

# **Ground Penetrating Radar Survey Report:**

**Tel Hazor, Israel**

**Data Acquired August 9, 2005  
Report compiled September 29, 2005**



**Survey and Report Published by Mnemotrix Systems, Inc.**

**Copyright © 2005 Mnemotrix Systems, Inc.  
All International Rights Reserved  
Chief Surveyor, Jessie Pincus Ben-Avraham**

On August 9, 2005 Mnemotrix Systems, Inc. as requested, acquired follow-up GPR survey data at the Hazor Archaeological Site. Chief Archaeologists Amnon Ben-Tor and Doron Ben-Ami of the Institute of Archaeology of Hebrew University served as archaeological guides to the Geophysical Team of Mnemotrix Systems, Inc.

The main reason for the survey request was to look for a possible continuation or presence of a cavity that exists to the east of the Palace courtyard area, and help to determine the advisability of continued excavations under an area of the site which is at this time in stasis.

It was clear that the challenge would be the rough terrain we would need to traverse to collect the data. Our goal was to “see” under rocks to a depth of about four meters. Building from lessons learned in our 2003 field experience at the site, we applied our insight from that time to the 2005 study to acquire data in a more effective way, and gain what we hoped would be good results at this area near the site of the Palace complex.

Our two chief targets for this study were to see if (1) there may be a cavity in GPR Survey Area 1 which could possibly be a burial, or if that area has been filled in and is not of immediate archaeological interest, and (2) if there may be a continuation of walls further west in the Palace Complex, GPR Survey Area 3.

Much time was dedicated to setting a profile that would yield good results, based on our experience from 2003 where we found that such things as over-the-horizon radar from above, and clay and basalt below, would nullify the sub-surface features of interest. As per our research for the 2003 GPR Survey it was known that this area has a particularly high clay content, in addition to the presence of a significant amount of basalt. These factors inhibit the GPR signal and so carried important weight for us as we set up our profile for data acquisition.

A 200 MHz antenna (with a deeper-looking pulse than what was used in 2003) was chosen to acquire all data. Where necessary wooden planks were set on the boulder surface to create a more even data acquisition surface.

### Area 1

The location of Area 1 in relation to the Palace complex can be seen in Figure 1. The survey area was about 5.0 m (E/W) x 2.0 m (N/S). GPR lines were acquired roughly every 0.4 m.



**Figure 1: Area 1 looking west. Notice placement of wooden plank to aid in data acquisition.**

At the very end of the western side of the survey area exists an excavated cavity that is now covered by sand bags. This pile can be seen in Figure 1 near where the red antenna rests. The last half to one meter of the surveyed area is above this previously excavated cavity. We hoped to see the presence or absence of a similar signature, which might be traced throughout the GPR data (see Figure 2).

