Defensive Architecture of the Mediterranean / Vol. XIV / Bevilacqua, Ulivieri (Eds.)

DOI: 10.12871/978883339794869

Geophysical surveys at the Aragonese Castle of Taranto (Italy)

Lara De Giorgi[a], Lucrezia Longhitano[b], Chiara Torre[c], Giovanni Leucci[d]

[a] Institute of Heritage Science (ISPC) National Research Council (CNR), Lecce, Italy lara.degiorgi@cnr.it, [b] University of Catania, Catania, Italy, lucrezia.longhitano@phd.unict.it, [c] University of Catania, Catania, Italy chiara.torre@phd.unict.it, [d] Institute of Heritage Science (ISPC) National Research Council (CNR), Lecce, Italy, giovanni.leucci@cnr.it

Abstract

The Aragonese Castle is located in the south-westernv most part of the island, corresponding to the acropolis of Taranto during the Magna Grecia period. It is at the top of a calcarenite body ascribed to the Last Interglacial time (MIS 5). Its building was completed in 1492, but there aren't indications of an official beginning; some architectonic particulars, including the structure of the church inside, seem to indicate that the building started during the X/XII century. Calcarenite ashlars present in the wall have size characteristic of the Magna Grecia/Roman time; therefore, it is possible that parts of the current fortification were built up the Magna Grecia/Roman one or, at least, reworking their parts. The present structure of the castle is the result of different phases, not yet well documented, of improvement and re-utilization that occurred during the century of life. The channel that separated the past acropolis from the centre of Taranto was cut at the end of the XIX century, on the occasion of the realization in this city of the biggest base of the Italian fleet; however, old documents indicate that in this area a small valley could limit the acropolis from the outside. The goals of the present work are: I - to individuate the original topography of the natural environment; II - to individuate past structures covered by new ones or sediments. The preliminary results are encouraging and point out the presence of different structures that could be of archaeological interest.

Keywords: Aragonese Castle, Taranto, GPR.

1. Introduction

The area is at the front of the southern Apennines, a fold-and-thrust belt developed following the closure of the Mesozoic Tethys Ocean, and the deformation of the Adriatic passive margin during Tertiary and Quaternary times. The thick basement of carbonatic Mesozoic rocks is partially sealed by Pleistocene fore deep deposits, which represent the infill of the Bradanic Trough. The upper portion of the middle Pleistocene succession consists of marine sands and conglomerates forming several orders of terraces (Bentivenga et al. 2004; Doglioni et al. 1999; Ricchetti, 1967; Ricchetti, 1979). A broad plain characterizes the morphology of the area, slightly sloping towards the sea, in many places marked by natural and/or artificial channels which form the drainage network (Fig. 1). The altitude is between 3 and 4 metres above sea level. The coastal belt is one of the most beautiful of the Ionian gulf because of the existence of humid zones. The area contains two overlapping and hydraulically separate aquifers: the first (superficial) aquifer is formed by the Pleistocene marine Terraced Deposits overlying the Pleistocene clays, holding a phreatic groundwater body. Unfortunately, the quantity of water that this aquifer can draw is not enough to satisfy the water requirement of the surrounding fields, so numerous wells emerge from the deep aquifer; the second (deep) aquifer lies in the Mesozoic limestones, made up of fractured and karstic carbonatic Cretaceous rocks, and in the overlying Lower Pleistocene calcarenite.

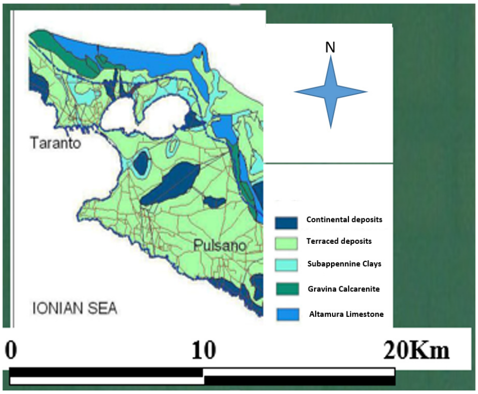

Fig. 1- The geological map of Taranto (graphic elaboration by the authors)

This deep groundwater body floats on a base of seawater from continental invasion, following the principle of Ghyben-Herzberg. In the area where the deep aquifer lies below the sub-Apennine Clays, it contains water under pressure and is therefore of Artesian type.

