Caesaria GPR Survey Report

Caesaria, Israel

Data Acquired 30 November - 2 December, 2005

Report Completed 18 December, 2005

GPR Survey at Caesaria with ancient aqueduct in background

Survey Executed by Mnemotrix Israel, Ltd.
Report Published by Mnemotrix Systems, Inc.

Background

On November 30th and December 2nd , 2005, at the request of the community of Caesaria, Israel, Mnemotrix Israel, Ltd. completed a preliminary GPR survey of the dunes close to the remains of the two aqueducts in Caesaria, Israel. See Figures 1 and 2 for general paths of these remains.

GPR surveying was explored in the hopes of finding archaeological remains in the dune area between the official archaeological tourist site and the beach further to the north. This beach includes remains of the ancient water aqueduct that is a key feature of the site.

Figure 1: Close-up of interested area for GPR.

Figure 2: General path of the aqueduct remains of Caesaria Archaeological Site.

Ground Penetrating Radar (GPR) is a non-invasive sub-service geophysical technique that among other applications, has been proven useful in Archaeology. The technology can work to make the archaeologist efficient in his or her planning by providing sub-surface information at a site pre-excavation to aid in efficient use of time and monetary resources.

Equipment used was a GSSI SIR 2000 GPR system using a high-resolution 400 MHz antenna in all grid areas. Standard field methods were used, acquiring data every meter in addition to standard post-processing methods. Datasets were linked and then studied in terms of visible reflections. Data modeling of this information in the form of useable figures was then completed, followed by the writing of this report.

Actions Taken

On November 30, 2005 the Mnemotrix Team came to the site to discuss the best possible location for acquiring data in the large field and dune area that would yield the best results, especially in view of limited time available in this survey season, as well as serving the interests of the community which needs to make important decisions on development issues as quickly as possible. It was understood that we would undertake a sampling of the area rather than to complete an intensive study of the entire area, which will take much more time than was available, and must be planned for if desired.

It was decided that several grids would be surveyed up the sloped area in order to have a view of the varying areas. As mentioned above, one goal was to ascertain if there might be something of large structural size, or any feature of archaeological interest. Figure 3 shows the general areas of GPR data acquisition via an aerial photograph. Of the 4 grids completed, it appears that 2 main areas have the possibility of containing archaeological data.

Figure 3: Aerial photo of surveyed areas with Ground Penetrating Radar (GPR) marked in red.

Low Area

The lowest grid was nearest to the shore of the Mediterranean Sea, seen in Figure 3. This was actually 2 contiguous survey areas (Grid 1 and Grid 2) that extended east. Together, it was 10 x 22 meters. The low area (grids 1 and 2) contained a pile of garbage in the SE corner, which shows up in the GPR profiles at about 0.5 meters into the sub-surface. There may also be some metal pipes, based on the scans. However, towards the western side of grid 1, central north and south, there is a large reflection indicating the probable presence of a feature about 7 meters wide that extends through much of the

north/south direction. It is located about 1 meter below the surface, and can be ground-truthed with excavation to determine its nature. See Figure 4 for a view of grid 1 of the lowest area.

Figure 4: Grid 1 of lowest area looking south, containing a possible archaeological feature.

See Figure 5 below for a close-up view of the imaged GPR features we are seeing which may possibly be archaeological. The curved signals (parabolas) have been emphasized in yellow to show what we are seeing. A velocity analysis of this feature shows characteristics of limestone, as different from, for example, the shallower features in the SE corner which we know to be garbage.

