New GPRTools for Archaeologists

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Introduction

GPRTools is a new Ground Penetrating Radar (GPR) Analysis software package[2] focused on Archaeologists and Anthropologists[3]. It is designed to have a low pain threshold to get advanced GPR and Magnetometry data processing in the hands of professionals and students. It introduces a few standout features which are discussed in this paper. This paper is not an advertisement for a service. It is meant to highlight stand-out contributions made for practical GPR and Magnetometry data processing by Archaeologists.

Background

Archaeologists often work with Geophysical experts to measure and analyze ground data. This is important for possible excavations and even more important if it can draw the same conclusions without excavation. Lowering the level of investment (time and money) for using Geotechnical methods remains one of the goals of GPRTools.

Geotechnical experts have the time and focus to invest hours and thousands of dollars into popular software analysis packages, such as GSSI's Radan-7, GPR-Slice or Geolitix to perform GPR processing. Each of these platforms presents similar capabilities, while offering unique features, but generally demand a steep learning curve to proficiency. Still, much of the target audience for commercial GPR equipment is the construction industry which means some features or time and money investments may not be very applicable to Archaeologists.

There is a long history of free downloadable tools for examining GPR data. The most significant of which is GPR Process and GPR Viewer which was developed by a team of people at the University of Denver and USGS led by Dr. Larry Conyers[4]. GPR Process is based on an older DOS operating system which is difficult for students today to work with. GPR Viewer remains outstanding and is the viewer of choice to examine amplitude plots. It

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[2] GPRTools release, demonstration videos and sample data are available at https://drive.google.com/drive/folders/1FIgn0_aeHlIVfqm8IVHB9elOwiZI70lz?usp=drive_link
[3] When referring to target audiences, I include both Archaeologists and Anthropologists. Future references in this paper only state Archaeologists but should always be interpreted as both. Anthropologists can contemplate the complexity of a civilization and the degree of organization by looking at GPR and Magnetometry data without needing expensive and damaging excavations.
[4] Visit www.gpr-archaeology.com/software for more information on these tools.

also supports translating other popular GPR data formats into .DZT formats. This was the first tool used by the author and continues to hold-up very well.

GPRTools was developed as a result of the Archaeology program at Foothill College in California. This field school training is driven by Professor Sam Connell who has a strong background in GPR and is driven to help kids find jobs or graduate school. The class offers specific access to GPR and Magnetometry instruments. It is also the case that Foothill College happens to be in the middle of Silicon Valley and it was probably only a matter of time that a retired Silicon Valley inventor who specialized in RF Time Domain Reflectometry for ultra high-speed communications systems' development would come along.

Contributions

There are countless ways computer programs could use processors and displays to implement GPR and Magnetometry processing algorithms and display results. Generally, scientists will figure out how to make a given tool work for their application—often even despite the tool's cumbersomeness. Real contributions go farther in that they offer new insights (beyond productivity). The key contributions of GPRTools include…

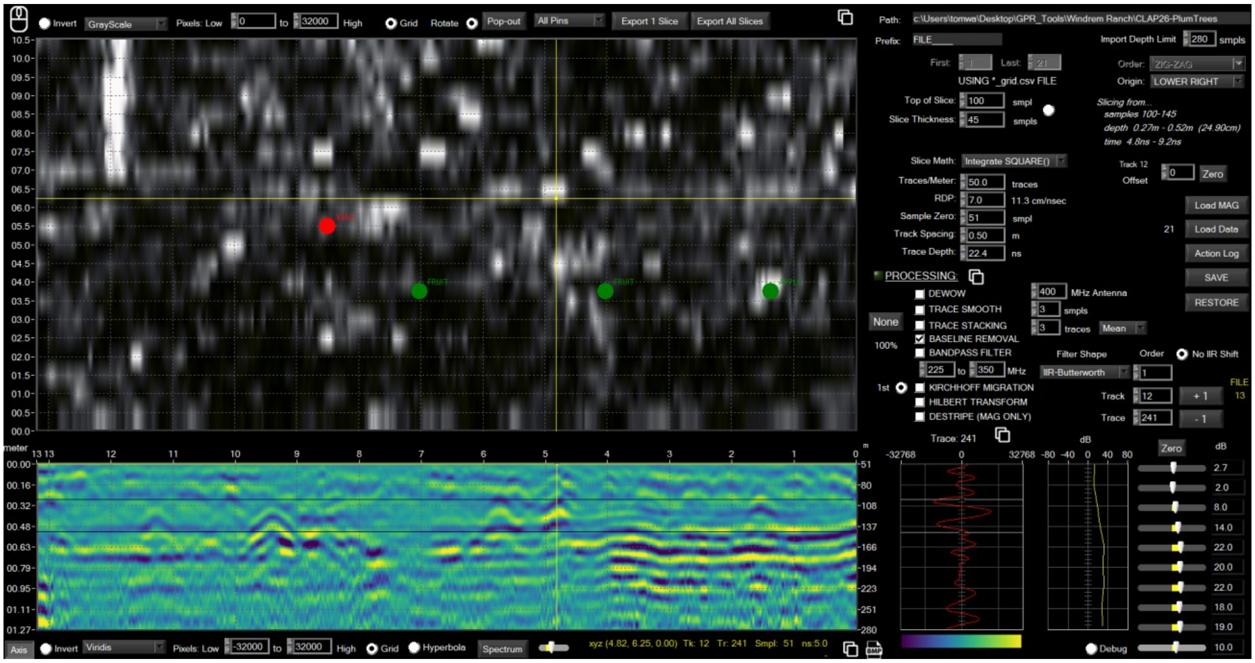
It's Free

Free means Archaeologists can try GPRTools without money investment. It means that students can use GPRTools without need of funding or licenses. There is no "free trial period" or "free operation for small projects". Users can benefit from quick and easy access to GPR and Magnetometry processing. If people don't like it they can throw it out without losing money. They can also take what they have learned to graduate up to other tools.

"Front Panel" Interface

With the intent of quick and easy operation, as opposed to typical windows-oriented software programs with layered pull-down menus and many icon ribbons, GPRTools uses a "Panel" interface. The GUI is all accessed through a panel of graph displays and controllable settings. What you see is what you get. It is a flat user interface. Within a few control presses, a new grid can be imported or an existing grid with settings can be re-opened. Each control operates live as it is pressed and each control has its own "mouse-over" help to drag new users through it. It is not necessary to remember lots of settings and menu hierarchy locations. Users can start and then experiment. You can't hurt it and you can't destroy your files.

The front panel includes all the GUI elements (some are pop-up sub panels). Another benefit of a front panel GUI is that GPRTools can be run mouseless on a touchscreen (in the field) and one of the controls allows all numeric entry through a pop-up numeric pad.



The main panel's key features are the upper-left large slice map which sits on top of a wide amplitude plot. To the right of the amplitude plot (and on the same scale) is both an individual wiggle trace view (showing the trace at the cursor) next to the depth-dependent gain adjustment graph and sliders. Controls to activate processing, set parameters and load, save and restore settings are distributed around the rest of the display.

