Ground penetrating Radar (GPR) using at controlled site to detect targets applied to forensics and engineering purposes

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Abstract

In this paper we present a simplified analysis of an electromagnetically geophysical surveying using the Ground Penetrating Radar (GPR) in an area at Brasilia-DF (see Figure 1 below and at the appendix, in higher scale), more exactly in the facility of the headquarters of Federal Police of Brazil (PF), where there is a controlled site for forensics geophysical applications named Forensics Controlled Site (SITCRIM). The objective of this study is to identify and show the buried objects at a trench locate at this controlled site. For the data acquisitions we used a GPR system with a double frequency antenna (250 and 700MHz), Opera Duo, produced by IDS Georadar.

Keywords: GPR, FORENSICS, SITCRIM

Introduction

The Ground Penetrating Radar (GPR) is a geophysical method that uses electromagnetic waves varying from 10 to 3000MHz to obtain subsurface related information. The difference between the signal send and the signal received is consequence of the variation of the physical properties of the environment in shallow investigations due to its high resolution and acquisition of a large volume of data taken in a short time interval. The received signal may be shown as a profile or a subsoil cross section. The interpretation of this GPR profile, also named radargram, allows identifying native faces on the subsurface, rock bedding of different lithologies, as well objects buried by human activities. The most common way of using GPR consists of execute reflection profiles along the marked line over the terrain, shifting the GPR antenna along this line, and executing lectures at equidistant points.

Method

The controlled site has an area of 25x25m and is located at the headquarters of the federal police of Brazil, and, inside this area, there are many trenches with the size of 10x1.5m. For this study, we covered an area bigger than the area of those trenches in order, to have a more complete data. So, there were taken several lines covering an area of 12.5x5.0m.
We took each parallel 2D section by 5.0cm spacing. Then we choose one of those sections that had that had higher intensity of anomalies and, then compared it to previous information of each buried object. Due to the time that each one was buried some objects does not present significant anomalies, once it may has reacted to the soil. At the day of data acquisition, it was a precipitation of 3.5mm of rain, but the day before this number was at the order of 11mm of rain, what has a direct effect at the data acquisition, increasing the soil moisture and consequently the soil conductivity.
For the data processing we followed a simplified routine in the software Reflexw (developed by Sandmeier software, Germany). That routine consisted on apply an static correction, then we removed the background noise, after this we applied a gain type energy decay, so applied an FK filter, then we did a time cut at the time of 60ns and then the migration FK, also known as STOLT. Done this we started the phase of interpretation that brought our results

Figure 1 *– location of SITCRIM*

Results

The GPR results remarkably show the bound of the buried objects, highlighted by the yellow arrows, and where the soil is scrambled due to trench excavation. At the picture (d) it's possible to note a great parabole, suggesting a low speed zone that may be caused by tire properties. At (a) it has seen a hyperbole at the begin and the inclination along the anomaly suggesting that it can be the inclined bar. In addition (c) we can observe the metal pipes that present a horizontal anomaly pattern along the line, and by their metallic composition they present high reflection.

We deduce the objects at the other images by the hyperbole distancing, as well the depth of the top of the object, to know which precision a direct exploration must be done.

GPR profiles taken over the objects where:

