

Ground Penetrating Radar Survey Report:

The Bethsaida Archaeological Project Bethsaida, Israel near Sea of Galilee



Data Acquired 30 June, 2008

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**Ground Penetrating Radar (GPR) Study:
Bethsaida, Israel, near the Sea of Galilee
*14 November 2008 Report of 30 June 2008 Study***

Background

The mythical city of Bethsaida in the northern Galilee region of Israel is frequently mentioned in Second Temple period sources, in relation to the ministry of Jesus. Dr. Rami Arav under the auspices of the University of Omaha discovered this ancient city and has undertaken excavations there for over two decades. During that time many habitation layers have been unearthed, studied, and reconstructed. In recent years an Iron Age City Gate complex was uncovered and reconstructed as shown in Figure 1, dating to the time of Hebrew Biblical sources. A fuller history of this well documented site can be found at the University of Omaha website, at <http://www.unomaha.edu/bethsaida/history.htm>.



Figure 1: Portion of Bethsaida Iron Age Fortified City Gate

Since 1986, the site has been fully excavated down to the Iron Age city gate as shown in Figure 1 which is known as Strata 5, and includes a fortified E style gate, street, houses, palace, and sacrificial area. While much is known about Strata 5, much less is known about the elusive Strata 6 which is believed to be the earlier city on top of which the Iron Age city was built. Parts of a Strata 6 road have been found running beneath Strata 5, but its relationship is not yet pieced together and fully understood.

Mnemotrix Systems was asked to complete an archaeogeophysical survey to shed some light on these issues, and to help make a determination how to excavate the lower area with as little damage as possible to the reconstructed area of Strata 5.

The intent of the GPR study was to go over the top of the Iron Age stone courtyard, past the gate, and go full length as much as possible to decode what lies below. Of note is that this area has been GPRed previously but without definitive result. As was later discovered, the previous GPR antenna used did not use as high resolution as we were able to provide in this survey. Additionally, there is a heavy presence of basalt which contains iron, and throws off GPR due to its metal content. According to Dr. Arav the basalt content at Bethsaida is even more concentrated than at Hazor where Mnemotrix has previously encountered such issues. However, as will be shown in this report, using a 400 Mhz antenna, a survey wheel, high density data acquisition, and thorough post-processing into a 3D grid, we were in fact able to image distinct anomalies worthy of investigation.

Description of Survey Area

The GPR survey was conducted on the full extent of the courtyard of the Iron Age Stratum 5 city-gate in Area A (see Figure 2). This area was 21.5 x 3.7 meters (east-west x north-south). On the northern and southern borders existed the smaller rooms that are characteristic of this city fortification. Previous archaeological excavation has unearthed the presence of Stratum 6 in the surrounding areas (see Figure 2). The yard is paved with large basalt stones about 30-40 cm wide making an uneven surface for the GPR, as are shown in Figure 1.

We set up our data collection control point within one of the chambers of the double E Iron Age Gate. Per Rami Arav regarding what they know from past studies, in one of the nearby sections (the NW one) the Strata 6 shows up 0.75 meter depth. On the other side of the fence (the Eastern lower section), the dug out area of Strata 6 is 3 meters below. Thus it can be seen to run at an incline.

The 21.5 x 3.7 meter grid was marked out for the GPR survey in an E/W x N/S direction. We began our data acquisition in the NW corner pulling from the west to the east, proceeding south, pulling the length of the long rectangular area. Field observations showed that some sort of distinct feature worthy of note was showing up in the field in the eastern side, getting stronger as we moved south. A second dataset was collected in a perpendicular direction over the area where this anomaly was revealed, every 50 cm as was the first dataset, this time acquiring data north to south, proceeding west.

