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Melite Civitas Romana Project: preliminary results from GPR survey

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***Abstract* – Ground-penetrating radar mapping allows for a three-dimensional analysis of archaeological features within the context of landscape studies. The method's ability to measure the intensity of radar reflections from deep in the ground can produce images and maps of buried features not visible on the surface. A study was conducted in some areas near the Domus Romana in Rabat (Malta) in order to investigate the buried archaeological structures. The ground-penetrating radar analysis showed them to be anomalies likely associated to archaeological remains.**

I. INTRODUCTION

The Domus Romana is located at the south-western periphery of Rabat overlooking Mtarfa to the west. It was here on February 3, 1881 that fragments of a mosaic were discovered during the planting of trees along the esplanade fronting the fortifications of medieval Mdina [1]. News of the discovery was brought to the Superintendent of Public Works and subsequent excavations under the direction of Antonio Caruana, the Keeper of the Malta Library, revealed a luxurious suburban mansion with elaborate mosaics arranged around a peristyle [2, 3]. Construction of the Domus was dated from the last quarter of the second century or first quarter of the first century BC on the basis of the decoration. The importance of the remains led to the construction of a small museum building to protect part of the ancient house. The expansion of the museum building in the early 1920s led to further excavations by Sir Themistocles Zammit between 1920-1925 concentrating on the area to the north-west of the Roman Domus where Zammit uncovered remains of humbler houses and a section of Roman road [4]. Zammit also excavated along the façade of the museum where he found several Arabic burials, as well as in the fields across the road to the train station [5]. None of Zammit's excavations were fully published and all of his trenches – with the exception of the areas to the immediate NW of the Domus – were backfilled and none of the remains are visible today.

Although the area to the NW of the Roman Domus was cleared during Zammit's excavations, new investigations have shown that there are areas where undisturbed archaeological layers may survive in situ: an area along the edge of the ridge cut by the train station road, areas along the ancient road, a possible cistern and the open fields to the immediately to the north and northwest of the site and adjacent to the museum building. Although Zammit excavated three trenches in the fields across the train station road, no record was made of the finds.

Previous remote sensing carried out by Heritage Malta to the south of the Roman Domus has shown the effectiveness of remote sensing in the geography and geological conditions prevalent in the area. It was therefore deemed expedient to conduct remote sensing profiles using Ground-penetrating radar in the fields to the north and northwest of the Domus (Areas A and B) and along the façade of the museum building (Area E) in order to ascertain the extent and location of Zammit's excavations and to place these excavations within the broader urban fabric by identifying buried archaeological features pertaining to the environs of the Domus and the urban layout of Roman Melite. It should be noted that (Areas B1, C, D and F) in fig.1 are also areas of interest in potentially establishing the nature of this urban layout. However, as they are further removed from the previous excavations of Zammit, remote sensing of these areas will be conducted at a later date.

Ground-penetrating radar (GPR) is a near-surface geophysical technique that allows archaeologists to discover and map buried archaeological features for landscape analysis in ways not possible using traditional

field methods. The method consists of measuring the elapsed time between when pulses of radar energy are transmitted from a surface antenna, reflected from buried discontinuities, and then received back at the surface. When the distribution and orientation of those subsurface reflections can be related to certain aspects of archaeological sites such as the presence of architecture, use areas or other associated cultural features, high definition three-dimensional maps and images of buried archaeological remains can be produced. Ground-penetrating radar is a geophysical technique that is most effective with buried sites where artifacts and features of interest are located within 2–6 meters of the surface, but has occasionally been used for more deeply buried deposits.

A growing community of archaeologists has been incorporating ground-penetrating radar (GPR) as a routine field procedure for landscape analysis [6, 7, 8, 9, 10]. The efficacy and applicability of GPR in the detection of buried structures have demonstrate by several authors [7]. Conclusions from these studies indicate that GPR was the most important tool used to delineate structures and to maps and images act as primary data that can be used to guide the placement of excavations.

II. RESULTS AND DISCUSSION

With the aim investigate the presence of buried structures three areas were chosen.

The GPR prospecting was carried out with the IDS Hi Mod system with 600 MHz and 200 MHz antennae. Data were acquired in continuous mode along 0.5m spaced survey lines, using 512 samples per trace, 80 ns time range for 600MHz antenna and 160 ns for 200MHz antenna, manual time-varying gain function. The investigated areas were three and labelled respectively area A, area B and area E (Fig. 1).

