Newsletter – August 2019

GPR-SLICE Subscribers,

We would like to welcome the following organizations to the GPR-SLICE community:

- School of Geosciences, University of South Florida
- Universal Engineering Sciences, USA
- Environmental Protection Agency, Victoria, Australia
- RSK Group Ltd, United Kingdom
- College of Agriculture, University of Nevada, Reno
- Jorge Alarcon, Archaeologist, Colombia
- Christmas Island Phosphates, Australia
- Zetica Ltd, United Kingdom
- Universidad Nacional de San Antonio Abad del Cusco (UNSAAC), Peru
- Murphy Surveys, Cork, Ireland
- GB Geotechnics Ltd, United Kingdom
- Korea Cultural Heritage Foundation, Korea
- GroundTruth Ag, North Carolina
- Kiewit Infrastructure, Alexandria, Virginia
- United States Army Corps of Engineers, Alexandria, Virginia
- Petersburg National Battlefield Park, National Park Service, Virginia
- School of Environment, The University of Auckland, New Zealand
- Dept of Geology and Geological Engineeering, University of Mississippi

- Georadar, Estonia
- University of California, San Diego
- Fort Peck Tribes, USA
- Royal RSS Oil & Gas, Dubai, U.A.E.
- Nordgeo, Poland
- Locators Pty Ltd, Australia
- Credal AG, Switzerland
- Utility Mapping Pty Ltd, Australia
- Beobom, The Netherlands
- GTStudio, Italy
- Department of Engineering, Sungkyunkwan University, Korea

One of our newest users from January - Aero 360 in the Philippines took 4 licenses initially - and has now expanded to 18 subscriptions of GPR-SLICE along with GPRSIM! They are the largest subscriber among our 298 organizations. The next largest subscriber is the National Park Service with 8 licenses located over 4 offices, followed by the US Army Corps of Engineers with 5 subscriptions over 4 offices as well. The College of Agriculture at the University of Nevada started their new subscriptions with 2 licenses.

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Of our total of 298 organizations actively subscribing or maintaining purchased licenses, 55 now have multichannel options which represents 18% of the GPR-SLICE user base.

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We would like to introduce our newest distributor, Dr. Daniel Bigman and his company www.LearnGPR.com.

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Major features and options added to GPR-SLICE include:

- Compilation of the frequency at maximum amplitude per pulse
- 2D Time Slice Composite menu added to Pixel pulldown menu for placing multi-grid surveys with variable grid densities into a single - origin referenced image - and with the transform menu detecting which grid is clicked on to allow image adjustments (as for mosaic noises)
- Z level plane slicing now available in the OpenGL Topo Volume Warp menu with real time topography - eliminating the need to generate a separate corrected topo volume to examine level slices
- KMZ 2D radargram popup in Google Earth
- 3D Lidar las/laz data format conversion option added to the 3D volume pulldown menu
- Vector tunnel longitudinal menu option added for vertical tunnels as well as default horizontal tunnels

Compilation of the frequency at maximum amplitude per pulse

A new option was placed into the Spectra+Gain menu to map the frequency at the peak spectral amplitude across a site. The changes in the peak frequency can be interpreted as a possible indicator of areas with more moisture content. Areas where the frequency is relatively lower or depressed than other areas might be correlated with higher moisture content or can be related to subsurface material changes in conductivity in those locations.

To generate this new data file for gridding, one enters the Spectral+Gain menu and clicks the button "compile frequency @ maximum amplitude (Figure 1). This will perform a Fast Fourier Transform on each pulse and look for the peak amplitude over all the frequencies. When discovered the x,y location of that pulse (GPS or non GPS) is compiled along with the corresponding frequency. A file called peakfreq1.dat is written to the \dat\ folder of the project. This file can then be gridded over the

site by highlighting the peakfreq indentifier in the Grid menu (Figure 2). The units on the plot legend are MHz which can be set and customized in the Options menu.

