

## **NAZARETH EXCAVATIONS PROJECT: A GPR PERSPECTIVE**

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### **Abstract**

High-resolution ground penetrating radar (GPR) surveys were carried out to image any archaeological features that may be located beneath the present floor of the Cactus House and several adjacent sites, Nazareth, Israel. The Cactus House occupies a portion of a much larger structure located in close proximity to Mary's Well and the Greek Orthodox Church of the Annunciation. Excavations in the basement of Cactus revealed a portion of a hypocaust and furnace of a bath house. Radiocarbon results date the present bath house (in the basement of the store), excavated by the owners, to the Crusader period. The lower yet-to-be excavated archaeological site is hypothesized to be a Roman bath house which would have been where Jesus and his family would have bathed. The objective of the geophysical surveys was to gather, in a non-intrusive and non-destructive manner, as much information as possible about underlying features of the excavated portion of the bath house as well as surrounding locations.

GPR data was collected in 3 localities within the Cactus House and 3 sites adjacent and behind the House. The data was collected using a pulseEKKO 1000 GPR system (225 & 450 MHz antennae; 200 V transmitter). Step sizes ranged from 0.05 m to 0.1 m. To aid in interpretation, three dimensional (3D) cubes were assembled from a series of identical length 2D GPR profiles running parallel to each other along an x-y grid system. The 3D cubes provide a unique perspective of the subsurface layers that will aid in locating sites for excavation. The application of radar stratigraphic analysis on the collected data provided the framework from which to investigate both lateral and vertical geometry of any potentially buried archaeological features.

The resulting images from these geophysical surveys show that various anomalies exist in the subsurface and may indicate archaeological features exist below the present floors. For example, the upper bath house may have been built upon an earlier bath house that more closely aligns with the water system located and excavated at the adjacent Mary's Well site. Several test probes and samples for radiocarbon dating are planned to be undertaken based upon the results from these geophysical surveys.

### **Background**

Most religious denominations have established different places where they think significant Biblical events occurred. To date, no physical evidence of the lives of Jesus, his mother, Mary, and his father, Joseph, has been found. Mary, the mother of Jesus, is one of the more elusive and important figures in religious history as she appears in Judaism, Christianity and Islam's most holy texts. The historically significant Mary's Well, the site in the Orthodox tradition where Angel Gabriel announced

to the Virgin Mary that she was to give birth to the baby Jesus, is located west of the Sea of Galilee in the town of Nazareth, Israel (Figure 1). The water in this well is legendary and is said to have extensive healing powers. Although the history of the bath house isn't completely clear, it is mentioned in several biblical and other subsequent writings (Freund, 2003). Our archaeological expedition to Mary's Well is a search for information about the historical Mary and her family.



**Figure 1:** Location map of Nazareth, north central Israel.

It is not easy to reconstruct the history of Nazareth during this time period (1st century CE) because structures have been destroyed and rebuilt multiple times. The place where we have been investigating is significant because it is an original archaeological site, never excavated, and occupies a portion of a much larger structure located in close proximity to Mary's Well and the Greek Orthodox Church of the Annunciation. Elias and Martina Shama-Sostar who operate the Cactus House became suspicious when they started to dig out the basement of their shop to add new storage space. Their excavations revealed a portion of a hypocaust and furnace of a bath house of an unfixed age as well as other finds (Figure 2). Radiocarbon results now date the excavated bath house to the Crusader period. It is below this floor that there may be preserved a former Roman period bath house and associated artifacts of visitors that go back 2,000 years. One theory suggests that this lower bathhouse would likely be the place where Mary and her family would have come to bath and draw water and therefore indeed the place where the Angel Gabriel spoke to Mary.

The objective of the Nazareth Excavation Project is to gather as much information as possible about underlying features of the excavated portion of the bath house. The initial investigations are to be carried out in a non-intrusive and non-destructive manner with results suggesting locations to excavate. This paper will report on the high resolution ground penetrating radar (GPR) surveys that have been conducted within and adjacent to the Cactus House.



**Figure 2:** Excavated hypocaust within the bath house located beneath the Cactus House, Nazareth, Israel (Photo: Christine Dalenta)

## Methods

GPR is known for its ability to detect and map buried archaeological features in a safe, quick and non-destructive manner (Sternberg and McGill, 1995; Conyers, 2004). The GPR technique is based on the propagation and reflection of pulsed high frequency electromagnetic (EM) energy. This field technique can provide near surface, high resolution (dm to m scale), near continuous profiles of many sediments that are of low electrical conductivity (Davis and Annan, 1989; Jol and Bristow, 2003).