2. GPR data acquisition and analysis

The GPR survey was performed with Sir 3000 georadar system using a 200 MHz centre frequency antenna. The following acquisition parameters were selected: samples per scan, 512; recording time window, 100 ns; gain function, manual. The raw data quality did not require advanced processing techniques, but a more straightforward interpretation using the GPR-Slice software (www.gpr-survey.com).

The following data processing has been performed (Leucci, 2019; Giannino & Leucci, 2021): (i) amplitude normalization, consisting of the declipping of saturated (and thus clipped) traces using a polynomial interpolation procedure; (ii) background removal, whereby the filter is a simple arithmetic process that sums all the amplitudes of reflections that were recorded at the same time along a profile and divided by the number of traces summed the resulting composite digital wave, which is an average of all background noise, is then subtracted from the data set; (iii) Kirchhoff two-dimensional velocity migration, which is a time migration of two-dimensional profile based on two-dimensional velocity distribution is performed. The goal of the migration is to trace back the reflection and diffraction energy to their 'source'. A close examination of the data showed the presence of numerous reflection hyperboles from a point source. This allows us to estimate the EM wave velocity propagation ranging from 0.07 m/ns to 0.09 m/ns in the surveyed areas.

The A5 profile has been acquired in the lecture room using the 200 MHz antenna (Fig. 2).

The analysis of the raw data pointed out: a low penetration of the electromagnetic signal '60 ns' (about 2.7 m in depth with the average electromagnetic wave velocity of 0.09 m/ns); the presence of an interface, labelled I, located at 1.6m in depth. Such interface could represent the bedrock; the presence of numerous anomalies with a characteristic hyperbolic shape that, from ESE toward WNW, are denominated: S) located along the abscissas 3 m, 8 m, 10 m, 13 m, 22 m, 27 m, 29 m, 34 m, 38 m, 42 m, 47 m respectively and 0.2m in depth; such anomalies are due to the probable presence of hydraulic network; G) located at the abscissas 1-5 m and 1.6 m in depth; such anomaly could be related to the presence of a structure of archaeological interest; H) located at the abscissas 34-40 m and 1.6 m in depth; such anomaly could be related to the probable presence of a man-made structure (cistern?).

Profile A6 has been acquired in the courtyard using the 200MHz antenna (Fig. 3).

The analysis of the raw data pointed out: a good penetration of the electromagnetic signal '100ns' (about 4.5 m) in depth with the average electromagnetic wave velocity of 0.09 m/ns); the presence of an interface, denominated 'saturated zone', located 4.5 m in depth. The such interface could represent the zone of transition with a more significant presence of water (groundwater); the presence of numerous anomalies with a characteristic hyperbolic shape that, from WSW toward ENE, are denominated: S) located along the abscissas 10 m, 21 m, 33 m at 0.4 m in depth; such anomalies are due to the probable presence of hydraulic network; K) located along the abscissas 2-6 m at 0.8 m in depth; such anomaly could be related to the possible presence of a man-made structures; R) located along the abscissas 36-41 m at 0.8 m in depth; such anomaly could be related to the probable presence of a zone strongly re-handled and therefore to man-made structures subsequently filled with discard materials.

Profile A7 has been acquired in the courtyard using the 200MHz antenna (Fig. 4).

The analysis of the raw data pointed out: a good penetration of the electromagnetic signal

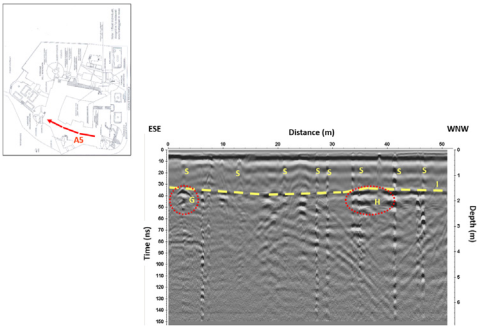

Fig. 2 - Processed radar section related to A5 profile (graphic elaboration by the authors)

