

GPR applied to archaeology on the campus of UFOPA, Santarém, Pará

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This paper was prepared for presentation during the 13th International Congress of the Brazilian Geophysical Society held in Rio de Janeiro, Brazil, August 26-29, 2013.

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Abstract

This paper describes the research conducted in the area of the archaeological site known as Site of Porto (PA 00788), located in the Tapajós Campus expansion of the Federal University of Western Pará (UFOPA), in the municipality of Santarém, state of Pará. The research involved the application of GPR and archaeological excavations, which allowed recovery of artifacts related to the Santarém culture, like features of trash deposition, areas of activity related to the production of lithic artifacts and funerary patterns of secondary burial in the housing space.

Introduction

Santarém is one of the highlighted regions in Amazon Archaeology for discussing hypotheses related to the emergence of preterit complex societies. Researchers have shown that between the sixteenth and seventeenth centuries, the region was densely populated with large indigenous villages. It includes the site of Porto (PA 00788), which is now partially occupied by the facilities of Cargill and by the Pará Docks Company where is located the city's port. Part of the site is also situated on the Tapajós Campus of the Federal University of Western Pará (UFOPA). The site is part of the archaeological urban occupations in Santarém, having been the subject of excavations conducted by Curt Nimuendaju, in the 1920s (Gomes and Luiz, 2013).

One of the ethnic groups identified in the Santarém region is that of the Tapajós, responsible for a very distinct type of ceramic, known specially from its ceremonial artifacts (Gomes, 2002). Therefore, it is important to know not only the ritual contexts associated with the elaborate pottery, but also those related to everyday practices of subsistence within the village.

The research presented here, carried on the site of Porto (PA 00788), in the expansion area of the Tapajós Campus of UFOPA, aimed to investigate the contexts of the Tapajó pottery in Santarém in order to detect features and areas of activity related to preterit indigenous communities. Part of the research involved the application of geophysical methodology using the Ground

Penetrating Radar (GPR) for the indication of areas for archaeological excavation.

It is observed that the GPR has been successfully applied in other areas in the Santarém region to assist archaeological research (Roosevelt, 2007; Souza, 2012). Its success is related to the rapidity, easiness of application and the results it can produce. Moreover, in the areas of Santarém where GPR has been applied, other geophysical methods (magnetic and inductive electromagnetic), commonly employed to assist archaeological research, did not produce good results due to interference from the electrical power of the city.

Area of Research and Geophysical Survey

The geophysical survey conducted on the Tapajós Campus of UFOPA consisted of electromagnetic measures with GPR. The measures were performed into 3 areas called Area 1, Area 1A and Area 2 (Figure 1). Only the results of areas 1 and 1A are presented here because they are the ones that have been subjected to archaeological excavations.

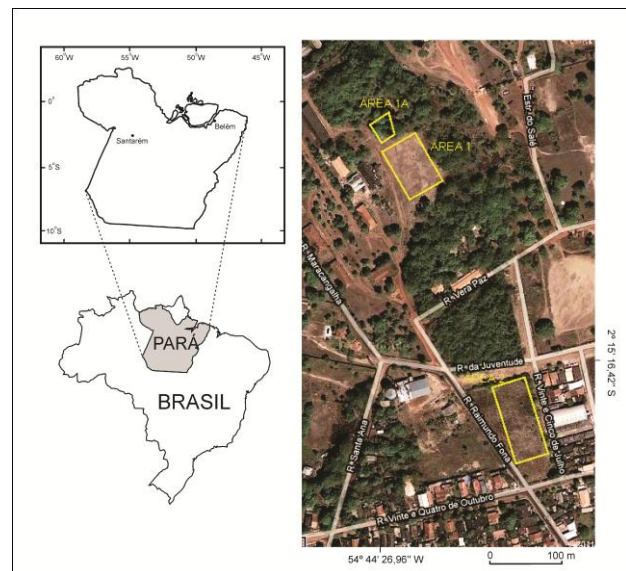


Figure 1 - Localization of the GPR geophysical survey areas in UFOPA Campus.

