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The complex bedrock structure at the Manfredi Castle (Supersano, Lecce)

De Giorgi[1] L., Leucci[1*] G., Longhitano[2] L., Masini[1] N., Torre[2] C.

[1]Institute of Heritage Sciences, National Research Council, 73100 Lecce
[2]University of Catania, 95124 Catania
[*]corresponding author, giovanni.leucci@cnr.it

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***Abstract* – Reflection seismic, GPR and penetrometer surveys, were performed at the Manfredi Castle (Supersano, Lecce, Italy) in order to help the engineers in the restoration work. The study tries to understand: 1) whether, using high-resolution reflection seismic data, is possible to provide an essentially continuous structural image of the shallow subsurface; 2) to reconstruct, using both seismic and penetrometer surveys, the bedrock surface below the castle; 3) to discover, using GPR data, the presence of features of archaeological interest. From a technical perspective, the survey was successful. The reflection seismic data effectively image the shallow subsurface and support the penetrometer data. The GPR data pointed out the presence of some man-made structures that could be of archaeological interest.**

INTRODUCTION

Supersano is a village located 40km south of Lecce in the Apulia Region (south Italy) (Fig. 1). Here is situated an important monument the Manfredi Castle.

The Manfredi Castle was built for the most part in the sixteenth century. In reality, a first nucleus, from the Norman period, is incorporated into the subsequent constructions: the façade supported by four corner towers, of which only one is visible and not enclosed by subsequent extensions, still retains rigid lines. The imposing facade has a large entrance door open in a wall which is now half external to the rest of the façade. A large and long balcony allows a veranda overlooking the rooms on the second floor. In the 14th century the castle belonged to the Del Balzo family, and then passed to the Manfredi family until today it hosts the municipality of Supersano.

This study was carried out as part of a more extensive project for the conservation, safety, and enhancement of the Castle, aimed at improving the understanding and presentation of this important heritage structure.

As part of a recent restoration project, a multidisciplinary approach was employed to investigate the subsoil structure of Castle. The geophysical data acquired through a ground penetrating radar (GPR), seismic reflection and penetrometric surveys [1, 2, 3]. The geophysical investigation of monuments is a topic of great interest worldwide [4, 5, 6, 7], because it allows collection of information regarding the preservation state of walls, pillars, columns, ceilings and foundations. Geophysical prospecting also makes it possible to identify fractures, metal hinges embedded in the historical structures, either initially put in them or added during subsequent restoration works [8]; raising or spreading humidity [9, 10, 11], or even voids ascribable in some cases to walled windows, doors, ciboria, and more [2].

In this work, we present the results of the integrated geophysical prospection carried out in side and outside of the castle.

Fig. 1. The Manfredi Castle in Supersano (Lecce, south Italy)

THE PENETROMETER SURVEY

Along the North, East and West masonry of the building have been performed 24 dynamic penetometer surveys (Fig. 2). The different surveys have depth ranging from more than 2m and 6m from the surface. The penetometer test consists of plunging in the ground, with a beating maul to free fall, a conic point connected to a battery of auctions and to record the number of shots (N) necessary to an advancement of 10cm of the point in the ground, in absence of lateral attrition. Since this value (N) depends on the resistance opposed by the ground to the advancement of the conic point and therefore from its consistence, it is possible to define the dynamic breakup resistance to the point (Rd), characteristic parameter of the state of accumulation of an incoherent ground and the cohesion of a cohesive ground and to recognize the power of the crossed bodies.

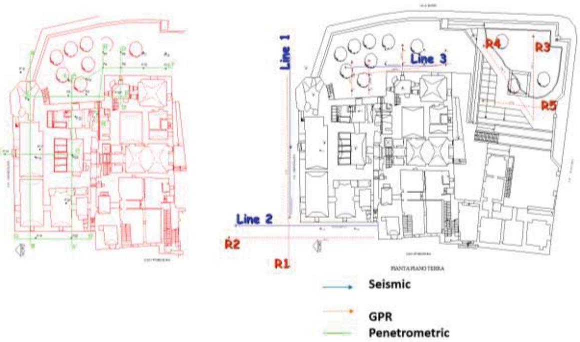

Fig. 2. The location of geophysical surveys

Results (Fig. 3) show the presence coverings and fillings of medium-fine grain size of anthropogenic contribution. The different penetometer surveys are correlated long the masonries transversal and longitudinal sections. This representation allows an immediate vision of the existing geometric relationships among the different described bodies. The histograms related to the single tests in abscissa the value of N and in ordered the depth that, in the specific case, it is reported to the topographical surface. From the analysis of the data is possible to note that under the surface plan is present an incoherent body whose power is inclusive between 2 and 6 meters, pending on the calcarenitic-sandy substratum characterized by values of N> 10.

