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A multidisciplinary approach for the evaluation of the archaeological heritage of Borbona (Rieti, Italy)

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ABSTRACT
The area of Borbona (Rieti, Italy) has been sparsely researched from a historical and archaeological perspective. In order to obtain new data on unexplored areas, a systematic study was carried out combining archaeological explorations, photogrammetric surveys and geophysical prospections. All data was stored in a Geographic Information System, which enabled spatial analysis and the creation of thematic maps. The aim of the research was to discover the unknown territory and trace its origins. The project identified ancient habitats and significant Roman architectural fragments. The research aims to pass on the history and culture of Borbona to future generations and promote a sense of belonging. The protection of historical heritage and archaeologically endangered areas as well as the enhancement and promotion of existing cultural assets are fundamental measures to increase the attractiveness of the land in the present and preserve its identity in the future.

Section: RESEARCH PAPER

Keywords: Borbona; archaeological surveys; photogrammetric surveys; geophysical prospections; thematic maps

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1. INTRODUCTION

Borbona is located in the province of Rieti (Lazio Region, central Italy), an area that is particularly neglected by historical and archaeological studies. This is partly due to its geographical location, which is always surrounded by mountain ranges, and partly because there seems to be a lack of relevant archaeological evidence, most likely due to the high seismicity that characterises the entire area. Borbona is in fact located in the inner Sabina, in a valley surrounded by the great mountain ranges of Terminillo, Laga and Gran Sasso. It has always been a border area: in Augustan times, it was incorporated into *Regio V Picenum*, but bordering on *Regio IV Samnium*, in late antiquity it was included into the Ducato of Spoleto and under the rule of the Regno di Sicilia and later the Regno delle Due Sicilie, in an area bordering on the Papal States. Also from the 17th century, it was one of the border areas of the Regno di Napoli in the Abruzzo Ultra region. Its position as a frontier area has caused both a cultural richness, a mixture of cultures and peoples, but also a certain poverty in historical documentation and cartographic production. For all these and many other reasons, there is a certain lack of studies on Borbona. There are only a few sporadic contributions published in regional volumes offering general information on the localities of the province of Rieti [1], [2], or published in local journals, but limited to specific topics [3].

For these reasons, a systematic study of the historical and archaeological context of the Municipality of Borbona has begun, in which the Institute of Heritage Sciences (ISPC) of the National Research Council (CNR) has been tasked with initiating a series of activities aimed at promoting and enhancing the examined territory. The project involves collaboration with researchers from the University of Molise for geophysical investigations.

In this work, in order to obtain new data on unexplored areas, a multidisciplinary approach was adopted, which adheres to the following workflow:

- Collection of archaeological finds accidentally discovered in the study area.
- Implementation of a detailed archaeological database.
- Entering of this database in a geographical information system (GIS) by using the software QGIS.
- Appling spatial analysis techniques to derive thematic maps.

- Archaeological field research to discover new archaeological finds in the numerous unexplored areas.
- Analysis of topographic maps and historical and recent aerial photographs.
- Proximal remote sensing using a Remotely Piloted Aircraft System in selected areas.
- Creation of a Digital Elevation Model (DEM) of the surveyed area and a high-resolution orthophoto.
- Geophysical surveys in areas where traces on the ground were identified through proximal remote sensing and archaeological surveys.
- Creation of an updated computerised map of the archaeological finds in the study area.

Despite the somewhat discouraging promises, however, some surprising, unexpected discoveries were made during the research, partially presented during the Conference 'Metrology for Archaeology and Cultural Heritage' in 2023 [4].

2. COLLECTION, CATALOGUING, AND ANALYSIS OF ARCHAEOLOGICAL FINDS

2.1. Methods

After the study historical information about Borbona, the collection of archaeological finds accidentally discovered in the study area was the first activity that provided initial data to work on. A total of 354 finds dating from the archaic to the modern era bear witness to the continuity of human presence over time. In particular, two areas have yielded numerous archaeological objects: La Terra and the Piano di Santa Croce. The first one, considered the historical centre, overlooks the town from a hill, while the second one, nearly devoid of buildings, is a plain designated for agricultural and pastoral purposes, expanding at the southern end of the modern settlement.

In order to proceed with a more detailed analysis, it was necessary to catalogue the finds and input the information into a detailed archaeological database, integrated into a geographical information system (GIS) using QGIS software. Within the database, distinct layers were created for classes of archaeological objects, and data fields for the description of individual items were identified (historical period, chronology, description, materials used, production methods, measurements, and interpretation).

