

Subsurface Views

Sensors & Software Inc.

New: EKKO_Mapper 64-bit

Process Larger Grids

Sensors & Software continually advises looking at the big picture in the subsurface to better understand GPR data. Collecting data on detailed grids that fully encompass the area of interest yields great rewards.

Slicing down through a closely spaced grid with EKKO_Mapper software often reveals subtle features not visible or noticeable on single cross-sections. As the advantages of grid collection became apparent, we have seen surveys increase from small, local grids of just a few tens of square meters to areas covering hundreds or even thousands of square meters.

But large grids have started to hit the limit of 32-bit Windows Operating Systems. With 32-bit systems, the computer's available memory for any single application is limited to 2 GB. This means that even if you have 8 GB of memory available on your PC, the EKKO_Mapper program can only use a maximum of 2 GB (likely much less than that due to Windows overhead requirements) unless process-slowng memory swapping is used. This restricts users to grid data sets with a maximum size of about 200 MB or roughly an area 50 x 50 m, depending on the GPR system, depth, step size and line spacing.

The solution is to use a 64-bit Windows Operating system that allows applications to access up to 8000 GB (8 Terrabytes) of memory.

(continued on pages 2-3)

From our customer's files

Airplane through Runway

Officials at the Mid Delta Regional Airport (former Greenville Air Force Base) in Mississippi were shocked when the wheels of a refurbished Boeing 737 suddenly dropped through the concrete taxiway. The aircraft sustained \$1.5 million in damages. A large void was discovered underneath the taxiway.



The wheels of a refurbished Boeing 737 suddenly dropped through the concrete, causing \$1.5 million damage to the aircraft. A large void (inset) was discovered underneath the taxiway.

Geologists speculated that subsurface processes, associated with the flooding of the nearby Mississippi River the previous spring, caused voids to form under the concrete.

Nearby Greenwood-Leflore Airport was alerted to the incident. With more than 45,000 flight operations annually, the potential danger to people, aircraft and equipment that regularly cross runways and taxiways was evident.

Officials hired TEACO Geophysical, a GPR service provider, to demonstrate the efficacy of using GPR for mapping voids. Airport engineers decided to survey 2 areas overtop of a 56" diameter, bricked storm drain that crossed a taxiway and runway; locations they felt would most likely be susceptible to voids.

(continued on page 2)

In this issue

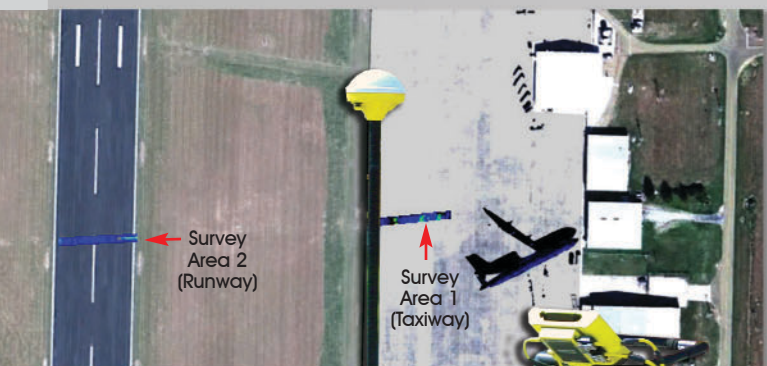
Process Larger Grids	1, 2-3
Airplane through Runway	1, 2, 4
See us at	4

Airplane through Runway

(continued from page 1)

Both areas were surveyed using a pulseEKKO PRO system with 250 MHz transducers on a SmartCart configuration. Survey Area 1 was 60 x 5 meters with lines spaced every 0.5 m in both the X and Y directions for total survey line length of 1.3 km. Line A-A' on page 4 shows a cross-section over a pipe; a classic hyperbola revealing the location and depth of the pipe. The linear path of the pipe can be seen on the 95 - 100 cm depth slice of the grid data. Line B-B' shows a cross-section over a void; strong, horizontal responses from the void on the left mask one side of the hyperbolic response from the pipe. The areal extent of the void is revealed in the 40 - 45 cm depth slice; the void's high amplitude responses are plotted in red.