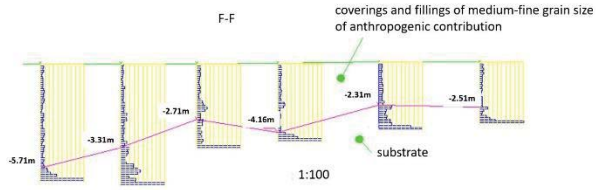

Fig. 3. The results of penetrometer

SEISMIC SURVEY

Seismic lines 1, 2 and 3 (Fig. 2) were acquired using a 12-channel Strataview seismograph model Nimbus 1220 with CDP configuration, single 100Hz geophones, and 5kg hammer source. The source was impacted six to ten times at each shot-point, depend upon visual inspection of back-ground noise on the shot gathers. The source interval, receiver spacing, and near-offset for seismic lines B and 2 was 3m, while for line 3 was 2m.

A standard processing runstream was applied to the data. Seismic line 2 shows several reflection events characterized by several P-wave velocity propagation.

The velocities are (Fig. 4):

- V_{p1} = 590 m/s, could be soil material;
- V_{p2} = 830 m/s, could be more compact material;
- V_{p3} = 1000 m/s, could be fractured calcarenitic;
- V_{p4} = 1300 m/s, could be calcarenitic;
- V_{p5} = 1500 m/s, could be limestone.

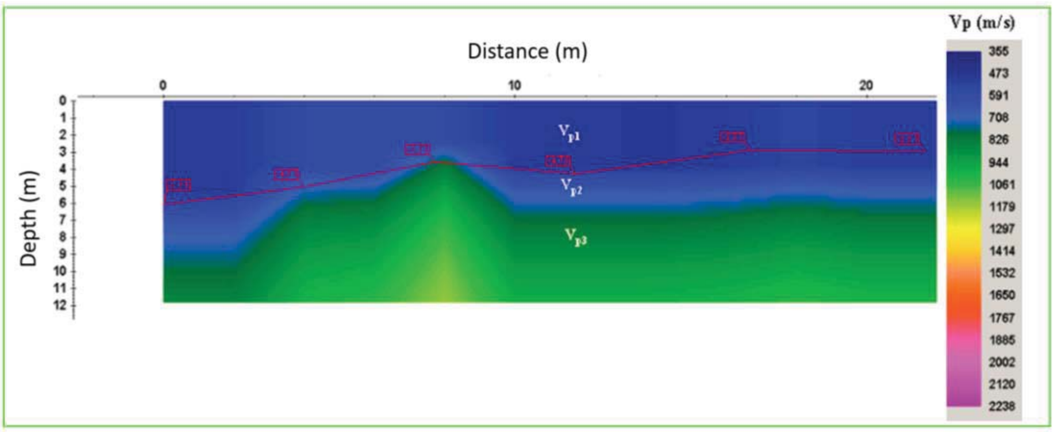

Fig. 4. The seismic wave velocity distribution

GROUND PENETRATING RADAR SURVEY

GPR profiles were acquired using a Sir_System2 radar with 200MHz antenna by GSSI.

The data analysis (Fig. 5a) has put in evidence the presence of two anomalies (labelled B and C) along the abscissas 5-8m and 10-16m. These anomalies are about 1.2m in depth. The anomaly labelled B, for shape and dimensions, could be a man made structure, while the anomaly labelled C could be a rehandle zone. An interesting anomaly (labelled A) along the abscissas 5-9m and 1.2m in depth. Such anomaly, for shape and dimensions, could be a man made structure (probable cavity) (Fig. 5b).

