Ground Penetrating Radar (GPR) Investigations at Fort Pulaski National Monument, Chatham County, Georgia

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ABSTRACT

On August 3-4, 2004, staff archaeologists from the Georgia Department of Transportation (GDOT) conducted a series of ground penetrating radar (GPR) assessments of selected areas within Fort Pulaski National Monument, in Chatham County, Georgia. This work was accomplished as part of an ongoing cooperative relationship between GDOT and the National Park Service (NPS).

This series of investigations was focused on identifying archaeological materials associated with the construction village west of the actual fortifications. Results of the survey indicate numerous areas of high reflectivity, indications of possible sub-surface targets and areas of archaeological interest, as well as overall sedimentary conditions. Verification of the sub-surface targets will need to come from future archaeological work and ground truthing excavations.

ACKNOWLEDGEMENTS

This project would not have been possible without the cooperation and enthusiasm of the staff from both Fort Pulaski National Monument (FOPU) and the Southeast Archeological Center (SEAC). I wish to express my sincere appreciation for the time and help of the following individuals: John Breen, June Devisfruto, Mike Hosti, all of FOPU, and Dr. Guy Prentice of SEAC. Without their tremendous knowledge and expertise we would have been at a significant disadvantage. I also wish to thank both Jim Pomfret and Terri Lotti, my colleagues at the Georgia Department of Transportation, for their hard work and invaluable input during all stages of this project. Eric Duff, Archaeology Section Chief at GDOT, was gracious enough to allow us time to complete the GPR work, and we are thankful for his encouragement and support.

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INTRODUCTION

On August 3-4, 2004, staff archaeologists from the Georgia Department of Transportation (GDOT) conducted a series of ground penetrating radar (GPR) assessments of selected areas within Fort Pulaski National Monument, in Chatham County, Georgia (Figure 1). This work was accomplished as part of an ongoing cooperative relationship between GDOT and the National Park Service (NPS). GDOT personnel included Shawn Patch, Jim Pomfret, and Terri Lotti. All work was performed under the direct supervision of Dr. Guy Prentice, regional archeologist with NPS' Southeast Archeological Center (SEAC), based in Tallahassee, Florida.

This series of investigations was focused on identifying archaeological materials associated with the construction village west of the actual fortifications. Archival and historical research, as well as above-ground features, indicated several areas where former structures were believed to have stood (Groh 1999). Due to limited field time and existing field conditions our work was restricted to the grassed areas near the Visitor's Center that are currently maintained and relatively free of dense vegetation.

METHODS

In order to efficiently collect and process GPR data, we first established an arbitrary grid over the entire area where we expected to work. Grid north was oriented parallel to the existing sidewalk leading from the Visitor's Center to the north dock, with an approximate declination of 8° east of magnetic north. We then set steel rebar at major grid points (e.g. 500N, 500E) using a combination of tapes and a manual transit (Figure 2). Secondary points were then identified by triangulating from known points and marked in the field with pin flags. Once the grid was laid out we then made decisions on the actual locations for GPR transects.

GPR data were collected with a GSSI model SIR-3000 unit with an attached 400mhz antenna (Figure 3). Transects were spaced at 50 cm intervals, which is approximately the width of the antenna. In most cases we generally begin from the southwest corner of each grid and pull the antenna in alternating transects along the Y axis. Radan, the software we use for post-processing, by default assigns the southwest corner of each grid values of 0,0. However, Radan can also handle other grid configurations, so for this project we allowed field conditions to dictate both the starting point and transect direction, and in many cases we began data collection at other grid points and pulled the antenna in different directions. The only problem with proceeding in this manner is maintaining detailed notes for individual grids.

In all, we collected data from seven discrete grids (Figure 4, Table 1). We selected grid locations based on hypothesized locations of ruined structures and field conditions. Although the vast majority of our survey area is open, with short grass, there are several large cedar trees and cisterns that required consideration in grid placement and size. We tried to not run the antenna too closely to trees because of their extensive root systems and potential interference with data collection.