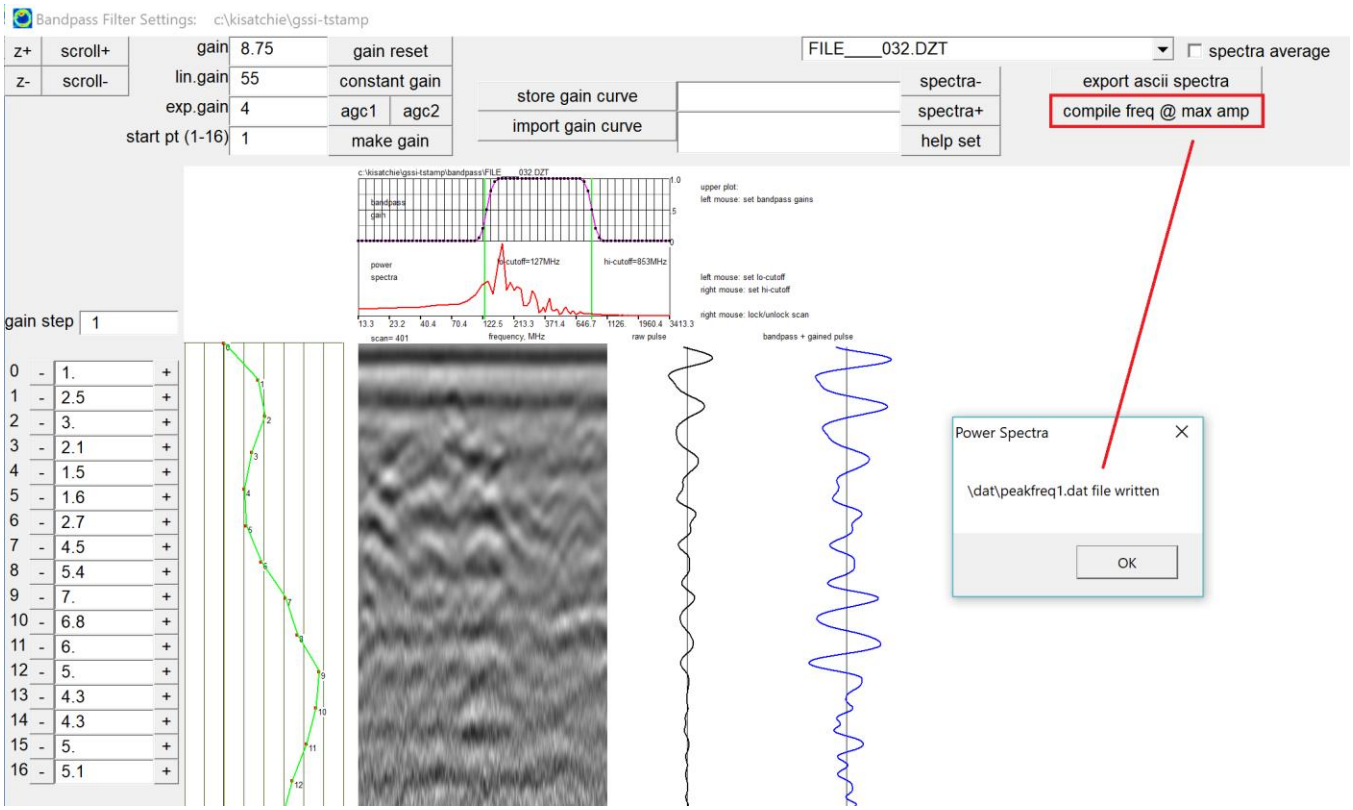

Figure 1. Location of the new operation to compile the frequency at maximum amplitude in the Spectra+Gain menu.

It may be useful to apply this calculation on data that has been bandpassed to remove peak spectra which might dominate on the low or high end frequencies. The user may also want to experiment with different narrowed bandpassed cutoffs to empirically see which frequency range may hold the most information. The frequency at maximum amplitude may have a variety of causes not related to moisture or even conductivity and might simply be a result of structural features. There is possibility that this gridded data may illuminate features in the ground that might not otherwise be detected with simple amplitude mapping.

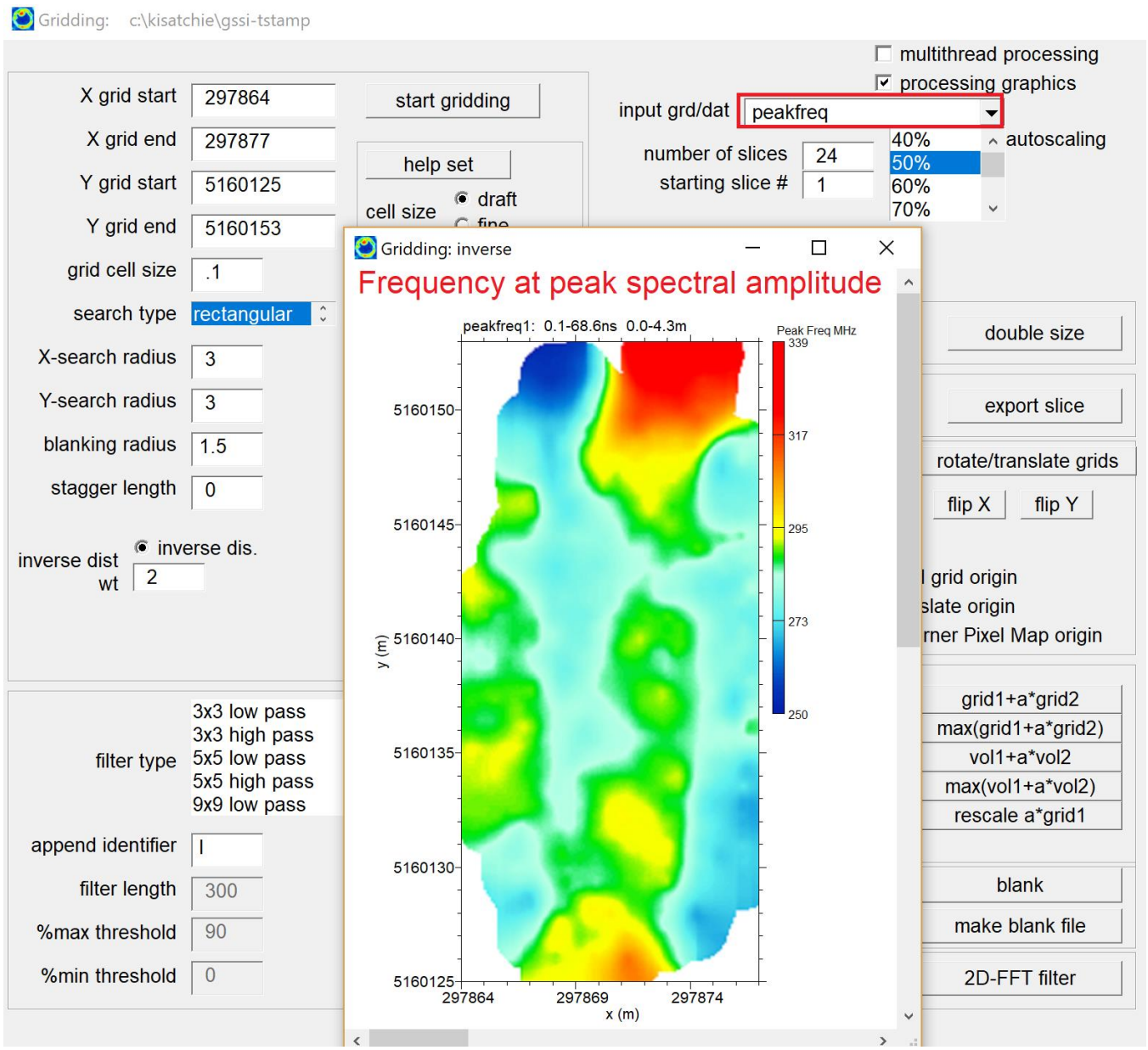

Figure 2. Example of gridding the peakfreq1.dat file containing the frequency of the peak spectral amplitude.

