

First Brazilian Federal Police Test Site for Forensic Geophysical Research

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Abstract (Font: Arial Bold, 9)

There is a growing need in the Brazilian Federal Police - BFP for indirect search for buried objects. This kind of search is performed using geophysical methods such as GPR – Ground Penetrating Radar. Until recently there were no standardized forensic targets in Brazil to use as reference for actual field measurements. The BFP built a controlled site - SITCRIM - with known objects buried at specified depths to be used in training programs, object profiling and describing the profiles obtained at the site.

Introduction

Geophysics is an important tool in conducting investigations, saving time and resources, since there is speed and accuracy in data collection, and may be used to locate chemical spills, pipeline rupture, fraudulent building or road constructions, preventing major environmental damage or people injuries.

Furthermore, geophysical surveys can be useful in choosing the locations that will be sampled, and assist in security police team field in dangerous situations and possible contamination of the sample and / or people and have the advantage of preserving the traces in crime scene - one of the key conditions in the forensic examination.

The BFP built a controlled site - SITCRIM. The site was installed in an area in the vicinity of the National Institute of Criminalistics in Brasília (Figure 1).

Method

The main geophysical instruments used were the GPR – Ground Penetrating Radar (Lima Alves et al., 2013), the Resistivity meter (further publication) and magnetic gradiometer (França et al., 2013). The geophysical survey of the site was performed in two passes: the first one before the construction of the trenches and the second one after all the objects were buried (Figure 2). Results The geophysical equipments were able to find the different objects and determine their depths.



Figure 1: SITCRIM location.



Figure 2: Geophysical survey performed after all the objects were buried.

We have performed several surveys with GPR using GSSI equipment and IDS. The GSSI antennas used were 200, 270, 400 and 900MHz. The IDS antenna utilized was a dual frequency, 250 and 700MHz (Figure 2). We used an average velocity of propagation of the electromagnetic wave of 0.08 m/ns. This velocity was found by hyperbolic approximation with the site own appropriate targets.

The line spacing varied according to the survey from 0.05 to 0.5 m.

The processing steps were applied according to the characteristics of the data and essentially depend on the interpreter. Once chosen the processing flow for a GPR section, the same is applied to other sections.

The data were processed in ReflexW software, version 6.0 (developed by Sandmeier. KJ, 2012 - Sandmeier software, Germany). The processing routine consisted of converting the file format, setting time zero, temporal filters (dewow and band-pass), gain (decay energy), migration time domain (fk migration - Stolt) and propagation time conversion to depth.

In addition to processing two-dimensional (section by section), the GPR data set conducted with the same antenna was positioned and interpolated allowing the generation of a new data set, now with 3D information of subsurface.

SITCRIM Trenches

The test site was created with six trenches aiming at different issues with more than 60 items (Figure 3):

1 – Engineering forensics: pipes, bricks, walls, ceramic tiles (Figure 4).

2 – Commonly buried objects of police interest: guns, ammunition, simulated drugs, clothes, money, and metallic safe (Figure 5).

3 – Environmental forensics: metallic barrels and plastic drums in different positions and depths (Figure 6).

4 – Anthropological forensics: bovine bones (Figure 7).

5 – Geological forensics and hydrodynamic tests: soils of several compositions (Figure 8).

6 – Miscellaneous forensics: escape tunnel made of concrete plates (Figure 9).



Figure 3: SITCRIM just after excavation and placing the targets. In the background, the Criminalistics National Institute.



Figure 4: Objects in Trench 1.



Figure 5: Objects in Trench 2.



Figure 6: Objects in Trench 3.

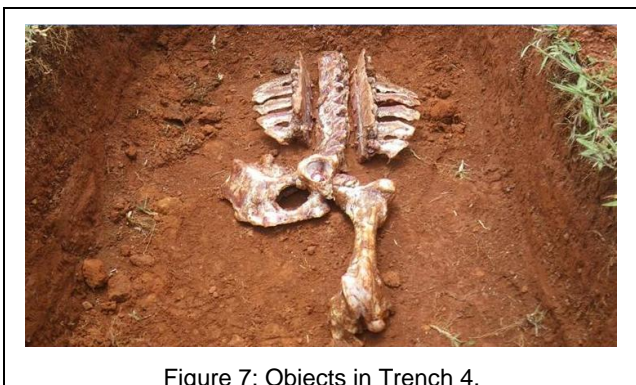


Figure 7: Objects in Trench 4.