The discovery location of each finds was known, so by georeferencing each one, it was possible to identify concentration areas and apply spatial analysis techniques to derive thematic maps.

2.2. Results

A total of 169 archaeological findings were discovered in the Piano di Santa Croce, with 154 dating back to the Archaic and Medieval periods, and 15 from the Modern era. Cataloguing and GIS positioning activities have been completed for the ancient finds, including 37 ceramic fragments, 69 coins, 40 various metallic finds (clothing accessories, processing waste, and metallic construction finds), and 8 bricks of *opus spicatum*.

Five archaeological finds concentration areas have been identified indicating a significant occupation of the area during Roman and Medieval times. (Figure 1).

The discovery of certain findings has suggested the hypothesis of the Piano di Santa Croce was used as a residential and/or productive area during the Roman era. This is the case with the 8 bricks of *opus spicatum* (Areas 3, 4, 5), which bear witness to the presence of structures or at least paved floors. This

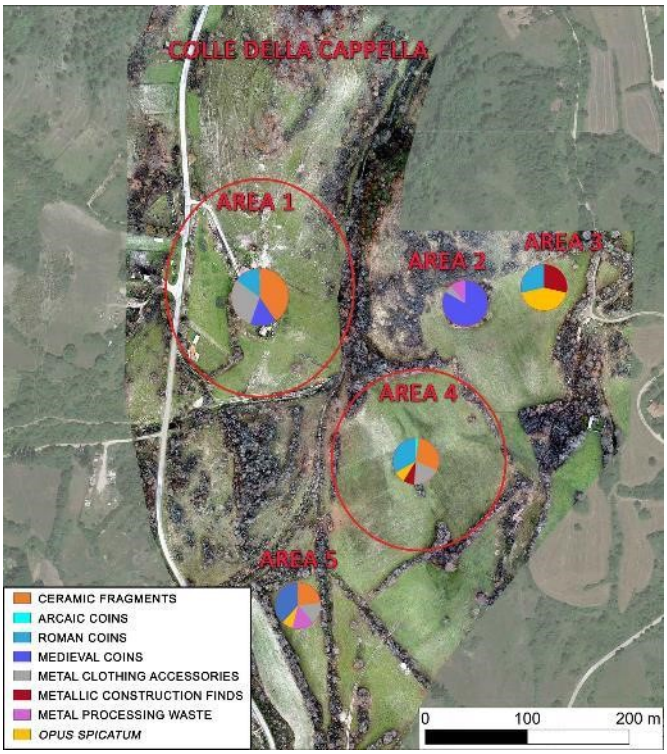

Figure 1. Piano di Santa Croce. Ortophoto from proximal remote sensing. Identification of concentration areas and types of archaeological findings.

hypothesis is strengthened by the discovery of 2 copper alloy nails (Area 4) with a square section and a circular, more or less hemispherical head with a diameter of approximately 1.3 cm and a length of about 6 cm. Although, at the current state of research, there is still no chrono-typological framework for these objects, it appears that this specific production, in terms of material, dimensions, and shape, is often associated with the remains of settlements [5], [6]. They were likely used in carpentry work, in non-structural elements of dwellings, in household furniture, and in tools. Lastly, it is worth mentioning the discovery of a ceramic fragment recognizable as a loom weight and 6 fragments of metal processing waste concentrated in Areas 2 and 5, which, although significant indicators, require further investigation for dating.
Area 2 is certainly significant, which, in addition to 4 bronze processing waste materials, has also given back a considerable number of Medieval coins, dating between the 12th and 14th centuries.

The concentration of findings is all located within a nearly circular, small-sized flat area (approximately 90 square meters) entirely surrounded by brambles.

These coins amount to a total of 29, including 20 *denarii* struck by the mint of Rome in the name of the Senate in the late medieval period, 6 from other Italian mints, and 3 French coins dating back to the 12th and 13th centuries.

Medieval-era evidence is also found in other sectors, where 6 *denarii* from the Roman Senate are originated, all concentrated on the slopes of the so-called Colle della Cappella (Area 1), 1 *denarius* from the mint of Ancona, and 18 late medieval clothing accessories evenly distributed in the areas of Piano di Santa Croce.

