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The watch towers in Malta: a patrimony to preserve for the future

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***Abstract* – In this contribution we will focus on some results achieved within the international bilateral project "Non-invasive investigations to enhance the knowledge and the enjoyment of cultural heritage" (funded by the Italian National Research Council and by the University of Malta). In particular, we will focus on some GPR and geoelectrical investigations performed on the so called Red Tower and on the so called White Tower, both on the western side of the island of Malta.**

I. INTRODUCTION

The watchtowers of Malta are a cultural patrimony to preserve and deliver to the future generations. Indeed, in the 17th century there were watch towers in many places of the Mediterranean Basin, especially aimed to identify the ships of the ottoman enemies, but those erected by the Knifes of Malta in their island at that time are in some cases particularly interesting and well preserved.

Nowadays, some of them are endangered by the erosion of the cliffs, and up to some years ago many of them were abandoned. However, there are several projects for their re-qualification, and some towers have been or are being restored. It is in particular the case of the Red Tower (or St. Agatha Tower) and of the White Tower. The Red Tower was built in 1647 and perhaps is one of the most important watchtowers built by the Knights of Malta. Nowadays it is exploited for exhibitions and is a relevant touristic attraction. The White Tower (or Arhax Tower) was built in 1658, and after the period of the Knights (ended with the conquer of the island by Napoleon in 1798) it was exploited also by the English, that ruled the island after the defeat of Napoleon (officially after the Treatise of Paris of 1814) up to the independence of the island, acknowledged in 1964.

In the framework of the bilateral project "Non-invasive investigations to enhance the knowledge and the enjoyment of cultural heritage", we have performed a GPR [1-2] and ERT [2] investigation close to the Red Tower and a GPR investigation close to the White Tower, looking for ancient structures and remains from the 17th century on. In the following the main results achieved on both sites will be separately described.

II. PROSPECTING AT THE RED TOWER

As said, an ERT investigation was performed close to the Red Tower. In particular, in order to investigate below the tower, a special configuration was exploited with the electrodes distributed along the perimeter of the tower, so to surround it. A dipole–dipole equatorial-parallel array was used. The exploited georesistivimeter was a Syscal Kid Switch 24, and the data were processed using the software ErtLab (http://www.geostudiastier.it) that makes use of Finite Elements algorithm. In Fig. 1, three ERT slices are shown. The areas with higher resistivity values between 45000 and 55000 Ohm m^{-1} indicate the probable presence of empty volumes under the tower. The 3D visualization by iso-resistivity surfaces shows the 3D extension of the probable empty volumes below the tower.

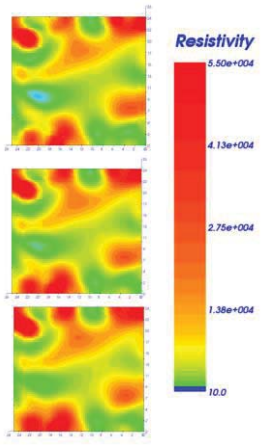

Fig. 1. From top to bottom, ERT slices under the Red Tower at the depth 0.5, 1 and 1.5 m, respectively.

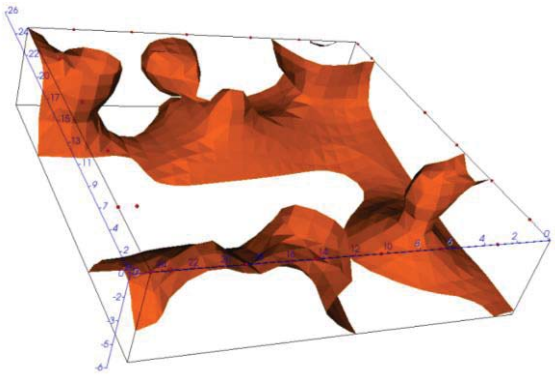

Fig. 2. Perspectival visualization of the resistivity of the soil under the Tower by isosurfaces

GPR data have been gathered also around the tower with a RIS Hi Mode system equipped with a dual antenna at 200 and 600 MHz. In particular, two small areas have been prospected with parallel Bscans with transect 50 cm close to the cover of a known cistern. From the slides, the size of the cistern can be clued, and at the depth of about one meter a probable pipe connecting the tower to the cistern is seen among the main anomalies. The two images in Fig. 3 have been achieved from the antennas at 600 MHz. The data have been processed with the commercial code GPRSlice [4], and the processing consisted of zero timing, background removal filter, band pass filter and migration. The cover of the cistern is the grey circle on the right hand side of the images. The two prospected areas are two rectangles about sized 2x10 m (closest to the cistern) and 3x10 m (closest to the tower). It was not possible to prospect the intermediate area because of the roughness of the surface.