2D Time Slice Composite

A new menu that will place multi-grid surveys into a single composite image is now available on the Pixel pulldown menu (Figure 3). This new menu will allow a user to show all the time slices from a survey site with multiple grids and to place in a single composite image with a common origin. To use the new menu, the user will need to first create a project and transfer all the desired \grid*.grd time slices from various projects that they want to composite together. All the *.grd file should have a common origin and these can be UTM as well. The new menu does NOT need to have a common grid cell density and this can be different between the surveys. Once all the *.grd file are transferred, clicking the Help Set button in the menu will discover the first time slice for each grid set which will be placed into grid filename menu slots.

One can draw the grids with any pixel size they want. The menu should be able to handle a graphic block that is 65000x65000pixels. For a site that is say 1km x 1km and the user made 10cm resolution time slice grids, this would be just a 10000x10000 graphic window which is still much smaller than the maximum limit!

The transform menu is also enhanced. When the composite image is displayed, the user can click on any grid block and the software will know which transform and grid # it is on. The user can adjust the transform for just that one block if they like particularly if there are mosaic noises. They can balance these and quickly compare by using the Redraw One button which will just show the changes to that one block without redrawing the whole image.

The menu is also programmed to allow easy changes to go to the next time slice level down by clicking the -/+ button in the Composite menu. In addition, placing blocks at different levels in to the composite image can be done either manually by setting the menu slot names, or by using the convenient Z+/Z- button in the Trasnform menu which will increment the active block to the next lower or higher level. One can imagine that over large sites the overburden depths can vary and placing continuous features may require extensive use of finding the appropriate block depth slice. (Future updates to this menu will allow or overlay analysis as which is currently not available).

The inspiration for this menu came from discussions with Dr Hyun dok Oh from the Korean National Cultural Properties Research Institute who I met at a recent symposium in Japan in February. Dr Oh has large sites, 10-30 hectares that he is working on. He has composited many of his individual data via a photoshop type program and needed a more robust method to actively adjust and display these large datasets. Recently, I had communications with several other researches that are also doing large surveys. Some had severe mosaic noises on their sites that have not yet been adjusted for. This new menu should allow them a more flexible method to fix mosaic noises between data blocks.