In La Terra, on the other hand, 152 finds were discovered, including many from the medieval period and some from the Roman era. They are mainly concentrated at the NE end of the elevation, Area 6, and along the southern slope, Area 7 (Figure 2).

Figure 2. La Terra. Satellite image with identification of concentration areas of archaeological findings

As for the discoveries from the Roman era, 3 coins are reported, of which 2 are almost illegible, generally dating back to the imperial age. Additionally, a set of decorative accessories made of copper sheeting of uncertain dating was found, including a stud that undoubtedly adorned a male belt. It features a profile with a spherical cap, articulated with a central button and a series of engraved circles both on the top and at the base. The type is known in the Roman era as a decorative stud or ornamental *bulla* of the *cingulum*, namely the Roman imperial military belt [7]. The association would align well with the hypothesis of the presence of a Roman *castrum* in that area.

A very significant coin, and the only one that could testify to the late antique period in Borbona, comes from the central area of the Terra, not included in the listed concentration areas. It is a bronze specimen, presumably dating between the 7th and 9th centuries AD based on typological and stylistic comparisons. On the obverse, it features a frontal standing figure holding a long staff ending in a cross in the right hand and supporting the cruciferous globe with the left hand. On the reverse, there is the value mark 'M' in the field with a cross above it.

In Area 7, finds from the Early Medieval period have been predominantly collected, including 7 coins and a series of metal objects related to personal belongings, such as various types of fastenings, attachments, and elements of personal ornamentation, as well as tools for artisanal and domestic use. These findings, together with others from the same period, demonstrate the fortification of the Borbona hill at least since the Early Medieval era.

3. ARCHAEOLOGICAL FIELD SURVEY

3.1. Methods

A regional archaeological field survey within a 25 km radius around Borbona was conducted to verify the possible communication routes connecting the town to nearby settlements. Borbona is strategically located in relation to the more northern centers of Romanized Sabina, such as *Nursia*, *Reate*, and *Amiternum*, in an area delimited by the ancient *Via Salaria* to the west, the *Via Caecilia* to the south, and the *Falacrinae-Amiternum* axis along the Apennine ridges.

Specific surveys were then carried out in the territory of Borbona, where the identified wall structures in the Piano di Santa Croce were analysed.

Lastly, within private cellars, significant architectural elements from the Roman era, long forgotten, were rediscovered in the area of Colle San Venceslao, thanks to the recovery of some photos taken at the time of the discovery in the 1980s, during the construction of the modern urban settlement.

3.2. Results

Some wall structures may be related to an ancient roadway, preserved precisely in the Piano di Santa Croce, to the west of the discovery areas. These are two parallel walls in the NE-SW direction that converge towards the so-called 'Colle della Cappella.' They are approximately 2 meters apart, constructed with stone blocks, laid more or less regularly, preserved to a maximum height of about 1.2 meters but mostly collapsed.

The visibility of the walls is compromised by the presence of shrubby vegetation that has caused collapses and disturbances, but in the small remaining portions, it was possible to measure the thickness, approximately 2 meters. Another wall structure with a much smaller thickness, 60 cm, is located about 15 meters further east. On the eastern side, facing the current Via Santa Maria del Monte, three orthogonal wall segments are connected to form small spaces, mostly collapsed.

The hypothesis that it could be an ancient communication route was derived from the orientation, location, and typology of the structures. Furthermore, the two parallel walls, in particular, follow a path present in the IGM cartography of 1955, marked with the symbols of sheep tracks. The same roadway is also found in the aerial photo of the Base Flight taken in 1954, now preserved in the National Aerophotographic Archive of Rome at ICCD (Figure 3). Following the traces of the same path in the field, sometimes interrupted and faint, with the help of the mentioned cartography and aerial photo, researchers reached Laculo, a location southeast of Borbona, even though the cartography indicates that the road should have connected with the *Via Salaria*. Laculo is one of the few places where there are still traces of the ancient Sabine goddess *Vacuna*, later identified with many other Roman goddesses, especially *Victoria*, associated with wooded areas and waters. [8].

Just like in Laculo, there must have been an inscription in Borbona, no longer traceable today, from the Roman era dedicated to the Roman deity *Victoria/Vacuna*, walled into the Sanctuary of Santa Maria del Monte. It was drawn, transcribed, and then published in 1882 by Mommsen (*CIL IX, Regio IV*, 4637).