This layout is critical. The always-active slice map is vertically aligned with the always-active track amplitude plot which is horizontally aligned with a specific trace wiggle plot alongside the trace depth amplitude gains. With cursor movements in either the slice map or the track amplitude plot and by noting slice top and bottom markers in the amplitude and wiggle plots, users can easily navigate all around their data.

Always-Active Slice Maps

This feature needs to be called-out as a significant improvement to static slice maps. Alone, slice maps are very important to enhancing GPR interpretation because of the 2-dimensional correlation shown in the image. However, adding the ability to roll the mouse knob over the "Top of Slice" or the "Slice Thickness" controls in real-time provides an animation of the map which significantly helps interpretation. It lets one see objects that stay in place despite scrolling versus noisy objects that come and go during scrolling. With this feature, the human eye and brain does a wonderful job at interpreting what is really there.

Simple Grid Import with support for Complex Grids

To import a new grid of GPR data, one sets the data file Path, the file Prefix, the first and last file numbers and makes selections for if the data was recorded zig-zag or not as well as defines which corner of the display to call (0,0) and then presses "Load Data". Next, a user would probably activate the baseline removal processing to normalize their data. Finally, a user would be able to adjust gain curves using sliders for 9 gain depths or adjust brightness with all gains at once. When done, users would be looking at a beautiful first-look at their data.

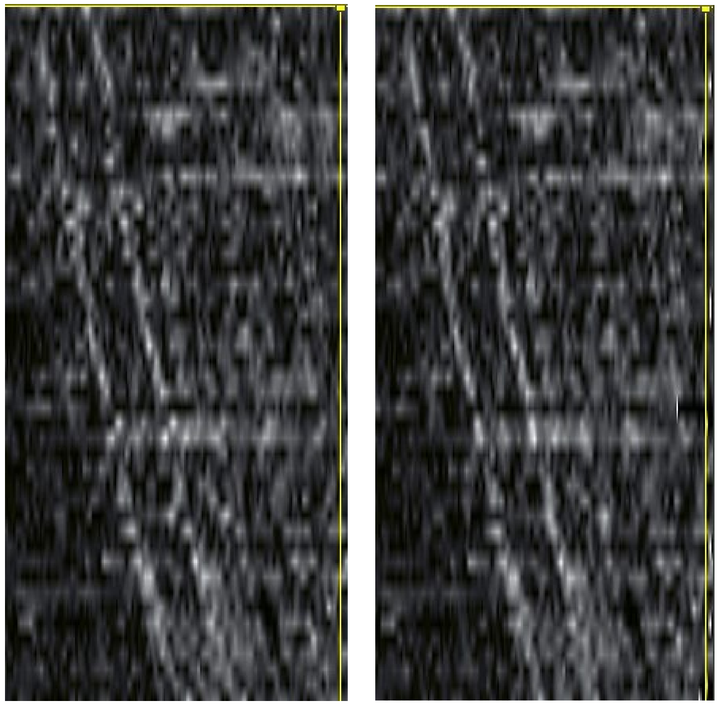
Advanced grids with arbitrary trace lengths and directions are easily imported using an ASCII Excel file that defines traces, start and stop locations, anchor points and file numbers. When importing simple grids, the ASCII grid files are automatically created and can be edited if adjustments are wanted. For example, simple imports use the starting point of a track as the reference for that track. Using the grid file, this can be changed to the ending point of a track on a track-by-track basis if needed when this provides a more accurate reference.

	A	B	C	D	E	F	G	H
1	# GRID LAYOUT DEFINITION							
2	# DZT files: FILE___125 to FILE___139							
3	# Grid Order: ZIG_ZAG							
4	# Created on: 06-24-2026 at 17:16:47							
5	#							
6	scans_per_meter			50				
7	plan_track_length			12.4				
8	# Track#	File#	START	END	Anchor			
9	0	125	0	12.4	START	# 620 traces / 12.400 meters		
10	1	126	12.4	0	START	# 620 traces / 12.400 meters		
11	2	127	0	12.48	START	# 624 traces / 12.480 meters		
12	3	128	12.4	0	START	# 620 traces / 12.400 meters		
13	4	129	0	12.4	START	# 620 traces / 12.400 meters		
14	5	130	12.48	0	START	# 624 traces / 12.480 meters		
15	6	131	0	12.32	START	# 616 traces / 12.320 meters		
16	7	132	12.24	0	START	# 612 traces / 12.240 meters		

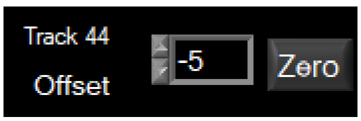
Track-by-track Offsets with Real-time GUI

It's not uncommon to adjust the starting point of a track. Most tools support this in the way grids are imported in setup files (including GPRTools). In GPRTools, support is also given for a real-time user interface that lets users cursor to a horizontal track and shift if left or right as they watch the updated slice map. This makes re-aligning data to some ground-truthed feature quick and easy. It is very visual. Saved setups will remember these offsets for the next time.

Here's an example of a roadway found in GPR data. On the left is the raw data from a 60-meter long zig-zag data collection. On the right, corrections to offset have been inserted to register the data locations to a physical phenomenon.



This may appear subtle, but the overall impact on later image focus even elsewhere in the data is dramatic. To accomplish this, the track offset control is used.



The cursor is used to indicate which track to adjust and then rolling the mouse knob over the offset control shifts the track left or right. The slice map is updated instantaneously, and the user continues to roll their mouse knob until the image shows the alignment they like.

The example above was taken from data collected in a field in Baudes, France. Fixing the near-surface level track alignment based on this linear feature in the data significantly improved the resolution of church and villa foundations seen elsewhere in the data.

