Piedmont (Hammack and Thieme 2012) and the other being a city cemetery on the Lower Coastal Plain (Giddens 2011). Shallow subsurface anomalies thought to represent unmarked graves were successfully detected and mapped using GPR in both investigations.

While GPR is only one of several geophysical methods which can be used to detect graves and other features in the shallow subsurface, it has proven to be the most versatile single method (Conyers 2004; Daniels 2000; Milsom 1996; Tarver and Bigman, this volume). There is also a distinct advantage to using GPR in that we are able to estimate the depth below surface of various subsurface features (Conyers 2004; Daniels 2000; Goodman et al. 1995).

There is currently great demand for GPR investigations of cemeteries and other historic properties not only from archaeological field teams but also from land managers who hope to identify possible unmarked graves without disturbing any of the human remains which may lie therein. Some operators simply run transects and mark apparent anomalies based upon the data displayed on their computer monitor. In most scientific applications of GPR to cemetery investigations, however, data are collected from closely-spaced transects using an antenna which transmits in the range from 250 MHz to 1 GHz. Processing of individual two dimensional profiles of each transect and of the entire set of profiles for the survey grid requires expertise in specialized computer software written specifically for analysis of GPR data (e.g. Conyers 2010; Goodman 2012; Oden and Moulton 2006).

Even when data are carefully collected and processed using the most advanced software, however, anomalies from shallow geophysical investigations can be difficult to interpret. This is no less true of the anomalies mapped using GPR than it is of mapping by other methods. A variety of processes, both natural and cultural, are typically respon-
Figure 1. Location of the Sunset Hill Cemetery (“SH”) and Dixon-Rainey Burial Ground (“DR”) within the state of Georgia, USA.
sible for the anomalies identified in archaeological sites and historic cemeteries. Very often the features which are the primary target of the archaeologist or land manager are somewhat rare in comparison to natural features such as tree roots or more recent cultural disturbances which also show up as anomalies in the GPR study. One way to improve clarity in the interpretation of GPR data is to classify anomalies on the basis of their characteristic appearance on two-dimensional GPR profiles or three-dimensional time slice maps. This approach was used in analyzing the results from the Dickson-Rainey Burial Ground site field investigation as reported by Hammack and Thieme (2012) and later in this paper.

Several papers in this issue of Early Georgia provide examples where archaeological excavation has been used to provide “ground truth” for the results from GPR and other shallow geophysical methods (e.g. Tarver and Bigman, this volume). Although such “ground truth” by excavation was not possible in either of the case studies reported here, there is very specific and independent evidence of the presence of unmarked graves at both sites. In the case of the Sunset Hill Cemetery in Valdosta, the area investigated by Giddens (2011) was specifically described in a National Register nomination (Davis 2004; SHPO 2004) as well as in a privately published history of Valdosta (Pendleton 1998). The current manager of the cemetery as well as his predecessor both found the results of our investigation to be plausible and consistent with the common occurrence of grave shafts and human remains in locations which are missing headstones or other clear indications of their presence.

With respect to the Dickson-Rainey Burial Ground site, a report of a field visit to the area from 1957 describes eight marked graves and about 40 graves altogether. This was only seven years before the property was condemned to be used for Lake Tokesofkee in 1964 (Hammack and Thieme 2012: 6-14; LDS 1957). An aerial photograph from 1938 also shows a forested grove at the location of the burial ground, surrounded by cleared fields (Hammack and Thieme 2012: 14). These sorts of archival and informant sources can serve as independent evidence regarding some if not all of the anomalies identified using GPR.

**SUNSET HILL CEMETERY**

Sunset Hill Cemetery sits immediately south of the campus of Valdosta State University (Figure 2). It is one of the oldest cemeteries in Valdosta and is listed on the National Register of Historic Places (Davis 2004; SHPO 2004). The GPR investigations reported below were at the site of the Slave Memorial within the cemetery. A granite memorial archway was erected here in 1995 to mark a section which African American workers were told may contain “slave” graves by a local woman during the late 1930s or early 1940s (Pendleton 1998; SHPO 2004: 15). Grave digging was halted in that section of Sunset Hill Cemetery and there is no record of any interments. As reported by Pendleton (1998), however, unmarked graves may represent not only slaves but also Union soldiers who were stationed in Valdosta and succumbed to infectious disease from 1865 to 1866.