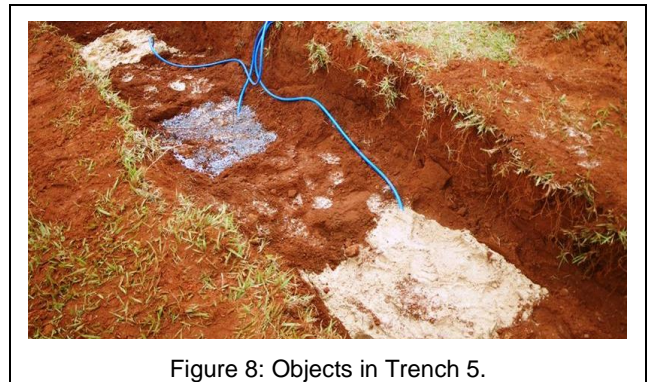


Figure 8: Objects in Trench 5.

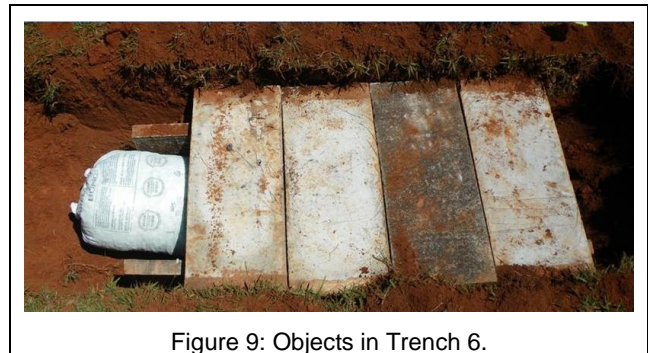


Figure 9: Objects in Trench 6.

Some Results

The results of the GPR survey were analyzed by 2D sections individually as well as through cuts in depth (depth slices) made in the 3D data set, producing several slices of signal amplitude.

Figure 10 shows one of these profiles for the trench 3 and interpretation.

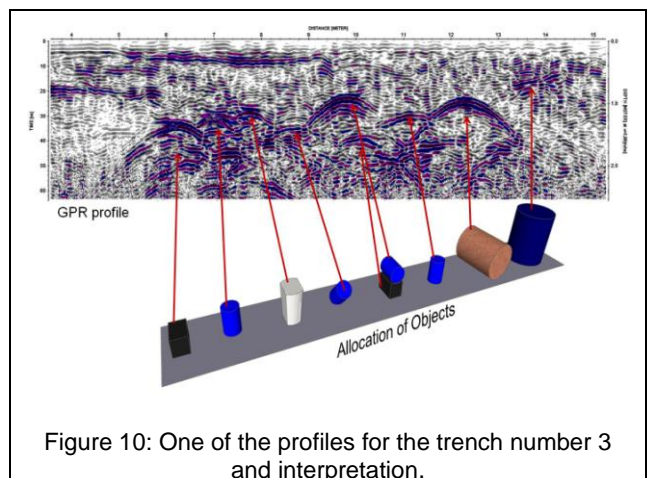


Figure 10: One of the profiles for the trench number 3 and interpretation.

Figure 11 shows a slice at 50cm and the bovine bones buried in the trench 6 and interpretation.

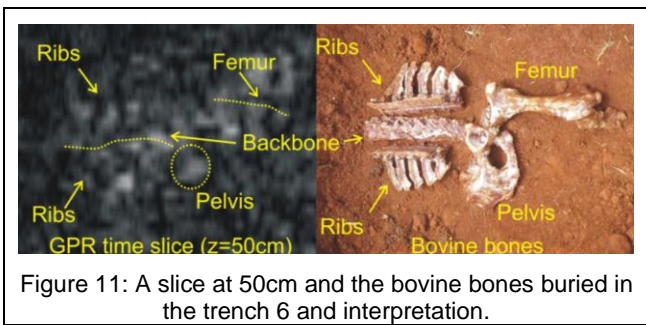


Figure 11: A slice at 50cm and the bovine bones buried in the trench 6 and interpretation.

There are other results in Lima Alves et al. (2013) and França et al., 2013.

Conclusions

The geophysical equipments were able to find the different objects and determine their depths. Some issues were encountered when dealing with small and/or non-metallic objects.

Figure 12 shows a 3D sketch of the test site.