Collected Data Point of View

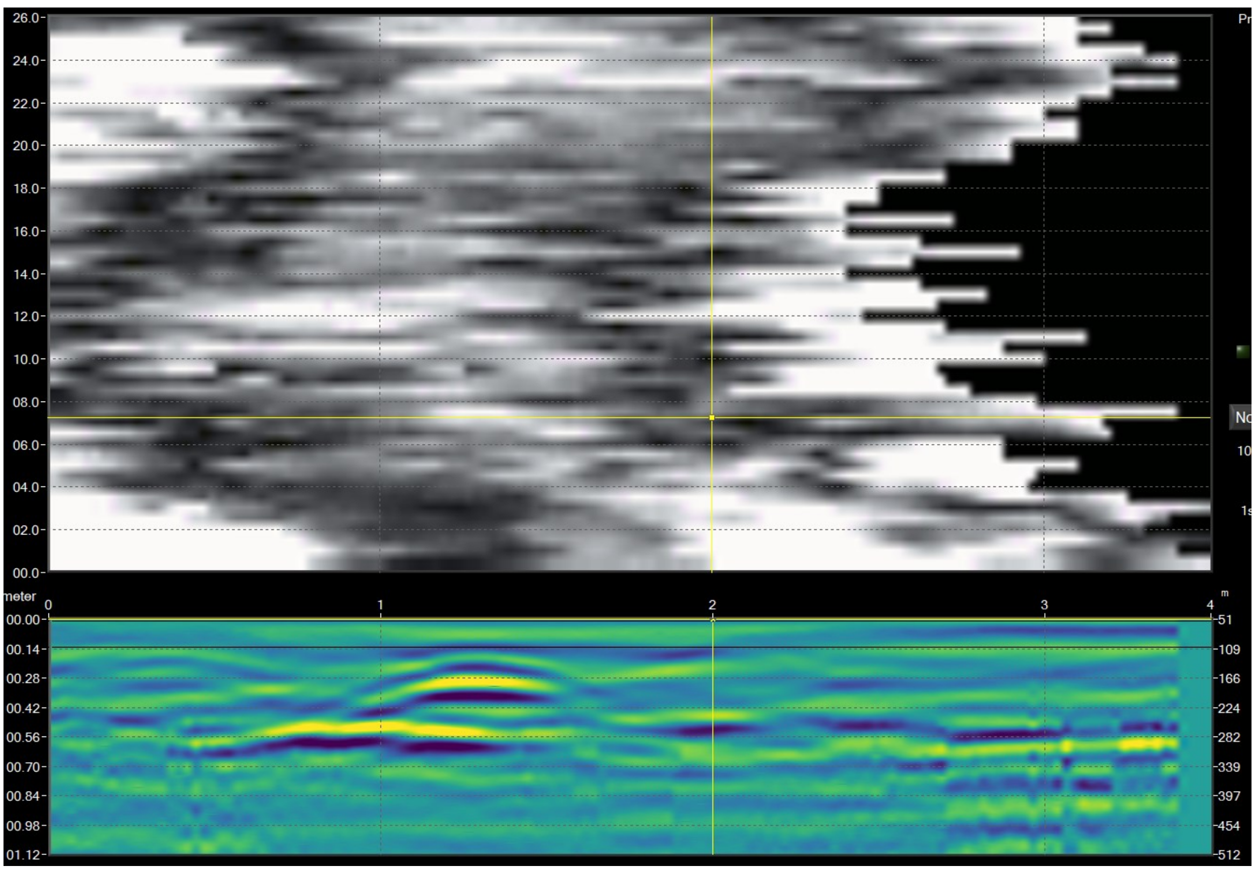
The panel layout is from the point of view of collected data tracks—not the geometry of a grid. This is critical to understand. The screen is maximized to view as many horizontal track "walks" stacked vertically with neighbor tracks to form a slice map. This is always a fixed rectangle in this view to maximize display pixel usage. This slice map is also aligned vertically with a single amplitude plot below it. Which amplitude plot to display is set by the cursor location in the slice map rectangle. This provides easy navigation to slice maps and amplitude plots throughout the collected data.

To help with visually connecting this fixed rectangular view to a user's comfortable interpretation of their collected grid, users can define which corner of the rectangle corresponds to where they might want to call the (0,0) point. Axis cannot be flipped and horizontal lines will always represent walking through a track, but the origin of the grid (the starting point for the first track) can be assigned to be upper or lower, right or left of the rectangle.

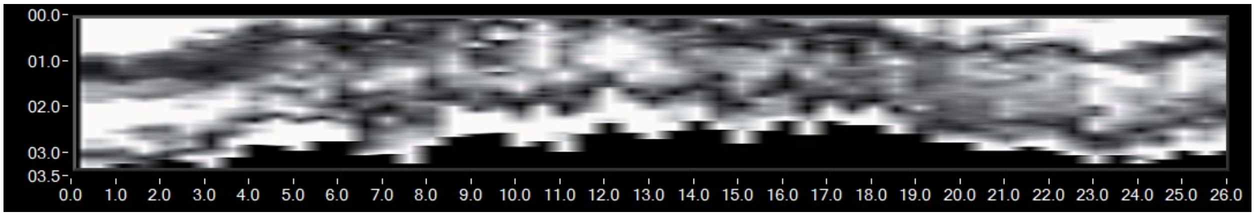
It is common to want to then look at the data in the real geometry of the grid. To do this, users use the “Pop-out” control to create a new pop-out window that has the correct geometric aspect ratio. The pop-out feature also supports rotating the image +90 degrees. Rotation plus grid origin allows the pop-out image to be in any desired orientation.

This is confusing, but for users who want to study both the slice maps and the associated amplitude plots, this provides an easily navigated way to look all around your data.

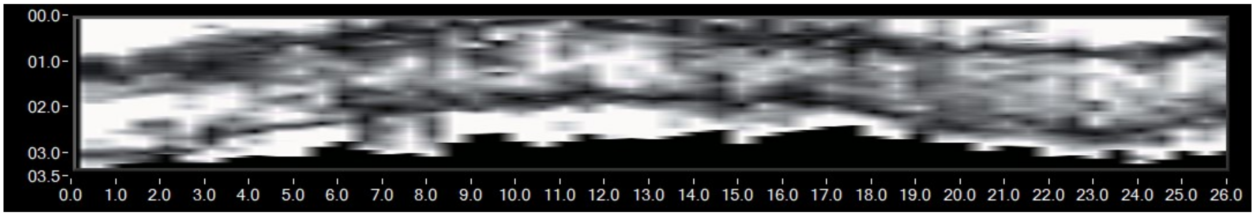
As an extreme example, this data is from a 4 x 26 meter grid of a supposed Stagecoach Road where today there is only a narrow walking path. The scans were made along the 4 meter dimension to measure data transverse to the expected Stagecoach path. Actual track lengths and positions were somewhat erratic as the grid actually fell-off into a creek.



This view shows that the entire slice-map view is still used to present the GPR track data despite it only really representing 4m in width. The Amplitude view at the bottom is of the cursor-highlighted track demonstrating how to navigate through your data for both slice maps and amplitude plots. The rotated “Pop-out” view of this data which restores the physical aspect ratio is...



This is also a good place to demonstrate the track-by-track offset feature again.



The pitch of these two wheel marks is measured on GPRTools at 56.6” which matches the expectation for a 1860’s Stagecoach.