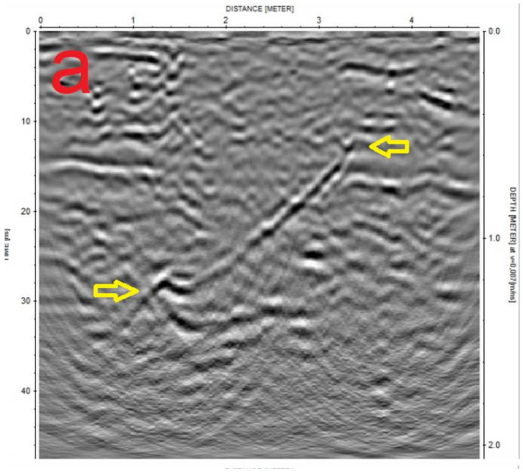

Figure a *– an inclined bar*

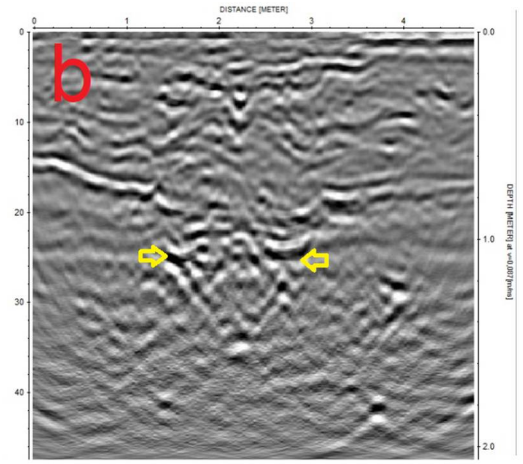

Figure b *– ceramic pieces*

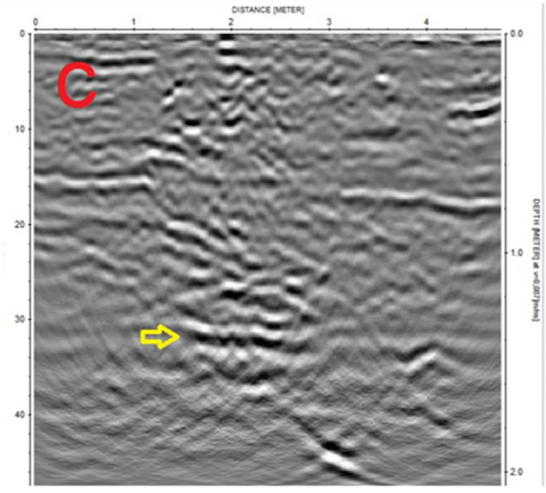

Figure c *– a metal pipe*

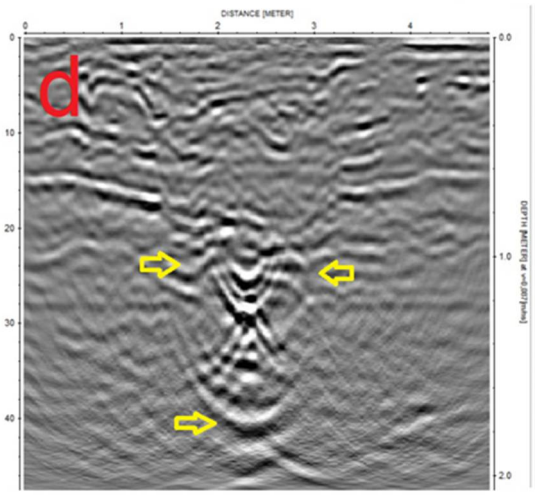

Figure d *– a tire*

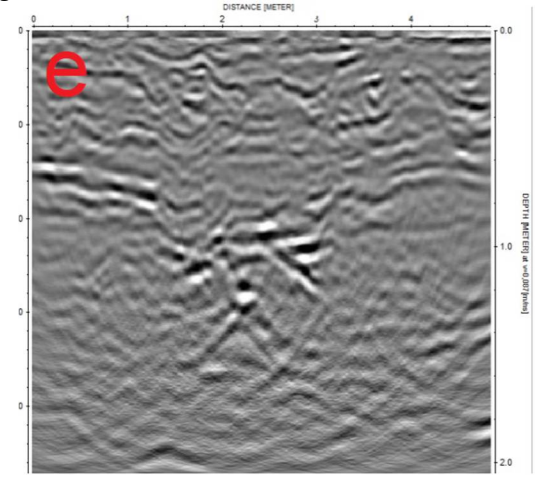

Figure e *– funeral urn*

The images show certain anomaly patterns that are not too clear, but make a well indicate the property difference between than showing where the target objects besides the trench bounds are.

Conclusions

The geophysical methods used in this work have proven to be effective to investigate the shallow subsurface, with high resolution. That allowed us to identify our target objects, as well the parts where the soil were scrambled, either to dig the trench or to bury the target objects, and thanks to its high resolution we were able to identify the targets, from the hyperboles generated by its reflection, that is shown at the radargrams.

So we can conclude that the use of GPR is effective for engineering and forensics purposes, based on the results of our data acquisition and processing that we were able to identify, or, at least, induce, where and what were the targets shown in the radargram, based on their responses of reflectance in the form of hyperboles.

Ackonowledgments

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Appendix

As show at section of method, but now in higher scale, the location of SITCRIM

Figure 1 *– Location of SITCRIM*