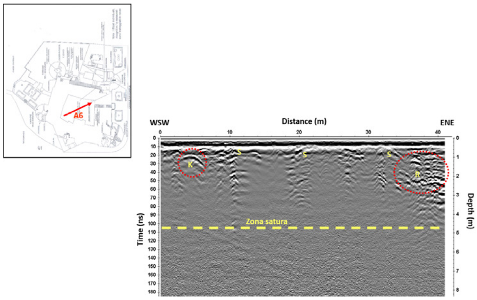

Fig. 3 - Processed radar section related to A6 profile (graphic elaboration by the authors)

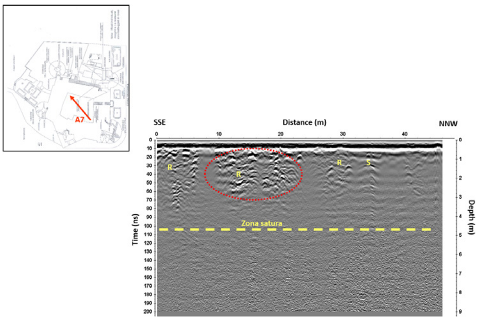

Fig. 4 - Processed radar section related to A7 profile (graphic elaboration by the authors)

'100ns' (about 4.5 m in depth with the average electromagnetic wave velocity of 0.09m/ns); the presence of an interface, denominated 'saturated zone', visible at 4.5 m in depth. Such interface confirms the zone of transition with a more significant presence of water; the presence of numerous anomalies with a characteristic hyperbolic shape that, from SSE toward NNW, are denominated: S) located along the abscissa 36 m at 0.4 m in depth; such anomaly is due to

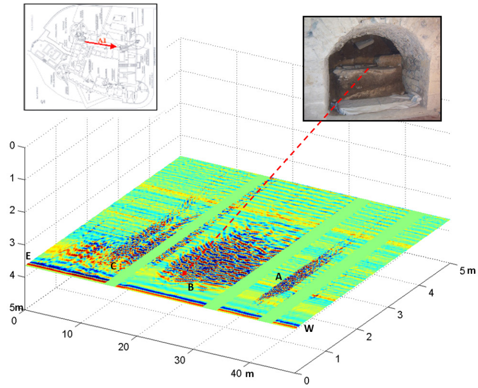

Fig. 5 - Processed radar section related to A1 profile (graphic elaboration by the authors)

the probable presence of hydraulic network; R) situated along the abscissas 0-7 m, 10-22 m, 27-31 respectively and to the depth of 0.6 m; such anomalies could be related to the probable presence of a zone strongly rehandled and therefore to man-made structures subsequently filled with discard materials.

The A1 profile has been acquired on the vertical wall using the 500MHz antenna (Fig. 5).

The analysis of the raw data pointed out: a good penetration of the electromagnetic signal 70 ns (about 3.15m in depth with the average electromagnetic wave velocity of 0.09 m/ns); the presence of numerous anomalies with characteristic hyperbolic shape that, from west to east direction, are denominated: A) located between the abscissas 8-11 m and depth between 0.60 and 2.4 m; B) located between the abscissas 16-28 m and depth between 0.60 and 2.4 m; C) located between the abscissas 33-38 m and depth between 0.60 and 2.4 m.

The dimensions of such anomalies make one think about the probable presence of void zones or man-made structures. The significant amplitudes of electromagnetic signal could cause us to think about the probable existence of small voids.