Fortunately, Survey Area 2 on the runway appeared to be free of voids.



pulseEKKO PRO 250 MHz
SmartCart with GPS



Surface collapses resulting from voids occur frequently, but usually with less costly outcomes. Flooding of the Mississippi River following persistent drought conditions seems to have been the cause of the voids in this case.

Void development could be caused by increased groundwater flow through preferred channels or leaks from the drain pipe caused by high water volume.

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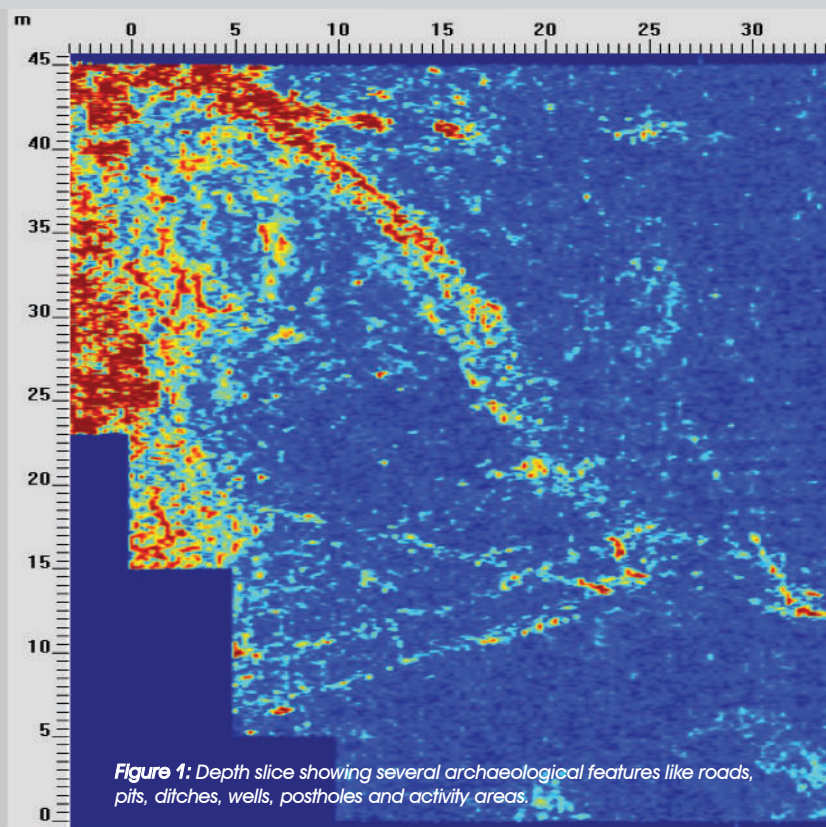


Figure 1: Depth slice showing several archaeological features like roads, pits, ditches, wells, postholes and activity areas.

Process Larger Grids

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The original, 32-bit version of EKKO_Mapper V4 was written at a time when 64-bit Windows operating systems were not widely available. Now, with Windows Vista and Windows 7 64-bit versions more commonplace, Sensors & Software has released a 64-bit version of EKKO_Mapper V4 to allow grids of virtually any size to be processed and displayed as a series of depth slices. One of our customers assisted with the testing of 64-bit EKKO_Mapper V4 on his large data set.

EKKO_Mapper 64-bit Case Study

In August 2011, Modern Archaeology Ltd. conducted a GPR survey in a heavily plowed farm field in Sweden. The goal was to locate the remains of a settlement /port/trading site/stronghold from around 300-1000 AD; the Swedish Iron Age. Many burial mounds of monumental size, as well as several rune stones and churches from the early Christian period, exist in the vicinity of the site.

The area of interest for GPR was identified from an earlier large magnetometer survey and a 113 x 45 meter grid was set up with the help of a high accuracy RTK GPS. Using a Noggin 500 in the SmartCart configuration, data was collected in Y-lines with 0.25 m line spacing and a 0.05 m step size along each line. Almost 20 km of profile data was collected over two days covering an area larger than 5000 square meters.