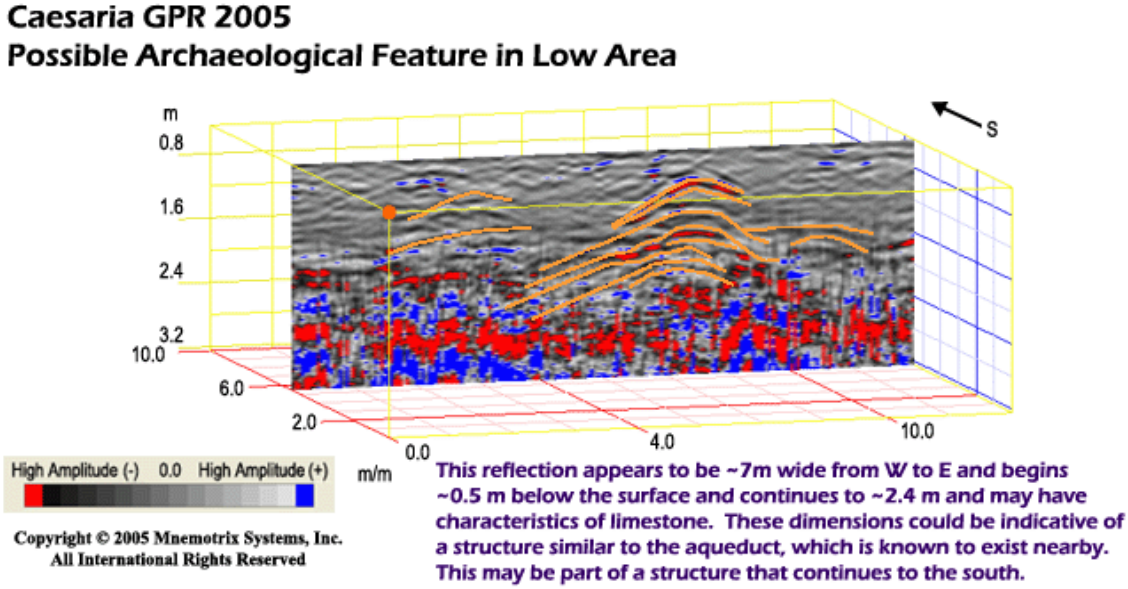

Figure 5: GPR anomaly in Grid 1 showing possible archaeological feature.

This 7 meter wide reflection may continue further south of the grid. As mentioned above, we did only a sampling of the area, and as this feature proceeds to the edge of our grid, it may be that it continues on. The dimensions are such that this feature could point to a portion of some structure. Other archaeological and historical research indicates the presence of at least two aqueducts in this general area.

Middle Area

Moving higher up the slope, the middle area (Grid 3 [Figure 6]) contains a large reflection somewhat similar to what is seen in Grid 1. It continues from the south to the north strongly for about 8-9 meters. It seems to be about 1 meter wide, and seems reminiscent of other Jerusalem Old City GPR survey work which later revealed portions of old walls [See Figure 7]. The whole reflection seems to be about 4 meters wide (E/W) and generally is focused at about 1 meter depth. If this feature is what we could call a wall, then the 1 meter depth is most likely the top of the "wall." This would qualify as easily as a portion of an old aqueduct, which was made of similar material. The signal (parabolic reflection) is highlighted in yellow below for emphasis.

Figure 6: Grid 3 of mid elevation area looking south, containing a possible archaeological feature.

Figure 8 shows a picture of the excavated and preserved aqueduct of the site. This is structurally what we may be coming upon in the Low and Middle Areas (Grids 1 and 3).

