SUBSURFACE VIEWS

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In this issue

SplitView – A Powerful New Feature for LMX200™ systems

What do you get if you combine LineView and MapView? You unlock a powerful new feature called SplitView, coming soon as a free update to your LMX200™ systems when using an external GPS. It will change the way you locate utilities and other targets with GPR.

Since the LMX200™ GPR system for utility locating was introduced, the real-time view during data collection was LineView – the cross-section view of the GPR data (Figure 1).

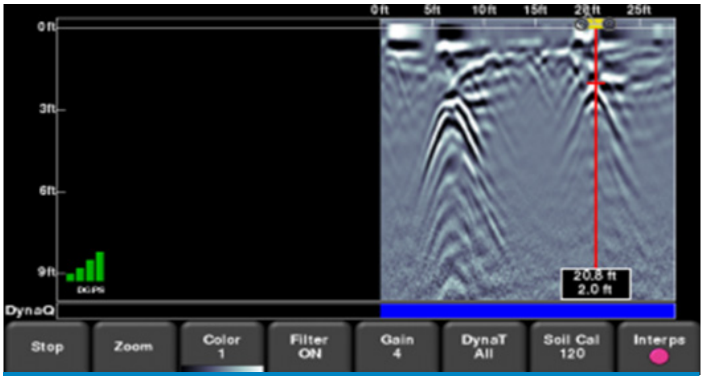

Figure 1: LineView image of a Line Scan.

New data scrolls onto the screen from the right side, scrolls across the screen and scrolls off the screen on the left side. Hyperbolas from subsurface objects such as utilities scroll across the screen as you pass over them.

If you were using an external GPS, after you finished collecting the GPR data, you could open MapView to get a bird's-eye view of all the data you had collected in the current project, including the GPS path of Line Scans, grid lines of Grid Scans, plus any added flags and field interpretations (Figure 2).

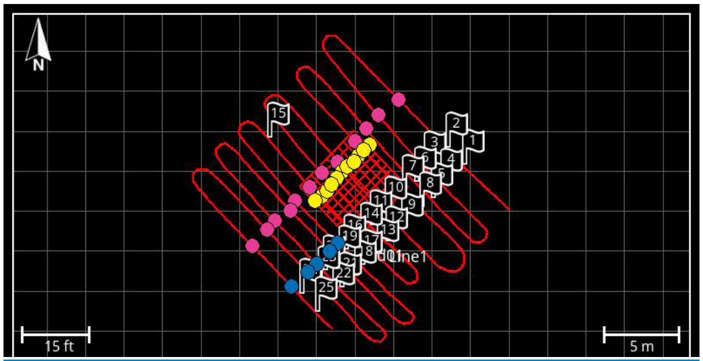

Figure 2: MapView displays Line Scan GPS path, Grid Scan lines, flags and field interpretations.

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The LMX200™ system now has SplitView, that displays both LineView and MapView simultaneously during data collection. (Figures 3 and 4).

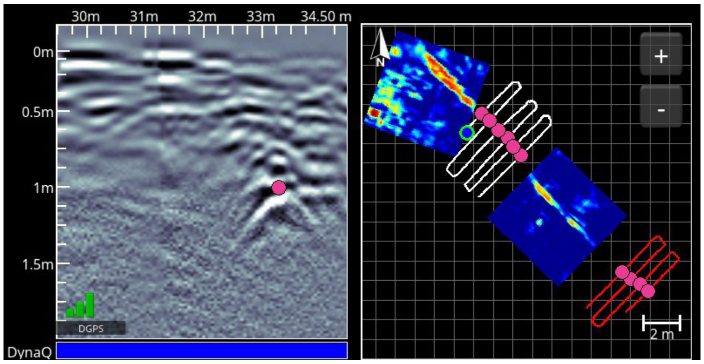

Figure 3: LMX200™ now has SplitView, that combines the benefits of LineView and MapView onto one screen.

The MapView side of the screen shows all the GPR data that has been collected in the current project; more importantly, it also shows where the LMX200™ is currently located in the survey area (Figure 4, blue dot).