Slice Math Selections

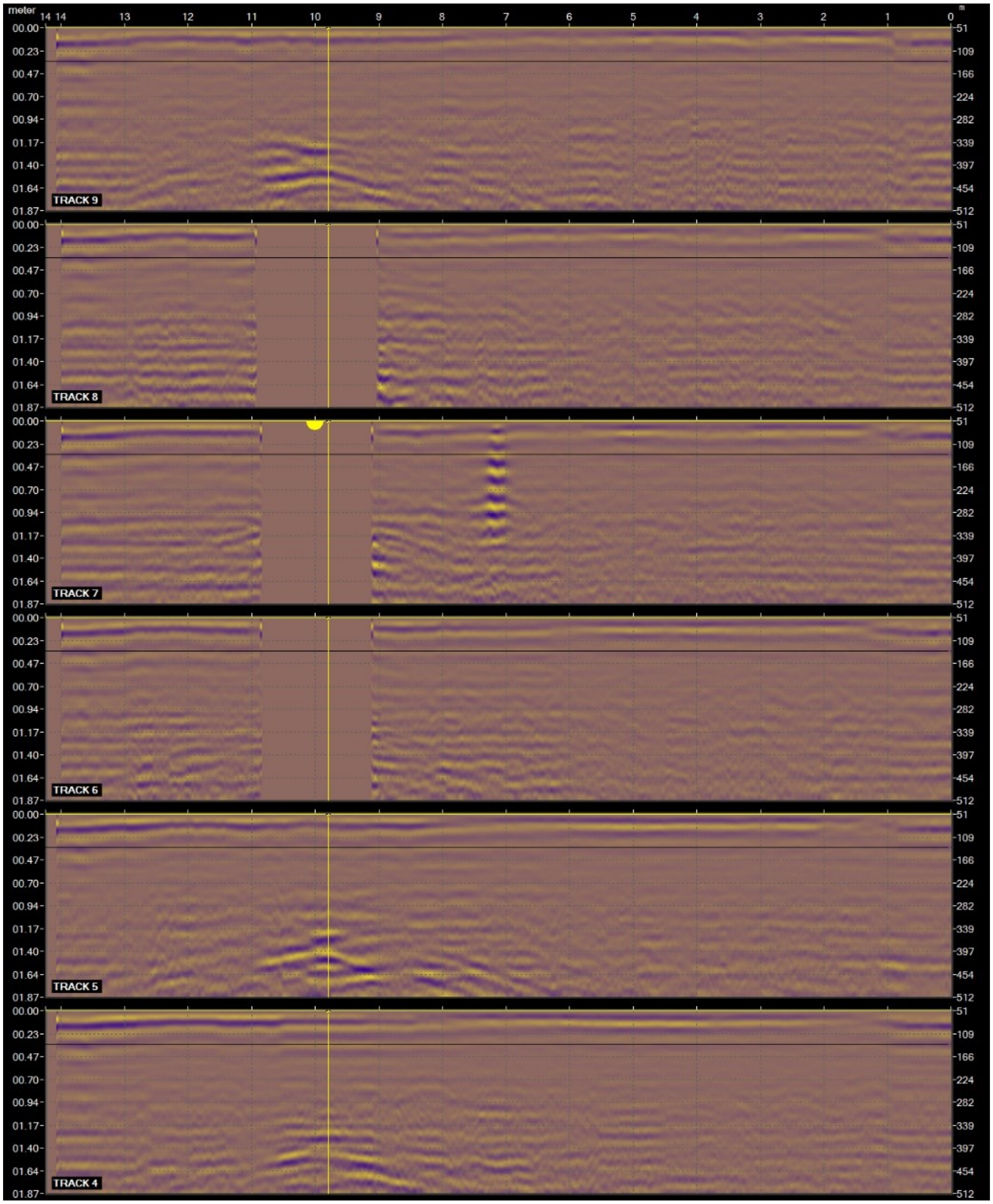
Modern GPR processing tools include slice maps; however, the math used to create a slice map can be critical to what the slice highlights. GPRTools includes three choices for slice map math. Like other controls, these operate in real-time, so it is easy to step through them and see their impact on the map.

Slice math is the algorithm to choose the brightness of a given X/Y location in the 2D map given that it is made up of data between a chosen slice top and slice thickness. One method is to integrate (sum) the absolute value of all wiggle trace responses inside the vertical slice window. As trace samples are both positive and negative, this can have a canceling effect although studying large negative reflections or large positive reflections can draw attention to types of dielectric transitions (low to high or high to low). The second is to assign brightness based on the peak-to-peak difference between the lowest and highest response in the vertical window and the third is to first square all values within the vertical window and then to integrate (sum) all the squared energy in the window.

Users need to experiment with these choices to see how this impacts their data. It is notable that squaring the data makes bright objects very bright which highlights them at the cost of washing-out more subtle findings. Making a dark object very bright may sound counterintuitive, but a very dark object is also a dramatic reflection so it may well be worthy of highlight. Slice math and color pallet choice is often tightly linked.

Stacked Amplitude Plot Export

Graveyard grids are an example of GPR data that benefits by correlating between slice maps and amplitude plots. Specifically, multiple neighboring amplitude plots. GPRTools support an easy way to create a bitmap export of a selectable number of neighboring tracks all aligned vertically to make it easy to pick-out track-to-track correlation.



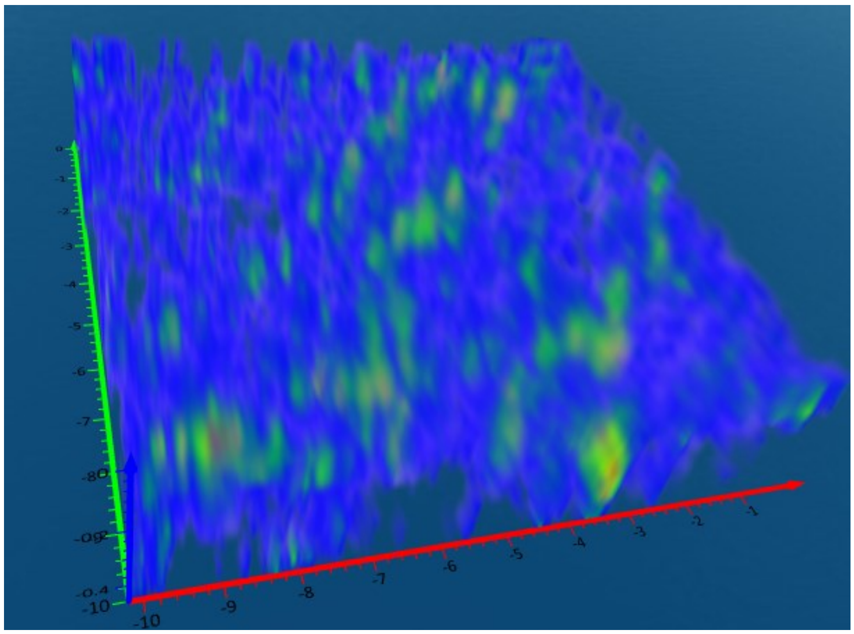
Here we see data from 6 neighboring tracks showing a casket that extends above and below a large grave marker (so large that GPR equipment had to scan around it—note the missing-data areas on tracks 5, 6 & 7). We also see a clear single shallow response on track 7 a couple meters to the right of the gravesite. Further research and excavation suggest this was a temporary post hole used to erect a boom to install the monument over the grave.

Lots of things reveal themselves when encouraged by visual correlation. This image may also contain another smaller grave, a little deeper and to the right of the larger casket.