The result showed several archaeological features like roads, pits, ditches, wells, post holes and activity areas, confirmed by ongoing excavations (Figure 1).

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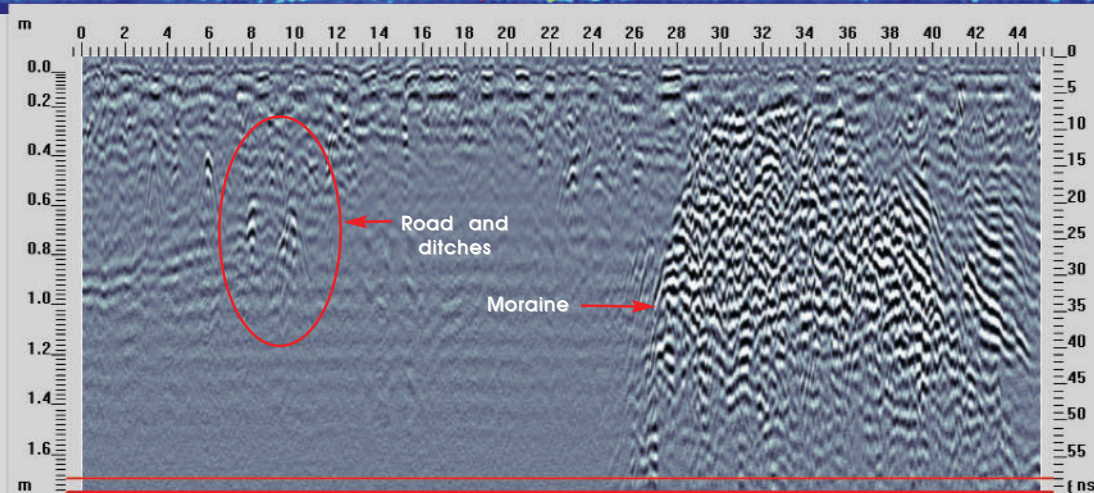
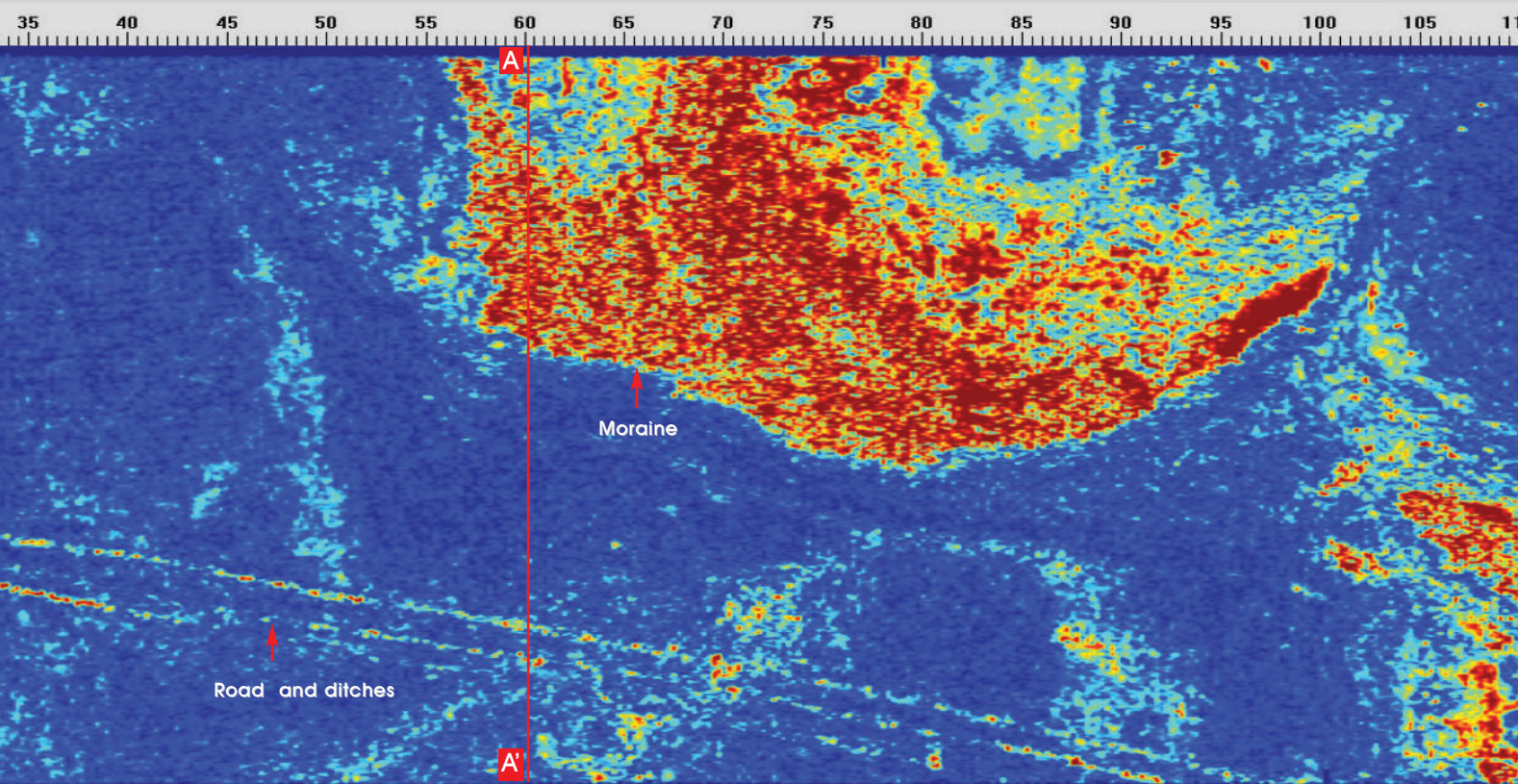


