GPR Considerations for Archaeological Sites

Ground Penetrating Radar (GPR) can be a very important tool when discussing archaeology and can be a helpful addition to accompany other methods of geophysical, archaeological and historical research and/or fieldwork. A very important element of said fieldwork is to express to the site researcher an understanding of what GPR can do (and its limitations) in order to manage expectations for their particular project. The last thing one would want is a disappointing result, especially for research funding and project aims. Every site is different and has its own set of variables to be considered, as this geophysical technique is not suited to all of the archaeological possibilities.

Some of the main things to talk with people who are interested in using GPR on their site are:

(1) location/site conditions
(2) survey size (grid size) & weather
(3) expected subsoil conditions
(4) expected target type/properties, size & depth
(5) deliverables (depend on objectives of researcher)

#1. Location/site conditions

One of the major obstacles is the survey conditions themselves – in particular, the ground surface. Although the GPR machine is robust and for outdoor use, it works best over flat ground (think of a golf course, a well manicured lawn or an asphalt carpark.) The antenna glides along the surface to allow the radar wave to enter/exit the subsurface and properly record the ground matrix. Ideally, there is no air in between the antenna base and the ground surface as to concentrate all wave into the ground and not be absorbed by the air which can limit penetration and resolution.

For example, one archaeological site may be a cemetery. Buried remains or graves can be quite difficult to record even in optimal conditions, and, if the terrain is not suitable, a GPR survey may not produce the desired results. If one can imagine an antenna bumping up and down over rough vegetation and roots/stumps, one can see how this could be very disruptive to the signal and could potentially negate the data recorded in that particular area of the site.

Therefore, in the majority of GPR cases there must be vegetation clearance of surface obstacles if possible (trees, shrubs, bushes, overgrowth, tall grass, etc) In some places, this may involve a heavy rake &/or whippersnippes while in others, it can mean chainsaws and heavy removal. It can be time consuming and expensive to the researcher in preparing the site pre-survey, depending on what is required for the particular location. As such, it is very important to highlight that the more flat and uniform the ground can be, the quicker one can survey and the better the potential for optimal data collection.

Also, the landscape of where the site is located must be considered - is the site in a densely concentrated area, are there buildings/radio towers, tall trees or rocky outcrops nearby? This can interact with the GPR and produce airwaves and false readings in the data.

As this can be an in-depth conversation, best practice would be an on-site visit or at minimum current photos and maps of the site at the start of the conversation with the researcher so one can figure a survey plan. It should be highlighted as well that sometimes, this may mean that once all variables are considered, GPR might not be the right fit for the particular project.

#2. Survey size & weather

This would be something to discuss for planning out the fieldwork and for the surveyor to give a reasonable quote for budget. Distance and/or multiple grids might mean overnight accommodation, travel costs (airfare, car-rental), per diem, etc whereas a smaller, local grid might be able to be completed in 1 workday. GPR is also weather-dependent as it cannot operate where rain/drizzle may affect the internal computer and external lead connections. Moisture can affect the subsoil as rain increases the conductivity so it is generally best to wait after a rainfall and drainage has completed before attempting a GPR survey.

#3. Expected subsoil conditions

This would be a discussion of the subsoil (if known) as GPR is not suitable to all soil types. Rocky soil and heavy vegetation roots can produce interruptions in the data while sandy soil can allow better penetration. Site location near the coast (salt intrusion) is also a consideration as salt can absorb a lot of the signal and reduce penetration/resolution. The water concentration of the subsoil is another consideration (is the area boggy, dry and/or have good drainage?) The GPR machine can be calibrated according to subsoil water properties to give a more accurate data reading. Another element to discuss is known previous activity of ground disturbance within the boundaries of the site.

#4. Expected target properties & depths

This can vary depending on the type of material one is expecting as well as the anticipated depth. Targets can be as tiny as a lithic or as big as an airplane or structural foundation, but depending for what one searching, GPR might be useful (or not) Also, the expected depth of targets is a consideration. Different GPR antenna frequencies are employed for different site depths so it's important to choose the one that closely matches the specific site parameters.

In using the cemetery example again: if one has performed several GPR surveys in NL within the confines of known, disused cemeteries, one may hypothesize a general idea of what to expect in a historic context in terms of target inhumations. However, nothing is absolute without additional work, notably ground-truthing in the form of testing and/or excavation. With graves in particular there is an additional element to consider when utilizing GPR: depending on how they were buried and the passing of time, the decomposition of the body can make the grave invisible to the GPR as it will not produce enough contrasting data to show up on a survey.

#5. Deliverables

This is a conversation about what one would expect as a researcher in terms of results (i.e. will the site later include a phase of ground-truth such as testing or excavation, or is the GPR strictly for mapping purposes?) What type of report does one require and what are the deadlines for report production as well as data dissemination?

GPR will generate a vast amount of data which has to be processed and analyzed off-site. No analysis is performed in the field. Similar to the post-excavation phase after an archaeological dig, the post-processing phase of GPR can take a significant amount of time that can mean many hours post-fieldwork. Frequently, this adds up to much more time than it took to collect the data during the GPR survey. In addition to time, the accumulating hours can also be costly for the researcher. Therefore, it is advisable to have a discussion upfront while in the planning phase about what is expected by the researcher, their timeframes and how this fits with the achievable deliverables from the surveyor.

I hope this answers some of questions and gives a general overview of what GPR can and cannot do. I believe it's good to have the information at the start so we can try and figure the best approach for your project.

Any questions or concerns, please contact me below:

Thanks-you

Best regards,
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