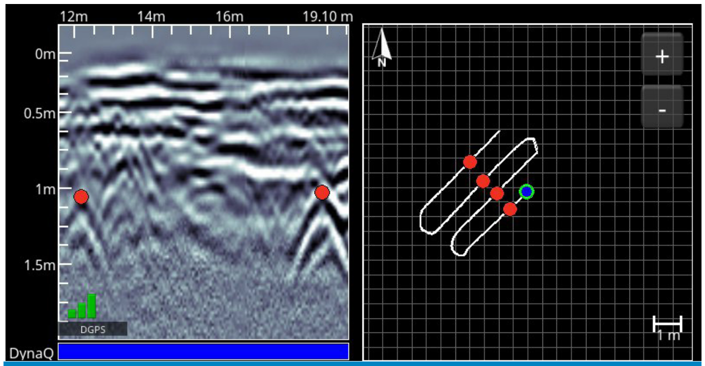

Figure 4: SplitView shows LineView and MapView on the same screen. Field interpretations and flags added to LineView instantly appear in MapView to show the spatial relationship between targets. The blue dot on the MapView screen indicates the current position of the LMX200™.

The implications of SplitView are extremely powerful for utility locators. Seeing the subsurface in LineView and a map of the GPR survey area in MapView, greatly assists with data interpretation. Add field interpretations by simply touching the top of hyperbolas on the LineView side of the screen. That same interpretation will instantly appear on the MapView side of the screen. Now you can see the spatial relationship between targets and can quickly determine if a series of hyperbolas are linear in orientation, and therefore more likely to be a utility.

For example, see the series of red field interpretations in Figure 4.

Experienced utility locating GPR operators know that hyperbolas from utilities do not always appear as strong responses. A localized patch of soil with high electrical conductivity over the utility can reduce the strength of the hyperbola and make it easy to miss. However, with SplitView, if we see that a series of hyperbolas all line up linearly except for a few, the LMX200™ allows you to scroll back through the cross-section data to the location of where the hyperbola should be and let you take a second look (Figure 5) and improve your interpretation.

Very weak hyperbolic response from the utility. It would be missed unless looking for it to make the utility interpretations linear.

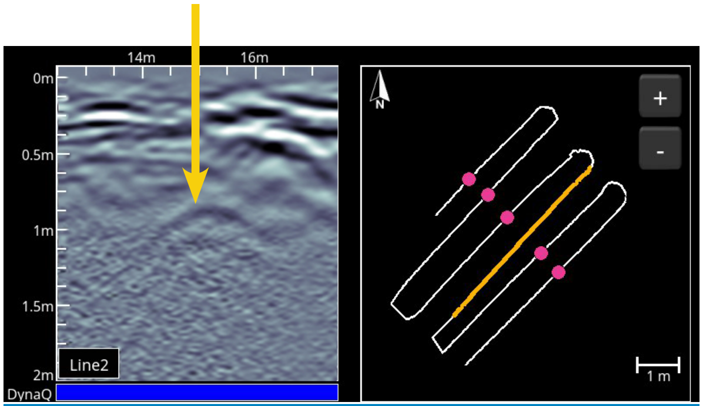

Figure 5: MapView shows that the operator may have missed picking a hyperbola. To take a second look at a cross-section at the location where there may be a weak hyperbola, use the left arrow key to move back through the collected data. The orange line in MapView indicates the position range currently displayed in LineView.

Another feature of MapView, both in regular MapView and the MapView in the SplitView screen, is the display of depth slices from processed grids (Figure 3). This display combines the data from Grid Scans and Line Scans to give you the big picture of your GPR data. This allows you to get the most from your GPR data, make solid interpretations and ultimately, do the most complete utility locating job possible.

SplitView and other new features will be shipping soon with new LMX systems. And since we strongly believe in providing continuous improvements to our customers, this upgrade will also be available free of charge to all current LMX200 owners. Contact Sensors & Software for more details.