To the North, the roadway we have discussed converges towards the Colle della Cappella, skirts it to the West, and continues towards the settlement.

This hill may have had a control function over the plain and the roadway just described in ancient times. Furthermore, the wall structures analysed during archaeological surveys, surrounding the summit of the hill, along with the typological, morphological, and geographical similarity of the hill to other ancient fortified centres in the nearby Cicolano [9], may suggest an ancient *oppidum*, partially used in Roman times. Finally, it could be the location of the *Ecclesia S. Crucis in Burbone extra* from the medieval period, now disappeared. According to episcopal records from the 18th century, the church was supposed to be in ruins but recognizable on a small hill towards the Sanctuary of S. Maria del Monte [10]. The description coincides with the

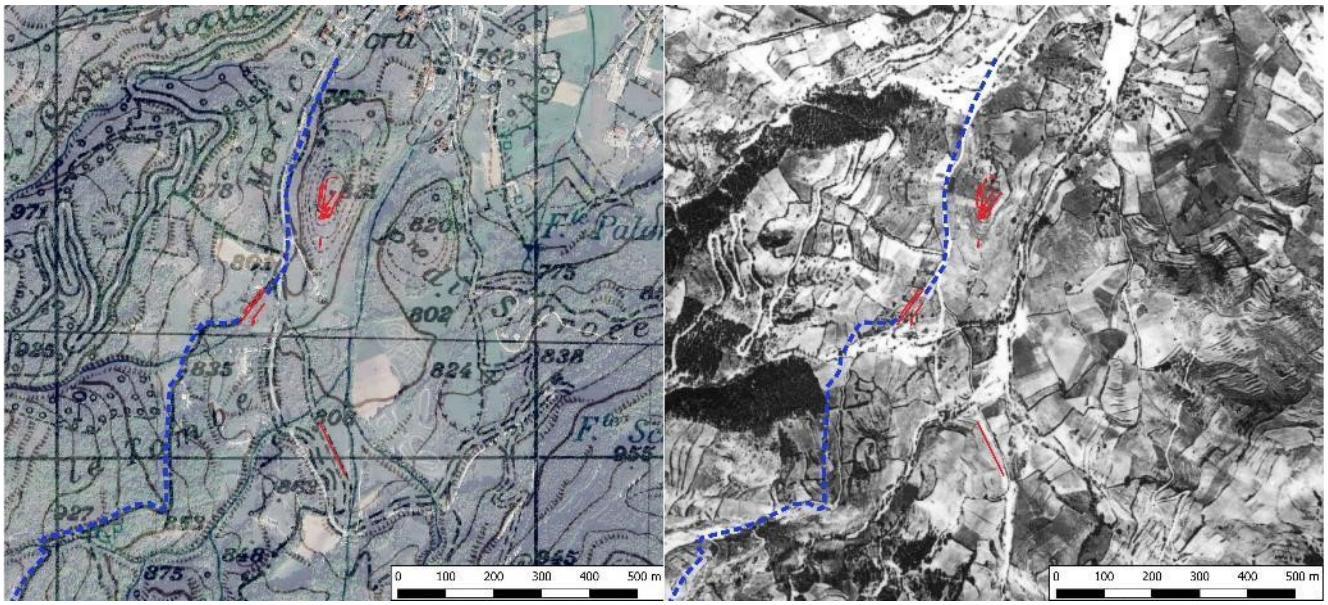

Figure 3. Piano di Santa Croce. In red, the discovered wall structures; in blue dashed lines, the ancient communication route identified in the IGM cartography of 1955 (on the left) and in the aerial photo of the Base Flight in 1954 - National Aerophotographic Archive of Rome at ICCD (on the right).

position of the Colle della Cappella, and its name recalls its presence.

Finally, the architectural elements found in private houses on Colle S. Venceslao represented a significant rediscovery as they had been long forgotten, never published, and over time, only vague accounts from the residents remained. Thanks to photographs taken by Massimo Firmani, a historian from Borbona, during the construction of the settlement we see today, it was possible to trace these artifacts dating from the end of the Republic to the beginning of the Imperial era, now preserved in the municipal offices. These include 2 bricks elements with a circular sector shape, likely arranged in stacked rows to form a masonry column with a diameter of 40 cm; 1 fragment of a mosaic with small regularly arranged white *tesserae*, along with its related preparation flooring; 4 blocks of white marble with an internal groove related to a water channel, often used in the peristyles of Roman villas; 2 bricks elements of *opus spicatum*. The fragment of *opus caementicium* pavement, composed of marble chips, photographed at the time of discovery, is now dispersed. A very similar fragment of flooring is currently embedded in a fountain in a hamlet of Cittareale, Conca, on D'Andreis Street, along with some white covering tiles and other ancient objects.