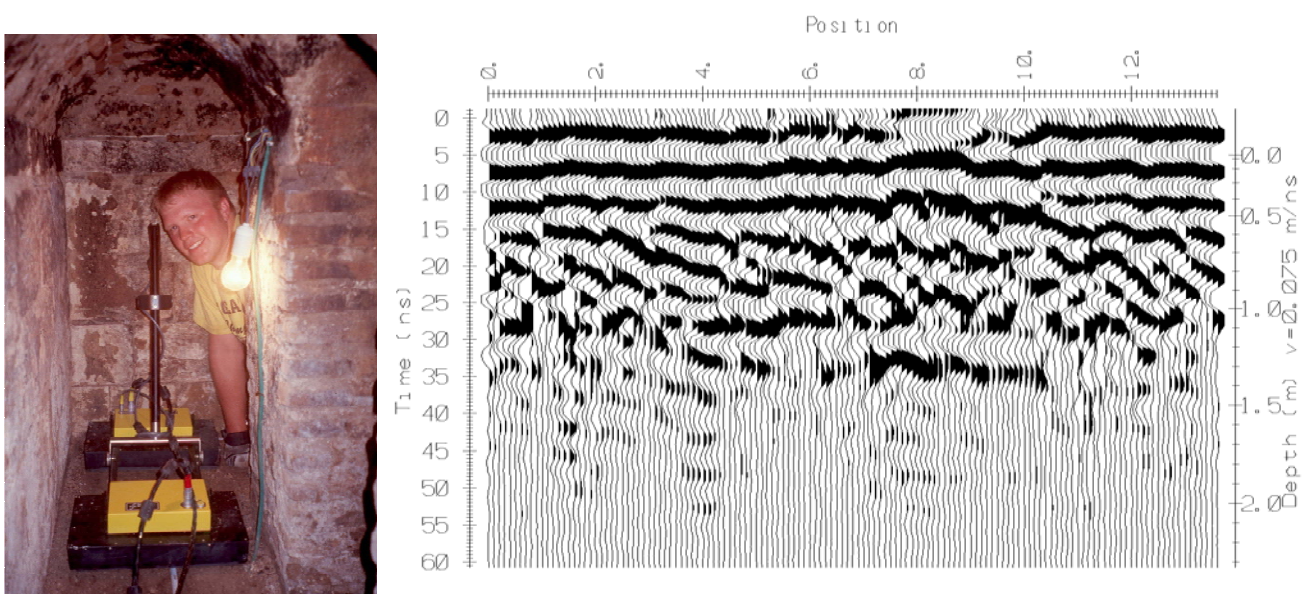
The data was collected using a pulseEKKO 1000 GPR system (shielded) with a range of antennae frequencies (225 MHz, 450 MHz, and 900 MHz) and a 200 V transmitter. Step sizes ranged from 0.02 m to 0.1 m. To reduce data collection time, a backpack transport system carried the computer, console and battery. The digital profiles were processed and plotted using pulseEKKO™ software. The application of radar stratigraphic analysis (distinct signature patterns) on the collected data provided the framework to investigate both lateral and vertical geometry of the buried archaeological features (Jol and Smith, 1991; Jol and Bristow, 2003).

Three dimensional (3D) cubes were assembled from a series of identical length 2-D GPR profiles running parallel to each other along an x-y grid system. Visual rendering of the 3-D datasets was done using Fortner T3D. The data for the 3-D cubes were acquired when sufficient space was available (e.g. tea room, oven room, unoccupied room).

