The Great Synagogue and Schulhof of Vilnius (Vilna): A GPR Survey Proposal

Vilniaus Didžioji Sinagoga

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Figure I: The Great Synagogue of Vilnius Footprint

In continuation with the full proposal for excavation and presentation of the Great Synagogue and Schulhof of Vilnius (Vilna) - Vilniaus Didžioji Sinagoga, the 2015 season of work will commence with a Ground Penetrating Radar (GPR) survey of the site to gauge the exact positioning of the underground remains and to better understand the archaeological potential of the site prior to the investment of further resources to fully uncover the remains through excavation.

A full explanation of the techniques, methodology and expected results of the GPR survey are provided below. It is proposed to cover three separate areas of the site, starting with the immediate area of the destroyed synagogue (area A in figure II), the aim being to identify the building of the synagogue and of the shulhof. Particular attention will be given to isolating the remains of the ritual bath (miqve) and the water system, as there is a strong possibility that these areas of the sites are better preserved as they were set below the original floor levels. The other areas to be GPR surveyed are area B to the north of
the synagogue complex and area C to the south, the aim being to outline the structures of the immediate area of the synagogue to connect the complex with the surrounding urban fabric.

Area A (pink overlay): Area above the structures of the Great Synagogue and the surrounding courtyards and buildings - 5700 square metres (excluding school building).

Area B (yellow overlay): Area to north of Great Synagogue – 2400 square metres.
Area C (green overlay): Area south of the Great Synagogue, Ramayles Yeshiva and original Zydu gatve – 2000 square metres.

Structures of the Great Synagogue and surrounding buildings marked in blue overlay.

**Explanation of the GPR Technology:**

Ground Penetrating Radar is a tool that allows archaeologists and geoscientists to work together to map an area that they think might yield important finds and explore the sub-surface **without disturbing the site.** This non-invasive, non-destructive survey allows us to assess and prioritize future work that could be explored through more invasive means: coring, sampling, small archaeological probes and long term excavation. Based on data that is collected, GPS locations can be pinpointed on the site maps so that future excavations can be extremely precise and planned with great care; especially in areas where there are identified artifacts of singular importance. This methodology can save money, time, and human resources in modern archaeological digs but it also insures that an excavation is planned with attention to the priorities of exigency (salvage) and/or in the case where possible human remains are located to insure that provisions are made in advance. Before GPR, archaeologists would excavate with little knowledge of what they might find below the surface. The way that the GPR system works is by sending high frequency electromagnetic waves (similar to FM radio signals) into the subsurface through antenna. These waves reflect off of changes in the materials/layers below surface and are “collected” by a second antenna. As the data is collected in the field and stored on a computer, a “raw” image of the soils underneath can be seen. Our team also includes a cartographer who will take all of the images, place them on maps with sites and GPS locations. Professor Philip Reeder, Dean of Sciences at Duquesne University in Pittsburgh, Pennsylvania, has agreed to participate in our work and prepare workable maps for use by the archaeologists in their future work including all sites identified. The Great Synagogue of Vilnius (Vilna) is an excellent target because the GPR system works well when a well-defined area can be worked on and plotted on an existing footprint. The depth of the target is important. In most of the areas that GPR works well the depth is up to four meters maximum depth. Both antennae will be used to see depth and detail. Zenonas Baubonis, together with Dr. Jon Seligman, will be determining the priorities for our work but during one week of work we may be able to do almost the entire area above or minimally (we do not want to work with the equipment in the rain, for example) connect the areas of previous year’s excavations.
With the data stored, post-processing after leaving the site can allow one extract details from 2D and 3D visualizations. These 2D and 3D images/maps of the subsurface contain various patterns that are often interpreted. The radio waves produced by GPR are directional into the subsurface and harmless to the environment, and is a very effective way in modern archaeology to perform a completely non-invasive sweep of an area to discover a foundation or structure underground without any excavation.
In the image above, we are collecting a large grid (30mx20m or could be more depending on the location) with a pulseEKKO 1000 GPR system and 225 MHz antennae. This is what we will be bringing to Vilnius. The backpack carries the console/computer to allow for portability while the 2nd individual is pulling the antennae along surface with the wheel triggering the system to send the electromagnetic (radio) signals into the subsurface. After the waves have been return, the computer receives the echo in real time, compiles the data and displays it on the screen.