Acknowledgments

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References

LIMA ALVES K, BLUM MLB & BORGES WR. 2013. Mapeamento de alvos forenses com GPR 3D. In: 13th International Congress of the Brazilian Geophysical Society, Rio de Janeiro, 2013.

FRANÇA PHP, BORGES WR & BLUM MLB. 2013. Resultados de Gradiometria Magnética Comparados às Derivadas do Campo Magnético Anômalo em Sítio Controlado da Polícia Federal - SITCRIM. In: 13th International Congress of the Brazilian Geophysical Society, Rio de Janeiro, 2013.

SANDMEIER KJ. 2012. ReflexW Version 6.0 - Program for processing and interpretation of reflection and transmission data. Karlsruhe, Germany. 479p.

BORGES, WR; Caracterização Geofísica de Alvos Rasos com Aplicações no Planejamento Urbano e Meio Ambiente. Instituto de Astronomia, Geofísica e Ciências Atmosféricas; IAG/USP São Paulo, 2007.

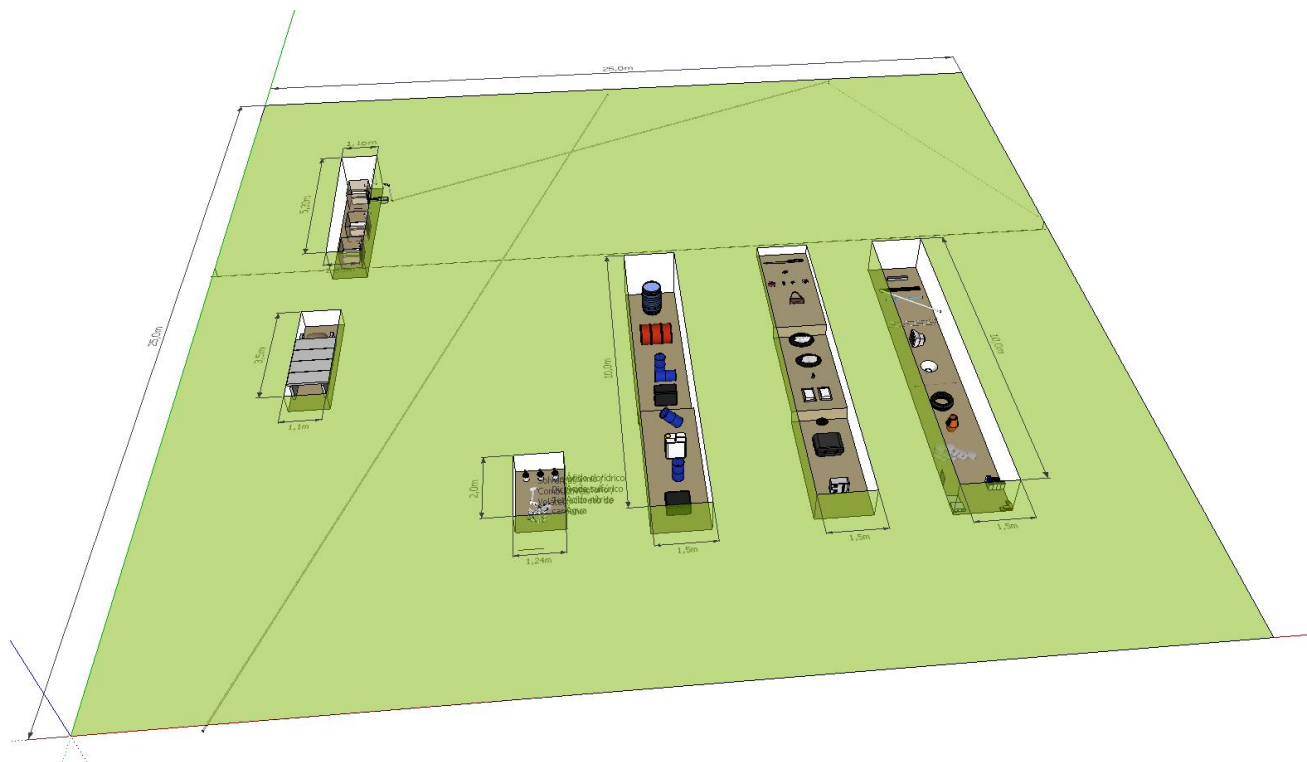


Figure 12: 3D sketch of the SITCRIM.