Stacked track images are simple .BMP files which can be viewed in any Windows photo viewer.

Simple 2D and 3D Data Exports to Surfer

GPRTools supports easy export of both 2D and 3D data for import into other presentation tools such as Surfer[5]. Both export mechanisms create simple .CSV files. 2D exports of slice maps allow for better presentation tools for eventual publishing. 3D exports allow users to specify a vertical resolution to compute defined-height slice maps and provide the X,Y,Z,C ASCII .CSV file that Surfer needs to create stunning 3D images that can be "trackball" viewed in any orientation and zoom level in a live animation.



This example exported to Surfer's 3D viewing tools shows rodent burrows running throughout the grid. By "flying" around the data it is easy to inspect the depths of the burrows as well as some deeper "chambers" probably used for food storage or sleeping.

Real-time Processing and Intermediate Storage

Radan-7 and other tools create numerous intermediate files when generating a particular analysis. It is often confusing which set of files is needed and must be kept together with all other files. GPRTools only uses the .DZT files from the original import. Settings that say what to do to this data are saved in ASCII "settings" files and used in real-time to recreate the desired analysis as needed. There are no intermediate GPR data files. GPRTools can create other files that are associated with a grid including the ASCII grid file, 2D/3D data export files, .BMP bitmap images and settings files, but none of these hold modified versions of the GPR data. Grabbing a set of .DZT files, the settings file and maybe the grid file, gives users all they need.

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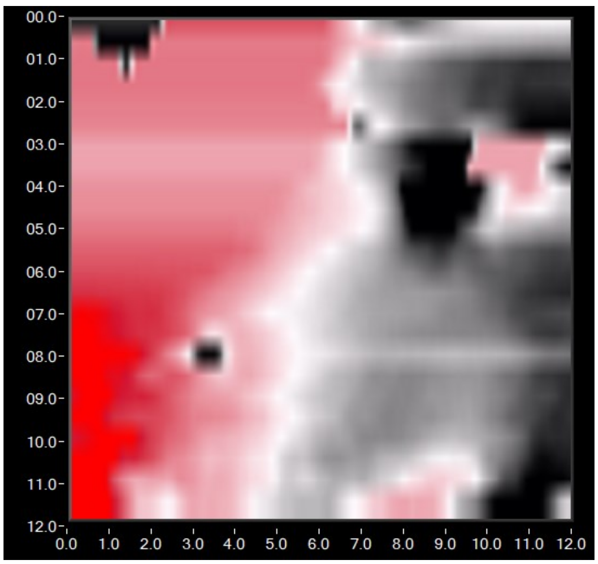
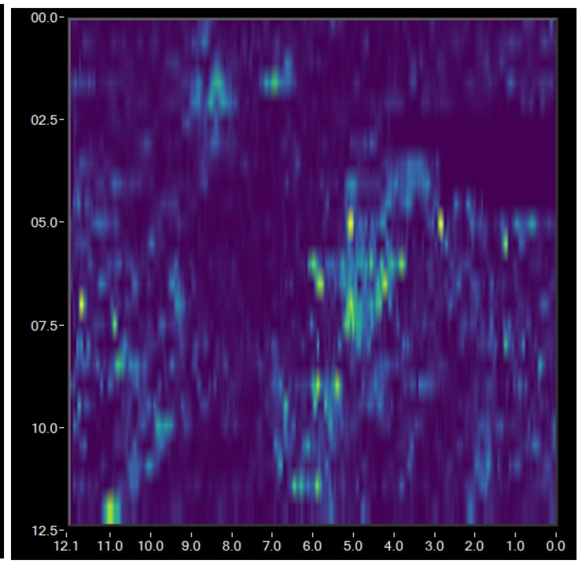
[5] See https://www.goldensoftware.com/products/surfer/ for information on Surfer software.

Reprocessing data on the fly with each parameter change is costly, but coding was done to use modern CPUs' multiple processing cores to accelerate processing. For most typical grid sizes and settings, changes appear almost instantly. This avoids the need for intermediate files. This can mean slower processing on lower-performance notebook computers.

GPR and Magnetometry Processing

GPRTools is able to process both GSSI .DZT datafiles (SIR-3000 or SIR-4000) from GPR as well as Magnetometry data exported by popular Bartington Grad 601 Magnetometers[6]. While Magnetometers don't offer any "depth" component to the view, it is convenient to see the same grid on the same analysis tool when measured with GPR and Magnetometry. While these devices measure completely different phenomena, correlation can be useful—especially if the same analysis software can present both.





On the left is a de-striped Magnetometry image of a grid. On the right is a smoothed, stacked and baseline processed GPR image of the same grid. The Red area to the left of center in the Magnetometry view is thought to be the original grade with the grey area to the right being fill. This was actually best identified in the Amplitude plots of the same GPR grid (not shown). Other near-surface features found in the GPR slice map clearly did not register in the Magnetometry data.

Mouse or Touchpad Operation

Most Geophysics experts would say they don't perform GPR analysis in the field. Archaeologists may want to say this too, but they're typically in a hurry trying to identify an area to do further ground-truthing on. Being able to collect a GPR grid, import it and then walk the site while looking at the GPR responses under your feet is a nice feature (great for teaching). It avoids future trips and re-measurements by giving immediate feedback.

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[6] See https://www.bartington.com/products/grad601/ for information on Barrington magnetometers.

Other Features

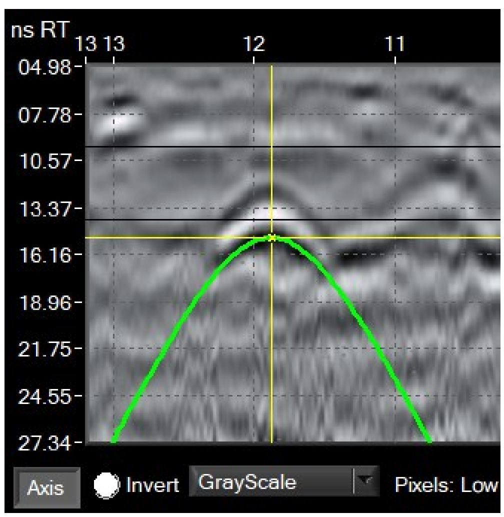
To give a complete introduction, it is important to also list the familiar features knowledgeable GPR or Magnetometry analysts will look for.

Installed Software – Internet not required

GPRTools is not a web-based "App". It must be downloaded and installed on your PC. Today, it only runs on Windows PCs. Once installed, there is no expiration date or licensing requirement. Your data is only stored on the PC and no connection to the internet is needed (beyond downloading the installation package).

Hyperbola Matching

One of the first things that is done during GPR data analysis is to determine the RDP (relative dielectric permittivity) value. This sets the velocity used during processing. Once velocity is known, processing can translate between time and distance. GPRTools supports overlying a graphic hyperbola onto any cursored location in the amplitude plot that corresponds to the present RDP setting value. By placing the hyperbola over a visible hyperbolic response, users can adjust the RDP value by rolling their mouse knob over the RDP control until the graphic hyperbola overlay matches the visible hyperbola response in the track amplitude view. Once determined, this value will be saved with the settings. Only one RDP value at a time is supported in GPRTools.