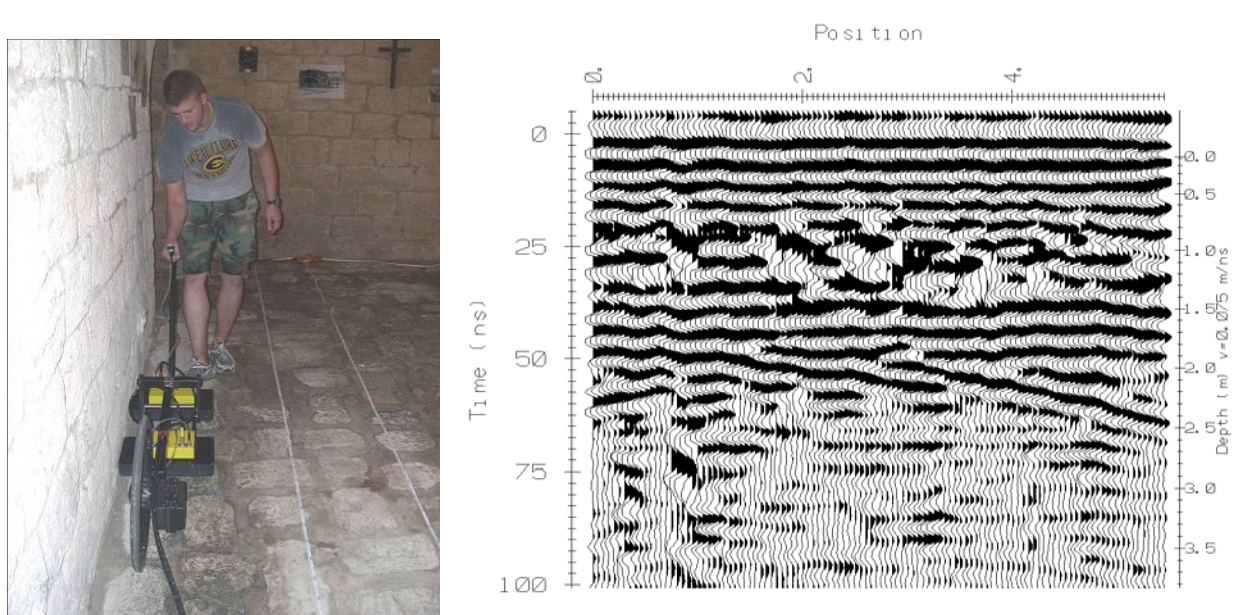
## Results

GPR data was initially collected within the Cactus House in 3 localities, here called, bath area, tea room, and oven room. Data from the bath area – indicates stratigraphy below the present floor (Figure 3). Of interest are the dipping features in the direction of the survey line (along the complete profile). Profiles in the bath area have a depth of penetration to approximately 1.0 – 1.5 m. Data from the tea room– indicates stratigraphy to greater than 2.5 m in depth (Figure 4). In the direction of survey there are 3 packages. From the surface to approximately 1.5 m are layers of horizontal to undulating

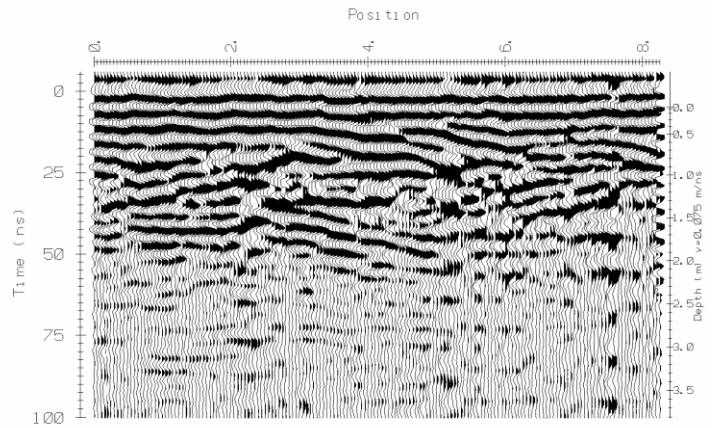
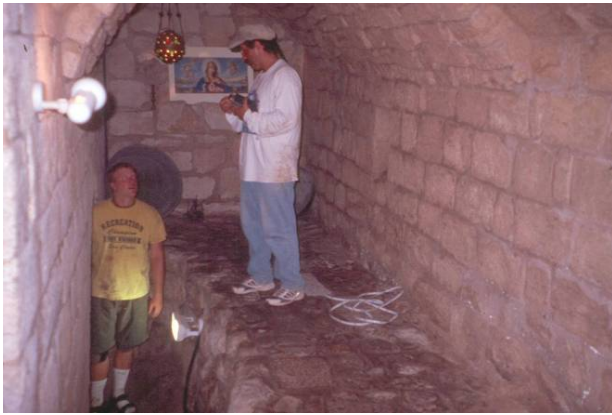
bedding, at approximately 1.5 – 1.7 m, there is indication of distinct layer of material, below which the layers start dipping in the direction of the survey line. Data from the oven room – indicates stratigraphy to approximately 2 m in depth (Figure 5). The lower dipping stratigraphy from the tea room area continues in the direction of survey of the oven room. Above the lower dipping strata are various layers of material that appear to be dipping at various angles with several being nearly horizontal.



**Figure 3:** Left: Data being collected with 225 MHz antennae within the excavated hypocaust (bath house) beneath the Cactus House. Right: GPR profile (225 MHz) collected in the excavated portion of the hypocaust.