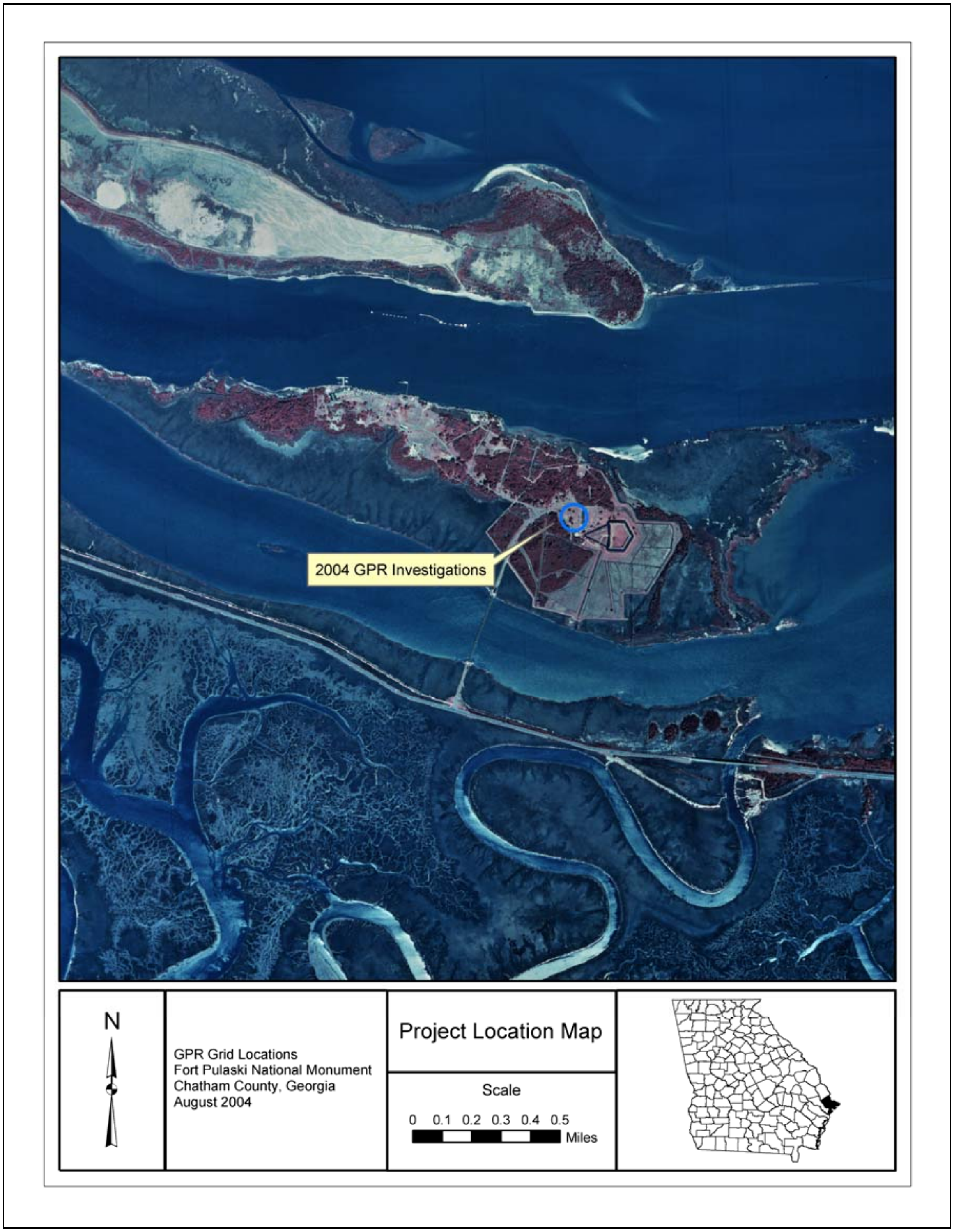

Figure 1. Location of GPR surveys at Fort Pulaski National Monument (source: 1999 *Fort Pulaski* southeast Digital Ortho Quarter Quad).

Figure 2. Establishing the grid with a manual transit.

Figure 3. Collecting GPR data with a 400mhz antenna.

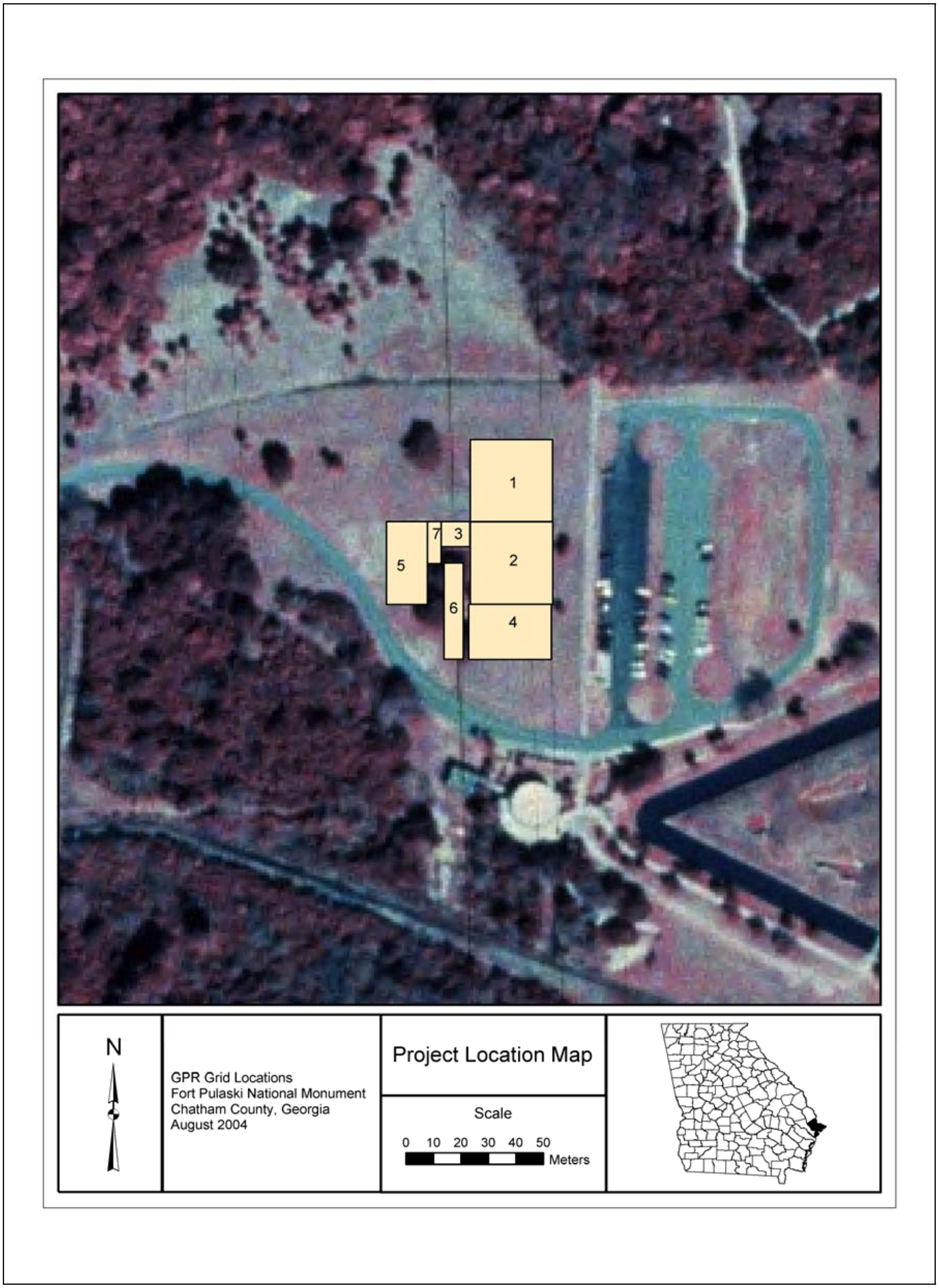

Figure 4. Detail of individual GPR grids (source: 1999 *Fort Pulaski* southeast Digital Ortho Quarter Quad).