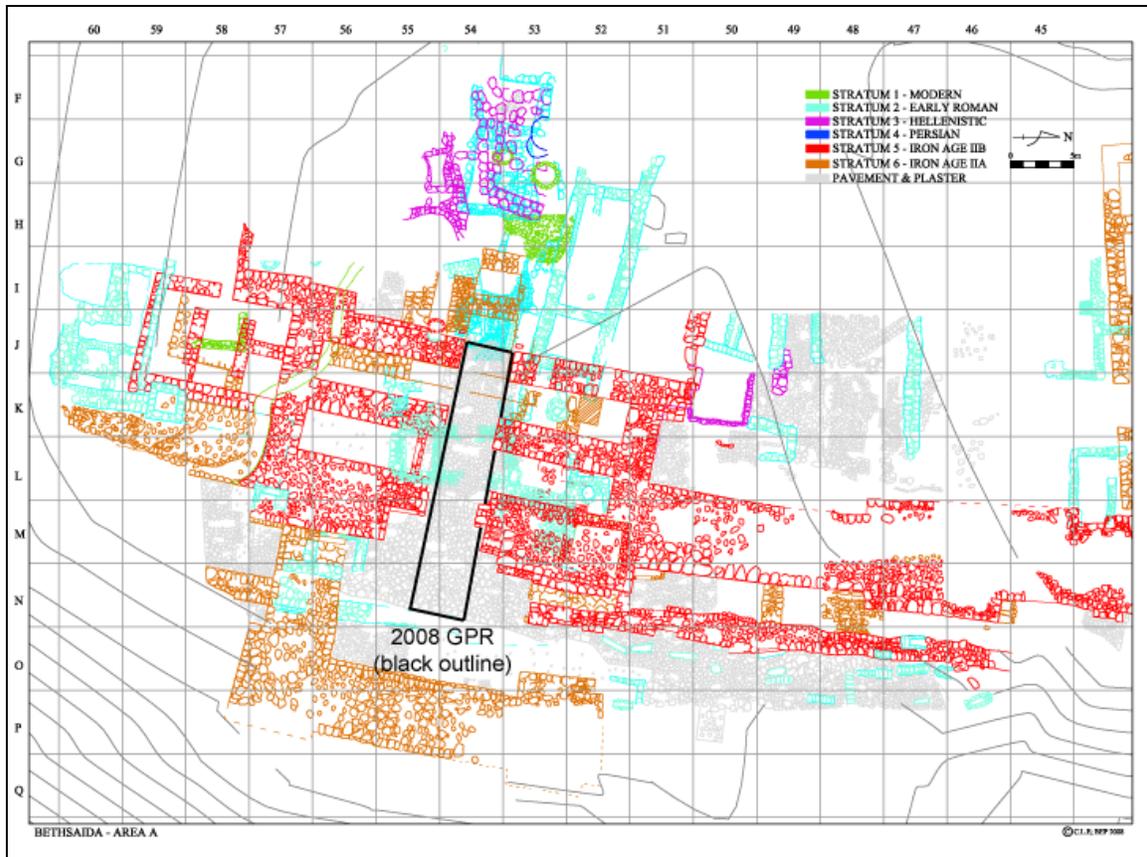


Figure 2: Map of Bethsaida Area A, 2008 GPR grid marked in black.

GPR Survey Actions Taken

In this survey, the key goal was to see if we could locate the presence of the Stratum 6 Iron Age IIA. Although other GPR surveys have been done in the past in this area, no significant results have been shown. The courtyard is key to the Chief Investigator, Rami Arav, because of its uniqueness in preservation. In addition, excavation of the courtyard to traditionally locate the Stratum 6 will be exceedingly difficult due to the large basalt boulders that characterize it. Thus he enlisted the help of the Mnemotrix team to see what was possible to be known about the sub-surface in a non-invasive manner.

Two full grids were completed of the rectangle shown in Figure 2 and also seen on the cover page of this report. The first dataset consisted of profile lines every half-meter proceeding from east to west moving from the south to the north. The second grid criss-crossed the first acquiring data every half meter but from north to south proceeding west. When the two grids are combined in a 3D dataset we have a significantly dense dataset worthy of real interpretation and study.

A 400 Mhz GSSI GPR antenna was used for both gridded areas. A 100 nanosecond window was chosen, which would give us a viewing window of about 2-5 meters depth.

Post-Processing and Analysis

For both grids, standard post-processing was completed including correction of the zero-position as the radar energy first enters the sub-surface and horizontal background removal. Horizontal background removal was used in order to filter out any area security radar and cell phone signals in addition to compensate as much as possible for the high iron content of the basalt stones (because of the iron there is a tendency towards "ringing" within the data).