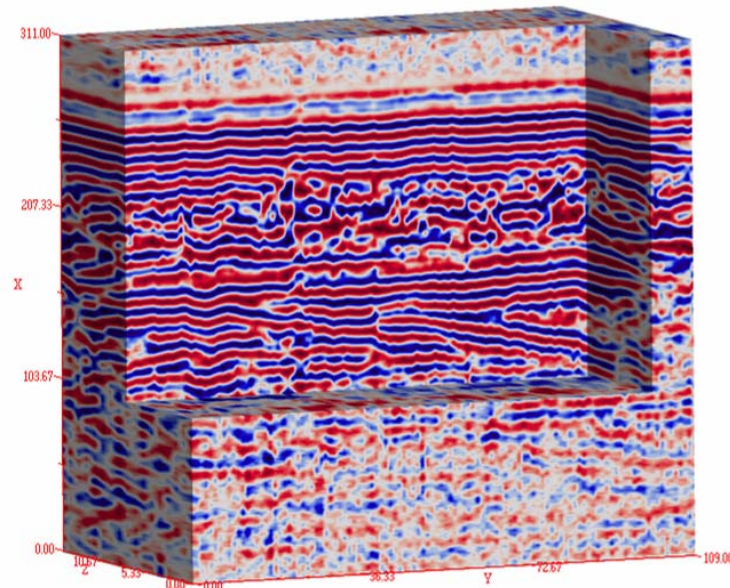


**Figure 4:** Left: Data being collected with 225 MHz antennae within the tea room of the Cactus House. Right: GPR profile (225 MHz) collected in the tea room.



**Figure 5:** Left: The oven room of the Cactus House. Right: GPR profile (225 MHz) collected in the oven room.

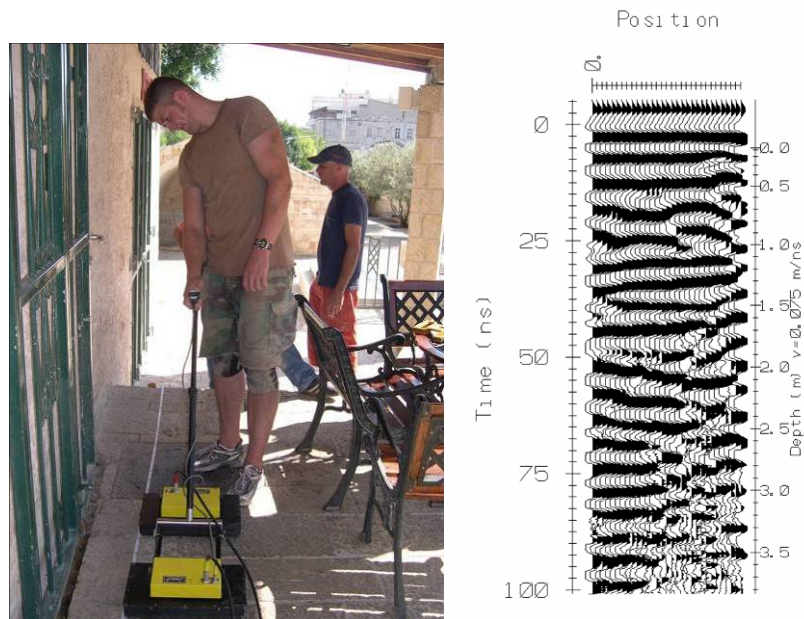
Three-dimensional cubes were assembled from a series of identical length 2-D GPR profiles running parallel to each other along an x-y grid system within the tea room and oven room (Figure 6). The cubes provide further evidence of the above interpretations. The reflections below the present floor in the Cactus House may indicate that the upper bath house was built upon an earlier bath house that more closely aligns with the water system located and excavated at the adjacent Mary's Well site. Samples have been gathered from these lower dipping layers for radiocarbon dating.



