

GPR Surveys in Three Estonian Medieval Towns

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Abstract

In 1995 and 1996 ground penetrating radar surveys were carried out for the first time in Estonian archaeology. GPR was used for research at three towns – Tartu, Pärnu and Viljandi. The medieval buildings of these towns have mostly perished. The average thickness of the remaining cultural layers in the central part of the towns is two meters or more. The radars of GSSI SIR-System 2 and 3 with 100 and 500 MHz antennas were mainly used. In extensive surveys radar profiles totalling about 10,000 metres in length have been recorded. The purpose of these surveys was to find the appropriate application for the radar in an urban archaeological context. In the course of the project we also attempted to resolve some more specific and concrete problems.

The surveys in Pärnu were intended to determine the extent and thickness of the cultural layer in the district of Old-Pärnu. This is the area where the town was situated in the thirteenth to sixteenth centuries. The cultural layer of Old-Pärnu had not been investigated previously. As preparation for the radar survey of this area, the GPR was used in a late-medieval suburb of Pärnu where the profile of the cultural layer (some 10 to 20cm in thickness) has been established through trial excavations. On comparison of the known archaeological profiles and the radar images it may be said that thin (about 10cm thick) layers containing organic matter originating from agricultural land use as well as horizons of compressed sand forming former surfaces were well observable in the radar images.

In Old-Pärnu the GPR was mostly moved along the sides of streets on two parallel measuring tracks 2-3 meters apart. On the basis of the resulting radar data interpretation the sites of subsequent trial excavations were selected. The archaeological profiles corresponded well with the fixed layers on radar images up to a depth of half a meter. The main result of the research was negative, in that the cultural layer of Old-Pärnu was proved not to be buried under the sand, but probably as a result of tillage to have been mixed and moved about.

In Tartu the survey was carried out on the area of the former town wall and neighbouring medieval housing. This area bordered on an earlier archaeological excavation site. The known archaeological stratification of the layers determined there, and going as deep as three meters, could be taken as the basis for interpreting the radar data. In the same area rescue excavations was planned in connection with work on a new pipeline.

It was relatively easy to identify the town wall itself, which was registered as a massive object with strong reflection situated as deep as one half to one meter below the surface. To follow the line of the town wall the radar was in the end repeatedly moved along a zigzag track over the buried construction. As the result of the GPR survey the pipeline was planned to run along the line of the medieval street lying between the town wall and medieval town quarter. This would result in less damage to the remains of buildings in the ground during the building works.

Other surveys in Tartu were carried out in the area of the former castle and the ruins of the cathedral. Here the main concern was to examine to what extent the natural relief had been reshaped. On the radar image patches of construction fill were clearly discernible, as well as underground passages and supporting walls that had been erected as a part of the seventeenth century fortifications.

The radar surveys in Viljandi were a part of a larger programme that connected the results of earlier archaeological excavations with the GPR data and, subsequently, with those from soil boring samples. On the basis of these data a report on the extent, thickness and character of the cultural layer in the medieval town territory was compiled. The total length of the radar profiles here was about 5000 meters. Soil samples were taken from 70 bore-holes situated on the segments of radar profile with a constant stratigraphy, as well as in places that attracted attention due to extraordinary or disturbed features. As the soil layers in the study area differed in composition, structure and dampness, the determination of the vertical scale of the profiles was solved by relying on the radar image of underground piping and cables of known depth.

On the basis of the results of the research work in Viljandi it can be said that, using of radar images, stratigraphical conclusions about the medieval cultural layer can be drawn. It also became evident that in archaeological research the regime of GPR measuring and recording has to be different from the usual regime used in geology. For example, the speed of moving the antenna, which in early surveys had been 5 km/h, was slowed down by half. As a result, the quality of recorded images and radar graphics was improved.

As the surveys in Viljandi were mainly focused on the cultural layers, the background echoes became more important than the anomalies with stronger reflections, such as stone walls or other structures. This made the role of the archaeologist, familiar with the local archaeological strata, more important.

In the course of the interpretation process the use of different colour playback and scanning regimes of data files was also more thoroughly focused on. The main problem here was the lack of an effective correlation filter, which would correct the colours of layers according to the mutual influence of absorption and reflection that have occurred above them. Theoretically, the help of a more objective or archaeologically oriented radar display would free the archaeologist from the need to go through the lengthy process of obtaining the practical experience necessary for interpreting the GPR data.

The GPR surveys in all three towns showed that the use of the 100 MHz antenna is often very effective because a clearer view of the interconnection between the natural relief and the general planning of the town can be achieved. In some cases, for instance when surveying the moat and the old riverbed, the 400 or 500 MHz antenna was useless. Although the application of GPR would not be appropriate in places like intensively used courtyards with numerous entrenchments and crossing underground timber and stone constructions, the utility of radar in urban archaeology depends mostly on having a proper research strategy. In addition to determining the general outlay of a town, the location of fortifications and streets and such, GPR can also be used to find answers to other questions. Among these are the problems brought to the fore in the course of archaeological investigations, concerning the location of layers and the extent of structures partly unearthed and partly remaining outside the limits of the excavation site. GPR survey could also be useful for determining the most suitable location for limited-area trial excavations. In rescue excavations, it could avoid the kind of stressful situations which may sometimes occur at the final stage of excavations – unexpectedly finding a cesspit or a well and running out of time as a result of this.

The research outlined above has confirmed that GPR as a tool for urban archaeology has various ranges of application. In combination with the results of preceding or succeeding excavations, GPR can provide essential supplementary information.

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