Massimo Firmani states to have spoken with the person who attacked them, confirming the origin of the fragment from Colle San Venceslao in Borbona.

4. ANALYSIS OF TOPOGRAPHIC MAPS AND HISTORICAL AND RECENT AERIAL PHOTOGRAPHS

4.1. Methods

Modern cartography, such as the IGM maps from the 1950s, and historical and recent aerial photographs, are the only sources of documentation for the study area. In fact, Borbona does not have a historical, geometric, and cadastral registry, for example, like the 19th-century Gregorian Cadastre of the Papal State, since it belonged to the Regno di Napoli and later the Regno delle Due Sicilie. Furthermore, it represents a small centre for which the Kingdom did not produce dedicated cartography but was instead included in general maps describing border areas.

Given the significant concentration of archaeological findings in the Piano di Santa Croce, a series of aerial photographs taken over time were collected and examined to identify possible signs or traces on the ground that could provide clues about the presence or absence of ancient structures underground.

These include satellite images available online and those made available by the National Geoportal, generally taken from the 1980s to the present day.

The research conducted at the National Aerophotographic Archive of ICCD allowed for the acquisition of available aerial images related to the study area: those taken for the Base Flight in 1954 and those acquired by the Royal Air Force of the United Kingdom in 1944.

4.2. Results

From the interpretation of aerial photographs, some anomalies have been identified: crop-marks, due to uneven vegetation growth; damp-marks, indicated by the differential distribution of moisture in the soil; and a shadow-mark, a micro-relief with a NE-SW orientation in a field coinciding in Area 4.

Two images were chosen where the anomalies are more visible, although the definition of aerial photos is not always optimal (Figure 4).

These are two orthophotos taken in 2008 and 2012, made available by the National Geo-Portal. Noticeable chromatic differences correspond to varying vegetation growth (white arrows), aligning with sectors B, C, and D surveyed through geophysical investigations. Additionally, a strip coinciding with a micro-relief in sector B is visible in both images (blue arrows), as highlighted in the results obtained from geophysical investigations.

5. PROXIMAL REMOTE SENSING

5.1. Methods

In order to verify the existence of anomalies identified on the ground through the observation of aerial and satellite images presented in Section 4, the CNR conducted photogrammetric surveys using a Remotely Piloted Aircraft System in the area of

