Topography correction and the importance of applying it to the GPR records

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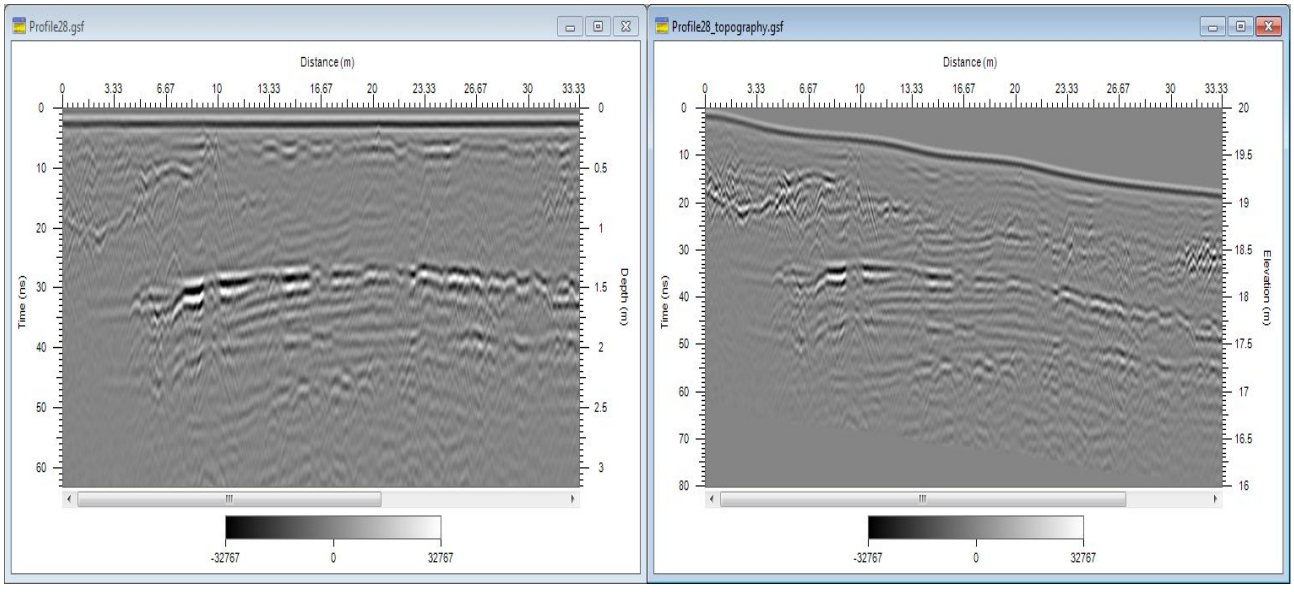
Introduction

The subject of this article is to introduce you to the importance of applying topography correction to GPR (ground penetrating radar) records and to inform you about the possible ways of doing it. Although the basis is taken from the geography terminology, I would like to emphasize that the usage of terms ”topography correction” and ”topographic data” in this article, are used only in relation to the GPR records.

What are ”topography correction” and ”topographic data”?

Topography correction is a process of linking the topographic data with the GPR data. The topographic data is a group of points creating a curve that represents the real surface of the site where the GPR data was recorded. Each point in the group has its own elevation value showing a vertical difference from a defined point declared to be zero elevation/altitude.

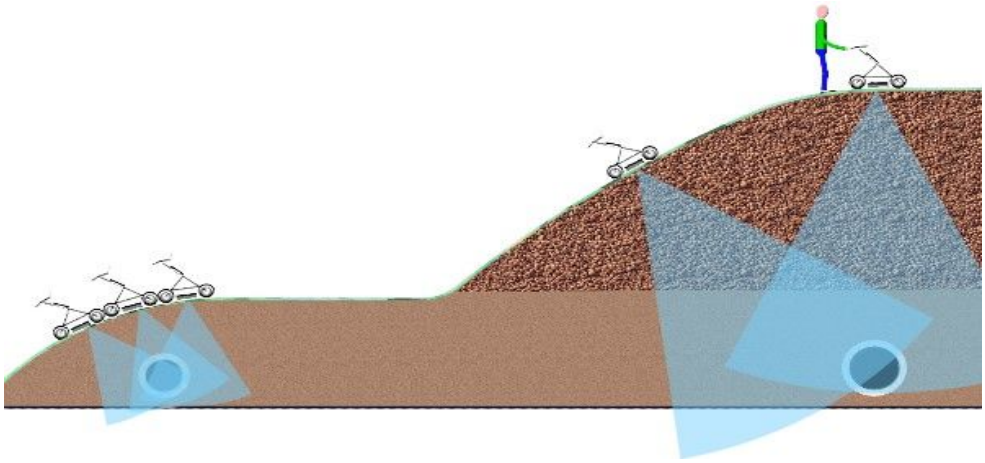
Simply put: Each consecutive trace gets an elevation offset, creating a more realistic view of the data.



