Deep utility survey application

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Introduction

Deep utility surveys are in most cases a nightmare to any GPR operator. The fact is that most of the utilities are in urban areas where there is a high amount of EM noise sources. Usually it is a complex net of entangled utilities, buried trenches and shafts that needs to be recorded and interpreted. The deeper one has to go, the harder it is to collect good quality data for the final interpretation.
Deep utilities are man made structures that can be found at the depths greater than 5 meters. A good set of examples are mining, metro and sewer tunnels.

Always give a reasonable goal for your surveys! Locating a coin at 10 meters is impossible, so keep the vertical and horizontal resolution guidelines near you. This will tell you the minimum size of the chest filled with coins, you can expect to find.

When looking for utilities try to keep the traces/unit reasonable high. Also beware of the excessive use of stacking. Preferably collect the profiles with the minimum length of two depths you wish to achieve. If you are careless about these options the data you collect will be hard to interpret or you might even miss some objects.

Survey example

In this survey example we used the GCB100 antenna to do a deep utility survey. The object of interest is an old military tunnel at unknown depth (expected depths 10-15m). Only a general area where it can be expected was known. The expected size for the tunnel was determined from the similar number of tunnels previously excavated and investigated (2m height, 2-5 meters width).

Wondering about the abundance of military tunnels we have here? Read this for some background: http://en.wikipedia.org/wiki/Boden_Fortress

Equipment for the job

Antenna name	Recommended settings			Size of target (m)	Recommended area of application
	HP(MHz)	LP(MHz)	Range (ns)		
GCB100	50	200	50-350	0.5	Geology and deep utility survey

GCB100 is a full shielded ground coupled antenna with excellent balance between the high penetration and good resolution. Compared to the same frequency range antennas from other manufacturers it is made much more compact (1/3 of the size of others). This great reduction in size makes the antenna easier too use even on rough terrains or in a confined space. The suggested areas of application for this antenna are geology surveys (stratigraphy) and deep utility surveys. Depths of interest vary from 5-30 meters and shallow objects should be disregarded due to antennas ”blind zone”.

The ”Blind zone” effect exists for all antennas. The zone stretches from zero depth to the depth equal to 1.5 wavelengths in material. Due to the larger wavelengths, this zone is more noticeable for lower frequency antennas. In this part of the recorded data any reflected signal gets superimposed to the direct coupling wave. This effect causes the interpretation of data hard or even impossible in some cases. The ignorance about this effect caused wrong interpretations and confusion for many surveyors. The GPR practitioners disregarding this fact either declared the zone to be a homogeneous layer or were desperately trying to locate known elements in the data.

Small size and full shielded body of the GCB100 make this antenna resilient to the EM noise and easier to manipulate when collecting data. Therefore it is chosen by many companies in the world for deep utility surveys. Antenna is quickly mounted on a group of cart or tow systems like any of our antennas. This makes it more maneuverable and easy to use.

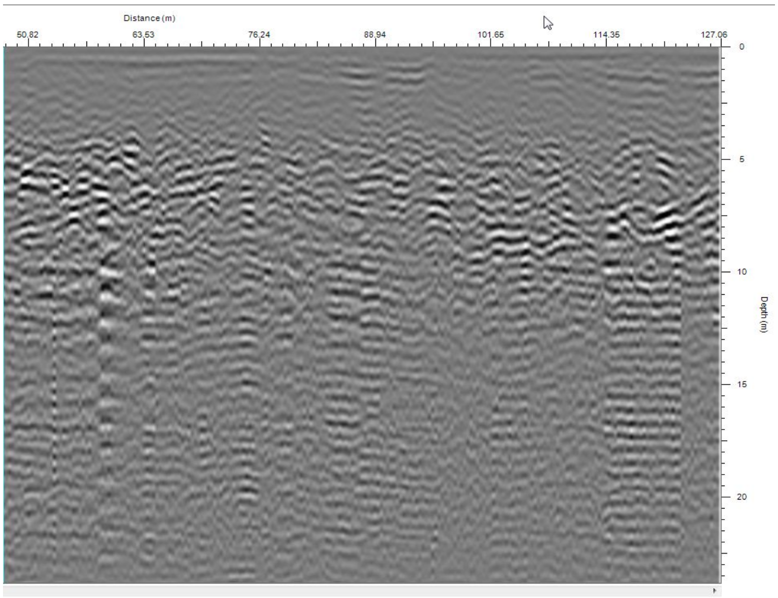
Conducting the survey

The survey was taken upon the hill raising from the river bend. The height difference between the start and the end of the profile is around 50 meters, making it a rather steep hill to do a survey on. The information that we could gather before the survey was crucial. It provided us with the possibility to conduct our survey by following the paved road up the slope of the hill. Also at any given moment we were sure that we were more or less perpendicular to the predicted direction of the tunnel. The only uncertainty was if the slope of the hill was going to lift us too high above the tunnel and it would be out of the selected depth range.