Table 1. Summary Information for GPR Grids.

Grid	X-length (m)	Y-length (m)	Area (m^2)
1	30	30	900
2	30	30	900
3	10.5	9	94.5
4	30	20	600
5	15	30	450
6	7	35	245
7	10	15	150
Total			3339.5

Upon completion of each grid, GPR data were downloaded to a laptop computer for initial processing in the field (Figure 5). Essentially, this step allowed us to assess the overall quality of the data, look for possible errors, and get a general feel for sub-surface conditions and identify potential targets. The ability to process data in the field is an invaluable step and provides for a quick analysis at the gross level.

Figure 5. Real-time field processing of GPR data.

Additional post-processing was completed in much greater detail once we returned from the field. Due to the large file sizes of GPR raw data, we were unable to compile a single "super 3D" image of all grids in Radan; rather we processed each grid individually and exported them to Surfer, where they were all placed on a single grid.

The primary advantage and use of Radan is its ability to process GPR data in 3D. Each grid is recreated and can be displayed in plan view, or rotated in almost any direction for custom viewing. A major component of the Radan work involved "time/depth" slicing and 3D imaging. Radan has the ability to assign user-defined values to time slices (e.g. 10 cm, 20 cm), and these in turn can be exported. Another useful feature in Radan is the ability to "slice" the data along the X,Y, and Z axes, and then manipulate the view to examine the linescans from individual transects.

Once a 3D image was generated in Radan for each grid, we then created time slices at regular depths and exported them to Surfer for additional manipulation. Surfer works very well at manipulating files containing X,Y, and Z coordinates. Once in Surfer, each grid was analyzed individually. We could then change color values to amplify high reflectivity targets. Surfer also allows for multiple time slice images to be displayed side-by-side and stacked vertically for better interpretive results.

The composite radar images presented in this report have been assigned arbitrary color values to indicate levels of reflectivity, and they are not uniform. In some cases, different color values tend to work better than others, and we have found no single range that works well in all cases. Accordingly, we have tried to display GPR data in such a way as to maximize their interpretive value on an individual basis.

RESULTS

In all, we collected radar data from seven discrete areas tied to a much larger arbitrary grid system. Total surface area was approximately 3565 m^2. Results of the survey indicate numerous areas of high reflectivity, indications of possible sub-surface targets and areas of archaeological interest, as well as overall sedimentary conditions.

During the post-processing stage we attempted to combine data from each grid into a single "super 3D" image, but were unsuccessful because of extremely large file sizes and the inability of our computers to handle the processing requests. In light of that fact, we organized the data into two separate "super 3D" files; the first containing data from Grids 1, 2, and 4 (Figure 6), and the second containing data from Grids 3, 5, 6, and 7 (Figure 7). We then created "time slices" for each super 3D file at various depths (Figures 8-10, 12).

Figures 6 and 7 are tiled images for eastern and western halves that show all time slices in a side-by-side format. This is intended to provide a quick feel for what the data look like and examine overall trends. All time slice images are 20 cm thick.