Area 1 includes a soccer field. In this area, the measurements were made along 76 lines spaced 1 m. The line lengths varied from 80 m (lines 73 to 76) to 88 m (lines 1 to 72). The direction of the lines was SE-NW.

The Area 1A is located in the back of Area 1, is adjacent to an arboretum and is covered by trees. Twenty measurements lines spaced 1 m were performed in the area. The length of the lines varied greatly due to the irregularity of the area and the existence of obstacles (usually the presence of trees). Most lines had a length varying between 35 m and 49 m. The line 16 was stopped at 14.5 m due to the presence of a tree, while the line 9 could not be executed because its position coincided with the position of an alignment of several trees. The direction of the lines was SW-NE.

Areas 1 and 1A have Archaeological Black Earth (ground layer where archaeological artifacts are found) varying, in accordance with the Munsell table, between 7.5 YR 2.5 / 1 (black) to 7.5 YR 3/2 (dark brown) with lithic artifacts (flakes, micro-flakes and sharpeners) and ceramic in surface, associated with the late Santarém occupation. They are distant about 200 m from the Tapajós river, having the first area been previously occupied by a dump and then a soccer field, which caused impacts to the archaeological record. It is estimated that about 1 m of archaeological layer has been removed in the process of leveling the soccer field.

The GPR measurements were performed with a GSSI SIR-3000 system using bi-static antenna of 400 MHz center frequency. The instrument was operated in time mode, being the control of position measures obtained by marks inserted into the record at intervals of 10 m.

The GPR records were processed with the Reflex-Win Software from Sandmeier. The processing basically involved: (a) interpolation of horizontal positioning marks to obtain uniform horizontal scale; (b) application of dewow filter (high-pass filter); (c) establishment of zero time in the register; (d) application of gain to compensate for signal attenuation; (e) application of background removal filter; (f) application of band pass filter (cutoff frequencies of 200MHz and 800MHz), (g) speed estimation of radar wave for conversion of time in depth using superposition of hyperbolas (the velocity was estimated in 0.9 m/ns).

Results

The images obtained with GPR along the measure lines showed the following anomalous patterns that were associated with structures or archaeological artifacts: small hyperbolas, discontinuities and valleys (Figure 2).

After observations in the field, two priorities were established for the anomalies recommended to be tested by excavations. The anomalies that occur in places where can be seen traces of Black Earth and/or ceramic fragments/lithics were recommended as of highest priority for excavation. Those that occur in places where it was possible to observe ferruginous concretions were considered of lower priority.

Results in Area 1

In Area 1 anomalous patterns have been identified in 68 of the 76 measures lines executed. In this area it was possible to observe ceramic fragments on the surface of

the ground between positions 10 m and 12 m of lines 45 to 47, as well as Black Earth around position 70 m of those lines. These locations were therefore listed as priorities for excavations.

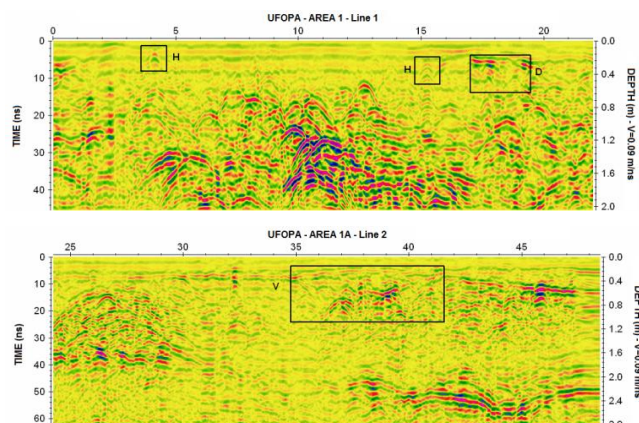


Figure 2 – GPR Images obtained in areas 1 and 1A. The rectangles highlight the anomalies that may have been caused by archaeological structures or artifacts. H = hyperbole, D = discontinuity, V = valley.