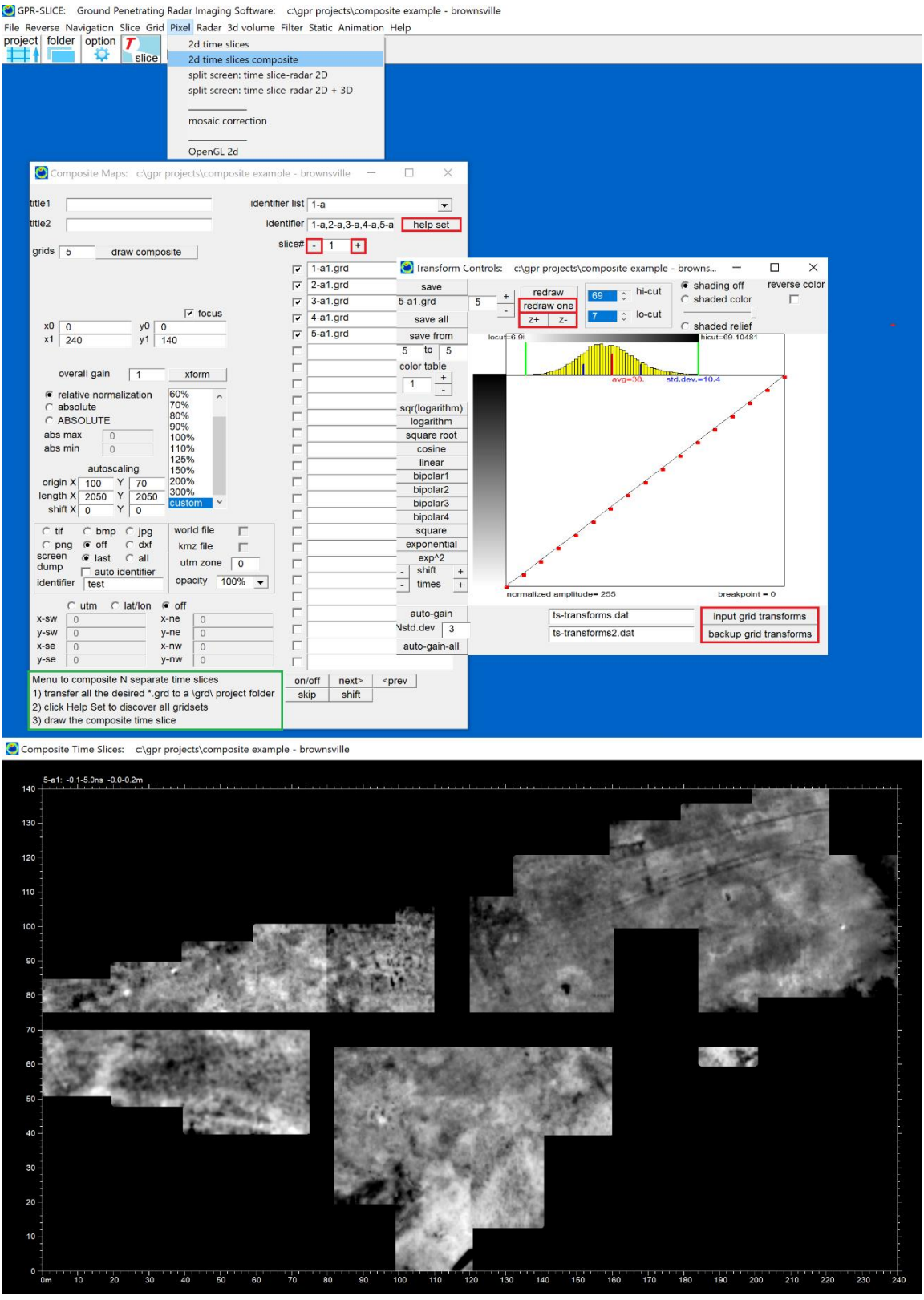

Figure 3. Example of the Composite time slice menu at a site in Brownsville, TX. (data courtesy of Steve DeVore, National Park Service)

Real time level plane time slices in the OpenGL Topo Volume Warp menu

A new option has been added to the OpenGL Topo Volume Warp menu under the main Static menu (Figure 4). Real time level slices can now be shown along with topographic slices. Before, the only way to get a level plane time slice from a volume with topography was to generate the topographically corrected volume first and then display level slices in regular OpenGL. The new option will allow for displaying level plane slices very efficiently particularly for sites that have significant elevation changes. Some users were unable to make a corrected topographic volume when elevation changes were on the order for 20 meters or more as the binary corrected volume would be too large to render in OpenGL. This new option to generate level slices real time without creating a new volume will add a lot of efficiency for looking at topographic volumes. When entering the OpenGL Topo Volume Warp menu a new button called ZL will appear which can be used to set the level slice plane. The original Z button is there to and called ZT to indicate that this is for a topographic Z slices.

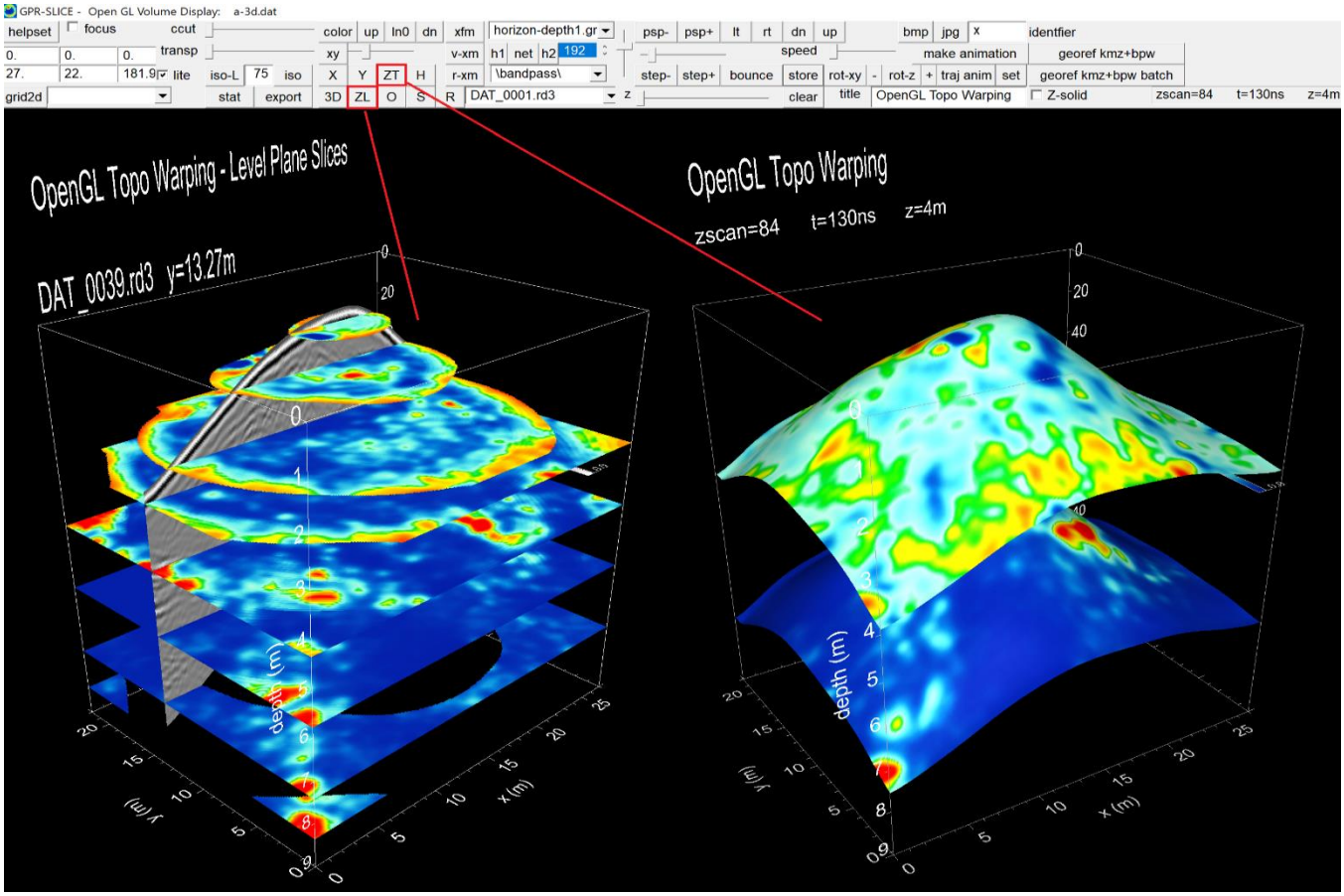

Figure 4. Example of real time topographic warping and real time level-plane slicing of a survey on a burial mound.