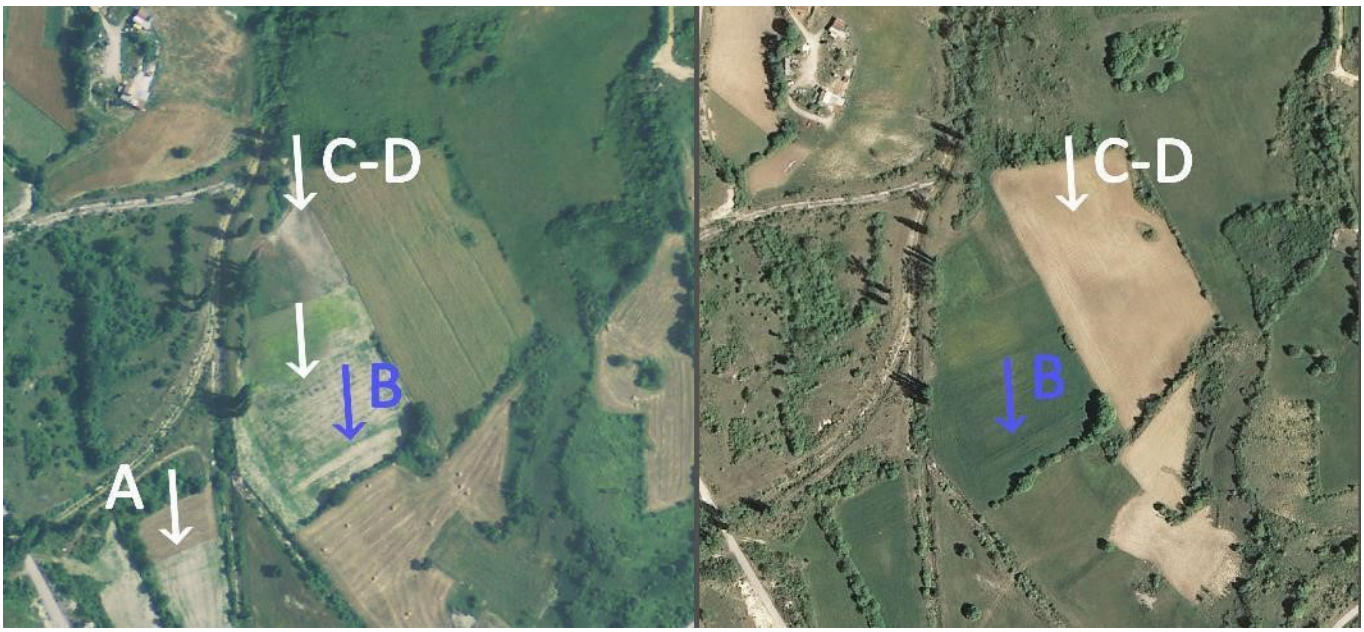

Figure 4. Piano di Santa Croce. Comparison of orthophotos taken in 2008 (on the left) and in 2012, highlighting identified anomalies and sectors surveyed through geophysical investigations (images from the National Geo-portal).

Piano di Santa Croce. The survey took place a few days after the vegetation was cut, and the ground was relatively dry.

Approximately 80 photographs were captured at an altitude of about 60 meters above the ground, ensuring that the images were clearer and more defined compared to the previously consulted aerial images. The photographs were processed using specific software employing the *Structure From Motion* technique. This process generated a photorealistic 3D model by creating a high-definition texture.

5.2. Results

The generation of the 3D model allowed for the creation of a Digital Elevation Model (DEM) of the surveyed area, highlighting the slopes of the agricultural fields, as well as the distribution of hills and ditches (Figure 5).

Subsequently, a high-definition orthophoto was produced and geolocated in the WGS 84 system within the GIS project. The chosen georeferencing technique utilized the integrated GPS data in the RPAS.

The accuracy of the geomatic surveys, calculated by assessing the alignment error of the photographs primarily derived from GPS data, is approximately 70 cm. The Ground Sampling Distance calculated is about 3 cm.

The photointerpretation of the orthophoto not only confirmed the identified anomalies but also provided a clearer understanding (Figure 6). In particular, orthogonal traces were highlighted, suggesting the presence of wall structures in the areas of concentration of findings (Areas 4 and 5 in Figure 1).

Therefore, in the same areas, geophysical surveys were scheduled and entrusted to researchers from the University of Molise to verify the presence of underlying structures.

6. GEOPHYSICAL PROSPECTIONS

6.1. Methods

Geophysical prospections are an important tool for indirectly identifying and characterizing archaeological sites before systematic excavations. Over the years, several studies proved the efficiency of geophysical methods in the location of buried anthropogenic remains belonging to different ages and typologies, in particularly through magnetic [11]-[13], frequency-domain electromagnetic (FDEM) [14]-[16], electric [17]-[19]and ground penetrating radar (GPR) [20]-[22] surveys. Depending on the type, size and depth of submerged bodies, the logistics and