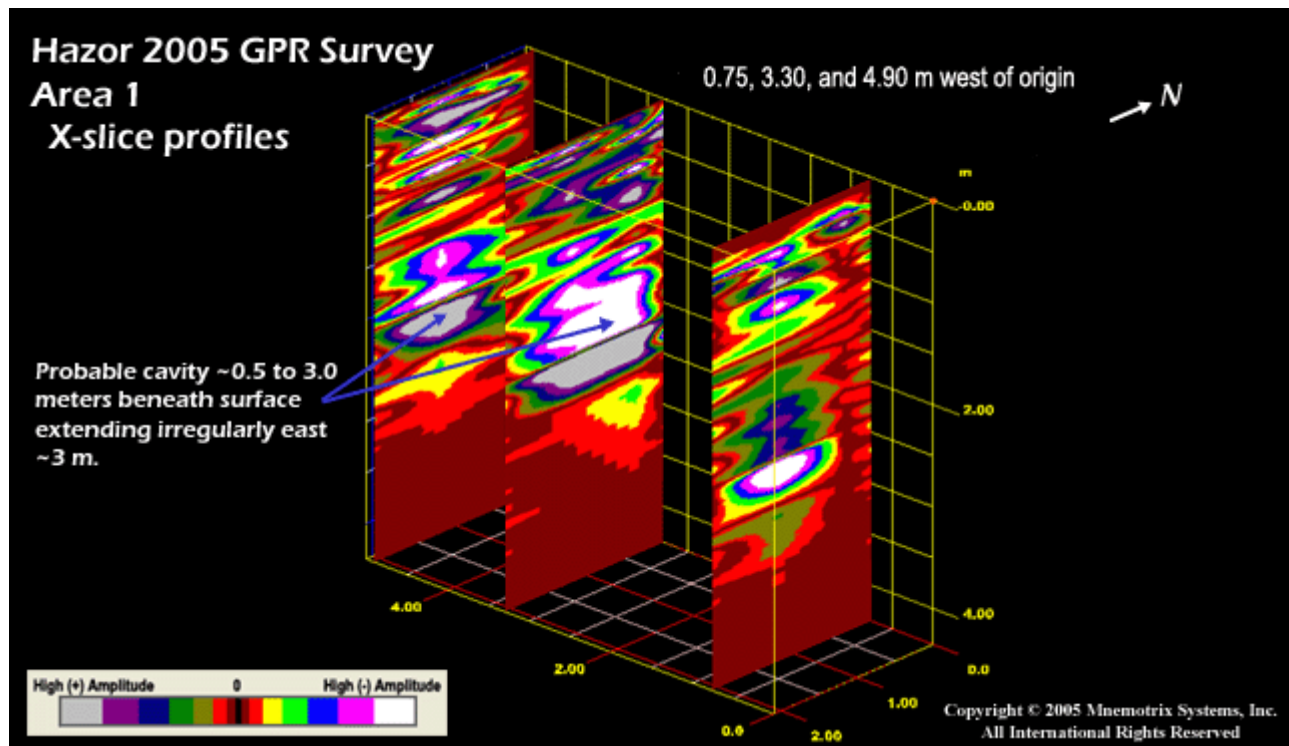


**Figure 2: Area 1 looking east with excavated burial in foreground where black cables sit.**

What we found in post-processing was a consistent high positive amplitude anomaly that extends irregularly east for about 3 meters (see Figure 3). This type of anomaly in other studies of this kind has been known to indicate the presence of cavities, although it can signify any kind of sharply contrasting reflection. Therefore, to aid in the analysis of this area, we created an animation of the depth slices as they “move” across the area in an east/west direction, which can be seen at this Internet URL:

<http://www.mnemotrix.com/geo/hazor/h05ana.gif>

*note: give the animation file enough time to download, and be sure you are viewing it with your web browser*



**Figure 3: View of GPR Survey Area 1, showing excerpts from animation to aid in analysis.**

Because of the Area 1 anomaly's similarity to the cavity reflections that we see in the western end, and its similarity to some other cavities which have been imaged with GPR and ground-truthed to be burial cavities, we believe there is a strong possibility that this high-amplitude anomaly may indeed be a cavity. What is certain is that it is a very strong high amplitude reflection. Other explanations for this could be possibly large boulders of basalt, a material we know is present throughout the site.

To further test the validity of this high amplitude reflection we were seeing in this particular area, we decided to test at least two other areas nearby to see if this kind of anomaly was also showing up randomly elsewhere. If this were true, it would further support the suggestion that the strong anomalies are coming from the basalt material. As it turned out, we did not see this kind of high amplitude in the other areas.

## Area 2

GPR Survey Area 2 is located just NW of Area 1 in an excavated pit-like area. The survey area is 2 m x 2 m. GPR lines were acquired roughly every meter. Partial views can be seen in Figures 4 and 5 below.



**Figure 4: Area 2 looking north. This survey area is located just NW of GPR Survey Area 1. The excavated cavity lies directly SE. Another view can be seen in Figure 5.**

What we found in GPR Survey Area 2 was an absence of the strong positive high-amplitude anomaly that was prevalent in Area 1 (see Figure 6), further supporting that what we saw in Area 1 is specific only to that location. This leads us to believe that the anomaly in Area 1 is unique and defined.



Figure 5: Area 2 (in the foreground) and 1 (including red antenna) overview looking east. The excavated cavity area (Area 1) is to the right of the basalt boulder standing in the middle of the picture. Area 2 is just east of the horizontal line of sandbags in the foreground.