KMZ 2D radargram popup in Google Earth

A new option was added to the Radar 2D menu at the request of a subscriber that wanted to deliver a KMZ image of a flat 2D radargram on a site to their customer. The radargram shown of course would not be a georeferenced radargram as the file can be a GPS random profile, but the user wanted to be able to show the 2D radargram profile and a link of the beginning of the line on the site. An option was added to allow one to create all the popup radargrams images in batch that will open in Google Earth. In the Radar 2D menu one will first click the BMP checkbox, followed by the KMZ checkbox and then the number of radargrams to display and their pixel sizes (Figure 5). The naming convention of the kmz files will follow exactly the radargram names with the .kmz extension. For those not familiar with the KMZ popup option, one must click on the yellow pin in Google Earth to see the attached image (Figure 6). The size of the radargram image will follow the pixel length settings set in the Radar 2D menu.

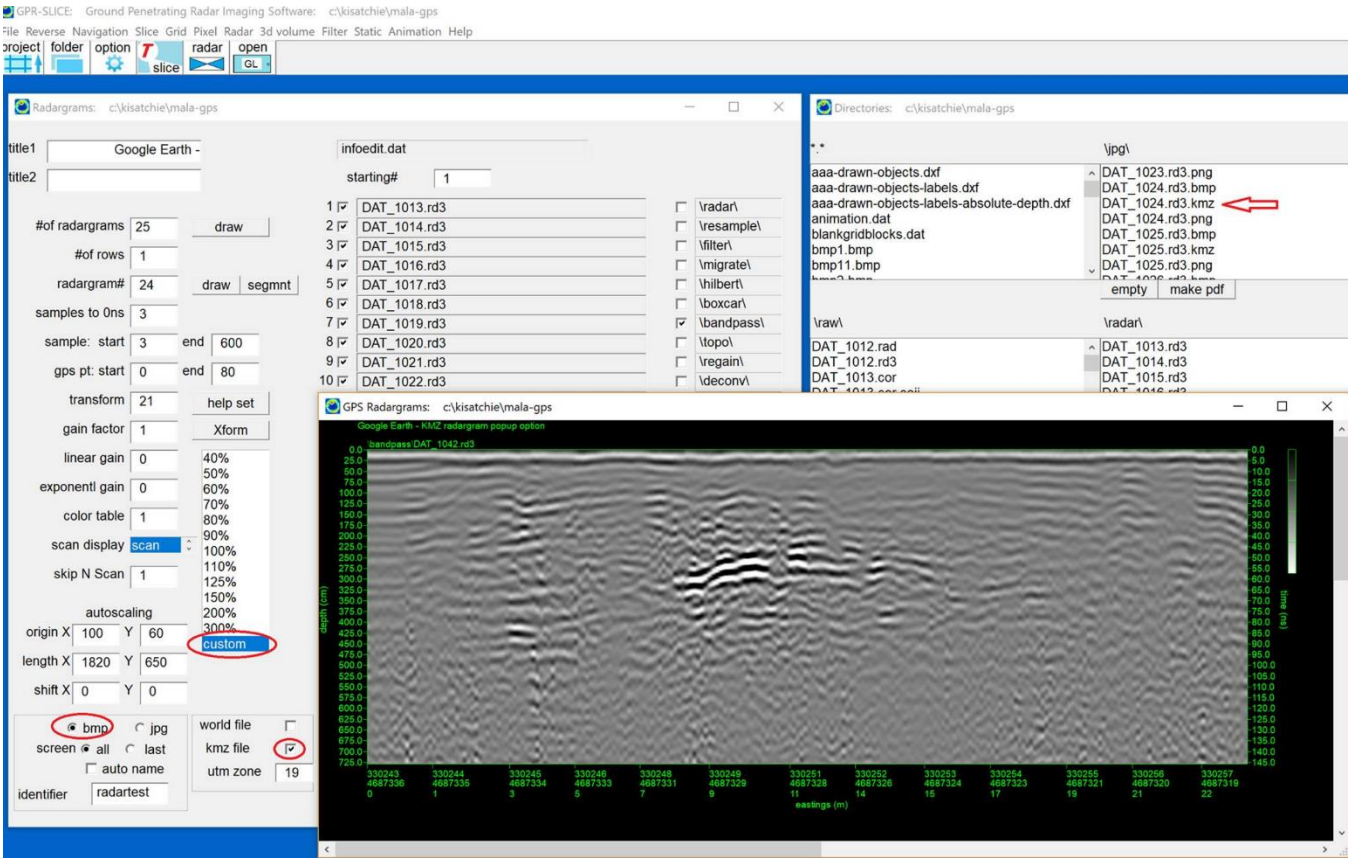

Figure 5. Settings in the Radar 2D menu needed to create KMZ popup radargrams. KMZ popup files can be generated in batch.