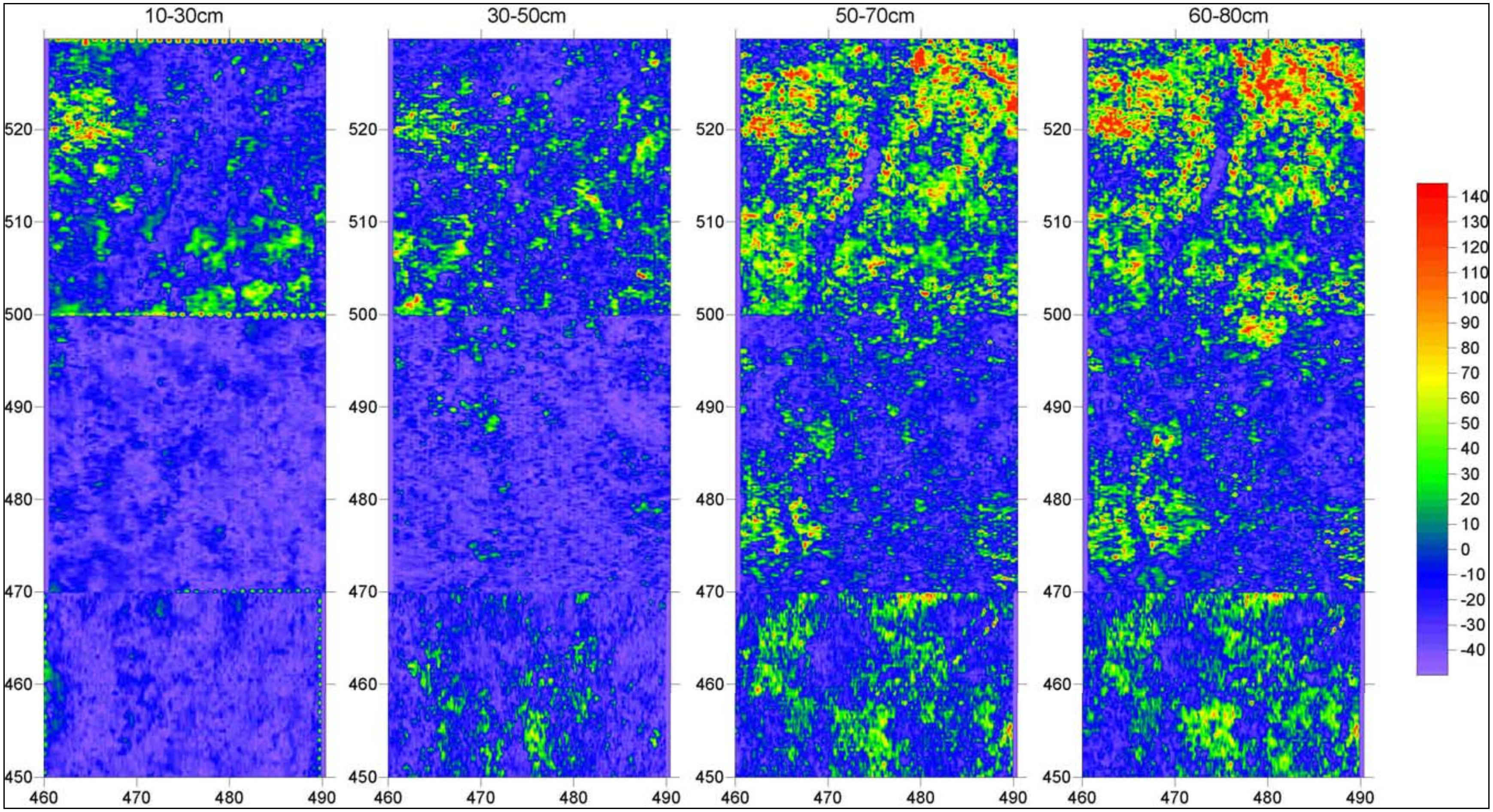

Figure 6. Tiled image of time slice data for Grids 1, 2, and 4 (eastern area).

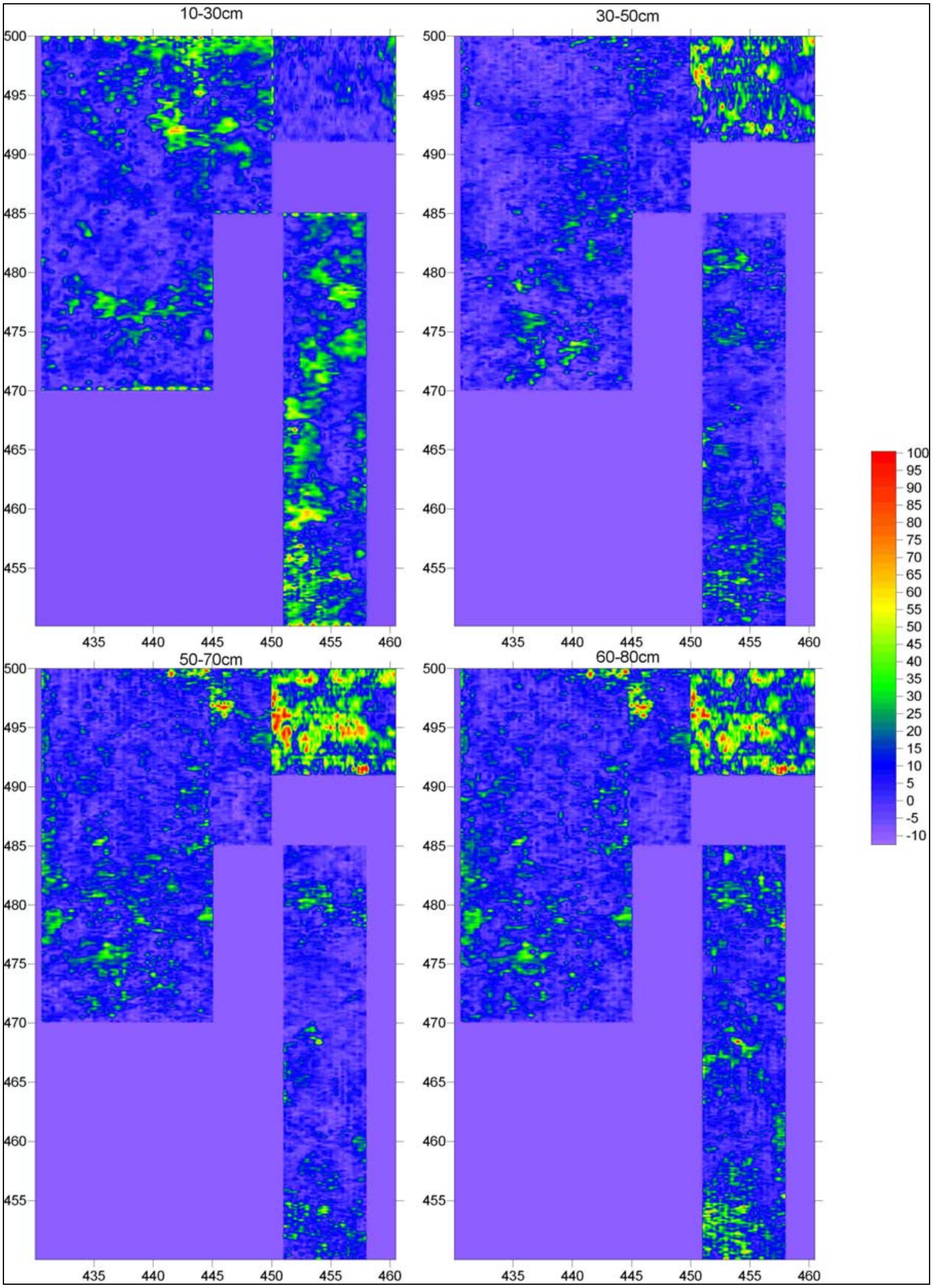

Figure 7. Tiled image of time slice data for Grids 3, 5, 6, and 7 (western area).