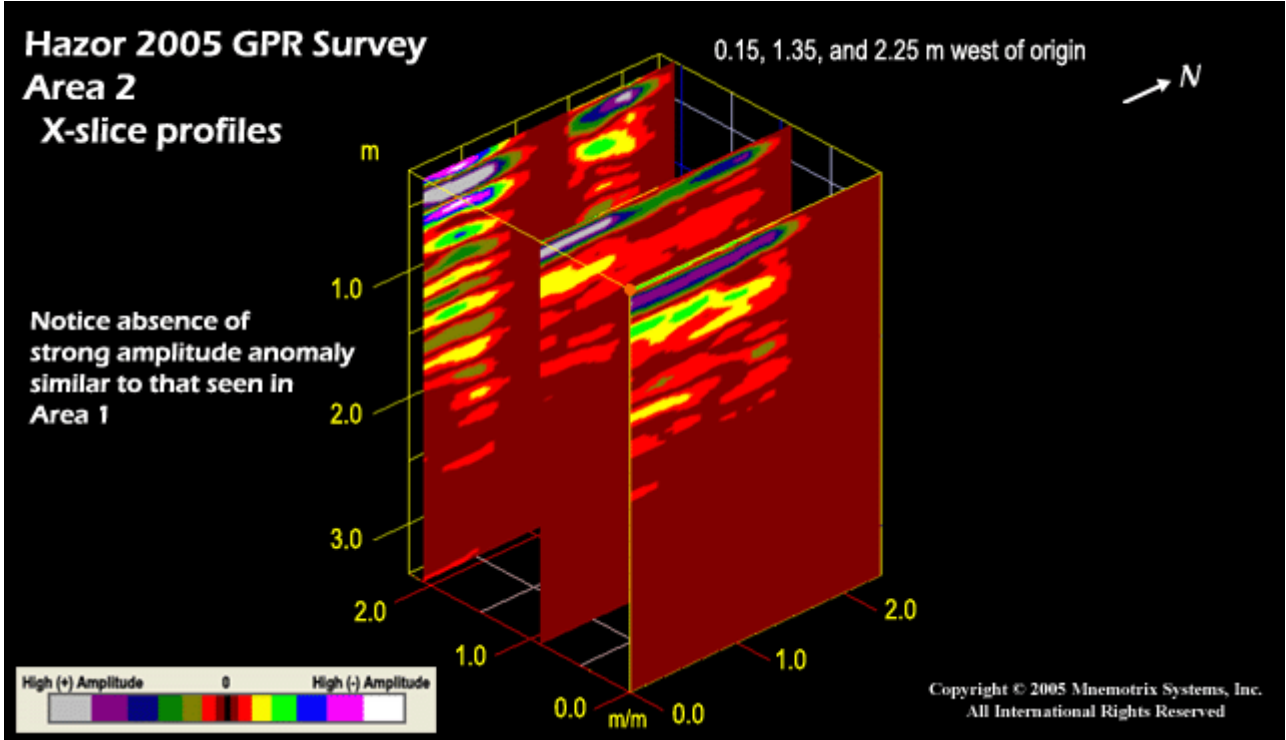


Figure 6: GPR Survey Area 2. Notice the absence of the strong anomaly that was seen in Area 1 (Figure 3 and corresponding animation).

### Area 3

GPR Survey Area 3 is located further west of Areas 1 and 2. Since time was limited, this area was surveyed in as many test lines across the area as we had time for, rather than a tight and complete grid of the area. Our purposes here were two-fold: to establish, again, if the high amplitude anomaly seen in Area 1 could also be seen elsewhere, as well as to see if we could quickly find any indication of the continuation of walls in the sub-surface.

This area sits directly in the Palace complex and is under shade of the metal overhang present at the site. At the time there was a large brick pile present, which can be seen in Figure 7. GPR data was acquired in the E/W direction on either side of the brick pile.

Results from Area 3 showed, first, no presence of a similar high-amplitude reflection, further supporting the idea that the anomaly in Area 1 is unique and defined.



Figure 7: Area 3 looking west. General location of anomalies are represented by green x-markings.