What was seen in the sub-surface was the first half-meter of rocks from the surface. Then we see the appearance of a horizontal feature on the northern border. By looking at field pictures this seems to be located in the area of the pile of soil that was on the northern edge of the gridded area. The X coordinate is 12.62 meters from the western edge and reaches to 9.2 meters, making the length of the feature ~3.65 meters long. It is present from depths 0.81 m to 1.8 m. We are unsure of the identity of this feature, however it does stand out from the surrounding matrix, thus we believe it is a feature of archaeological significance.

As we proceed in depth, the sub-surface becomes more homogenous and the data becomes "fuzzy" from lack of signal penetration at 4.40 meter depth. The very last appearance of anything related to the "Rectangular Border Anomaly" is 2.95 meter depth. This point is X=11.6, Y=0.74. The anomaly tends to be located 30-40 cm south of the northern boundary. Another view of the feature is seen in Figure 4, proving its existence as a true anomalous feature in the sub-surface of this gridded area.

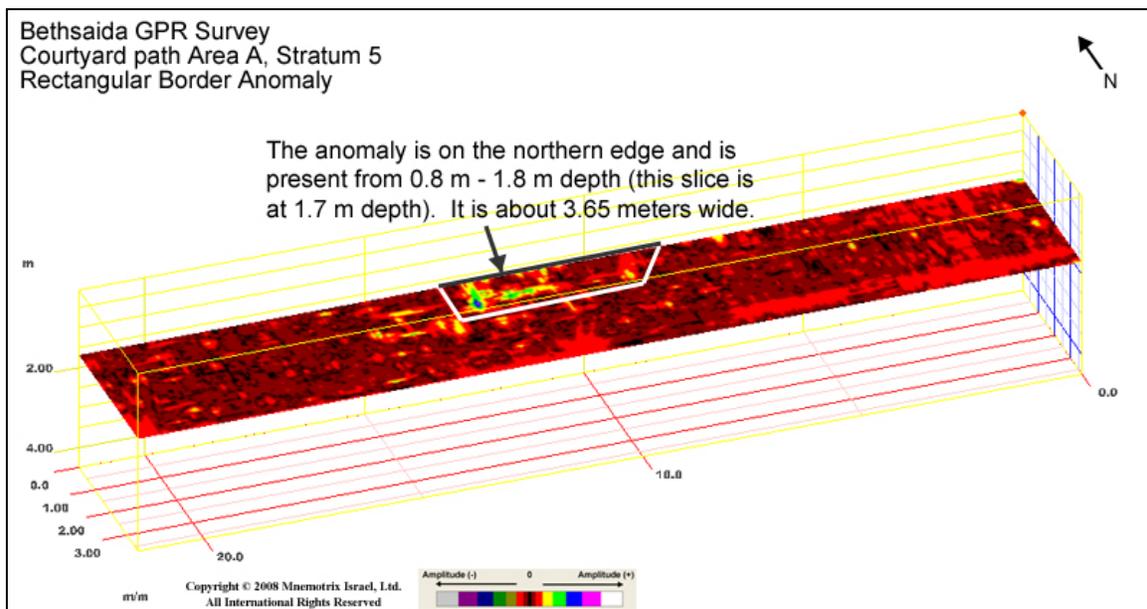


Figure 3: View of edge anomaly feature at 1.7 m depth.

