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Geophysical investigation at “Castle of Canossa”

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***Abstract* –Canossa Castle is located in a commune of Canossa 18 km (11 mi) South of Reggio Emilia, Reggio Emilia province of Italy. Canossa Castle was constructed in 940 by Adalberto Atto, son of Sigifredo of Lucca. Lombard chieftains needed this strategic hill to defend their lands against intrusions of other barbarian tribes. Subsequent improvements made the stronghold one of the best defended castles in the country. Canossa Castle became particularly famous as a site of reconciliation between king Henry IV and Roman pope Gregory VII during Investiture Controversy in 1077.**

In order to planned excavations in the area close to the Castle geophysical surveys were undertaken in the spring of 2022. In this paper, the interesting results will be presented.

I. INTRODUCTION

The Castle of Canossa (Figure 1) was built in 940 by Azzo Adalberto son of Sigifredo of Lucca, the fortress of Canossa owes its fame, as every history manual recalls, to the dramatic episode of the war of investitures: here in January 1077 the emperor Henry IV humbled himself in front of Gregory VII as a guest of Countess Matilda, the most illustrious and celebrated descendant of the lord of Lucca. Canossa was much more than a castle: it was a vast complex where both the military need was met (the fortress with its triple wall was the pivot of the control system of a bundle of major communication routes) and the cultural need . Here, in fact, a monastery of Benedictine obedience was built, a laboratory for the conservation and diffusion of classical literature, and a church, dedicated to Sant'Apollonio. As part of the project "Castle cliff - Protection, conservation and use of the archaeological remains of the Village at the Foot of the Cliff - Canossa (RE)" and to investigate the remains of both defensive walls and the medieval village, geophysical surveys were undertaken in the spring of 2021.

The research carried out in the past had, in fact, been very punctual, while the aim of the project was to create a new path through the ancient remains that could have its own coherence and that did not impact on structures that were still buried and unknown [1]. Moreover, in this way, one could get an idea of the extent of the structures present.

Two geophysical methods were chosen electrical resistivity tomography (ERT) and ground penetrating radar (GPR). The geophysical surveys were carried out in two areas called respectively area 1 and area 2 (Figure 2). In area 1 ground penetrating radar surveys were carried out according to a 0.25m pitch grid with 512 samples/track; the other acquisition parameters were optimized on site and kept constant for all the acquired profiles. In area 2, the presence of a fairly pronounced slope (Figure 3) and thick vegetation made up of trees led the choice towards the use of the ERT methodology with the use of 24 electrodes arranged in a non-standard and roll-along way with a dipole-dipole electrode configuration.

Fig. 1. The Castle of Canossa

Fig. 2. areas investigated with geophysics

Fig. 3. Area 2: a fairly pronounced slope

II. GEOPHYSICAL DATA PROCESSING AND INTERPRETATION

For the GPR the quality of the raw data was moderate thanks to a series of expedients adopted in the acquisition phase. However, in order to try to eliminate a noise component, present in the data, and to allow simple interpretation of the data themselves, a processing was carried out [2].

The data analysis highlighted a good penetration of the electromagnetic signal which allowed to investigate up to a depth in times equal to 70 ns (for the 600MHz antenna) which correspond to a depth of about 2.4 considering an average speed of propagation of electromagnetic waves in the subsoil equal to about 0.07m/ns.

In particular, a series of reflected events (indicated with M) are highlighted (Figure 4). They are found at a depth of between 0.5m and 1.2m. These events correspond to the presence of probable masonry structures. The planimetry of the profiles, acquired in a grid with a step of 0.25m, made it possible to spatially correlate, in a 3D way, the anomalies present on each section using the analysis of the amplitude of the events reflected within assigned time intervals (time slices) [3].

The type of analysis applied to the study area gave satisfactory results. Amplitude slices were constructed at about 0.1m intervals. The blue color indicates a weak amplitude of the reflected signal (substantially homogeneous material); the colors from light blue to more intense red indicate variations in the amplitude of the reflected signal and therefore the presence of significant electromagnetic discontinuities. The variations in amplitude (therefore in colour) in the same slice indicate horizontal variations in the electromagnetic characteristics of the medium being investigated. Figure 5 show the amplitude slices relating to the 600MHz antenna. In them, it is possible to identify alignments indicated with M relating to probable masonry structures.