#UsingYourNoggin to reveal Ancient Cities in Peru

Equipped with a NOGGIN® 500 SmartTow™ System, researchers from the University of Western Ontario's Department of Anthropology are revealing the buried urbanscape of an ancient city on the North coast of Peru. Situated in a narrow strip of desert between the Andes and the coast, the Gallinazo Group of mounds represent the last visible remains of an ancient civilization that once thrived over 1000 years before the start of the Inca Empire. Approximately 30 mounds are visible today, ranging from small low rises to impressive mounds of eroded adobe bricks and refuse, spread over 600 hectares of flatlands on the northern edge of the cultivated land of the lower Virú valley (Figure 1).

Dating to the Early Intermediate Period (100 B.C.–A.D. 700), the Gallinazo Group was occupied at a time that saw the emergence of the first states and urban life on the Northern coast of Peru. However, despite the imposing nature of the site and its apparent dominance in the valley, very little was known about the size, layout and development of the city; all of which are key to our understanding of the origins and development of urbanism in the Andean region.

Since 2011 a team, lead by Dr. Jean-Francois Millaire, has been investigating the origins and development of the city through integrated geophysical survey and excavation. To date, he has demonstrated that the city was home to a population of between 10,000 and 14,400 people living in a network of agglutinated houses, plazas and public buildings. However, while making significant inroads into our understanding of the site, most work has so far centred on the largest mound. It is still unknown if the other, smaller mounds exhibit a similar urban layout and pattern of development.

Figure 1: Some of the numerous mounds of the Gallinazo Group amongst modern irrigated fields. The building in the middle of the image is a modern one.

In 2018 Millaire's team started to investigate other mounds at the site to establish if the observations made for the largest mound are similar for the city as a whole (Figure 2). Using a combination of visual and thermal drone imagery and ground penetrating radar (GPR), initial results suggest that Millaire's observations regarding the site's layout and development hold true for many of the other mounds, though some variation may occur.

Figure 2: Graduate Student Kayla Golay Lausanne surveying one of the smaller mounds at the Gallinazo Group with the NOGGIN® 500 SmartTow™ System. The largest of the mounds is visible in the background.

The results of the GPR survey have been particularly impressive with the NOGGIN® 500 SmartTow™ system revealing the pattern of buried rooms, floors, corridors and streets in extraordinary detail (Figure 3).

Further work is planned in 2019 to establish how extensive the variation in urban layout observed for some of the mounds is and how significant it is for our understanding of this ancient city and one of Peru's earliest civilizations.

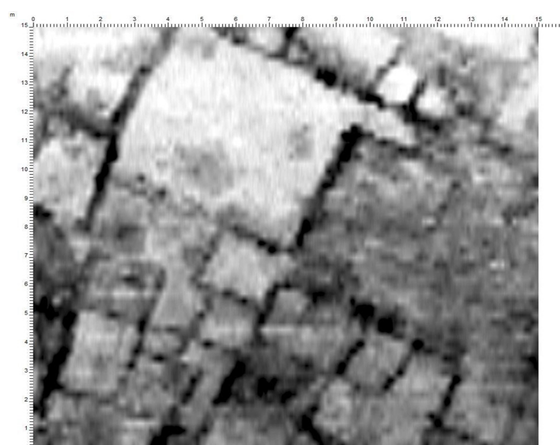

Figure 3: SliceView depth slice image from a small section of the NOGGIN® 500 survey at the Gallinazo Group shows numerous buried rooms and corridors surrounding a central plaza (top center).

Story courtesy of Edward Eastaugh and Jean-Francois Millaire from the Department of Anthropology, University of Western Ontario.

The Power of Average Time Amplitude (ATA) Plots – Part 2

Plotting the average amplitude of all the traces in a GPR cross-section shows the response character versus travel time (or depth) and provides the user with insights and key understandings of the nature of the data.

In Part 1 of our story about ATA Plots in our July 2018 Subsurface Views, we focused on how to use the Average Time-Amplitude (ATA) plot for:

- Quantifying the level of background noise
- Determining the depth of GPR penetration, and
- Analyzing GPR signal attenuation with depth

In this article, we continue looking at the power of ATA plots; how they provide insight on the transmit pulse and can help identify coherent system noise and air waves.