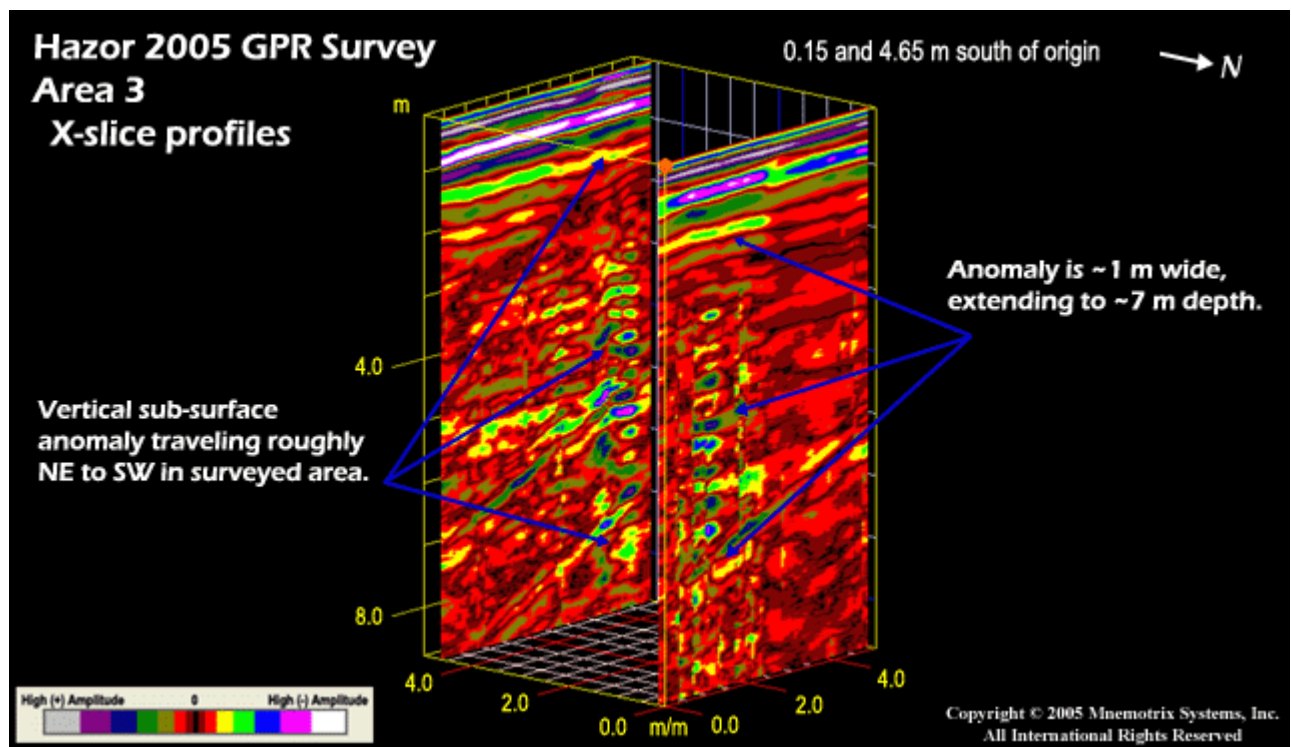


Figure 8: GPR Survey Area 3. Vertical anomalies on either side of the bricks shown by two green X's in Figure 7 which may be continuation of walls.

Secondarily, we could see on either side of the bricks two consistent vertical anomalies that travel roughly NE to SW in the survey area. These anomalies are more subtle than what was seen in Area 1, which means the materials the signal is passing through here are more homogenous.

Each of these Area 3 anomalies is about 1 meter wide and extends to about 7 meter depth (see Figure 8 above). This may be the continuation of a wall that runs north to south that can be seen in Figure 9 or one that is further east. At this time we are unsure of its exact definition due to a streamlined study of this area. However, combined with existing archaeological information it might be sufficient to support the next set of decisions to be made on this issue.



**Figure 9: View of site looking North from GPR Survey Area 3.**

If desired, another survey on this area can be scheduled to acquire more signal data and present a better scheme of the sub-surface.

## Conclusions

Based on the findings, the survey team feels confident that there is an anomaly of significant proportion present in GPR Survey Area 1. It is possible that this anomaly could be a cavity, as discussed above. The dimensions of the anomaly, if a cavity, would be sufficient to indicate the possibility of a burial. However, it is also possible that this anomaly is a hole filled with some material significantly different from the surrounding materials to create this high amplitude reflection. It is also possible that this anomaly may be blocks of basalt, as this is a common building ingredient at the site. Basalt tends to give a high positive amplitude reflection because of its high iron content. As to a definitive decision as to whether this is a burial, GPR cannot make that kind of archaeological interpretation on its own. What we are certain of is its significance as a definitive GPR feature.

GPR Survey Areas 2 and 3 showed an absence of the Area 1 high-amplitude anomaly, leading us to believe that the Area 1 anomaly is restricted to the surveyed spot.

Additionally in GPR Survey Area 3, two vertically aligned anomalies can be seen and are marked in Figure 8. These might be the wall continuation being looked for. More acquired data might confirm this hypothesis, or this might be sufficient for the archaeologists to make their best next decisions. For now, we leave it to the judgement of archaeologists Ben-Tor and Ben-Ami to decide on the next major step.