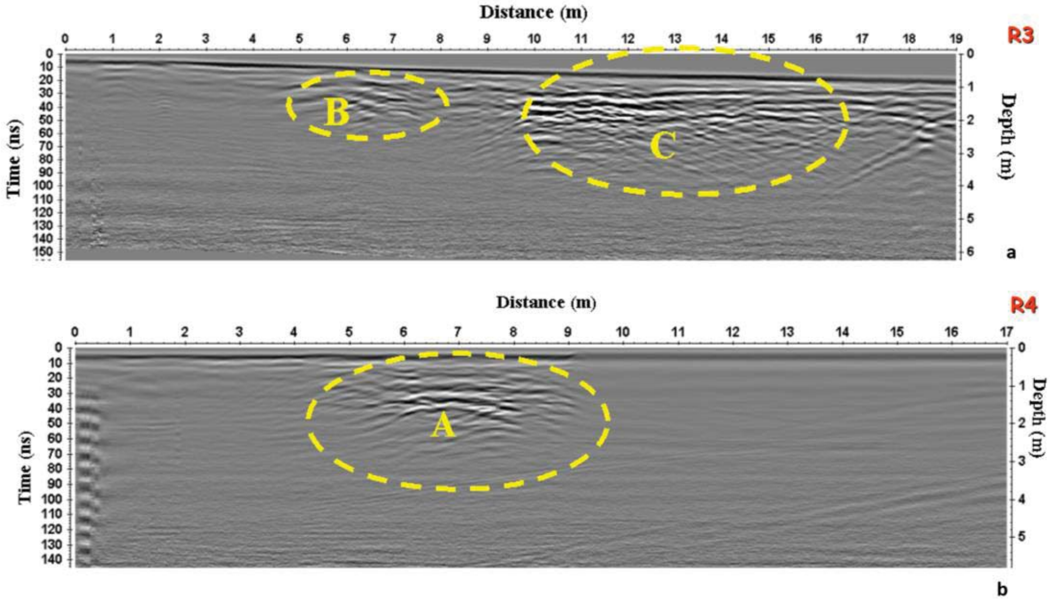

Fig. 5. The processed radar sections

CONCLUSIONS

The integration of the geophysical with the penetometer surveys were used to reconstruct the probable morphology of the substratum, buried below the castle. Is in fact well evident, in correspondence of the area occupied from the castle, the presence of a modest hillock. The flat summit of this relief coincides with the central and more ancient part of the castle (Fig. 6).

GPR surveys pointed out the presence of some anomalous zones that could be related with features of archaeological interest.

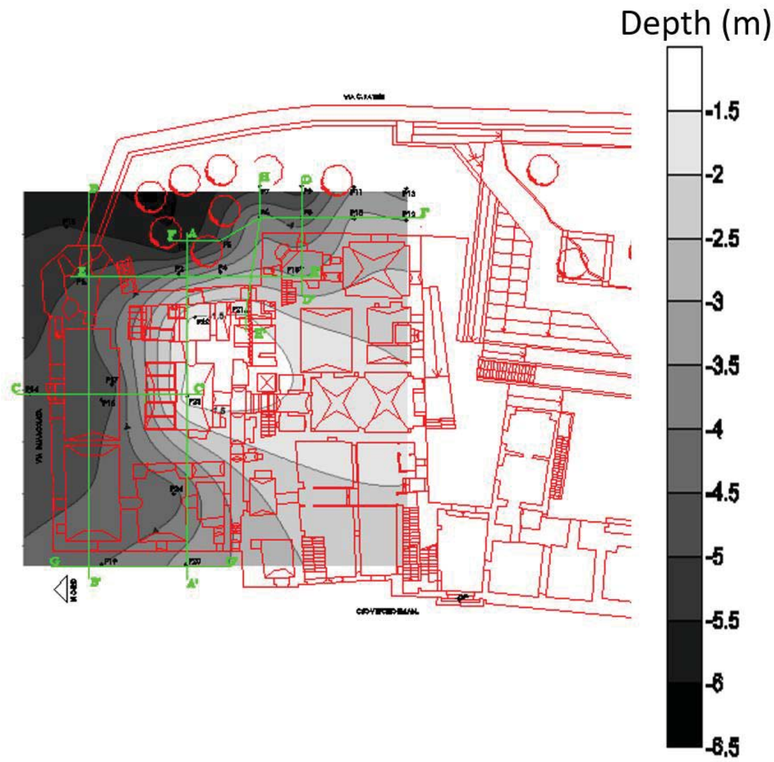

Fig. 6. The morphology of the substratum

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