Sunset Hill Cemetery was founded in 1861 on an initial 30 acre plot donated by Charles Ogden Force (SHPO 2004). The first interment was Dr. T. W. Ellis in February, 1861. Valdosta did not have many large plantations (Davis 2011), but a few former slaves were buried within family plots in the early years of the cemetery. Unmarked graves also exist throughout the present cemetery, and many of these probably do represent African American residents of the city. There is also a separate six acre tract which was opened at the northern end of the cemetery for African Americans buried after 1892. The cemetery has been integrated since 1956 but there is relatively little unclaimed ground for new interments other than within family plots used previously.

Immediately to the west of the granite memorial archway at the Slave Memorial (see Figure 3), we collected GPR data for a 20 x 20 m (400 m2) grid in January of 2011 (Giddens 2011). We used a MALÅ 250 MHz shielded antenna to collect 41 profiles running from East to West on January 3rd, 2011 and 40 profiles from South to North on January 22, 2011. Battery limitations dictated
that the profiles be collected in two separate days of fieldwork, with a total of 81 profiles’ worth of data collected for the 400 m² area. Figure 3 shows the MALÅ 250 MHz antenna being pulled along a profile from South to North just west of the granite memorial archway at the Slave Memorial.

All 81 GPR profiles were processed in RadExplorer 1.4 using a simple flow of four filters. A DC Removal filter was used to remove the noise from the DC battery and the transmitter itself as well as to correct for mean drift in the energy returned to the antenna receiver (Cassidy 2009: 150). A Time Zero Adjustment was made to 14 ns, the moment that the radar signal first encountered the ground surface. Amplitude Correction was used to boost the signal with depth below the surface (Cassidy 2009: 161-164), a function commonly referred to as “gain” on hardware and software from other manufacturers. The final function in the flow for this data was a Bandpass Filter, which increases signal to noise ratio (Cassidy 2009: 153).

The three-dimensional processing of the GPR profile grids collected at Sunset Hill Cemetery was performed using GPR Process (Conyers 2010). Time slice contour maps and three-dimensional surface plots were produced from the GPR
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Circular anomalies in Slices 3-5 (see Figure 4) probably represent disturbance by fire ants or other bioturbating organisms. As shown in Figure 5, much larger rectangular anomalies appear in Slices 6-7 at depths from 5.2-7.3 feet (1.6-2.24 m). These are interpreted to be probable unmarked graves which may represent either Union soldiers or slaves. The linear feature along the south edge of Slices 7 and 8 could be an underground pipe. Circular anomalies in Slices 9 and 10 possibly represent old pine tree tap roots.

The three-dimensional surface plot of Slice 6 (Figure 5) shows large rectangular features which probably represent unmarked graves in Sunset Hill cemetery. Subsurface anomalies marked out on the figure represent high and/or sharp relative amplitudes which occur at depths of 1.6-1.9 me-

Figure 3. Collecting GPR data along a profile running from South to North immediately west of the granite memorial archway at the Slave Memorial in Sunset Hill Cemetery, Valdosta, Georgia.
ers (5.2-6.2 feet). The anomaly patterns form right angles suggesting rectangular subsurface features. Another indication that these rectangular features are probably graves is the fact that all of them are oriented in an East-West direction.

In Figure 6, the size and shape of the anomalies in Slice 6 are shown in relation to the Slave Memorial itself in Sunset Hill Cemetery. With horizontal dimensions of up to six by eight meters (20 by 26 feet), the anomalies are clearly too large to be individual graves. One plausible interpretation is that these anomalies represent one or more mass interments in this area of Sunset Hill Cemetery. Based upon review of written history about the cemetery (SHPO 2004; Pendleton 1998) and consultation with Donald Davis of the Lowndes County Museum, the best candidates for such a mass interment would probably be Union soldiers stationed in Valdosta who succumbed to infectious disease during 1865 to 1866.

**Dickson-Rainey Burial Ground**

In 1957, representatives of the Church of Jesus Christ of Latter Day Saints visited a small ridge overlooking Tobesofkee Creek to record what was then known as the Rainey Family Cemetery (LDS 1957). They observed eight marked graves and about 40 graves altogether on property which has been traced in a title search by Stephen Hammack back to owners with the family name Dickson as early as 1857 (Hammack and Thieme 2012). A plat of 1871 shows a neighbor to the east of the Dickson family land by the name of W. Rainey, and so it seems likely that graves of both the Dickson and Rainey families are present within the site here designated as the Dickson-Rainey Burial Ground.