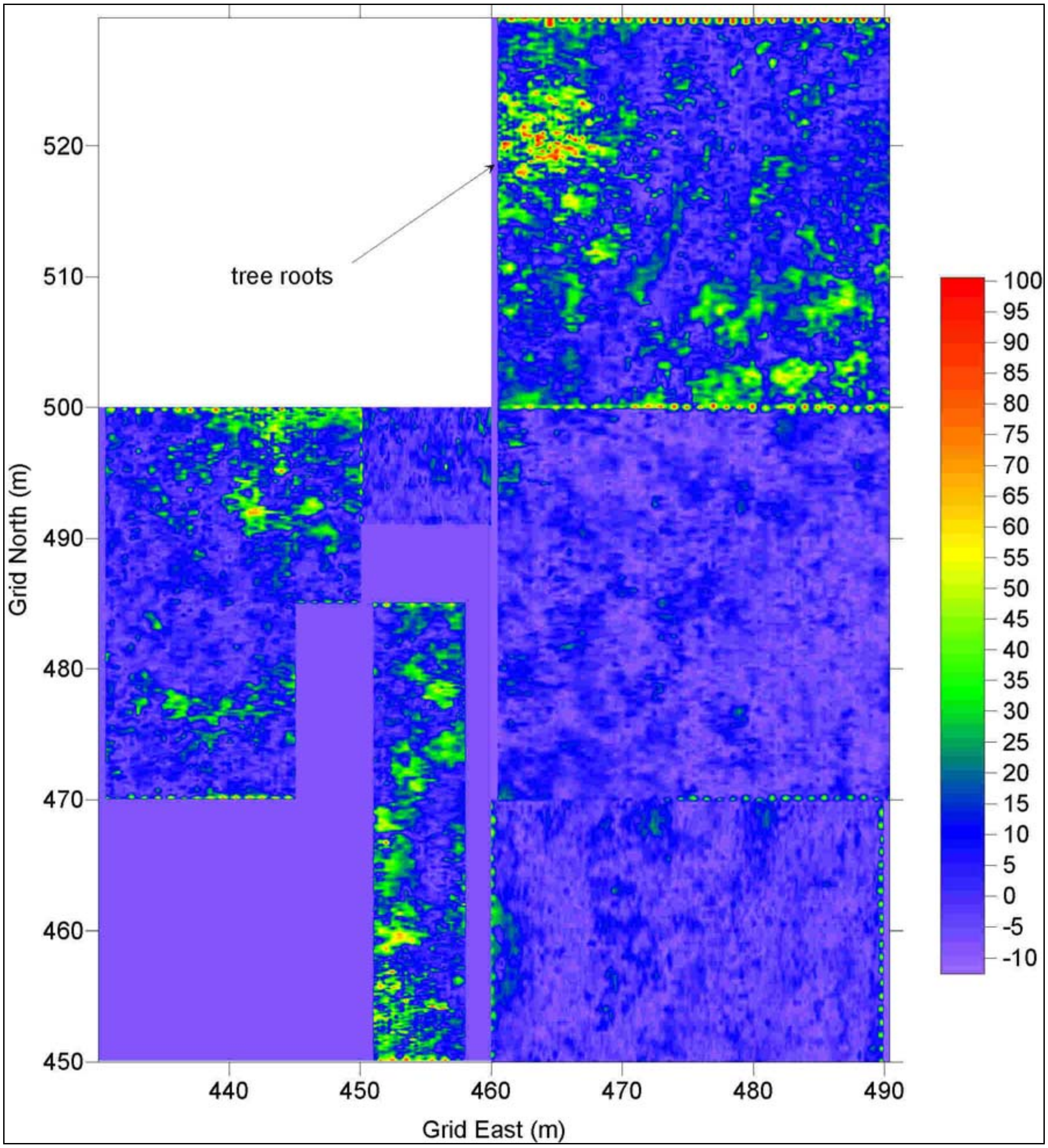

Figure 8. Detail of time slice data at 10-30cm depth.

Figure 8 shows time slice data from 10-30cm below the surface. Aside from the tree roots in the northwest quadrant of Grid 1, there are no obvious anomalies of possible archaeological significance. There are some high amplitude values in portions of Grids 1, 6, and 7 but they do not show any clear patterning and disappear quickly with increasing depth.