Transmitted Pulse

The highest amplitude signal in an ATA plot is normally the direct wave. This signal travels directly from the transmitter to the receiver. In some cases, the direct signal may exceed the maximum value that the receiving electronics can accommodate leading to the peak recorded voltage being less than the true value. This is referred to as signal clipping. When the peak receiver detection level is known, an ATA plot quickly indicates if the transmit pulse (Figure 1) is clipped. The example in Figure 1 shows signals for a receiver with a peak recording range of +/- 50 millivolts. Signals that exceed 50 mV are “clipped” as the plot illustrates.

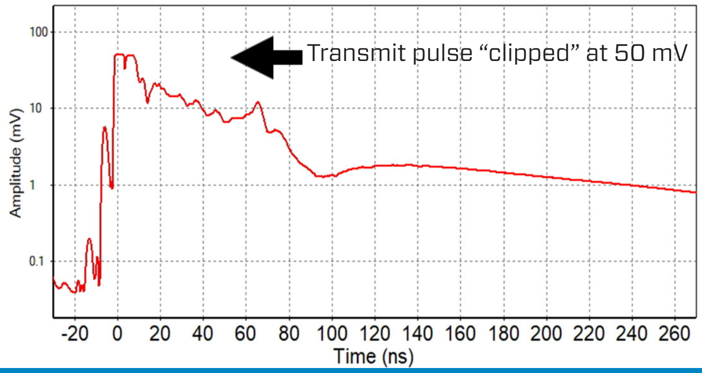

Figure 1: ATA plot showing a clipped direct wave pulse. The recording receiver electronics have a peak signal limit of +/- 50 mV.

A clipped transmit pulse can affect the use of a background subtraction filter (used to reveal weaker signals masked by the higher amplitude transmit pulse). If data are clipped, target responses in the zone of clipping are not detected. This effect is often referred to as “transmitter blanking”. If shallow reflectors are not of interest for a given survey, then a clipped transmit pulse is acceptable.

For fully bi-static GPR systems, clipping can be reduced or eliminated by moving the two GPR antennas further apart. Other approaches are to reduce the transmitter power or reduce the receiver gain (and hence receiver sensitivity). All these options are available in the latest pulseEKKO® systems where the user can move each antenna independently, adjust the transmitter voltage or change the receiver gain (in the case of the new Ultra Receiver). GPR systems, such as NOGGIN®, LMX® and CONQUEST® have antennas at a fixed separation and are designed so that signals are not clipped when the system is on the ground.

Coherent Noise

One of the challenging aspects of GPR systems is the presence of time invariant coherent noise. These signals are produced within the GPR system itself and are associated with signals that travel inside the electronics or on the associated cabling and support structure. For extreme cases, these appear as constant bands across a radar section and mask all subsurface responses.

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ATA plots are very helpful for assessing the level of time (and spatially) coherent noise. When data are acquired along a transect where there is substantial amount of change with targets at differing depths and spatial locations, the ATA plot should reveal a smoothly decaying response. The presence of localized peaks on the decaying response curve is indicative of coherent noise.

Figure 2 shows an ATA plot with an example of coherent system noise in the form of periodic banding across the cross-section, caused by signals moving on a metal cable near the antennas.