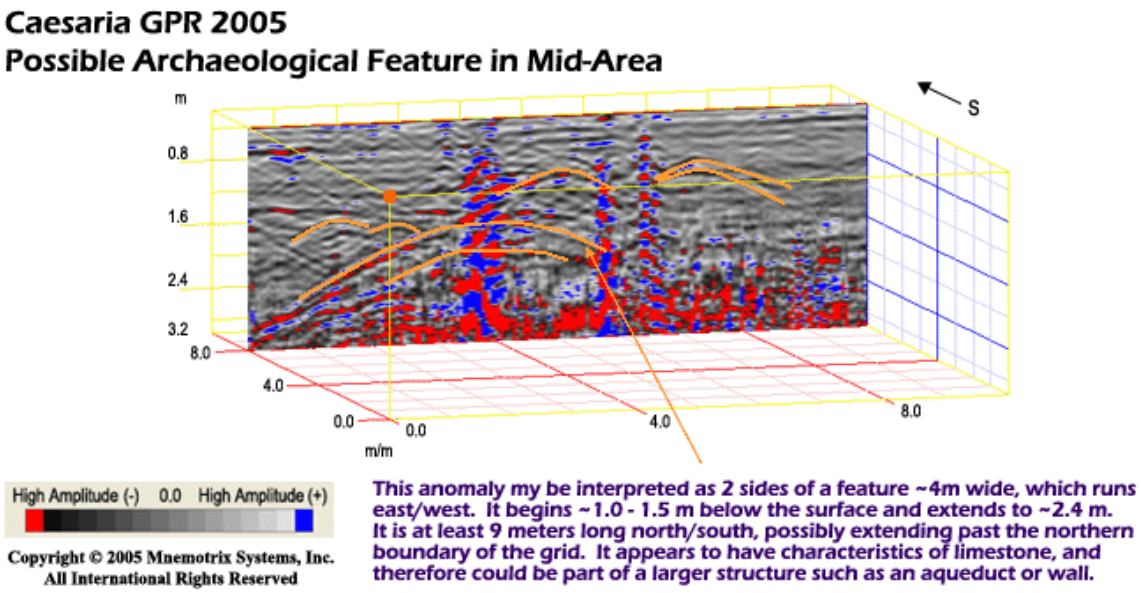

Figure 7: GPR anomaly in Grid 3 showing possible archaeological feature.

Figure 8: Closeup of structure of reconstructed ancient aqueduct nearby GPR Survey area, and potentially fitting the characteristics of the anomalies found in Grid 1 and Grid 3.

High Area

The high area (Grid 4) on the hill had good GPR results in that clear signal data was acquired; but the reflections here are more regular and look geologic in origin, rather than archaeological. There is one patch of interest in the western side that is located at about 2 meter depth, but only is a little over 1 meter wide in the x and y axes. That is, it does not seem large enough to necessarily be part of a larger archaeological feature, nor does it have the type of high contrast reflection which usually indicates a cavity such as a grave (See Figure 9).

Figure 9: GPR Grid 4 towards top of the hill.

Issues for further research and follow-up:

We do not have an archaeological map of the area of the aqueduct and the dimensions and placement of the other features around it. This might be helpful to assist further analysis. We know that there were two aqueducts that were constructed through history; the first "high" aqueduct built by King Herod, and a later "low" aqueduct that was built with different methods.

In regards to further GPR studies in the area, it is important to note that the terrain is an issue. Below is an example of the kind of vegetation which covers much of the site. While it is important to safeguard the natural habitat, this vegetation provides an obstruction which cannot be ignored for data acquisition.

Of note is that in the weeks between our GPR Survey on Nov 30th and Dec 2nd and the submission of this report on 18 December 2005, an archaeological crew under the auspices of Israel Antiquities Authority came in and flattened the area we had surveyed. This may make re-identification of the areas surveyed harder, but it also might make it possible to do a more thorough widespread survey of the whole area, without having to deal with the rough terrain.

Figure 10: Vegetation and terrain over much of the area of interest which must be traversed by GPR.

Summary and Conclusions:

Of the 4 GPR sample grids completed, it appears that 2 main areas have the possibility of containing archaeological data. The dimensions are broad enough to indicate the possible presence of an old aqueduct or other wall or structure, and have velocity characteristics of limestone.

We saw features rather clearly in all the survey areas. The top area (Grid 4) looks like it is probably of geologic interest rather than archaeological. The mid area (Grid 3) and lower areas (Grids 1 & 2) show some features which are probably explainable by more modern causes such as some garbage dumping, but also show some features which are most likely of archaeological interest and definitely should be given further investigation.

We have many more photos and figures which were not included in this report to avoid redundancy. However, the photos can be studied closely for follow-up research in this area.

We would welcome a ground truth excavation in the areas we saw to better understand the nature of the GPR anomalies. Additionally, if a more widespread GPR study of the area can be organized it could be quite revealing or even exciting, and would certainly give us a clearer idea of what might lie beneath the surface of this ancient spot.