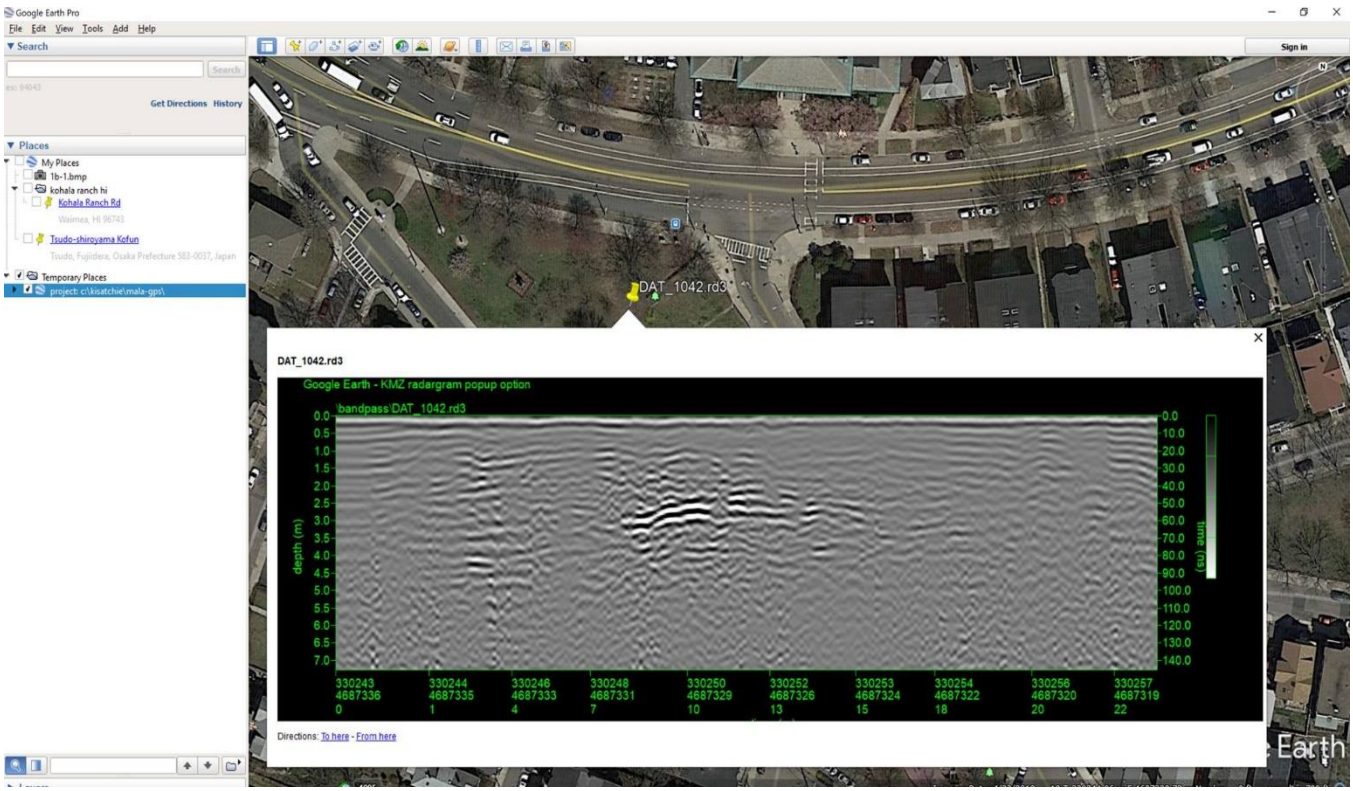

Figure 6. Example of a KMZ popup 2D radargram in Google Earth. The user must click on the yellow pin to see the associated image appear.

Note: These projections are simple 2D radargram images. One always has the ability to make GPS radargram animations with a Google Earth image (or imported World File image) and show the random GPS tracks profiles ontop of a georeferenced map inside OpenGL (screen shot 4). The complete animation menu can be exported and given to a client without the need of the USB security key, as the exported Animation menu is unprotected and can be freely transferred.

Longitudinal tunnel vector with vertical orientation

Bill Steinhart, senior geophysicist with Rettew Associates has a gpr survey in which they are investigating the soil around several vertical diffusion wells. The wells are 10 feet in diameter and 25 feet deep. His plan is to scan vertically up each well several times spaced 30-40 degrees apart.

In order to provide a vertical tunnel orientation, the Vector Longitudinal Tunnel menu was enhanced to allow for setting the tunnel axis (Figure 7). With this option the orientation for vertical tunnel surveying can match the survey geometry.

Note: This menu is specific and limited to vertical or horizontal orientations. There is always the complete general option for the user to have an import file called - vector_survey_user_set.dat file imported under the Create New Info file menu which will have the 3D start/end points along with the 3 vectors set by the user. This import can reproduce the vector application in the Vector Longitudinal Tunnel menu and can provide any vector positioning that the user needs.