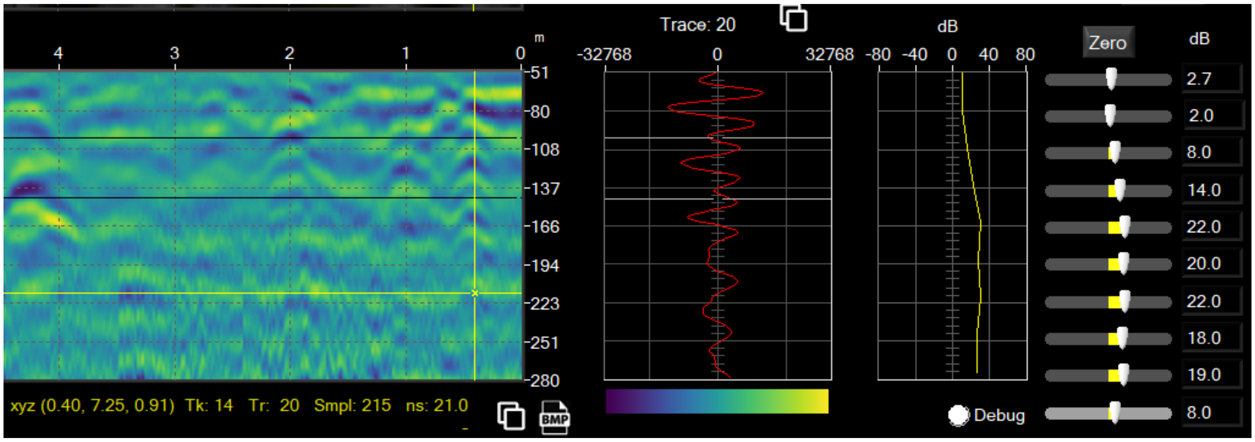


Once determined, this RDP allows the y-axis of the amplitude plot to be alternated between time in nanoseconds or distance in meters.

Depth Gain Adjustment

GPR trace measurements must be equalized for the inherent attenuation the deeper signals suffer as they travel through more earth. Equalization applies gain to the smaller echos returned from deeper measurements to bring their amplitudes up in par with other more shallow measurements. GPRTools supports 9 levels of gain that cover the imported data depth. Actual gain values are interpolated between these 9 anchor points.

Gains operate in real-time so it is possible to watch a wiggle plot, a track view and the entire slice map as a gain is adjusted.



Gain anchor point controls shown on the far right dynamically create the overall gain curve (shown as the yellow trace) which immediately impacts the wiggle plot, track amplitude plot and the slice map. Adjusting the grey 10th slider control simultaneously adjust all sliders to add gain to all depths. This image also shows the horizontal markers that are displayed in the track amplitude plot and the wiggle plot to indicate the top and bottom of the current slicing levels.

Gain anchor points can also serve another purpose when creating 3D datasets for export to 3D visualization tools such as Surfer that implement translucent viewing. When there are depth-based returns that one might want to demote in a 3D visualization for the purpose of drawing attention to other structure of interest, reducing the gain is an easy way to achieve this. For example, if a grid has near-surface clutter with a strong foundation at a deeper depth, gain can be turned-down for the surface returns allowing a clear view of the deeper foundation.

Signal Processing Algorithms

There are a variety of signal processing algorithms included in GPRTools. To activate an algorithm, the check-box control must be checked. More than one check-box can be selected allowing a cascade of processing to be done. Most processing is defined for GPR data. Only the Destripe algorithm exists for Magnetometry data. The algorithms include:

Dewow –	Removes self-coupled reflections that tend to have wiggle plots that walk away from being zero-centered. An antenna frequency can be entered to set time window of Dewow filter.
Trace Smooth –	Vertically averages same-trace neighbor sample values to reduce noise using a boxcar filter. User selects how many averages to use.
Trace Stacking –	Horizontally averages neighbor trace sample values to reduce noise. User selects how many averages to use.

Baseline Removal – Subtracts the average of all samples at each depth from samples at that depth to remove static background effects.

Bandpass Filter – Implements a selectable bandpass filter on each data trace to demote energy that is outside of the bandpass frequency limits. Filter types support sharp or smooth rolloffs with various impacts on filter ripple. Filter implementation carefully does not distort delay timing.

Kirchhoff Migration – Elevates falsely-detected deeper energy signals to their mathematically-computed origin depth to clean-up hyperbola returns.

Hilbert Transform – Self-demodulation of the radar reflection coefficient from the ringing sinusoidal GPR transmitter.

Destripe – Magnetometry Only. Subtracts the mean and spreads the standard deviation of returns on a track by track basis to remove effects of sensor orientation, multiple sensors and zig-zag measurements.