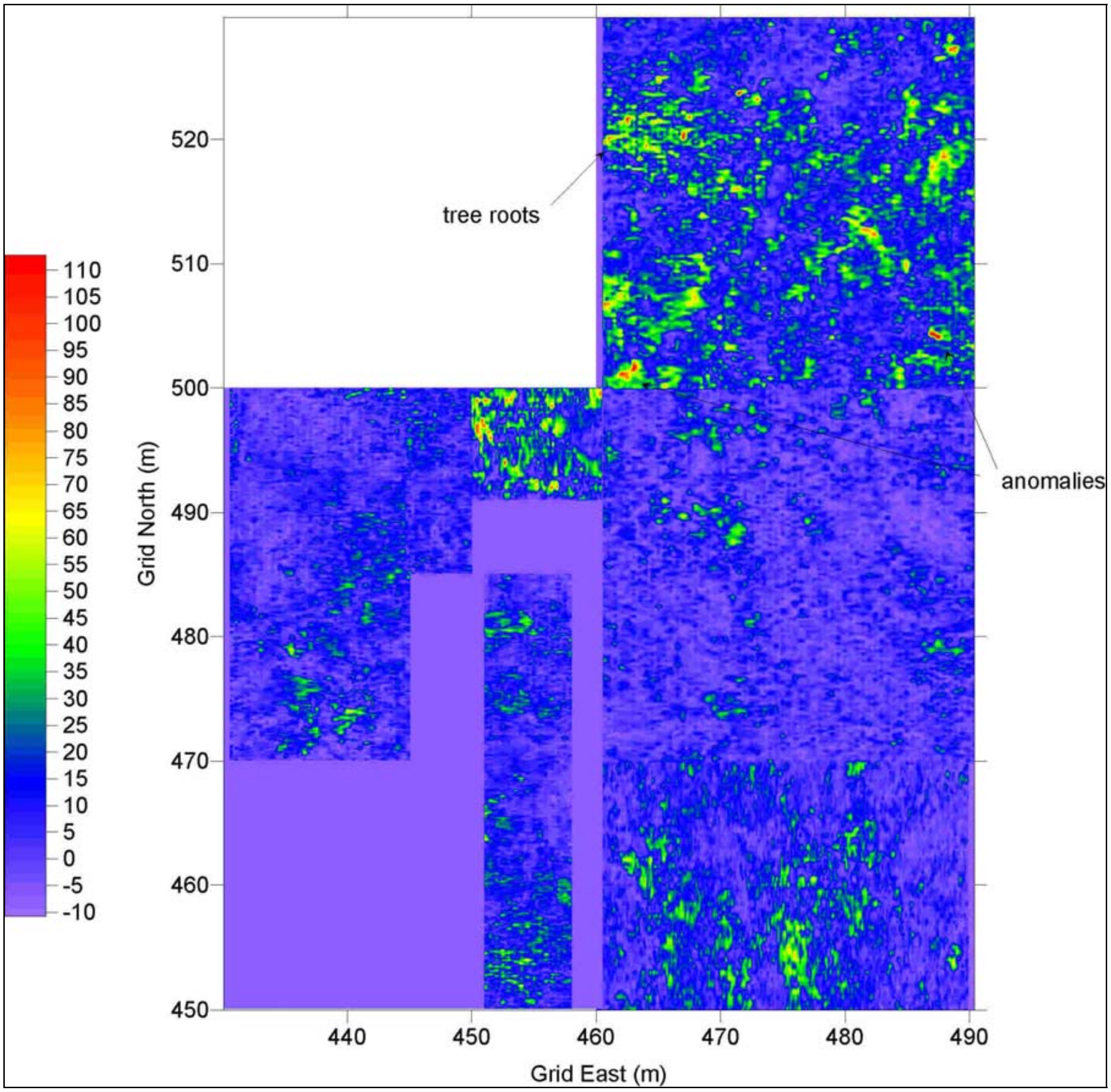

Figure 9. Detail of time slice data at 30-50cm depth.

Figure 9 shows time slice data from 30-50cm below the surface. The tree roots in Grid 1 are still visible, and two circular anomalies also appear, but there is little else of possible significance. However, there is a large amorphous area in Grid 3 that continues with greater depth.

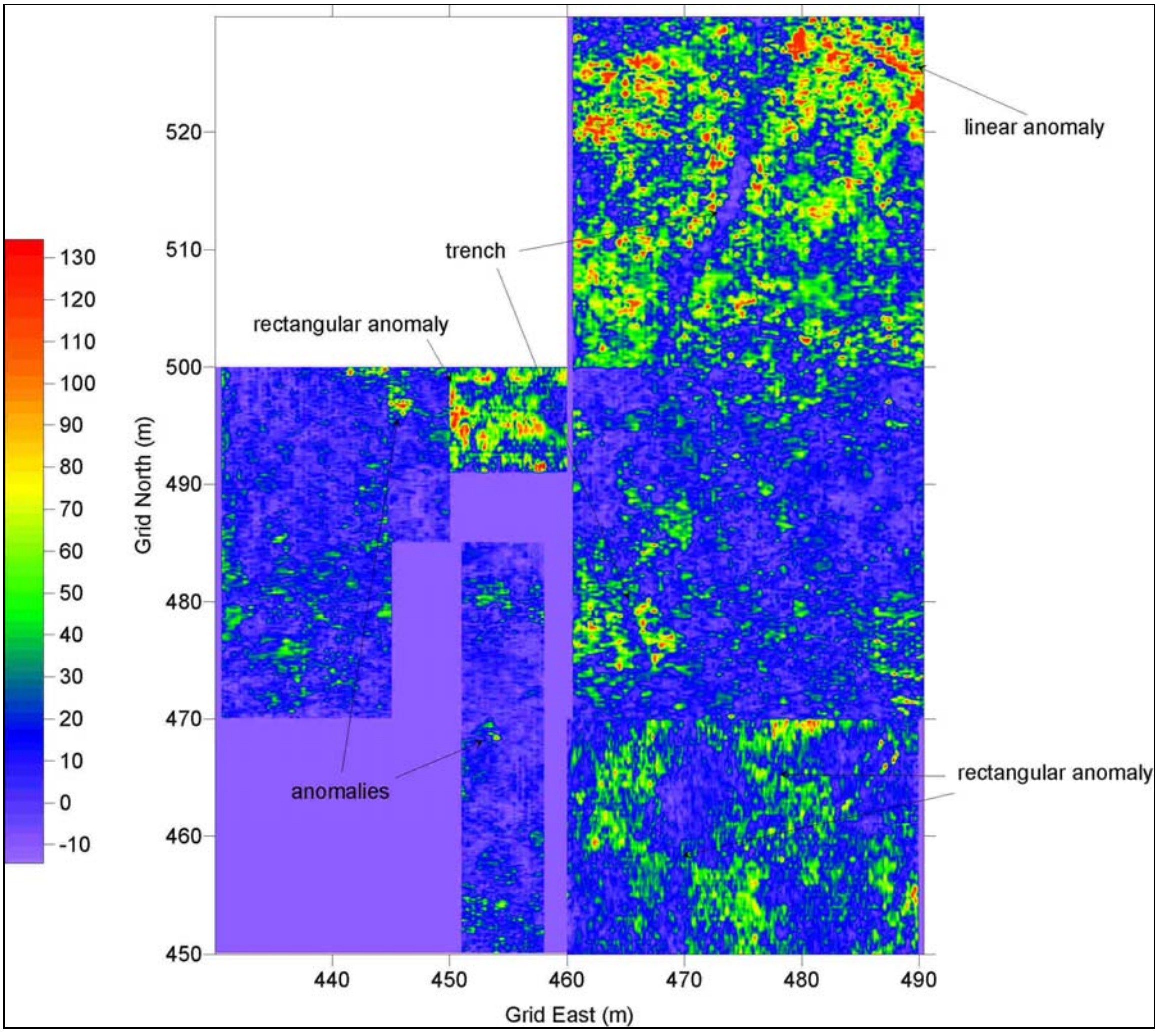

Figure 10. Detail of time slice data at 50-70cm depth.