Figure 2: A-A' cross-section at 60 m



Figure 3: A horse bridle pendant made of gold-plated bronze was found in the moraine.

The long linear features are ditches which act as a drainage system for a road. The drainage system was barely visible when excavated, but shows up clearly on the depth slices. The numerous ditches suggest that the path had been used for a long period of time. An 18th century map shows that this road was a cattle path leading towards an area at sea level in the Iron Age, making it of interest to archaeologists.

Archaeologists also discovered post holes, probably a round house, on the left side of the survey area.

The large anomalous area (Figure 2) in the upper right of the time slice is a subsurface moraine where many of the artefacts were uncovered, including a horse bridle pendant made of gold-plated

bronze (Figure 3). Such pendants usually come from graves of wealthy inhabitants. The grave in this case was likely destroyed by centuries of plowing.

This grid dataset was too big for the 32-bit version of EKKO_Mapper, but worked just fine in the new 64-bit version. Since the use of large area GPR surveys will increase in the future, the new version will save lots of work and processing time.

EKKO_Mapper V4 owners with 64-bit Windows operating systems who collect large grids should contact Sensors & Software for more information.

Photo, data and description courtesy of Lars Winroth, Modern Archaeology Ltd. ■

Technical Papers & Notes

1. **Creating an Isosurface Image with Voxler 2 Using 3D Data from ConquestView 3 or EKKO Mapper 4** - Sensors & Software Inc. Technical Note; 2010
By: Sensors & Software Inc. Technical Staff **ref 444**
2. **Creating 3D Animations with Voxler 2** - Sensors & Software Inc. Technical Note; 2010
By: Sensors & Software Inc. Technical Staff **ref 445**

Upcoming GPR courses & workshops

One Day Noggin® Short Course
March 5, 2011
May 7, 2011

Our Noggin® short courses are offered throughout the year to anyone interested in learning more about GPR and subsurface imaging.

One Day Conquest™ Short Course
March 6, 2011
May 8, 2011

Our Conquest™ courses are offered to anyone interested in learning more about our concrete imaging instrument.

See us at ...