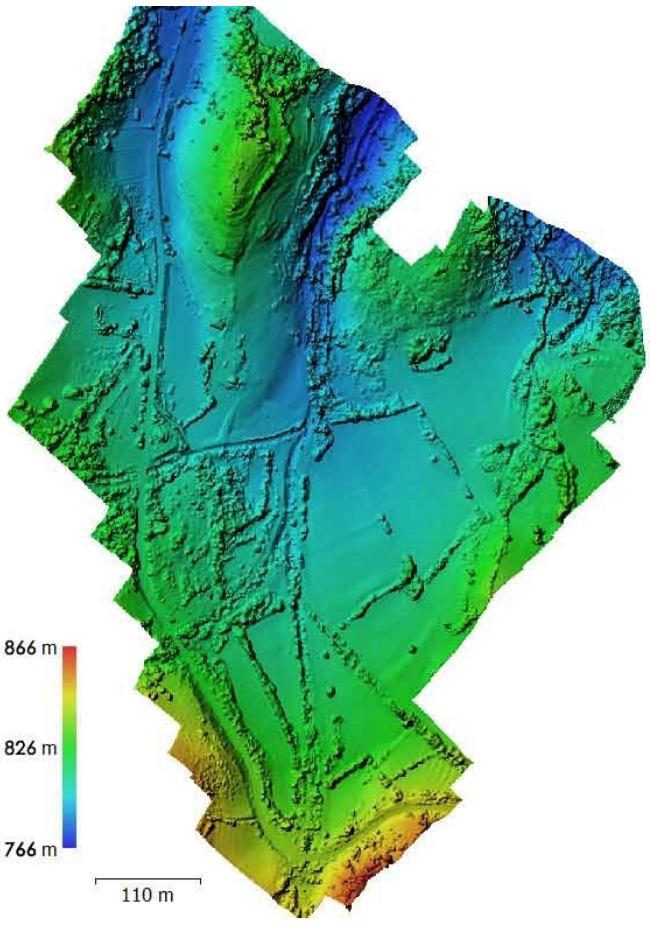

Figure 5. Piano di Santa Croce. DEM generated from the 3D model derived from proximal remote sensing.

Figure 6. Piano di Santa Croce. Orthophoto generated from the 3D model derived from proximal remote sensing. Indication of identified anomalies in yellow dashed lines.

the extension of the survey area and the geological setting, the proper method must be carefully adopted. In the case study investigated, frequency-domain electromagnetic (FDEM) was assessed as the best technique to address the specific challenge of the investigation, taking into account the contrasts between the sandy and clayey soils and the materials found during the archaeological made in bricks, ceramic and limestone materials. Furthermore, since the area was totally virgin and unexplored, the method was preferred to others to obtain an extensive investigation in a fast way to the end of identifying macro areas characterized by significant electromagnetic contrasts to be detailed in the future with higher resolution methods.

FDEM is a method based on the induction of low-frequency alternating currents through a transmitting coil underground by a primary electromagnetic field. It spreads in the ground and therefore also through possible target bodies, inducing eddy currents which generate a secondary electromagnetic field perceived by a receiving coil. The secondary field can be decomposed into the in-phase (real) component, sensitive to metallic objects, and the quadrature (imaginary) component, related to conductive materials, expressed in parts per million (ppm). From the quadrature component, the apparent conductivity of the materials affected by the passage of induced currents can be calculated the apparent conductivity of the materials affected by the passage of induced currents [23]. Conductivity is expressed in milli Siemens (mS) per meter (10^{-3} Siemens per metre), with the theoretical relationship to resistivity given by mS / m = 1000 / (Ω m).

In this work, data acquisition was carried out using the GSSI Profiler EMP-400 [24]. The survey was targeted in the area where traces in the ground were identified by remote sensing and archaeological investigations. The measurements were carried out in continuous mode with frequencies in the range of 2–15 kHz with vertically aligned dipoles. The study area was covered with profiles that were inserted into a regular grid at 1 m intervals.

During data processing, the measured conductivity values were converted into resistivity values and visualized in 2D maps using contouring software. A common logarithmic scale was used to visualize the resistivity maps to account for the wide resistivity range within the data set and to better represent the frequent changes in magnitude.

6.2. Results

Figure 7 reports the resistivity map relative to the frequency of 11 kHz obtained from the FDEM survey at Piano di Santa Croce. The adopted colour scale put in evidence resistivity highs with red/orange/yellow colours and conductive values with shades of blue. In archaeological prospecting, high resistivity values usually indicate a resistive target respect to the less resistive hosting soil that can be ascribable to the presence of stored tiles, piles of bricks, stone collapse, walls, building foundations or voids. Instead, low resistivity values may suggest the presence of sterile moist soil, a ditch filling in a resistive rock background, a dirt road, etc.

In the analysis of the results, therefore, particular attention was paid to the examination of the resistivity maximums,