The site became part of the Lake Tobesofkee Recreation Area in 1964, and it is currently located in Sandy Beach Park between Moseley Dickson Road and the lake itself (see Figure 7). Ground-penetrating radar (GPR) investigations...
were performed on June 21, 2012 to determine whether unmarked graves were in fact present and where they are concentrated. A MALÅ 500 MHz antenna was towed across a grid of 53 x 52 meters (2,756 m2), covering approximately 70 percent of the one acre site delimited using the historical research. The baseline for the GPR profiles extended between the SE and NE corners of the grid on a bearing 22.5 degrees east of magnetic north, 17.5 degrees east of true north. Professional surveyors from Bibb County assisted by surveying in the grid and mapping every geophysical anomaly using a total station.

Fifty-four GPR profiles were collected at the Dickson-Rainey Burial Ground site along transects spaced one meter apart. Each profile extended for 52 meters moving northwest from the baseline. With the time window set at 31.6 ns and an average velocity of 10 cm/ns for the radar pulse to travel through the sandy loam soils, the GPR profiles record anomalies to a depth of at least three meters within the area investigated. While the one meter spacing between profiles has proved to be a bit too great for detailed three dimensional imaging, the location and general dimensions of anomalies mapped using GPR does indicate that intact graves or grave shafts are still present at the site.

Anomalies were flagged in the field and then mapped in by the professional survey team (see Figure 9). Any significant interruption or “truncation” of horizontal bands in the upper 10 ns of a profile was considered to be an anomaly,
Figure 6. Slave Memorial site in Sunset Hill Cemetery showing the anomalies mapped in Slice 6, 20-24 ns, 5.3-6.2 feet below surface (based on an image from Google Earth).

Figure 7. Dickson-Rainey Burial Ground site depicted on the USGS topographic map of the Lizella 7.5 minute quadrangle (prepared using software from National Geographic).
and most anomalies appeared in two or more GPR profiles. Based upon the pattern of the reflections, we made a very general distinction between “N” (natural) and “C” (cultural) anomalies (see Figure 9).

A wider variety of features and processes are responsible for what we flagged as “N” anomalies. As discussed below, some of the “N” anomalies probably were caused by human activities such as heavy equipment modifications to the site after the time when the farm and burial ground were abandoned.

Approximately 20 possible grave shafts were identified at the “C” anomaly locations given by UTM grid coordinates in Table 1. Grid coordinates are for each location marked with a flag as the approximate center of the anomaly identified along a GPR profile. A typical example of a “C” anomaly is illustrated by the anomaly which was designated “C3” along the GPR profile 23 (Figure 10). The radargram for this profile has been processed with several filters using the program RadExplorer 1.4. As with the Sunset Hill cemetery investigation, filters were used for DC Removal, Amplitude Correction, and Bandpass filtering. For the Dickson-Rainey Burial Ground site, “time zero” was set at 6.8 ns which was at or above the first inflection or “wiggle” in traces examined for every profile. Time zero for each radargram should generally correspond to the original land surface, where the returning radar wave is scattered by the air (Conyers 2004: 122).

Horizontal reflectors appearing in the radargrams at approximately 5 ns (50 cm) and 7 ns (70 cm) represent soil horizon boundaries common to nearly all of the profiles for the Dickson-Rainey Burial Ground site. As illustrated by the “C3” anomaly in Figure 10, grave shafts originate from a former land surface which is no more than 50 cm beneath the present surface. Sharp vertical truncations where the soil was cut through during excavation typically occur on only one side of the

Figure 8. Dickson-Rainey Burial Ground site at Sandy Beach Park showing the four corners of the GPR survey grid (based on an image from Google Earth).
Figure 9. Shallow subsurface anomalies identified with GPR at the Dickson-Rainey Burial Ground site.

profile anomaly. The jumbled pattern of GPR reflections from the material which abuts the truncations on the other side represents “fill” material which was introduced into the grave shaft anomaly (Conyers 2004: 160-161). Some “C” anomalies also contain “hyperbola” patterns in this space abutting the truncations, indicating voids or chambers where a coffin may be found (Conyers 2006: 136-137; Goodman and Nishimura 1993). Metal or magnetized soil material was also indicated by a “ringing” pattern (Conyers 2004: 77-79) within many of the “C” anomalies.