CGA 2012
Las Vegas, NV
March 6 - 8, 2012
<http://www.cgaconference.com/>

CSDA 2012
Lahaina, HI
March 7 - 9, 2012
<http://www.csd.org/>

SAGEEP 2012
Tucson, AZ
March 25 - 29, 2012
<http://www.eegs.org/annualmeetingsageep/sageep2012.aspx>

Airplane through Runway

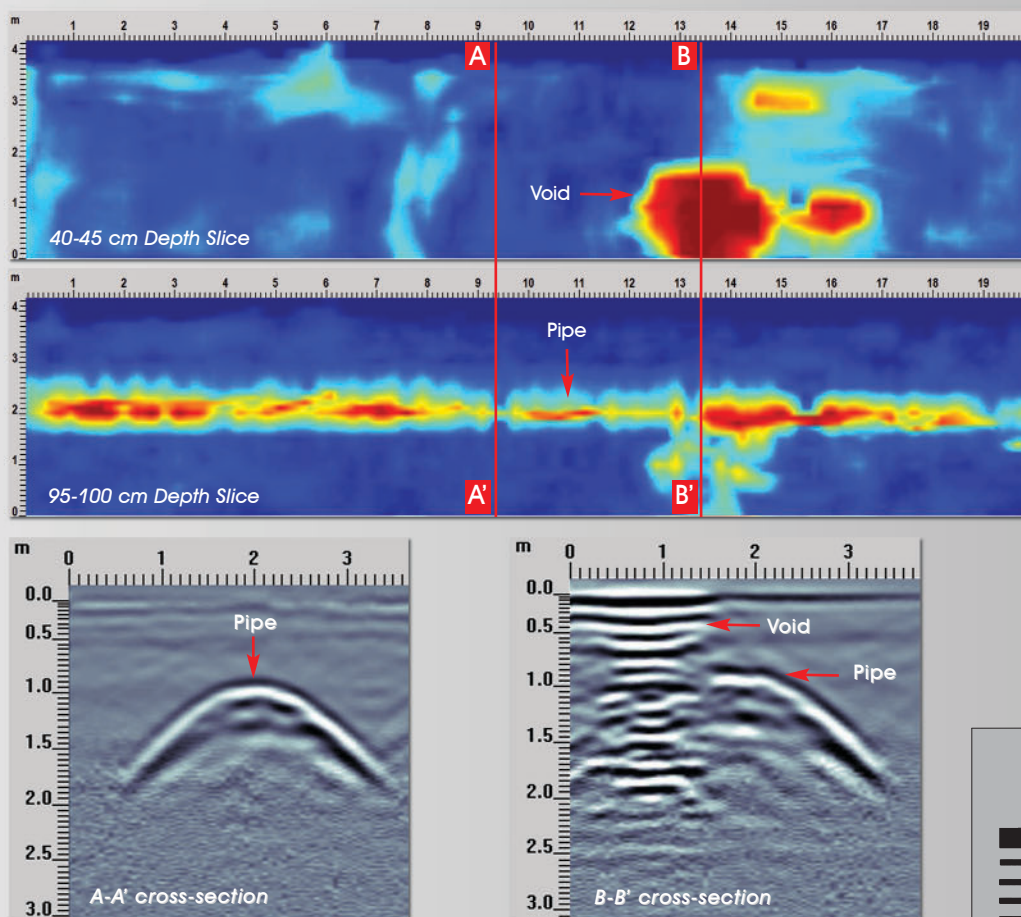
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With the first mechanism, once a groundwater flow path is established, the water washes away fine-grained materials (silts and clays).

Given repeated flooding events and enough time, these small features grow in size and manifest themselves as voids.

Soil support disappears as the "void" works its way upward as the overlying material collapses. This process, called "piping", results in an upward migrating zone until a bridging horizon (such as pavement) is encountered. The void can gradually increase in size, as in the present case, until the surface load breaks through suddenly.

More surveys at the airport in areas away from the pipe are anticipated to determine which mechanism is the cause and more importantly, whether more voids are present.



Story and pictures courtesy of Mark Teague, Teavo Geophysical. ■