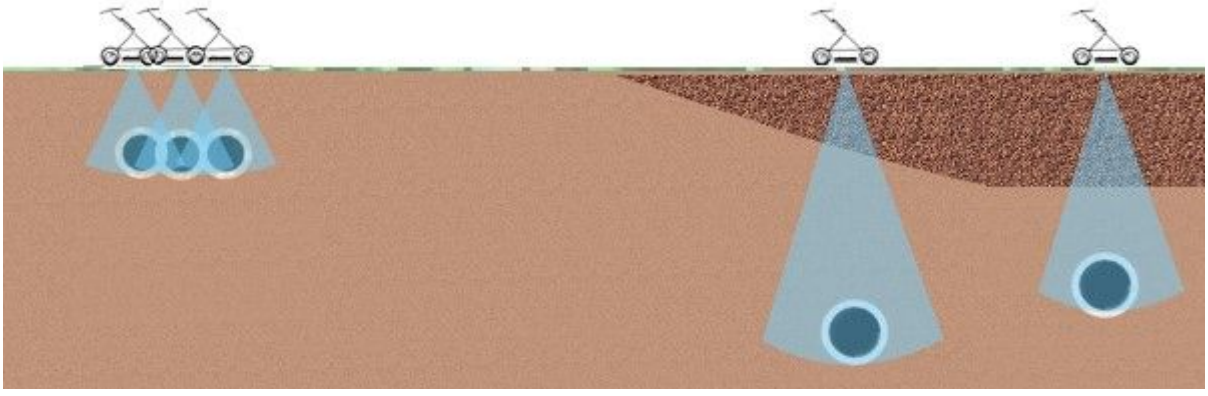
Why do we need to do it?

When interpreting our recorded GPR data we consider the surface (zero depth) position to be a very important value. Based on the surface position we are going to identify the vertical position, or depth if you wish, of all the objects and layers. Together with lateral and longitudinal positioning we create an exact global position. If the survey site is on a level relatively flat ground then the depth calculated from the surface is the true global value.

However, if the survey is taking place on an uneven relief ground the depth value will no longer represent the true and exact global position. Even more, there are known interpretation problems if one considers a relief changing surface to be a flat line. The most striking problems are: reading the same object from different angles and at different depths, uneven surface line transferred to flat layers and more. In order to avoid these problems we are forced to substitute uncertain depth values with globally exact elevation/altitude values. That is why we apply the topography correction before interpreting the data.



Collecting the data on a relief terrain



The resulting flat profile

When to avoid using topography correction

Despite the need and benefits of applying the topography correction there are a few occasion when you should avoid it.

One of the most compelling reasons is poor topographic data. If the values you implemented are not a good representation of the surface line you were moving over, you are just going to distort your GPR data instead of improving your results.

The next reason would be that it makes your survey unnecessarily complex and expensive. If the entire survey is not a highly complex one, or if it is short enough that you could consider the profile track to be flat, don't make it complicated yourself. A good example would be finding the **only** pipe in the field with no concern for and high precision positioning of all the adjacent objects.

Finally there is the question about the hardware and software that you are using to collect the GPR data. If your equipment, or at least the software backing it up, don't have an option to manipulate the topographic data along with the GPR data you will lack tools to combine the data in a proper way.

What to do if there is no topographic data available?