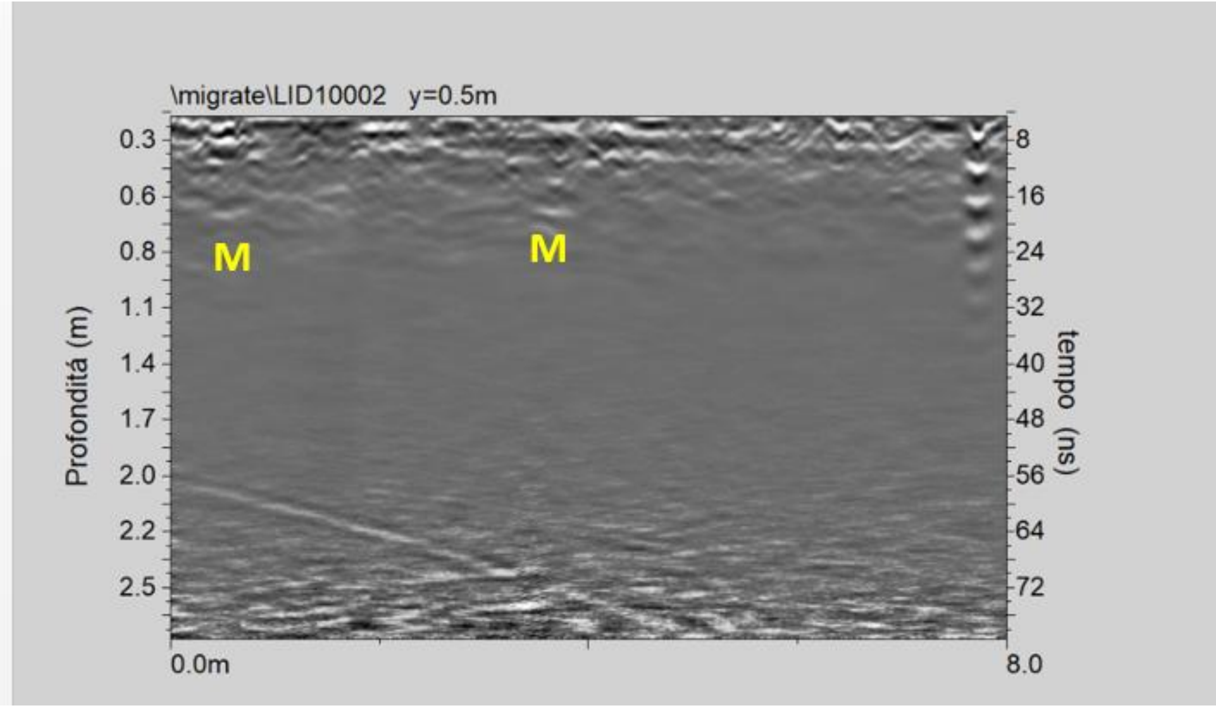

Fig. 4. processed radar section acquired with 600MHz

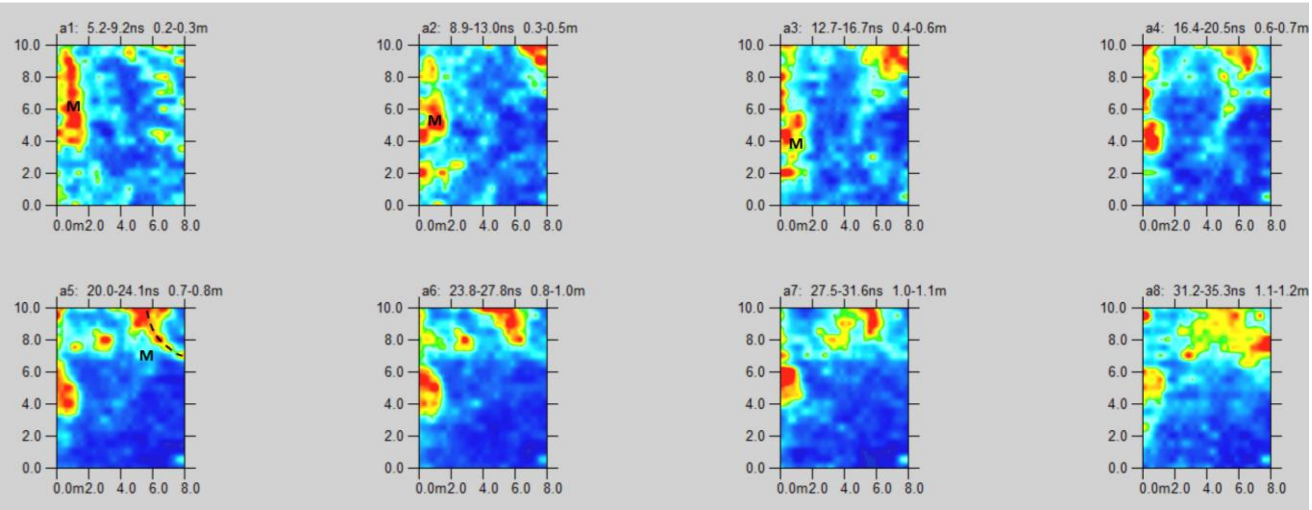

Fig. 5. Area 1: depth slices superimposed on the drone photo (600MHz antenna) the dashed black lines indicate structures of probable archaeological interest

The ERT data are visualized in Figure 6. The 3D visualization [4] through the depth slices (Fig. 6) better identifies (in a 3D way) the probable structures of archaeological interest evidenced by a dark dashed circle.

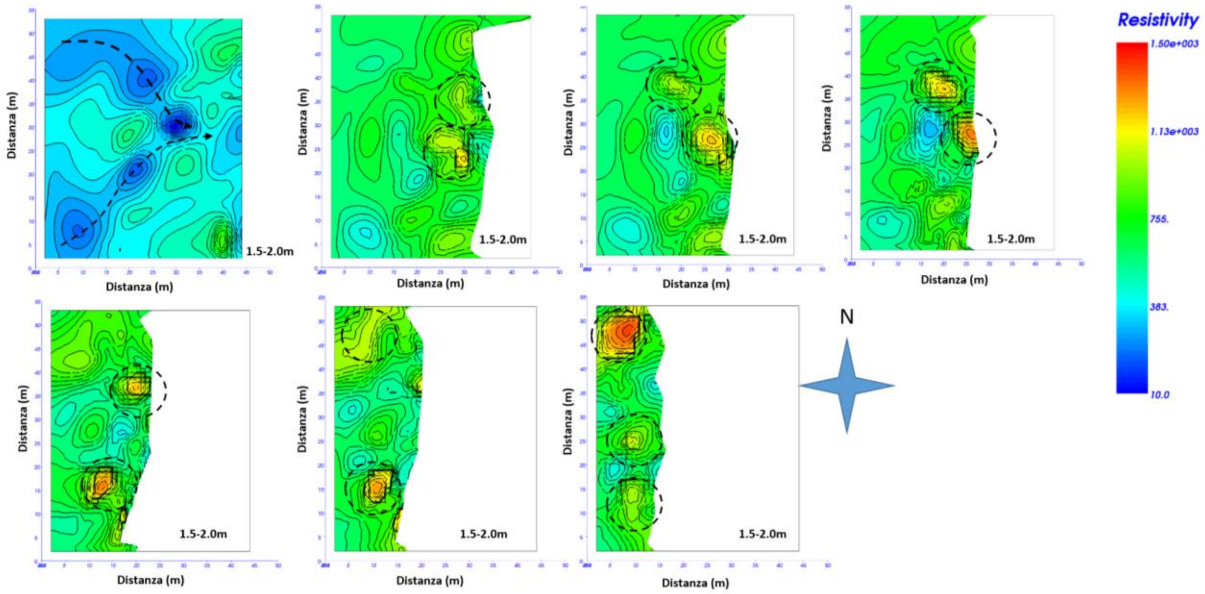

Fig. 6. Area 2: resistivity slices 1.5-2.0m (the depth refers to the walking surface at different heights)

III. CONCLUSIONS

The geophysical investigations have provided good results regarding the identification of structures present in the very first subsoil. Specifically, the GPR method made it possible to extend the investigation to a depth of approximately 2.4 m, highlighting anomalies probably attributable to structures of archaeological interest.

Along the slope below the rock it was not possible to use the georadar methodology (due to the high slope and the presence of dense vegetation) the ERT method was used in a non-standard configuration. In this case, it was possible to investigate the subsoil up to a depth of about 30m. The results highlighted the presence of a probable slip surface at a depth varying between 5.0 m and 8.0 m from the walking surface. At a depth of between 1.5m and 2.0m from the walking surface, resistivity anomalies attributable to probable structures of archaeological interest were identified.

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