The data were subsequently processed using standard two-dimensional processing techniques by means of the GPR-Slice Version 7.0 software [13]. On each GPR processed profile (Fig. 2a) a continuous and slightly undulating reflection event (labelled B and underlined by dashed yellow line) is visible. It is continuous and slightly undulating and irregular, and reaches a maximum depth below the surface ranging from about 0.8m to about 1.7 m. It probably represent the rock boundary. A hyperbolic shaped reflection events labelled “A” is visible. Its size is about 2m and the depth of the top is between 0.8m and 1.4 m (with an average electromagnetic wave velocity of 0.11 m/ns). This reflection event was interpreted as probably due to a buried structures of archaeological interest. In order to identify the depth evolution of buried structures, including their size, shape and location, time slices using the overlay analysis [11, 12] were built. The time slices show the normalized amplitude using a range defined by blue as zero and red as 1. In Fig. 2b the depth slices overlapped to the google earth photo of the surveyed area are shows. Several alignments are visible. Relatively high-amplitude anomaly (labelled A) correspond to the anomalies labelled A in the radargram. In Fig. 2c the data set is displayed with iso-amplitude surfaces using four threshold values 60% of the maximum complex trace amplitude. Obviously, lowering the threshold value, increases the visibility of the main anomaly and smaller objects, but also heterogeneity noise.

A relatively strong continuous reflections are visible on the threshold volumes between 0.8 and 2.5 m. In this case the anomalies labelled A could be interpreted as collapsed structures. The deeper anomalies could be interpreted as walls. This visualization technique help in the interpretation. Clearly the best interpretation must be performed together with the archaeologists.

The analysis of the GPR data acquired with the 200MHz antenna allows to obtain information about the deeper buried structures.

Particularly Fig. 2b in the 3D iso surface evidenced a structure (V) partially void.

III. CONCLUSIONS

The GPR survey allowed the acquisition of new data about the archaeological buried structures. In the area A several reflection events were underlined. The reflection event labelled A in Fig. 2 show a changing in the polarity of em wave. This important event could be related to a strong changing in the em properties of the subsoil. For example the presence of voids [10]. The 3D iso-surface representation (Fig. 2c) highlights the presence of an empty space (partially filled with collapsed material). Other reflection events are probably related to walls and collapsed structures.

Great difficulties have been encountered in the acquisition of data in the area B. Here in fact the presence of trees and stems with weeds has limited the area of intervention. Another negative factor is related to the presence of metal bodies buried a few centimeters from the surface. The events reflected by metal bodies masked the faint reflections of the electromagnetic wave coming from structures of archaeological interest. Here a particular data processing would allow to evidence some anomalies related probably to structures of archaeological interest.

Fig. 1. The surveyed areas

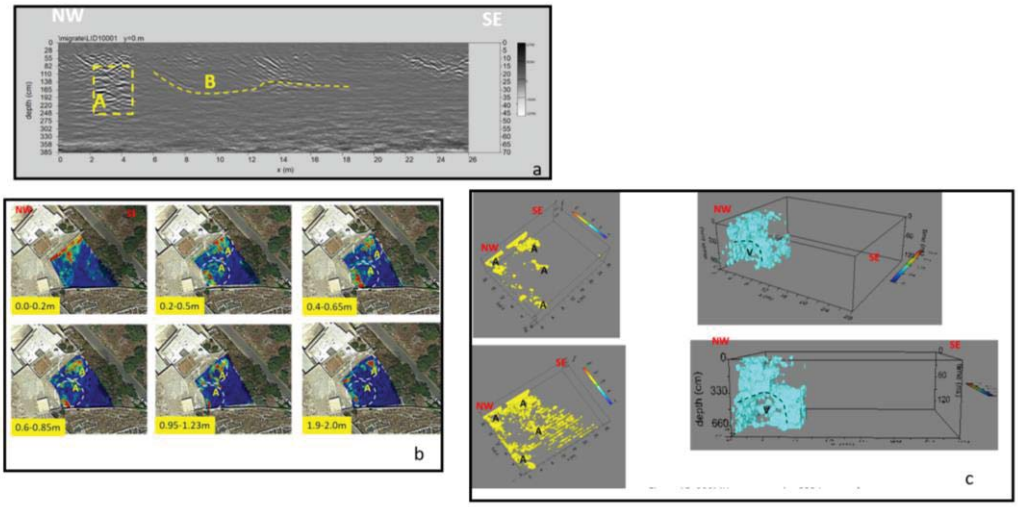

Fig. 2. a) GPR processed section; b) depth slices; c) 3D iso-amplitude volume

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