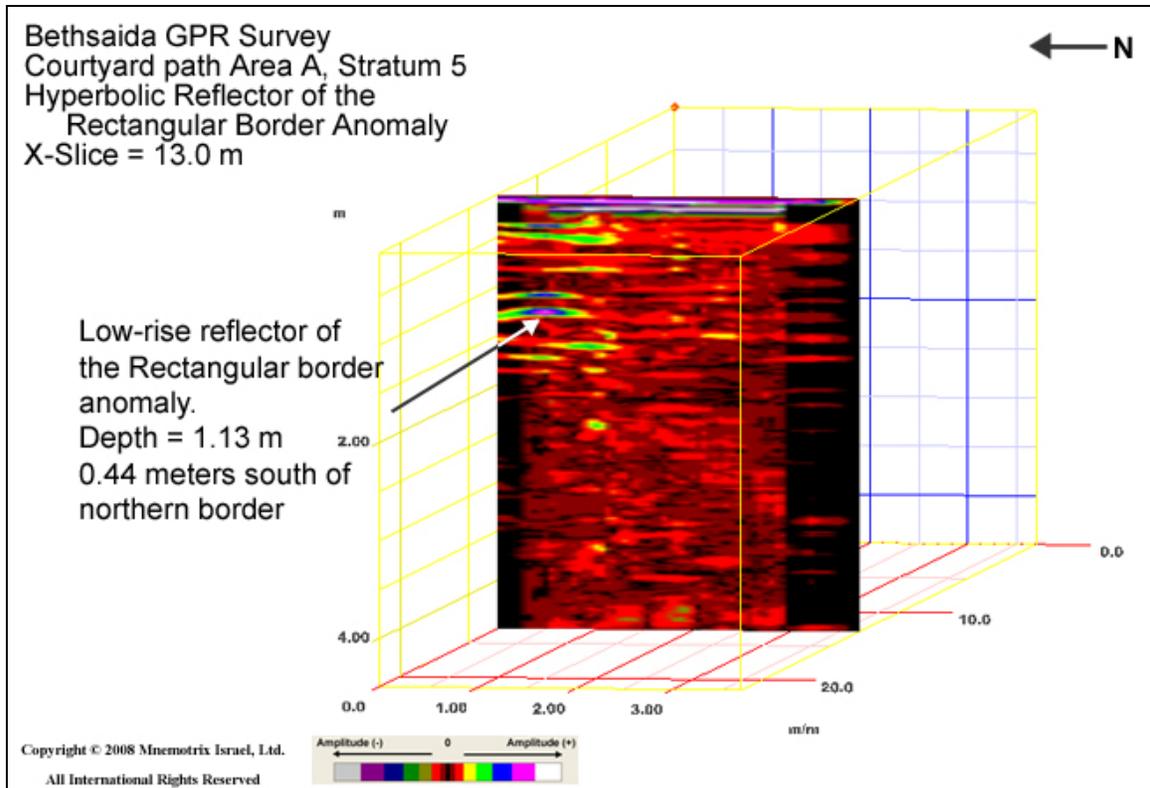


Figure 4: Side-profile of border anomaly. Low-lying hyperbolic reflector shows that the feature is a sudden horizontal change in the east-west axis of the grid.

Other observations include that by 1.75 meter depth the archaeological material appears to be gone or is similar to the matrix at that depth so that we are unable to see any difference in the GPR data. Around 0.45 meter depth located between X-amounts 7.53-8.6 (from the western border) there is a horizontal layer about 1 meter wide. Because of its low amplitude, we can assume that it is not made from a composition very significantly different from its matrix. It is significant enough, though, that it is able to be seen in the data. At 1.5 meter depth there is a significant horizontal layer across the entire Y-axis of the grid. We are unsure of its meaning at this time, but it is worth noting here.

Summary and Recommendations

In summary, we were able to gain clear enough data of the sub-surface with a 400 Mhz Frequency antenna at the Iron Age IIA courtyard to identify a significant anomaly in the sub-surface. We are unsure as of yet what its true identity is. But we see that it is a valid horizontal feature in the sub-surface. We are not sure if we are able to see and point out the "elusive" Strata 6, however it is clear from the GPR survey that all structural archaeologically related features seem to disappear by 2 meter depth, and what we find correlates to other potential expectations about the older strata.

Because this is such a difficult location to use GPR in due to the high basalt content, we hesitate to say that our findings are absolutely final, as a high basalt presence has the capacity of causing distance distortion among other phenomena. Even so, given the nature of GPR in this context, and the personal experience of the surveying team we can say we are confident that there is something in the sub-surface in the general area of the coordinates listed above, and that we know there is a change in the sub-surface before 2 meters have passed.

We recommend first excavating in the particular location marked in Figure 3 before expending more resources in the entire area. Because it is a small area the risk of destruction of the courtyard could be interpreted as minimal in relation to the rest of the entire surveyed area. Any data from this ground-truth excavation will prove helpful to the future interpretation of the same data-set so that we are able to understand what features are present in the GPR data and potentially "see" features that were not previously identified.