The profile A8 has been acquired in the courtyard, on the steps, using the 200 MHz antenna (Fig. 6). The analysis of the raw data pointed out: a good penetration of the electromagnetic signal '120 ns' (about 5.4 m in depth with the average electromagnetic wave velocity of 0.09 m/ns); the presence of numerous anomalies with a characteristic hyperbolic shape that, from SSW toward NNE, are denominated: S) located along

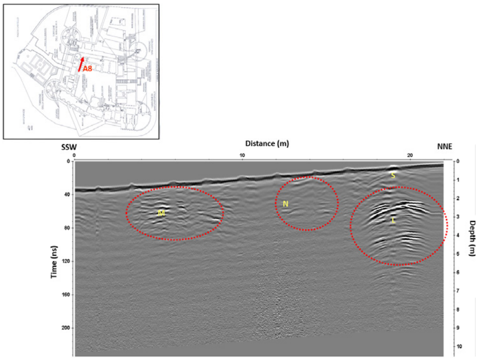

Fig. 6- Processed radar section related to A8 profile (graphic elaboration by the authors)

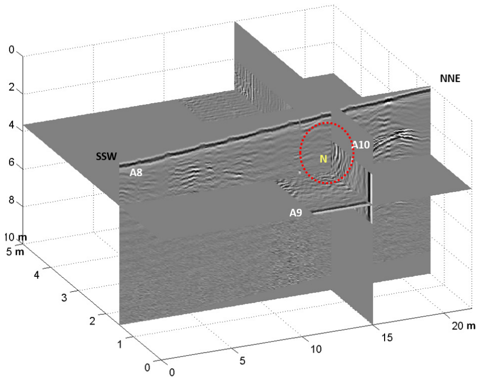

Fig. 7- GPR pseudo-3D visualization (graphic elaboration by the authors)

the abscissa 19 m; the such anomaly is due to the presence of a gutter set in surface; M) located along the abscissas 4-9 m at 2.4 m in depth; such anomaly could be related to the probable presence of a man-made structure; N) located along the abscissas 12-16 m at 2.4 m in depth; such anomaly could be related to the probable presence of a man-made structure; L) located at the abscissas 18-21 m at 2.4 and 4.5 m in depth; such anomaly could be related to the probable presence of a cavity. Fig. 7 shows a pseudo-3D visualization with the position of the profiles A8, A9 and A10 that evidence the anomaly N.

3. Conclusions

The Aragonese Castle of Taranto (Apulia Region-Italy) is one of the most important monument in the North Salento peninsula. It is one of the bases of the Italian fleet. To explore the knowledge on the buried structures of the castle, a GPR investigations were undertaken. The GPR survey results have had to underline the presence of man-made structures of archaeological interest.

The presence in the acquired radar sections of different reflection events of hyperbolic shape pointed out a probable buried man-made structures that could also have an archaeological interest. Some of them could be due to the presence of a cavity, such as the anomalies denominated L and N in the text; others are due to the presence of a hydraulic network, such as the anomalies denominated S in the text. The presence of the reflection events of hyperbolic shape has made a rapid and accurate analysis of the electromagnetic wave velocity that results to be 0.09 m/ns. This allows to transform the two-way time axis into a depth axis in order to place the structures in their spatial position. Further investigations, possibly in detail, could help better understand the complexity of the structure of the subsoil of the castle.

References

Bentivenga, M., Coltorti, M., Prosser, G. & Tavarnelli, E. (2004) A new interpretation of terraces in the Taranto Gulf: the role of extensional faulting. *Geomorphology*, 60, 383-402.

Doglioni, C., Merlini, S. & Cantarella, G. (1999) Foredeep geometries at the front of the Apennines in the Ionian Sea (Central Mediterranean). *Earth and Planetary Science Letters*, 168, 243-254.

Giannino, F. & Leucci, G. (2021) *Electromagnetic Methods in Geophysics: Applications in GeoRadar, FDEM, TDEM, and AEM*. Hoboken, John Wiley & Sons. ISBN: 978-1-119-77098-5.

Leucci, G. (2019) *Nondestructive Testing for Archaeology and Cultural Heritage: A practical guide and new perspective*. Cham, Springer nature. ISBN 978-3-030-01898-6.

Ricchetti, G. (1967) Osservazioni preliminari sulla geologia e morfologia dei depositi quaternary nei dintorni del Mar Piccolo (Taranto). In: Tipografia Zuccarello & Izzi (ed.) *Atti della Accademia Gioenia di Scienze Naturali in Catania*. Vol. XVIII. Catania, Università di Catania, pp. 123-130.

Ricchetti, G. (1979) *Contributo alla conoscenza strutturale della Fossa bradanica e delle Murge*. Bari, Adriatica Editore.