Figure 10 shows time slice data from 50-70cm below the surface, and it is quickly evident that there is much more activity at this depth. The most obvious anomaly is a large, linear, trench-like feature that does not reflect any energy. This is a bit unusual, because targets generally have high amplitude values, and this feature clearly does not (Figure 11). Although difficult to see, the trench feature continues southward into Grid 2 and is a very curious phenomenon. In the northwest portion of Grid 1 there is also a strong linear anomaly which corresponds closely to an old road on the topographic map, so we may have detected portions of that.

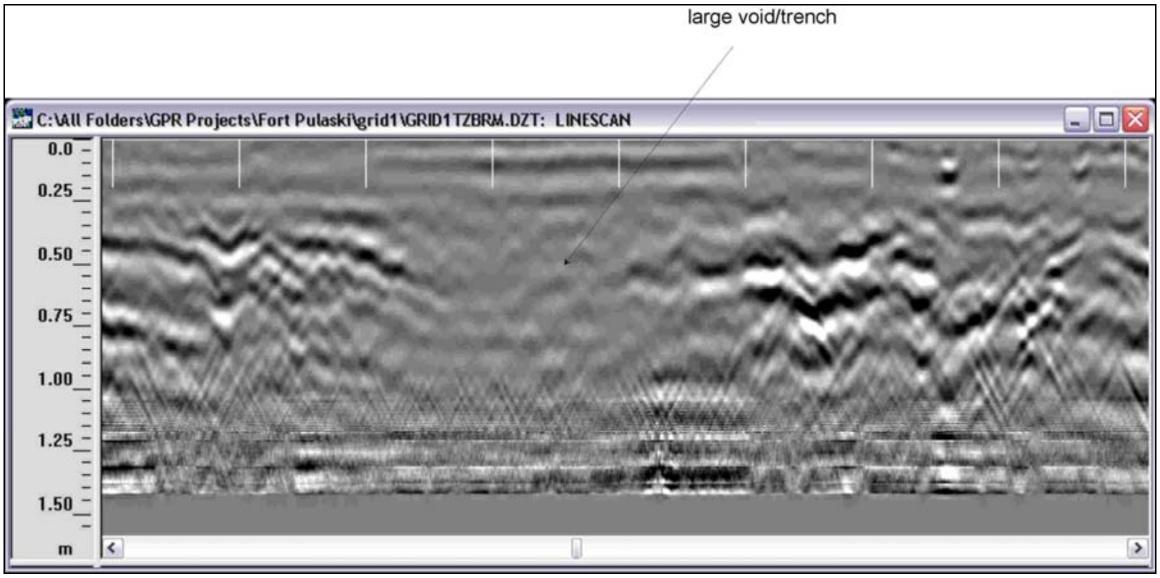

Figure 11. GPR linescan showing area of no reflectivity that corresponds to a large trench feature.

In Grid 4, there is a large rectangular area that does not have exceptionally high amplitudes, but nevertheless reflects some energy. This area could be associated with a possible structure or could represent soil irregularities. A second rectangular anomaly is present in Grid 3, although more irregular in shape, and is interesting because of its location between two large cisterns. Small circular anomalies are present in Grids 6 and 7, and could be isolated objects or foundation piers.

Figure 12 shows time slice data from 60-80cm below the surface, and closely resembles the data from Figure 11. Most of the same anomalies are still present, particularly the trench feature, the rectangular features in Grids 3 and 4, and the linear feature in the northeast quadrant of Grid 1. Other areas of high reflectivity are also present but have not been identified on this image.

When taken together, the GPR data have yielded some interesting results and indicated numerous targets of possible archaeological significance. While there are no obvious anomalies that clearly indicate structural remains, we believe they do exist but that they cannot be discerned from some of the surrounding “noise”.

We have also learned a great deal about the overall sub-surface conditions in the construction village area. Prior to beginning field work we were under the impression that sediments in the survey area were sandy and relatively undisturbed. However, we were quickly informed (Guy Prentice, personal communication) that most of the area was originally marsh that had been built up with fill to allow for construction. These conditions were subsequently confirmed once the GPR data were collected. Specifically, there is a consistent stratigraphic layer across most of the survey area at approximately 50-60cm below the present surface (Figure 13).