After we had taken a look at the initial readings, from our GPR scans of 225 MHz, we could see some anomalies present in areas underneath the surface. Based on the clustering of these anomalies, we focused a 2nd smaller grid (10m x 5m) with 450 MHz antennae to allow for a higher resolution survey. The GPR system we will be using for our study will depend on the target(s). The reason for doing this is that different GPR frequencies can produce a view of the subsurface with greater depth of penetration or greater resolution but often not with the same frequencies. In the case presented we could show a pattern of anomalies and the higher frequency antennae could determine whether there are more or less items present under the surface. Although the depth of penetration while using 450 MHz is less, the higher resolution can provide us with a more detailed view of the subsurface within this grid. Professor Harry Jol will be bringing from the University of Wisconsin, Eau Claire, – we will be using the pulseEKKO 1000 system with 225, 450 and 900 MHZ antennae. For deeper penetration we would be using the pulseEKKO 100 system – with 50, 100 and 200 MHz antennae. This GPR systems is an earlier version of the pulseEKKO Pro – see: http://sensoft.ca/Products/pulseEKKO-PRO/Overview.aspx. The pulseEKKO PRO is designed to meet the needs of GPR professionals, addressing a wide range of GPR applications. Some characteristics of this system include: a) operating bandwidth is selectable from 12.5 MHz to 1000 MHz to optimize the system spatial resolution required by target size and exploration depth, b) fully bistatic design enables variable antenna offsets and orientations for advanced survey types such as multi-offset, transillumination and multi-polarization, c)
selected components can exploit many deployment configurations available for practical field operation, d) data are acquired in Sensors & Software's industry standard format for analysis with a range of processing and visualization software products.

Dr. Dean Goodman Geophysicist, of GPR-SLICE Software and the Geophysical Archaeometry Laboratory in California, USA will be processing the data with 2D/3D time slices, isosurface and overlay analysis as well provide 3D models and animations. The time slices can be used to assist in determining the most likely areas to yield useful excavations. Based on Dr. Goodman’s suggestions for the best possible resolution, we will be collecting our grid field data at a 25cm profile spacing and at most a 50cm spacing between grid lines. Reporting is a daily part of the work. Often one day to another will allow discussions to take place with supervising archaeologists to determine what is going on in the subsurface. A written report will be produced with all of the images and an evaluation of the next steps. The report will be given in a preliminary draft form in July, 2015 and a more detailed report will be submitted by the end of the year 2015.

**Goals for GPR Study:** Our team has been producing a series of different illustrations for us to work with the local archaeologists from the data sets that we are producing. These data sets are analyzed to help pin-point locations at archaeological sites for further research and excavation so that all of the areas do not have to be disturbed. We have recently completed a three dimensional survey in Nazareth at the Church of the Annunciation (Greek Orthodox) giving us exact areas where the more ancient Church [below the 19th century building] can be excavated and now in Rhodes, Greece we are working on the 16th century Kahal Gadol Synagogue (destroyed in World War II) and which the archaeological authorities wish to excavate and restore but with a full knowledge of the sub-surface and earlier iterations of the synagogue from earlier periods that were built on the same spot.

Figure V: Rhodes-Greece, destroyed Kahal Gadol synagogue
Here is an example of how the analysis provides a variety of locations with GPS locations placed on a site map:

Figure VI: X’s indicate sites below the surface that were identified for excavation at Sobibor in Poland (courtesy Professor Philip Reeder)
Figure VII. Original floor of the Kahal Gadol Synagogue in Rhodes-Greece below the present floor. Raw data.
Figure VII: 3D Models of Applitude Maps to show the contour of the excavation areas

Figure IX: 3D model which will show entire stratum (device can show all layers and cut-aways and with the right software moves to reveal entire structures in the sub-surface)