Processing and Conclusions

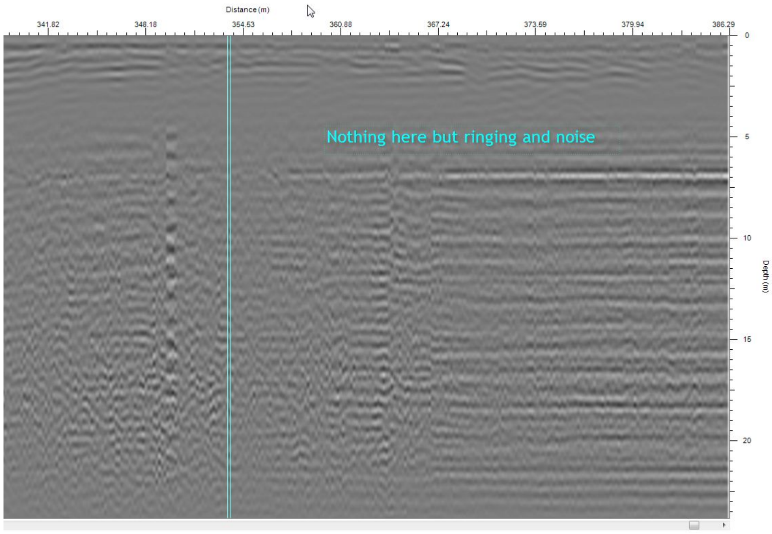
After collecting the data we opened the profile in the GPRSoft™PRO post processing software package. By using basic processing steps we cleaned up the data and made it ready for interpretation. The entire profile was more then 400 meters long. We decided to narrow the scope by eliminating the sections of the record that were unlikely to provide us with a result.

In the beginning of the file we were slowly climbing from the riverside and the soil is very sandy in that area. We decided to disregard that data as it would be very likely for a tunnel to collapse in that kind of soil. So it was not a logical place for a tunnel.



Sandy soil near the river

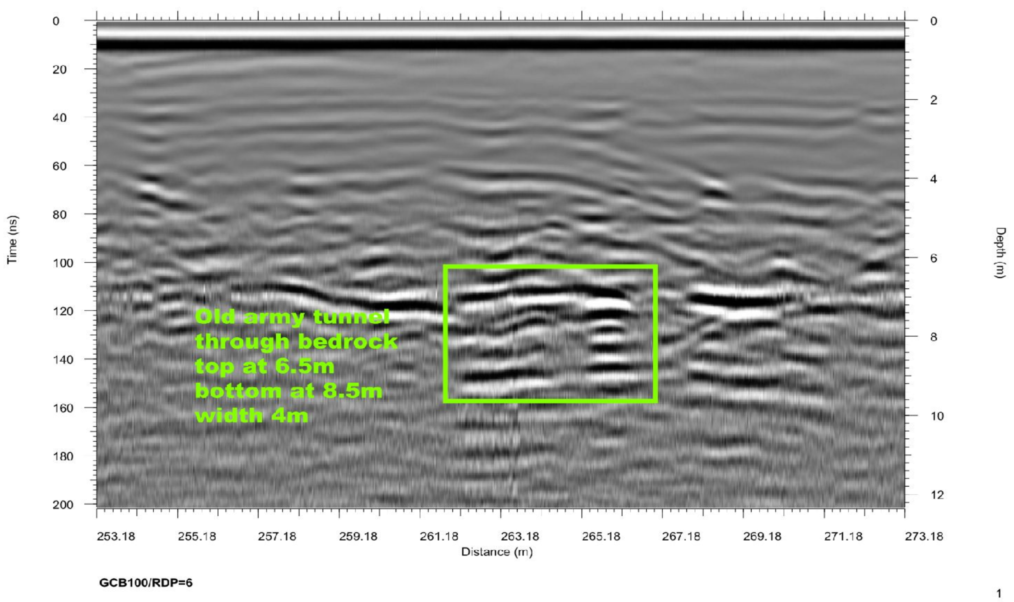
The end of the file was even more interesting because we suddenly entered a zone of soil with high conductivity and nothing could be observed there. The source of this disturbance is probably the replacement of the top soil filament with a very conductive material before the building of the power line towers.



Conductive material zone

That left us with almost 200 meters of data! We managed to further narrow it down to 100 meters by taking into consideration only a good contact visible with the bedrock. At this point we decided to disregard the data below 200 ns determining it to be too speculative for final conclusions.

This elimination process brought us to a reasonable amount of good quality data ready for final interpretation and conclusions. As it is shown in the last picture below we were able to determine the position and overall dimensions of the tunnel.



Old army tunnel