If you end up doing a survey with no means of gathering topographic data there is still a way to do the job. The easiest way to circumvent the topography, is to break your profile line into shorter parts. Each part should be a GPR record over a flat (although inclined) surface. Special attention should be given to making a good survey diary with as much information you can write down. Taking photos or making an as-precise-as-possible sketch is also a good idea. While interpreting the files beware of the beginnings and endings of part files. They represent the zones of intersection and possible wrong interpretations. Last but not the least it is important to be aware of the error you are bringing to your interpretation process – be conservative in your conclusions.

Tools to use to collect topography correction data for the GPR records

All of these methods have their pros and cons and it is up to you to make the final decision. While choosing your collection method you will have to evaluate: precision, time needed to acquire, overall compliance with the rest of the equipment and price. If you apply poor judgment in selecting the methodology for gathering the topographic data you might end up with unusable or distorted data – the entire process will be done for nothing. In order to help you we will present here the most common methods with their obvious benefits and possible pitfalls.

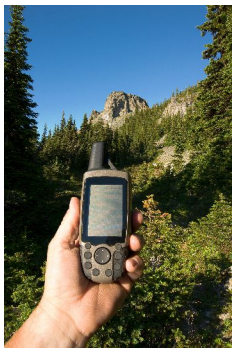
Geodetic measurement

Generally speaking the usage of topographic profiles created by geodetic measurements (theodolite and total stations) on the site is an excellent way to collect the topography data. At the same time you get the needed topography correction data and you are sure that any data you export from your GPR records will unmistakeably be positioned in the surveys site coordinate system.

If you are working on a bigger construction site there is a good chance that there was some geodetic measuring provided for the rest of the people working on the site. Although this data could be in a format more suitable for others, you might try to use it. In this way your reports will be understood by everyone in the specific site. It involves some more work from your side, but by complying to their general reference coordinate system, you will definitely have a more satisfied customer.

The downside of the method is the time consumption. The measured points have to be marked on the ground along the profile before the GPR data can be collected. Since actual combining of the data is done in the post processing phase, adding markers in the GPR data or precise survey diary is needed as well. Keep in mind that investing into or hiring these kind of equipment and/or expert workman is usually costly.

Global Positioning System (GPS)



Recently the development and availability of GPS systems has provided many types of businesses with a simple solution to keep their data, reports and products positioned precisely over the globe. GPR companies have also embraced this technology (with more or less success). The rise of GPS accuracy has provided the market with decent units for a reasonable price. An even more economic approach would be to rent the high precision GPS unit only when needed. In combination with a proper GPR unit the GPS based topographic data can be acquired during the GPR recording saving in such a way a lot of time.

The downside of the GPS systems is that they cannot be used indoors. Also when gathering GPS data, surrounded with tall buildings or trees, weak or entirely lost signal might produce poor data. In this cases the use of an external antenna is a must if you wish to improve your odds on getting good topographic data.

If you own a low end GPS unit and the elevation jumps up and down even while moving slowly you could try collecting the elevation data prior to collecting the GPR data. Even the cheap GPS units tend to give a correct elevation value in ”static mode” . Move your GPS from one mark point to another, and leave the GPS at each point for a few minutes. The value gathered in this way will in most cases be the proper elevation. Averaging this value will prove to be a very efficient way of getting rid of odd readings.