To assist documentation, a convenient copy buffer feature is provided to capture the current processing settings so they can be stored with any saved images or data.

```
GPRTools  08-19-2026 10:53:19
c:\Users\tomwa\Desktop\GPR_Tools\Windrem Ranch\CLAP26-PlumTrees
RDP=7.00  Slice=0.27m-0.52m (Integrate SQUARE)
Time0 is sample 51, Imported 280 samples, Gain: 2.7,2.0,8.0,14.0,22.0,20.0,22.0,18.0,19.0 [All Gain is 8.0]
Processing: /DEWOW-400 MHz/SMOOTH-3/STACKING-3/BASELINE/BPF-225 Mhz to 350 MHz/KIRCHHOFF/HILBERT/
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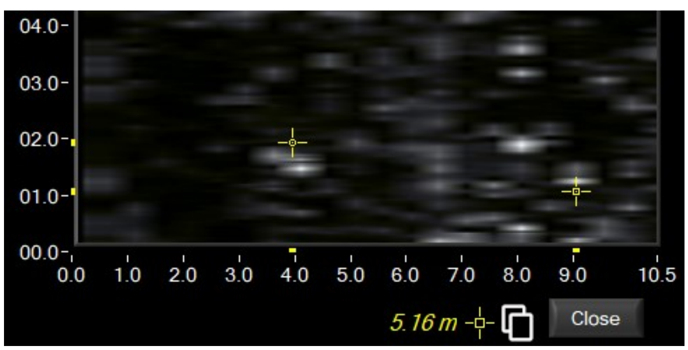
Cursor Distance Measurements

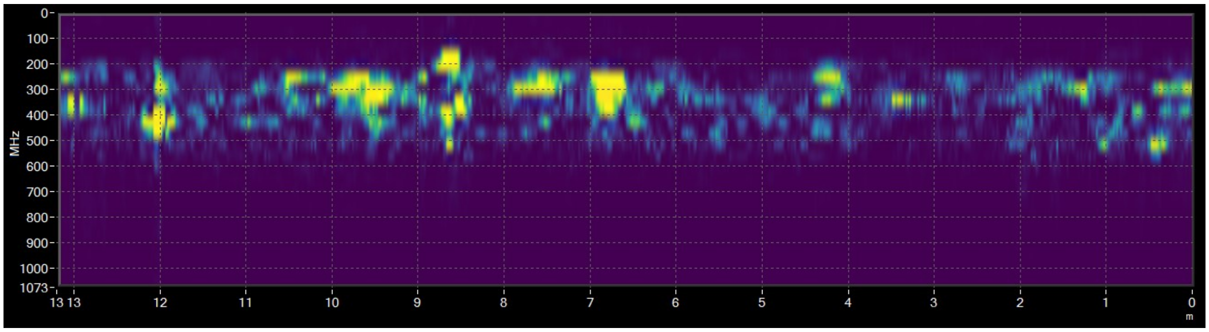
To support easily making distance measurements between features in a pop-out slice map view, measurement cursors are available. Dragging the cursors to different points in the slice map image will dynamically display the distance between the cursors.



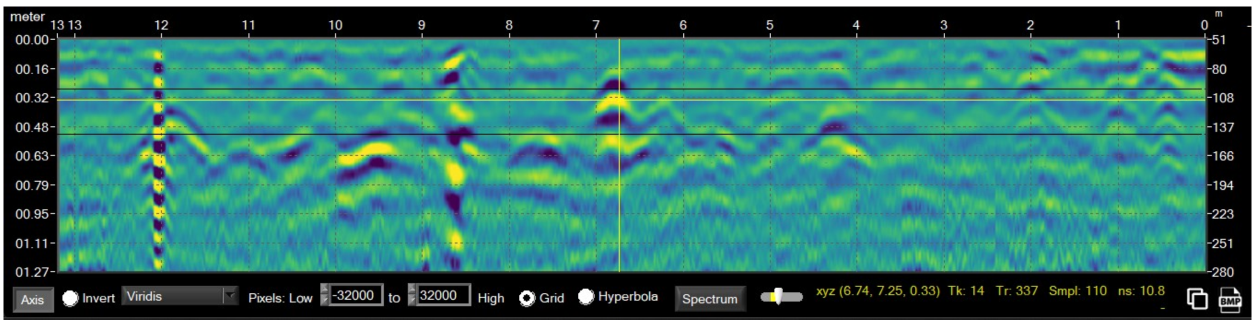
Spectrum Analysis with Persistence to Guide Bandpass Filter

The purpose of a bandpass filter is to remove unwanted signal and noise from a measurement based on the frequency content of the signal. Knowing which frequencies to favor and which to discount is aided by looking at the spectral energy of a traces (or an entire track) in context of a slice map or a track amplitude plot. If one can identify the frequency ranges of signals-of-interest as visibly shown in the slice map or the track amplitude plot, then those frequencies can be selected.

To start with, a user would press the “Spectrum” button when looking at a slice map. This will bring up both a spectrum graph of the selected cursor track and trace as well as a 2D spectrum map of the selected track.

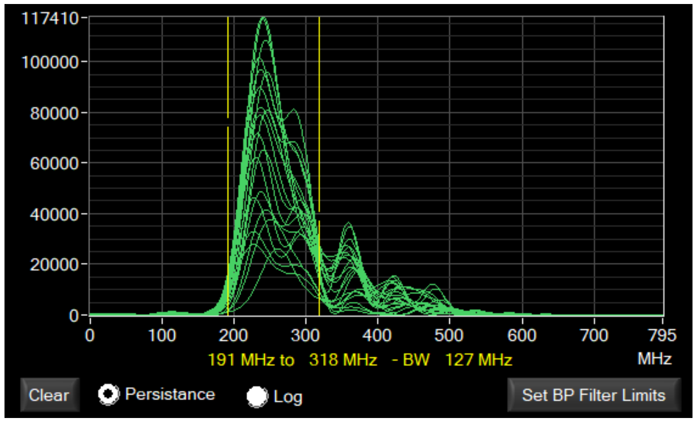


The 2D spectrum map visually aligns with the track amplitude graph allowing for 1:1 correspondence between what one might see in the amplitude graph and what energy spectrum it represents.

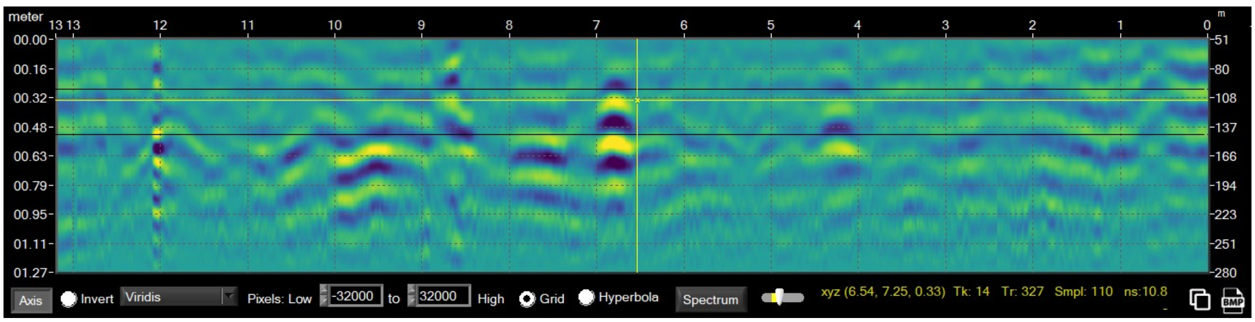


Once a feature of interest is determined in the amplitude graph, a glance at the corresponding offset into the 2D spectrum graph can show the frequency spectrum present at that feature. This is often good enough to draw attention to spectrum ranges of interest. However, the persistence mode of the additional spectrum graph can also be used to overlay many spectrums of the various interesting traces to see the details of spectral usage. Using this control, cursors can be used to set the bandpass filter’s frequency limits.

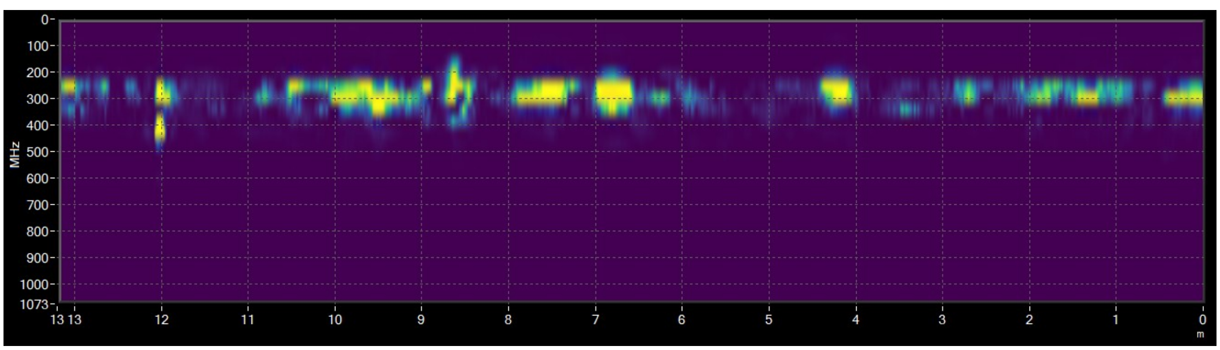
In this example, the candidate post-hole found just below 7 meters into the track has been singled-out as the item of interest. One might want to emphasize more post holes of this characteristic. The spectrum graph is then built using traces from 6.6 meters to 7 meters. The main lobe of the persistent spectrum graph identifies 191MHz to 318MHz as the spectrum of interest so these band pass filter limits would be set.



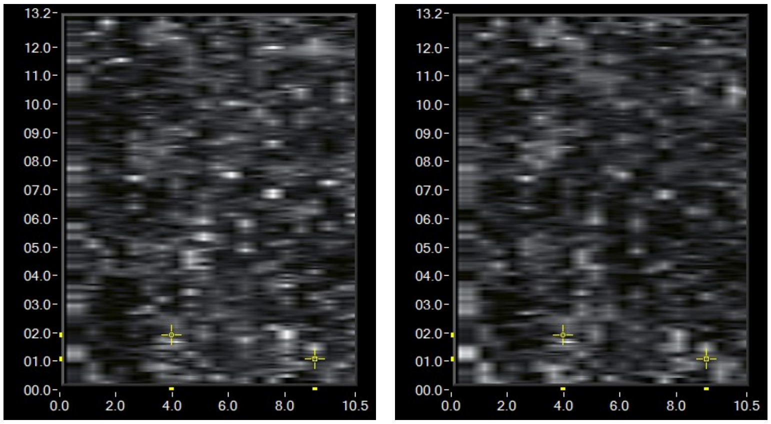
Setting these band pass filter limits then causes a new amplitude plot to be generated with the bandpass filter enabled. In this example, we can see how the feature just under 7 meters into this track has been enhanced. We can also see that other features, such as the possible metallic ringing at 12 meters has been reduced. Other details (especially higher frequency ones) have also been diminished.



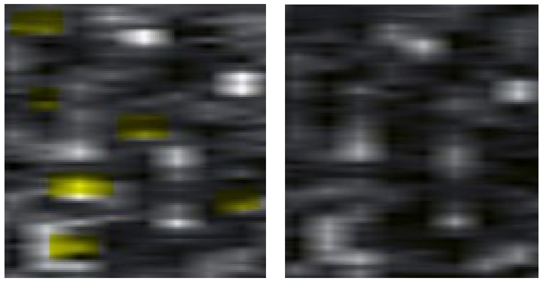
A look at the new band passed 2D spectrum shows how signals outside the desired band have been demoted.



Before and after slice maps at these depths can then be compared to see if the objective was met. In these two slice map images, the non-filtered slice map is on the left and the bandpass filtered slice map is on the right.



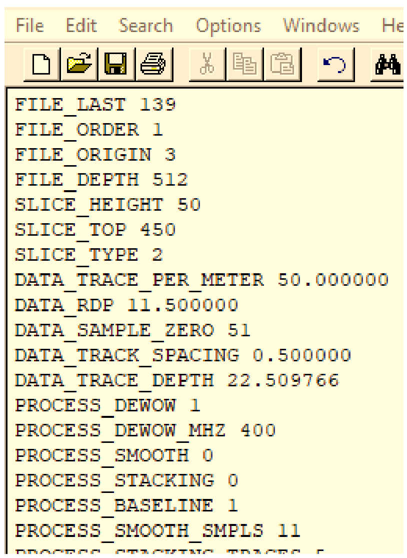
By drawing attention to the same small area in both images



Each of these small demotions (yellow) removes noise from the image and improves image analysis. This entire process becomes very interactive finding features that indicate frequencies of interest and experimenting with filtering.

Simple ASCII Settings Files

Cryptic configuration files often hide details that might be helpful during GPR processing and archive. GPRTools relies on simple ASCII files to define the control settings that drive the user interface. Files are created and processed automatically by GPRTools, but they can also be opened in any notepad editor for review or edit if that becomes helpful.