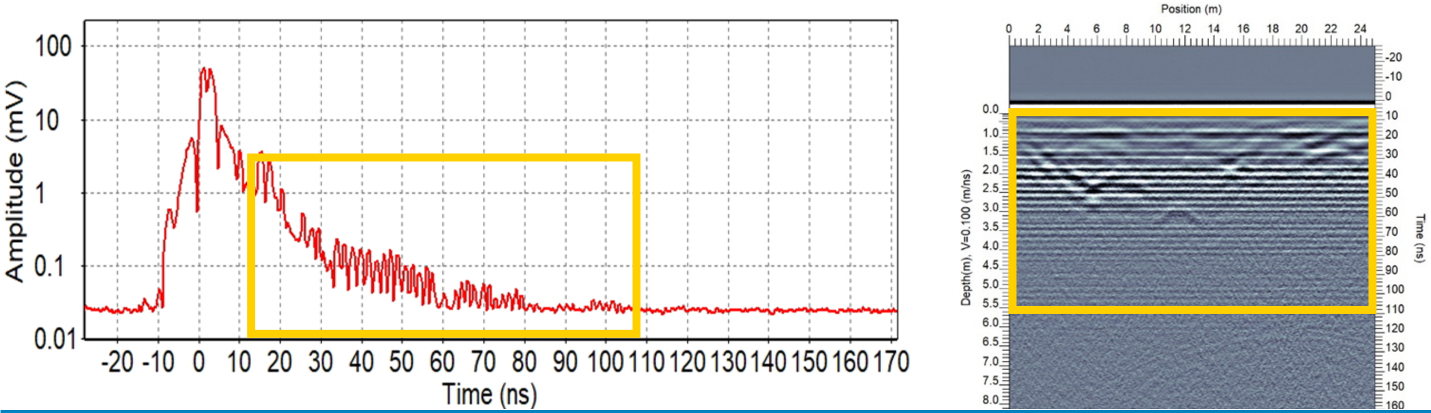

Figure 2: Higher amplitude signals that disrupt the smooth decay curve in an ATA plot should be analyzed to determine if they are caused by real, subsurface reflectors, system noise or air waves. In this case a poorly placed metal cable caused the banding or "ringing" visible in both the ATA plot and the GPR cross-section.

Background subtraction is often used to reduce these coherent signals, and noise reduction of 10 to 100-fold can be achieved in good cases. Since in serious GPR surveys, target responses are generally 10 to 100,000 times smaller than the direct wave signals, background subtraction is not a fully reliable approach to get optimal results. Weak signals may still be lost in the noise and background subtraction will reduce or eliminate relatively flat lying reflectors.

Serious attention to system design and component assembly are the best way to minimize this type of noise. We generally tell new GPR buyers to assess the level of coherent system noise when selecting a system and examine data without the use of background subtraction filtering.

Air Waves

After the GPR signals have attenuated down to the background noise level, it is possible to see signals that reflected from objects above the surface such as trees, buildings, ceilings (when the GPR survey is conducted inside a building) and canopies. These reflections are called "air waves" because the signals travel through air at the speed of light. Air waves are commonly seen when the time window is much larger than the depth of penetration (Figure 3).

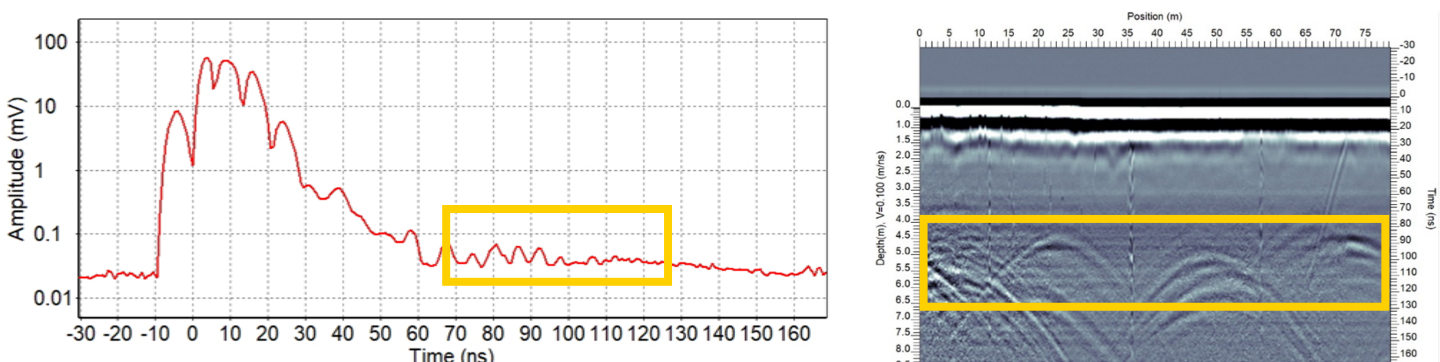

Figure 3: The broad hyperbolas on the bottom of the line are air waves from objects adjacent to the survey line. Calibrating for the velocity using the hyperbola-fitting method will result in a velocity of the speed of light (0.30 m/ns or 0.984 ft/ns).

There are times when amplitude events at later times on an ATA plot turn out to be real subsurface reflectors (Figure 4). One of the great benefits of ATA plots comes from being able to assess the relative amplitude of signals that appear in the GPR cross-section. As part of interpretation, the likelihood that a deep weak signal is a true subsurface target can be weighed.