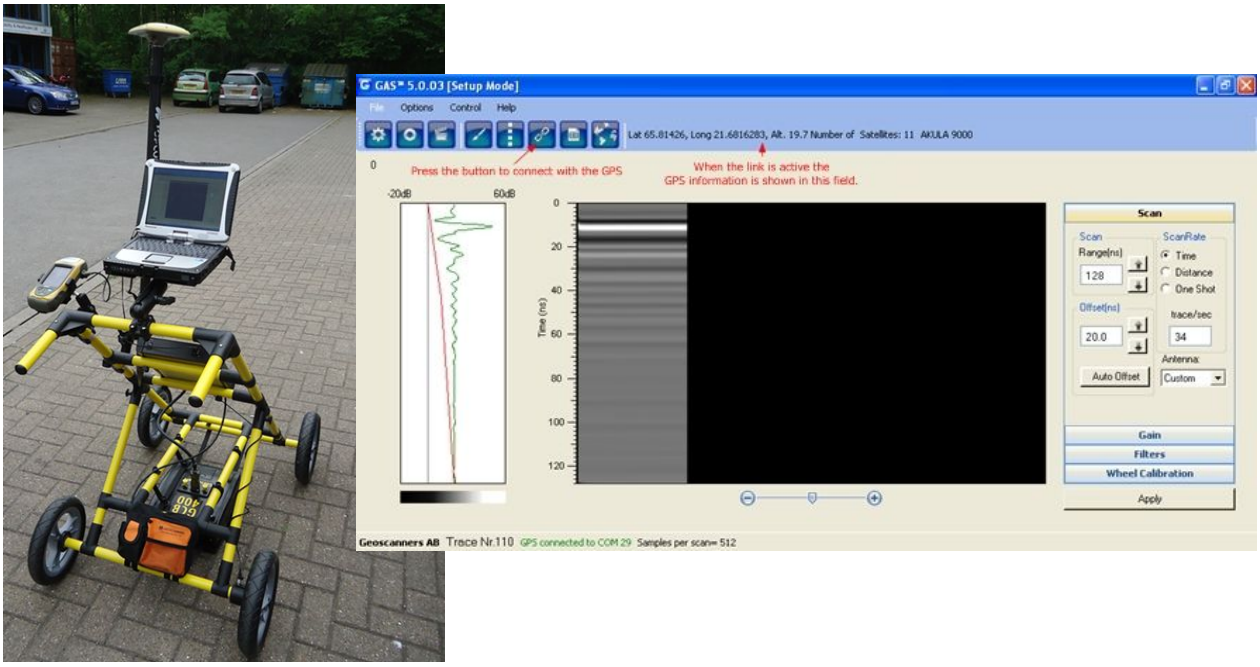
Other tools

There are other tools for creating topography data reports like barometric altimeters or accelerometers and inclinometers that allow you to produce the topographic data. If you have access to them, and as long as their reports or outputs can be adjusted to link with the GPR data, then they can be used as well.

Barometric altimeters are a nice tool but don't forget to do your collection of topographic data as quick as possible. While measuring, these meters could evaluate some weather induced change in the air pressure as the change in elevation, giving you a wrong value in the end. Accelerometers and inclinometers are weather independent but more often than not give a rough stepped elevation list.

Using the topography correction with Geoscanners equipment and post-processing software

Geoscanners AB is one of the leading manufacturers of GPR equipment. We believe that using GPR equipment doesn't have to involve PhD. education for the operators. We strive to produce as intuitive and simple as possible hardware and software products for the customers doing GPR surveys. Basic terms and knowledge is implemented through simple practical training and our equipment and software products are ready for use out of the box in most cases.



If you are using some other manufacturer equipment or don't use a GPS unit for collecting the topographic data skip to the GPRSoft®Pro section