Excavations in Area 1 were, however, performed in only 16 of the sites selected by the geophysical prospecting. These locations were chosen after conducting auger holes to depths between 0.80 and 1.00 m, at intervals of 20 m, which showed the occurrence of Black Earth and archaeological pottery and lithics. Only 7 of the 16 geophysical anomalies tested by excavations showed archaeological potential. The other anomalies were related to geological features, bioturbations and garbage recent.

Figure 3, for example, shows the excavation performed to test the anomaly described as valley with discontinuity in GPR image obtained on line 61 between positions 65 m and 67 m (Figure 4). The excavation revealed a pocket of black earth that extends to a depth of 1.10 m. In the pocket were found ceramic and lithic fragments (micro-flakes and sharpeners), which led to correlate the geophysical anomaly to a pre-colonial behavior related to actions of care, cleaning and maintenance of the village area, by opening a hole dug intentionally in the shape of valley for deposition of ceramic fragments, lithic remains and probably organic waste.



Figure 3 - Detail of the west side of the excavation executed to test the GPR anomaly of line 61 (positions 65m to 67 m), classified as valley with discontinuity.

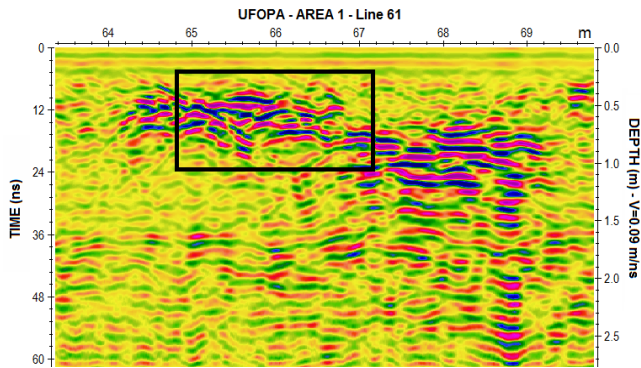


Figure 4 – GPR Image along line 61 showing the valley with discontinuity anomaly between positions 65 m and 67 m.

The excavation carried out to test the geophysical anomaly identified as a hyperbola in the line 52 between positions 49 m and 50 m (Figure 5) is shown in Figure 6. In the excavation was found a campfire with several fragments of charcoal, ceramic with Tapajós elements and lithics at depths between 0.10 m and 0.20 m. Between depths 0.30 m and 0.40 m was recovered a large splinter of silexite.

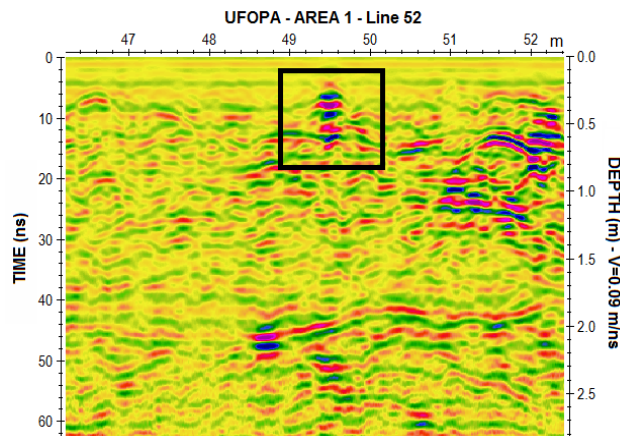


Figure 5 - Hyperbola-shaped anomaly observed in the line 52 between positions 49 m and 50 m.