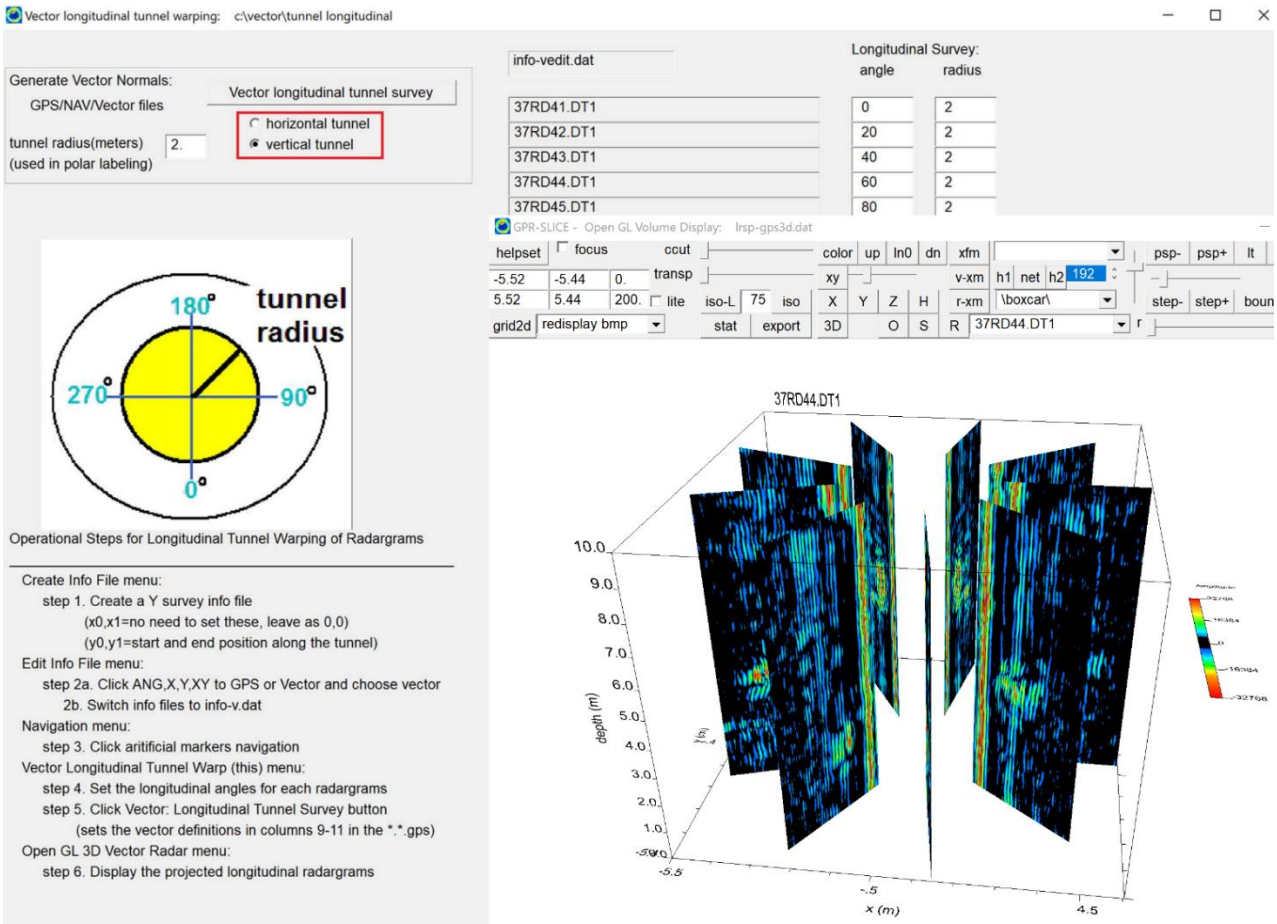

Figure 7. Example of the settings needed to achieve vertical tunnel orientations, using the Vector Longitudinal Tunnel Warp menu.

Software Update - Release of **GPR-SLICE v7.MT (reposted and updated from a February Newsletter)**

If you have not been following the updates on the website or our FB group page then the biggest news since OpenGL was added to the software some 10 years ago is that GPR-SLICE v7.0 is now GPR-SLICE v7.MT! So, what's new? Well the MT of course! GPR-SLICE 2019 is now a MultiThreaded – MT - application! If you have multiple cores on your computer, you can speed up processing by almost N times – where N is the number of logical cores! On many computers one can send 2 threads per core for processing - where the number of logical cores can be 2 times the number of actual cores. When one processes a set of radargrams, GPR-SLICE will send out each radargram process as a separate thread to be executed in Windows and to be run simultaneously on as many cores as exist on a computer. All-in-all, the speed of processing a set of radargrams can be increased almost by the number of logical cores one has on their computer!