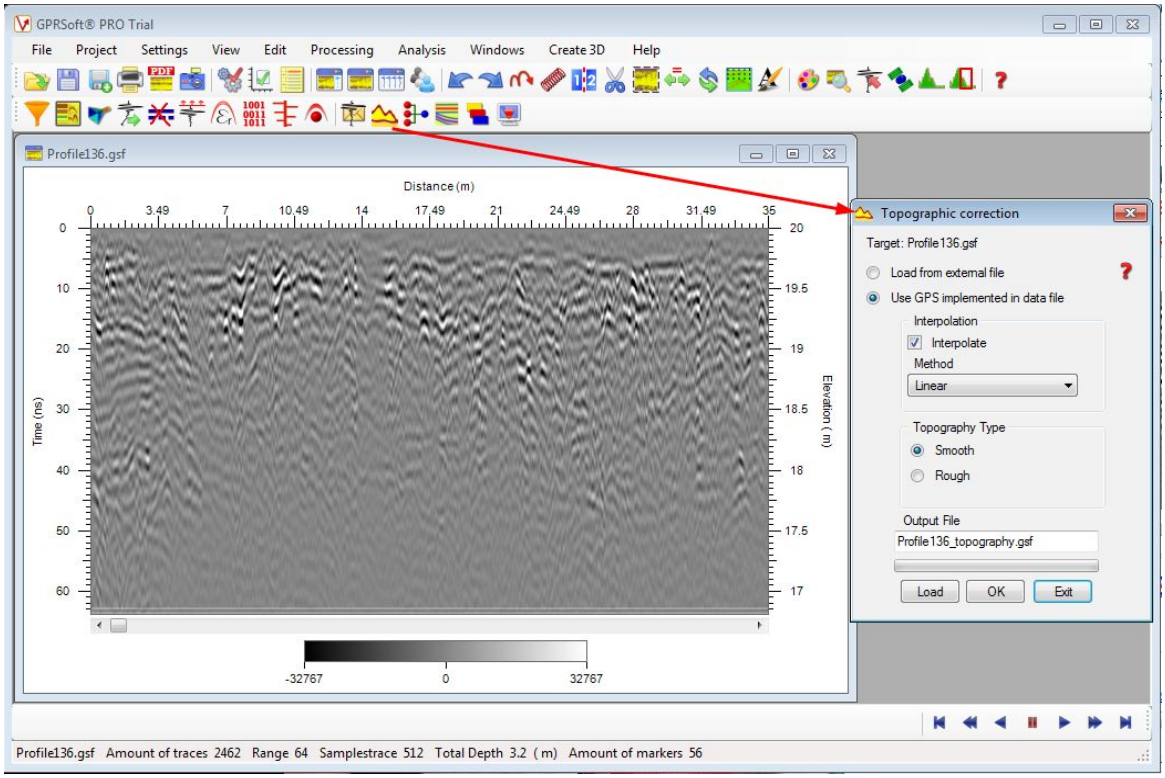
If you are working with the GPR unit made by Geoscanners AB and presuming that you own (or can hire) a GPS unit with satisfactory elevation precision and a standard NMEA0183 output, you are one step away from creating GPR data with corrected topography.

Our own *.gsf file format is specially designed to save (and read or export from afterward) all of the GPS and GPR data together. So unlike with some other manufacturers products, there is no need to manually link the data or even use third party software. The connection between the GPS unit and the GPR unit is done through a serial port of your choice. Any Bluetooth® , USB or the old RS232 port (if you still have it) GPS connecting option will do just fine. After connecting the equipment you will just have to create a link (press a button) inside our GAS software (Geoscanners Acquisition Software for our RADAR units). We call this the easy ”collect-all-in-one-go” approach. It shortens the time needed to do these kind of surveys and the knowledge needed to do so is just one press of the button more for your operators to learn. Now each point in your recorded data has an additional positioning information based on the true global elevation. In order to read the newly added data and create the final report open your collected GPR data in the GPRSoft®Pro software package.

GPRSoft©Pro and topography correction

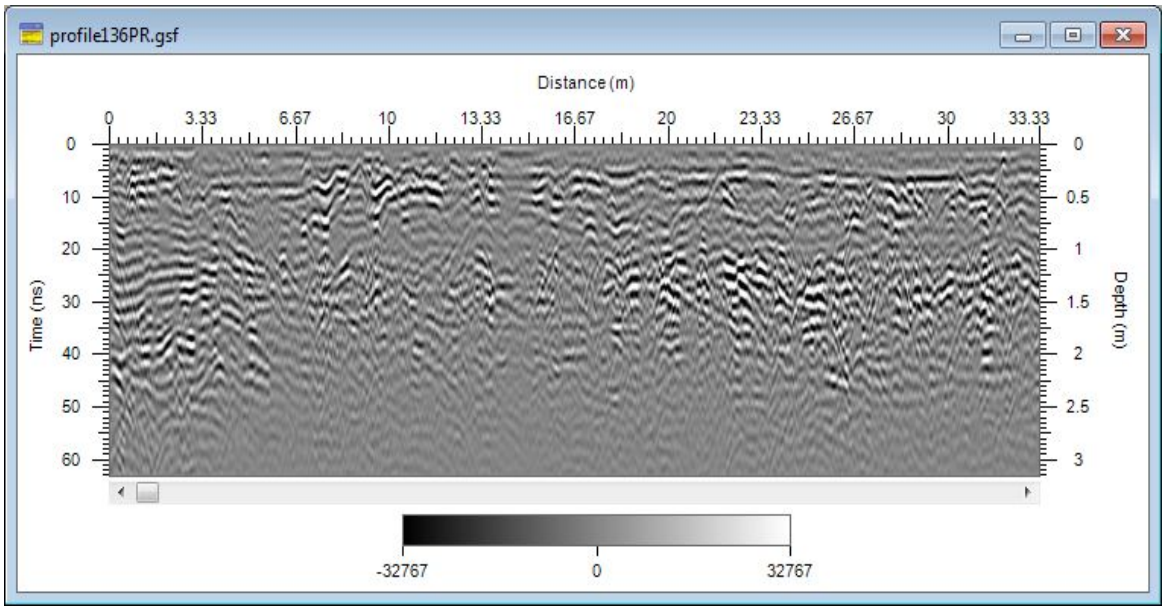
The GPRSoft©Pro software package consist of many helpful tools to interpret the collected data or create a report from it. One of those tools is dedicated to topography correction of GPR data.