III. PROSPECTING AT THE WHITE TOWER

We have prospected and area of about sized 6x6 m close to the White Tower. Local rumours say that up to the seventies of the 20th century some old cannons of the English army had remained, and that they (or at least part of them) might have been buried under a casting of concrete during those years, and so they should be still there now. As can be seen from Figs. 4 and 5, the achieved results are compatible with such a hypothesis. In particular, from the slice in Fig. 4 we see a localised and strongly reflecting anomaly (it is not visible at shallower depth level but it continues at deeper levels). Even clearer seems to be the processed Bscan shown in Fig. 5: there is a strongly reflecting anomaly, and it does not start from the surface.

Fig. 3. GPR slices close to the Red Tower. On the GPR slices close to the Red Tower. At the top: depth of about 70 cm. At the bottom: depth of about 100 cm

Fig. 4. GPR slice close to the White Tower at the depth of about 80 cm

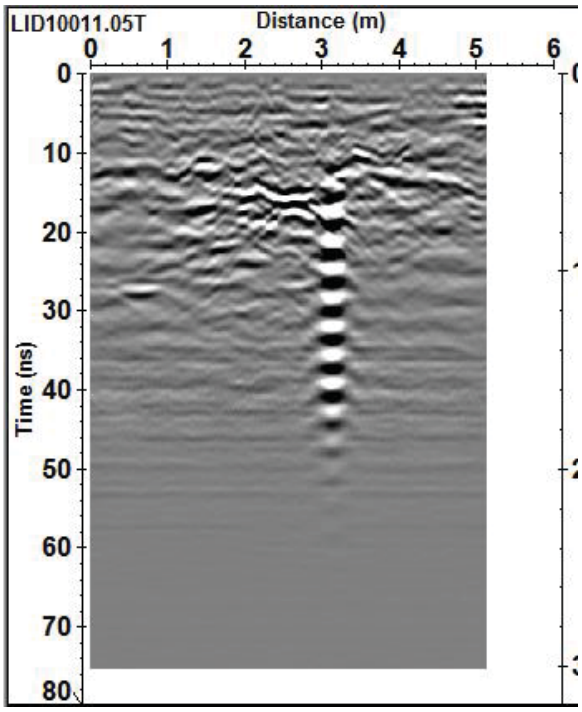

Fig. 5. One of the Bscans (processed data) close to the White Tower

IV. CONCLUSIONS

In this paper, we have briefly described part of the results achieved within a geophysical campaign on two watchtowers built by the Knights of Malta. The results seem to put into evidence possible voids under the Red Tower and possible cannons around the White Tower at a depth level of the order of 1 m. These investigations are enclosed in a wider campaign, that extends also beyond the quoted bilateral project and regards also other towers. Possibly, more details will be provided at the conference.

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REFERENCES

[1] R. Pierri, G. Leone, F. Soldovieri, R. Persico, "Electromagnetic inversion for subsurface applications under the distorted Born approximation" *Nuovo Cimento*, vol. 24C, N. 2, pp 245-261, March-April 2001.

[2] R. Persico, M. Ciminale, L. Matera, A new reconfigurable stepped frequency GPR system, possibilities and issues; applications to two different Cultural Heritage Resources, Near Surface Geophysics, vol. 12, n. 6, pp. 793-801, December 2014.

[3] G. Leucci, Nondestructive Testing for Archaeology and Cultural Heritage: A Practical Guide and New Perspectives, Springer, 2019.

[4] M. Lazzari, L. De Giorgi, G. Ceraudo, R. Persico, Geoprospecting survey in the archeological site of *Aquinum* (Lazio, central Italy), Survey in Geophysics, vol. 39, pp. 1167–1180, 2018

[5] M. Lazzari, L. De Giorgi, G. Ceraudo, R. Persico, Geoprospecting survey in the archeological site of *Aquinum* (Lazio, central Italy), Survey in Geophysics, vol. 39, pp. 1167–1180, 2018.