The largest anomalies on the site are the result of natural processes, particularly the growth of tree roots into the ground followed by natural decay as well as removal and burning of trees on the site. There is a tree line within fifty meters of the lower left (SE) corner of the GPR grid, and several trees were clustered toward the left (S) side of the grid. Roots of these trees and of trees which had previously grown on the Dickson-Rainey Burial Ground site have created distinctive geophysical anomalies. Anomaly “N1” as shown on GPR profile 2 (Figure 11) represents the roots from a cluster of four trees currently growing on this part of the Dickson-Rainey Burial Ground site GPR grid. Anomaly “N2” shown at the northwest end of the profile exhibits a similar pattern of radar wave reflections, and anomalies N2, N3, N6, and N8 are all interpreted to record disturbance by trees which formerly grew on the site. A grove of trees is clearly shown at the probable location of the Dickson-Rainey Burial Ground in an aerial photograph from 1938 (Figure 12) and some of these “N” geophysical anomalies may be at least as old as the graves themselves.

A number of other “N” anomalies resulting from natural processes or other human activities on the property were also identified and mapped in this investigation. Relatively deep disturbance, probably by heavy equipment, is evident along the eastern edge of the site, bordering the bare soil which is visible in the Google Earth image on Figure 8. In GPR profile 23 (Figure 10), anomaly N4...
Table 1. UTM Grid Coordinates (NAD83 Zone 17N) for “C” and “N” Anomalies at the Dixon-Rainey Cemetery, Bibb County, Georgia.

<table>
<thead>
<tr>
<th>Anomaly</th>
<th>UTM N (km)</th>
<th>UTM E (km)</th>
<th>Interpretation</th>
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</thead>
<tbody>
<tr>
<td>N1</td>
<td>3,635,604.17</td>
<td>238,849.69</td>
<td>4 Standing Trees, rooted together</td>
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<tr>
<td>N2</td>
<td>3,635,612.64</td>
<td>238,835.37</td>
<td>Trees removed after abandonment</td>
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<tr>
<td>N3</td>
<td>3,635,614.46</td>
<td>238,844.47</td>
<td>Probable tree or trees</td>
</tr>
<tr>
<td>N4</td>
<td>3,635,620.11</td>
<td>238,867.85</td>
<td>Scraped with heavy equipment, filled</td>
</tr>
<tr>
<td>N5</td>
<td>3,635,641.65</td>
<td>238,840.79</td>
<td>Old road bed</td>
</tr>
<tr>
<td>N6</td>
<td>3,635,638.54</td>
<td>238,879.38</td>
<td>Tree or gully</td>
</tr>
<tr>
<td>N7A</td>
<td>3,635,643.78</td>
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<td>Gully draining to Tobesofkee Creek</td>
</tr>
<tr>
<td>N7B</td>
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<td>238,860.22</td>
<td>Gully draining to Tobesofkee Creek</td>
</tr>
<tr>
<td>N7C</td>
<td>3,635,648.03</td>
<td>238,860.41</td>
<td>Gully draining to Tobesofkee Creek</td>
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<tr>
<td>N8</td>
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<td>238,857.29</td>
<td>Tree or gully</td>
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<td>Grave</td>
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<td>C2A</td>
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<tr>
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<td>Large Grave aligned N-S</td>
</tr>
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<td>C3</td>
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<td>Grave shaft dug to &gt;1.8 m (18 ns)</td>
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<tr>
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<td>Grave</td>
</tr>
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<td>C20</td>
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<td>238,857.22</td>
<td>Grave</td>
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Figure 10: Radargram for GPR Profile 23, Dickson-Raney Burial Ground site.

Figure 11: Radargram for GPR Profile 2, Dickson-Raney Burial Ground site.
Figure 12. Detail of a 1938 Aerial Photograph showing the probable location of the Dickson-Rainey Burial Ground site in relation to Tobesofkee Creek.
takes the form of reflections dipping to the east, opposite the direction in which the antenna was pulled. The disturbance here extends to at least 1.5 m while similar disturbance along other profiles barely extends beneath the upper 50 cm of parallel soil horizon reflectors.

A three-dimensional analysis of all 54 radargrams collected at the Dickson-Rainey Burial Ground site was performed using the time slice program GPR-SLICE (Goodman et al. 1995; Goodman 2012). Unfortunately, the one meter spacing between GPR profiles at the Dickson-Rainey Burial Ground site limited the detail shown on the time slice amplitude maps. While all of the “N” anomalies identified in the field were large enough to be identifiable on one or more of the time slice amplitude maps, many of the “C” anomalies were only present in one or two of the GPR profiles. Not all of the “C” anomalies could be identified with specific areas of either low or high amplitude on the time slice maps but several did coincide with areas of low amplitude at or beneath the depth for Slice 9 (Figure 13). At a depth of approximately 87-107 cm (2.9-3.5 ft) below surface there do appear to be some mappable areas of lower density sediment or even void spaces, shown as triangles on Figure 13.