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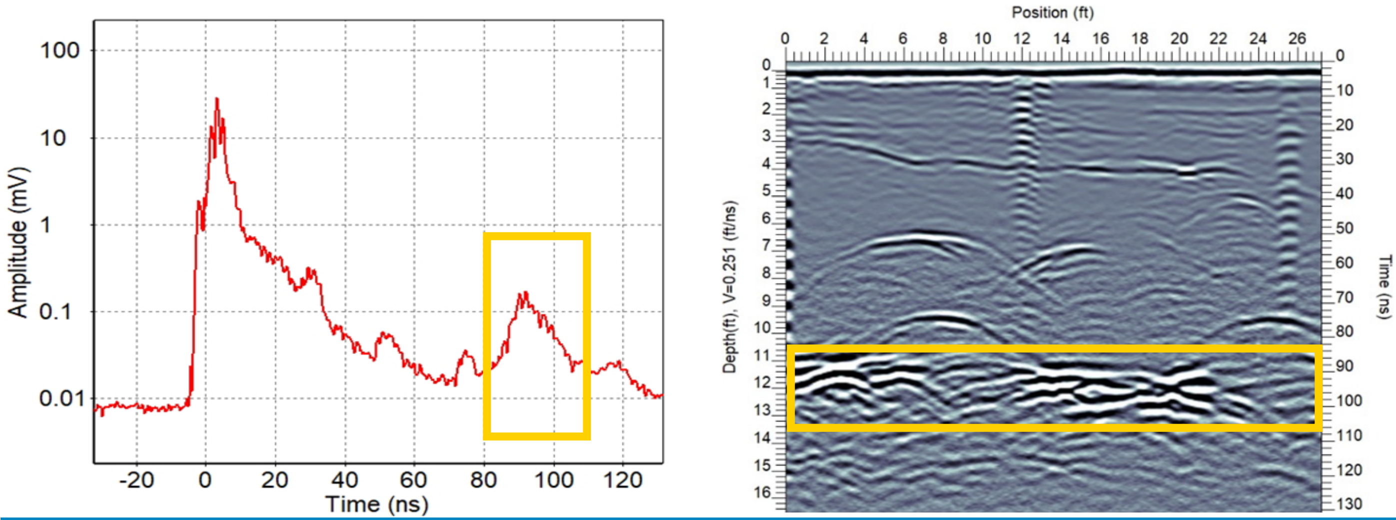

Figure 4: The high amplitude spike in the ATA plot is caused by reflections below a relatively flat-lying layer, as evidenced by the GPR line image on the right.

While we will not illustrate it here, displaying the ATA plot of a section before and after the application of time varying gain functions will help assess the reliability of the final cross-section when weak signals are strongly amplified.

Conclusion

ATA plots are available in the Processing module of the EKKO_Project™ software. This type of processing provides a powerful tool enabling users to make the best possible interpretation of the GPR data. The ability to differentiate noise from real subsurface reflectors, while not always easy to determine, means that the value of the GPR data is enhanced for the end use. The real value for everyone is to avoid mis-interpretation of data. To learn more about ATA plots and other powerful interpretation aids, contact us or see one of our on-line videos on data analysis.

Upcoming Courses

Subsurface Utility Locating with GPR course (NULCA-accredited) - May 6, 2019, Mississauga, ON, Canada

Concrete Scanning with GPR course - May 7, 2019 Mississauga, ON, Canada

3-Day GPR course -May 29-31, 2019, Mississauga, ON, Canada

Subsurface Utility Locating with GPR course (NULCA-accredited) - July 8, 2019, Mississauga, ON, Canada

Concrete Scanning with GPR course - July 9, 2019 Mississauga, ON, Canada

European 3-Day GPR course -October 9-11, 2019, Mississauga, ON, Canada

NOGGIN® 1-Day Course - June 14, 2019, Mississauga, ON, Canada

Upcoming Events

(GSA) Geological Society of America September 22-25, 2019, Phoenix, Arizona, USA

(AGU) American Geophysical Union December 9-13, 2019, San Francisco, CA, USA

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