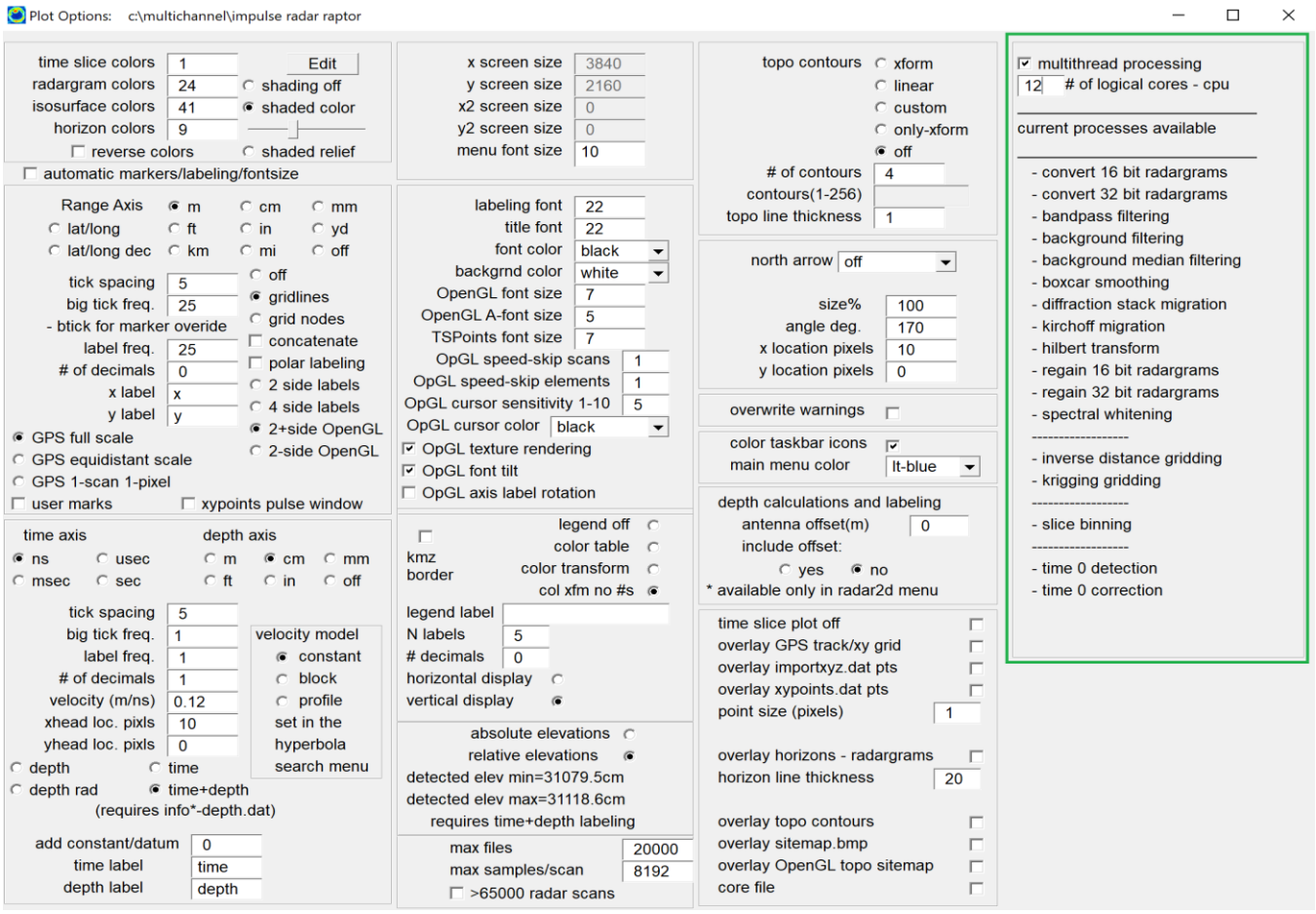

Figure 8. Option menu showing the available multithread processes

The list of processes currently available are outlined in the Options menu (Figure 8) and include radargram filtering, radargram conversion, radargram editing, time slice binning and gridding operations. Specifically:

- Convert 16 bit radargrams
- Convert 32 bit radargrams
- Bandpass filtering
- Background filtering
- Diffraction stack migration
- Kirchhoff Migration
- Hilbert Transform
- Spectral Whitening
- Boxcar Smoothing
- **Regain 16 bit radargrams (newly added MT operations)**
- **Regain 32 bit radargrams**
- **Spectral Whitening**
- -----
- Inverse distance gridding
- Kriging gridding
- -----
- Slice binning
- -----
- Time 0 detection
- Time 0 correction

These operations are the most fundamental processes and have been included in the first MT release. The desired number of cores can also be set and is available in the Options menu. If you are running other applications, you can limit GPR-SLICE to any portion of the available logical cores so all active applications will run smoothly. In addition, there can be a limit to the speed of operations such as when disk writing, so the user may want to test how many cores assigned improves the final speed of operations. This can also be different with some of the processes that require different kinds of computer resources.

Note: With MT turned on all processing graphics are disabled. For quick viewing of radargrams signal processing, radar editing or gridding operations, the same checkbox that is available in the Options menu is conveniently available in these menus as well to shut MT off.

Additional options added to GPR-SLICE Software

- Autocropping of jpg/bmp/png/tif non-gps output in the Pixel Map menu with KMZ border checkbox engaged
- Improved multithreading speed on large projects with several 1000 radargrams
- Super long radargram display switch for scans>65000 added to Options menu
- Option Menu custom title font size available for Radar and Pixel Map menus
- Grid smoothing listbox option added to BlueBox Batch run menus
- SEGY 32 bit radargrams now processed as 32 bit radargrams and not down sampled to 16 bits and multithread conversion active
- Bluebox runs with Edit no longer automatically reset the set gain curve - allowing for a constant gain curve etc. to be set for some manufacturers on conversion - specifically for GSSI equipment that have less than 32 bits of gain on 32 bit radargrams and to allow visualization of the ground wave
- OpenGL overlay image now will take any picture format including jpg, png, tif, and do auto conversion to 24 bit bitmap
- Logarithm conversion of import of 3D (ERT) data option added to Import 3D geophysical data menu
- Color transform setting button opened for OpenGL Volume with gridblock definitions
- Color option to set XYpoints picking available in a combobox menu item
- Hyperbola transparency display with weakened overlay color checkbox added to Hyperbola Search menu
- Multithread processing for Regain 16 bit and 32 bit radargram menus active
- Animation of overlay imaging in OpenGL Volume made from current zscan going downward with depth
- Legacy cylinder and tunnel binary warping of radargram menus adjusted for block writing and optimum speed processing
- Reverse of GPS radargrams and navigation files available for GPS zig-zag surveys in Reverse menu

Upcoming Events

Joint GPR Surveys with Ehime University – Japan, the Saitobaru Archaeological Museum – Japan, and the Geophysical Archaeometry Laboratory at sites in Mongolia, September 12-22, 2019

Dean Goodman
GPR-SLICE Software
***This newsletter is available in *.pdf form at** https://gpr-survey.com/newsletters.html