The “C” anomalies identified using ground-penetrating radar (GPR) at the Dickson-Rainey Burial Ground site may not all represent graves, but many do have a pattern or signature on the two-dimensional radar profiles which is very characteristic of grave shaft features (Conyers 2004, 2006; Goodman et al. 1995). The area where those features occur is only a portion of the one acre site initially defined on the basis of historic maps and archival research. Possible grave features are clustered in a rectangular area of approximately 24 m x 20 m (480 m²). Anomalies begin approximately 15 m in from the left edge of the profile grid and continue to about 39 m moving to the right. In the direction of travel of the GPR profiles, the possible grave features were found in a cluster between a distance of 25 m and 45 m from the baseline.

**DISCUSSION AND COMPARISONS**

The two field investigations summarized above demonstrate that significant results can be obtained on historic cemetery sites by using ground-penetrating radar in ways that have been developed for archaeological applications. Classification of anomalies on the basis of their characteristic appearance on two-dimensional radargrams or three-dimensional time slice maps improves the interpretation of GPR data. Published radargram and time slice analyses already show many if not all of the common subsurface features encountered on historic cemetery sites. The papers collected in this issue of Early Georgia will contribute significantly to identifying common examples found on sites here in Georgia.

Neither the Sunset Hill Cemetery nor the Dixon-Rainey Burial Ground site investigations represents an ideal case in terms of the available equipment, time available, or opportunities to obtain “ground truth” through excavation of the anomalies identified. Some such ground truth may eventually be possible in certain areas of Sunset Hill Cemetery thanks to its proximity to Valdosta State University and the fact that it is actively maintained and used for new interments. Because the cemetery and this part of Valdosta are laid out along cardinal directions, it is simple to align GPR profile grids with the expected alignment of grave shafts.

Stronger definition of east-west trending grave shaft anomalies is ordinarily possible when the GPR profiles are run from South to North or vice versa. We found this to be true for both radargrams and time slices prepared from GPR profiles run from South to North as opposed to East to West by Giddens (2011). While only a single direction of travel was used for the GPR profiles collected at the Dixon-Rainey Burial Ground site, a few of the anomalies identified as possible graves do correspond to areas of low relative amplitude oriented east-west on Figure 13. Despite the limitations of the data obtained using one meter spacing between GPR profiles, results significantly improved upon the initial field investigations using steel probes which failed to find voids or cavi-
ties aligned east-west at the Dixon-Rainey Burial Ground site.

In addition to differences due to field method and instrumentation, the Dixon-Rainey and Sunset Hill sites differ significantly in terms of physical scale as well as how much the interment of individuals was influenced by planning and cultural tradition through time. A cemetery typically has a more or less uniform orientation and spacing of graves or has systematic variation from section to section. Family burial grounds on small farms may not be as carefully planned, particularly where the land changes hands as seems to have happened with the Dixon-Rainey Burial Ground site. Based upon the GPR results it appears that the initial interments were probably made along the high ground on a natural ridge. Overlapping of some anomalies found in more than one GPR profile suggests the possibility that some graves were not well marked and were disturbed by new interments while the burial ground was still in use.

Figure 13. Map of shallow subsurface anomalies overlaid on 15.5-17.5 ns (88-108 cm) time slice for the Dickson-Rainey Burial Ground site.
Both field investigations reported above have been structured and pursued with insights gained during my own experience and interest in archaeological applications of ground-penetrating radar (GPR) and other shallow geophysical methods. However, the research objectives were less focused upon the identification of targets to excavate than is typical where shallow geophysics is applied in conjunction with archaeological fieldwork. In fact, many land managers are currently requesting such geophysical investigations precisely because they are not intrusive and will provide information about areas where it is not now and may never be possible to disturb the ground.

Although excavation always provides the most direct form of ground truth, other types of information can serve a similar function in corroborating the occurrence of features known to result in geophysical anomalies. As should be clear by now, the quality of historical documentation and the amount of archival research completed prior to a shallow geophysical survey can be very important for making strong inferences where there are limited opportunities to obtain ground truth through excavation.

In the case of Sunset Hill Cemetery, the Valdosta community clearly values and protects the Slave Memorial for reasons which transcend the actual materials or remains which may be found within the apparent interments there (Davis 2004; Gambill 1996; Poling 2004; SHPO 2004; Vickers 1995). The Dickson-Rainey Burial Ground, on the other hand, is on public property with many competing uses in addition to its veneration by the few remaining family members. Defining the limits of the area which may contain human remains could allow more space for these competing uses as well as better protection for the graves themselves.

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