Figure 7 shows details of ceramic fragments with Tapajônica culture characteristics found in the excavations performed in Area 1, while Figure 8 shows a vase found in excavation executed to test the geophysical anomaly shown in line 60 between positions 23 m and 24 m. In the same image the vase is being investigated in laboratory to verify the existence of bones. The result of this study showed no presence of bones, but with the sieving of the internal sediment was possible to identify the presence of micro-fragments of bone, however it is

not possible to determine if this artifact would function as funerary urn.



Figure 6 - Excavation executed to test the GPR anomaly shown in line 52 between positions 49 m and 50 m.



Figure 7 - Ceramic fragments associated with Tapajônica occupation. On the left stands a set with decoration painted in red and on the right, fragments of anthropomorphic statuettes.

Results in Area 1A

In Area 1A was performed only one excavation unit (1 m x 1 m), in order to test the geophysical anomaly identified on line 2 between positions 9 m and 10m (Figure 9). In the first 0.30 m of the excavation was found a layer of landfill formed by deposition of anthropogenic laterite and sand in dark-colored soil containing building materials, glass, metal, rare very fragmented ceramic artifacts and small lithic flakes. Between depths of 0.40 m and 0.80 m

appeared the archaeological layer containing best preserved ceramic fragments and lithic micro-flakes. Then it was found a lateritic layer composed of pebbles and thick concretions measuring between 0.10 m and 0.20 m in length. The materials found in this excavation justify the geophysical anomaly, although it has shown a low potential archaeological when compared to Area 1.



Figure 8 - Excavation in laboratory of the interior of an urn found in the test of GPR anomaly shown in line 60 between positions 23 m and 24 m.

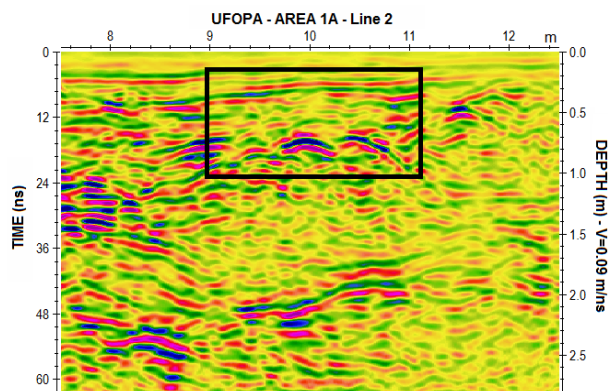


Figure 9 - GPR image obtained on line 2 of the Area 1A emphasizing the only anomaly excavated in area 1A.

Conclusions

The GPR anomalies allowed the recovery of archaeological artifacts from the site of Porto (PA00788), related to a pre-colonial occupation associated with the Tapajó culture. This area of the site revealed lithics and ceramic sherds in anthropogenic black earth soil which confirm a continuous occupation correlated to the Tapajó.

Most of the archaeological artifacts were found in the excavations carried out on the valley anomalous pattern.

Despite several anomalies identified by the GPR not being caused by features or artifacts related to past occupation, it can be considered that the geophysical methodology was successfully applied and should be used in other areas of the site.

Acknowledgments

The authors acknowledge the support of Professor Dr. José Seixas Lourenço, dean of UFOPA, by achieving part of the financing of research, related to the archaeological rescue project in the Tapajos Campus - UFOPA. Also thank the UFOPA students Ana Betânia de Sousa Pimentel, Andrei Nunes Figueira, Beatriz Martins Moura, Edvaldo Pereira, Graciela Melo Serique, Keiliane de Lima Bandeira and Miguel Ângelo de Sá Nieto, who assisted as volunteers in the excavations. The authors extend their thanks to Paulo Sergio Magalhães (UFPA technician) for the assistance in preparing the area for the survey and in collecting the geophysical data. The activities of topography, field preparation for geophysical survey and map production were performed by the UFOPA engineer surveyor Wagner Luís Gonçalves Silva, to whom the authors also thank. The student Edvaldo Pereira also contributed on photographic documentation of the excavations.

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