After opening your file in GPRSoft©Pro please select the Topography correction tool. A new toolbox window will open asking for the needed information to do the topography correction.

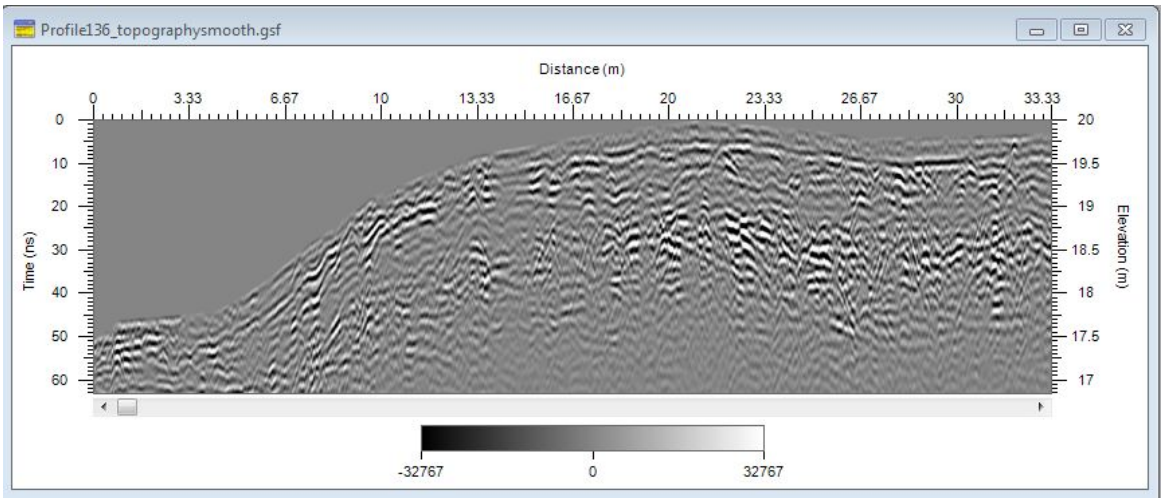


We are proud to say that our software package can open all of the major GPR file formats for processing so you can use any GPR equipment you presently own. However using our equipment will allow you to benefit from the specially designed file formats *.gsf and *.gof as well.

If you collected the topographic and GPR data using a GPS unit connected to Geoscanners RADAR unit, check the ”Use GPS implemented in data file”. If you collected the data in some other way or with other manufacturers equipment (and file format) select to load topographic data from an external file. The external file is a tab delimited *.txt or comma separated *.csv file. For details on the structure of the file press the big red question mark. After that there are a few interpolation methods you can choose from to connect the existing topographic points into a curve. Don't forget to specify the type of elevation change you've experienced while collecting the data (smooth or rough) and give the output file its name. Depending on the selection of the source of the topographic data, confirm the selections with ”Load ” or ”OK” button. That’s all, you are done!



Survey site compared to topography uncorrected data



Survey site compared to topography corrected data

References:

1. "Ground Penetrating Radar for Archeaology" Lawrence B. Conyers, Altamira Press. ISBN: 0-7591-0772-6 and 0-7591-0773-4.
2. http://www.geoscanners.com/videos/GPRSoft/topo1/topo1.htm