```
FILE_LAST 139
FILE_ORDER 1
FILE_ORIGIN 3
FILE_DEPTH 512
SLICE_HEIGHT 50
SLICE_TOP 450
SLICE_TYPE 2
DATA_TRACE_PER_METER 50.000000
DATA_RDP 11.500000
DATA_SAMPLE_ZERO 51
DATA_TRACK_SPACING 0.500000
DATA_TRACE_DEPTH 22.509766
PROCESS_DEWOW 1
PROCESS_DEWOW_MHZ 400
PROCESS_SMOOTH 0
PROCESS_STACKING 0
PROCESS_BASELINE 1
PROCESS_SMOOTH_SMPLS 11
```

Future Work

First, many of the features in GPRTools have come from user suggestions and practical cases. For example, adding all the available color palettes for slice maps and amplitude plots or integrating Magnetometry views. I look forward to more suggestions.

Additionally, improvements in the areas of pan/zoom features for amplitude plots and slice maps are planned. Selectable Kriging is also planned—although it must be disable-able as a regularly recorded grid of GPR measurements probably already is the purest presentation of user's data. At the risk of Kriging synthesizing things that are not there, it does offer an aspect of noise reduction. New ideas for clutter removal are also being studied. Especially true in areas such as the Myan peninsula, small randomly positioned rocks in the earth make identifying larger structure difficult and I look forward to a 3D probability field mapping based on numerous narrow slice maps to be able to improve the situation. This borrows on work done today in medical imaging.

Conclusion

GPRTools is not 100% comprehensive or perfect but it is rich with features and new development continues. Its focus is exposing the underlying GPR data with easy navigation and visual correlation between slice maps, amplitude graphs and trace wiggle plots. Its attention to both lab and in-field use opens up GPR analysis possibilities.

Acknowledgement

I am very lucky to have the friendship, guidance and input of Professor Sam Connell, Alex Apfell and all the students Foothill College's Archaeology program attracts. Math and physics are often a turn-off for a room filled with Anthropologists; but this program is able to pull them through. Each term, a handful of students pay particular attention to the geophysics work and I can't wait to see where they go with it. I start term eight in the fall.

Thanks must also be given to the "GPR-Club" organized by Alex Apfell that meets monthly to discuss GPR data from member work around the world. This group is exposed to my analysis using GPRTools and provides valuable comments and suggestions[7].

I must also thank Larry Conyers whose books Sam immediately gave me once I showed interest in GPR. Larry's commitment to the Archaeological use of GPR is outstanding and motivating.

Finally, I must thank all the people who have contributed inputs and suggestions to GPRTools. This will make the biggest impact to GPRTools' future.

[7] If you would like more information on this group, please email the author.