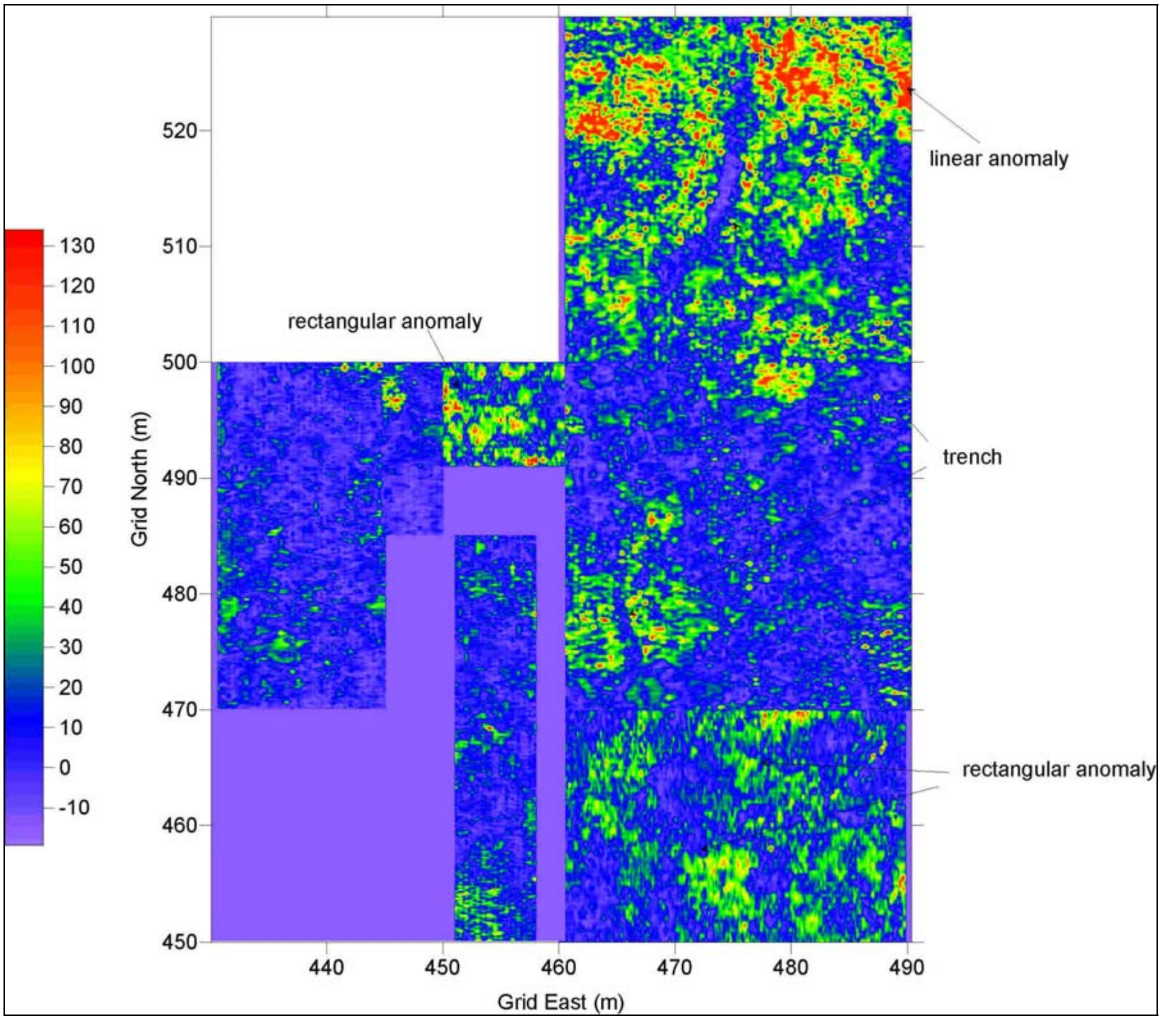

Figure 12. Detail of time slice data at 60-80cm depth.

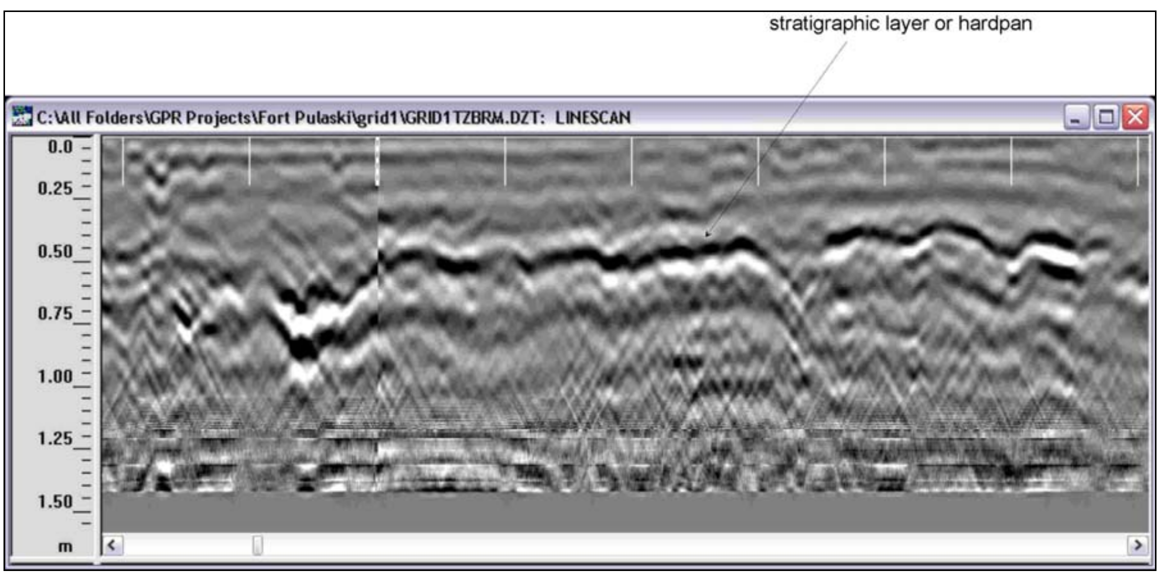

Figure 13. GPR linescan showing distinct stratigraphic layer or hardpan.

CONCLUSIONS AND RECOMMENDATIONS

Identification of the sub-surface targets identified from the GPR work will need to be verified with some type of archaeological investigations. Previous investigations in the Park have indicated that soil conditions are extremely difficult for traditional hand excavation, and we expect a similar situation in the construction village. During our discussions in the field, Guy Prentice suggested a limited program of core sampling and/or probing in target areas, and we agree that this would be a wonderful technique for quickly and inexpensively assessing the GPR results, and has the added advantage of being relatively non-intrusive. Depending on the results achieved with the core sampling, limited excavations may also be helpful.

There are also many opportunities for additional GPR work in other areas within the Park. GPR has the ability to provide accurate results in a highly efficient manner that can be of great benefit to both research and management. Additional studies could focus on some of the other locations with known historic structures and where field conditions are appropriate for GPR surveys.

REFERENCE CITED

Groh, Lou

2000 *Fort Pulaski National Monument: Archeological Overview and Assessment*. Southeast Archeological Center, National Park Service, Tallahassee, Florida.