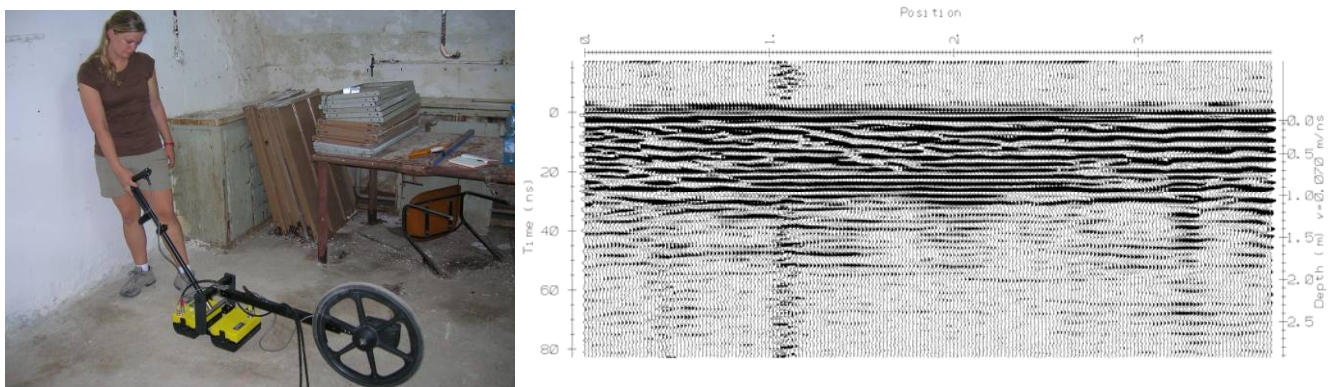
**Figure 6:** Chair diagram of a 3D cube collected in the tea room of the Cactus House. Where enough floor space was available parallel 2D lines were collected to better understand the subsurface through 3D perspectives.

GPR surveys were also conducted at several locations beside (sidewalk) and behind the Cactus House, Nazareth. These surveys were carried out to image any features that may be located beneath a sidewalk, a floor of an adjacent unoccupied room, and a cistern. The data collected along the sidewalk showed a ringing effect which was probably a result of electrical lines being run beneath the locality of interest (Figure 7). Data from an unoccupied room includes 17 – 225 MHz lines, 31 - 450 MHz lines,

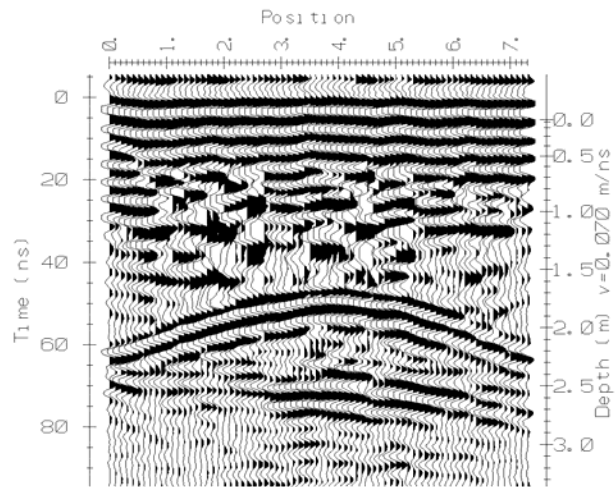
10 – 900 MHz lines. The 2D lines (and associated 3D perspectives) all indicate stratigraphy below the present floor (Figure 8). Of interest are the horizontal and dipping layers (most of which dip in the direction of the Cactus House). Profiles in the unoccupied room have a maximum depth of penetration to approximately 2.0 – 2.5 m. Data from a cistern include 2 – 225 MHz lines which indicate stratigraphy to greater than 2.5 – 3.0 m in depth (Figure 9). One of the profiles shows a hyperbolic feature rising to approximately 1.6 – 1.7 (below surface) while a cross line indicates this same reflection (layer) as being horizontal. Due to the extensive rubble on the cistern floor, only two lines could be collected and therefore no 3D images could be constructed. A test probe was conducted inside cistern to identify the GPR anomaly but the probe was aborted before reaching the anomaly for lack of archaeological material.



**Figure 7:** Left: Data being collected with 225 MHz antennae on sidewalk adjacent to the Cactus House. Right: GPR profile (225 MHz) collected on the sidewalk.



**Figure 8:** Left: Data being collected with 450 MHz antennae behind the Cactus House in an unoccupied room. Right: An example of one of 31 GPR lines collected (450 MHz) in the unoccupied room.



**Figure 9:** Left: Data being collected with 225 MHz antennae within a cistern behind the Cactus House. Right: GPR profile (225 MHz) collected along the rubble laden floor of the cistern.

## Summary

GPR data was collected within the Cactus House in 3 localities (bath area, tea room and oven room), along an adjacent sidewalk, and behind the Cactus House in an unoccupied room and a cistern. The data was collected using a pulseEKKO 1000 GPR system with antennae ranging from 225 to 900 MHz. Data from the GPR profiles (2D and 3D) indicates stratigraphy below the present floor and based on these results, locations for future excavations will be proposed. GPR provides a non-invasive and non-destructive approach to initially investigate significant archaeological sites.

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