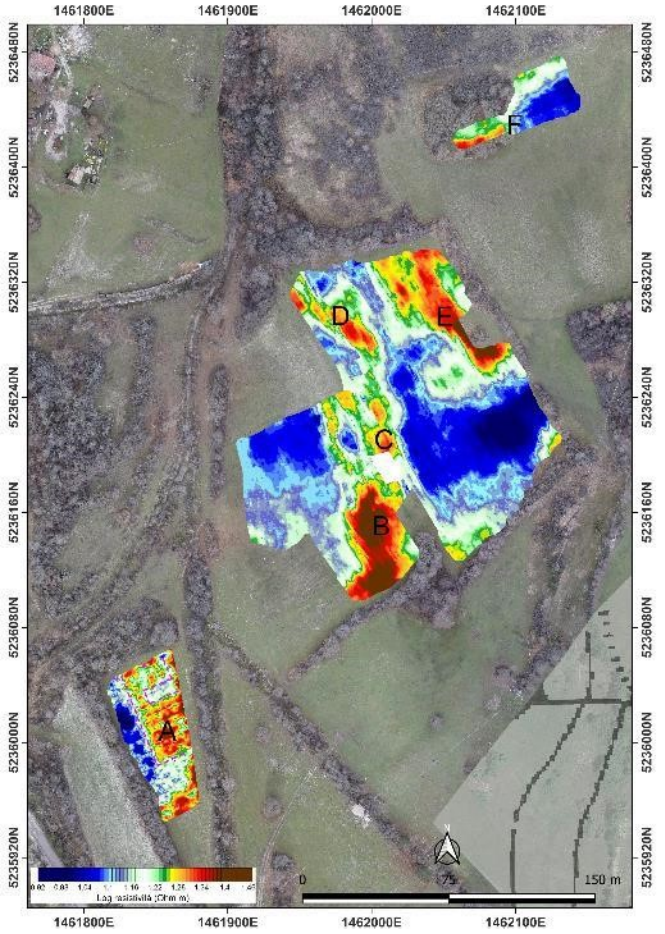

Figure 7. Borbona, Piano di Santa Croce: resistivity map relative to the frequency of 11 kHz.

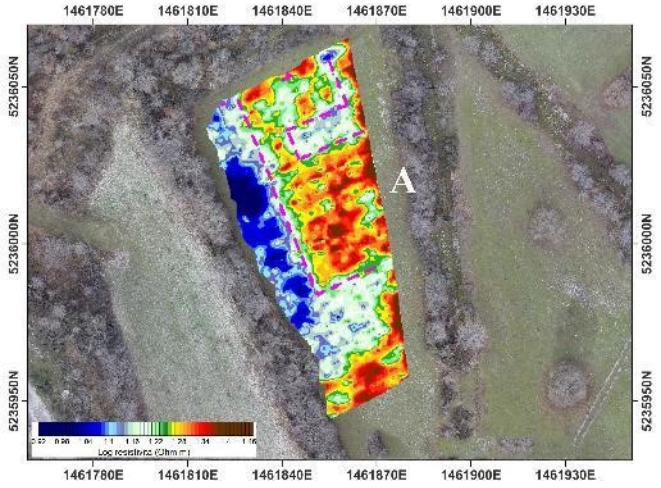

Figure 8. Borbona, Piano di Santa Croce: a detail of the anomaly A in the resistivity map relative to the frequency of 11 kHz.

especially in relation to the traces identified by remote sensing and the archaeological survey. From the regular progress of the measurements and, above all, from the identification of geophysical anomalies, it was possible to hypothesize the presence of buried archaeological structures and, in the most favourable cases, it was even possible to evaluate the directions and trends of the structures themselves, drawing them, with good approximation, their spatial distribution (A-F in Figure 7). A clear indication is provided in the case of anomaly A as it highlights high resistivity values drawing well-defined contours (Figure 8). In particular, it encloses a rectangular portion of land oriented NW-SSE within which it is possible to recognize divisions, even if fragmented, especially in the northern part where it is possible to hypothesize the presence of partition walls that define rooms. The B-F anomalies have the same orientation as the previous one and, even if the contours are less defined, they indicate vast areas in which the presence of high resistivity materials is ascertained, the nature of which is worthy of being verified through other high resolution prospecting methods. Since geophysical diagnostics is an indirect methodology, aimed at the spatial definition of the anomalies in the subsoil, direct verification with archaeological excavations is suggested for the complete study of the sites giving certainty of the nature, age and archaeological value of the anomalies found.

7. CONCLUSIONS

The research carried out until now has brought to light a completely unknown ancient history of Borbona. Historical sources are not helpful as they mention the settlement for the first time only in 1018 [11], and the period of its fortification is uncertain.

Thanks to the discovery of significant finds from the Roman era, conducted investigations, and geophysical surveys, it is possible to hypothesize the existence of at least two inhabited roman areas: the San Venceslao hill and the Piano di Santa Croce, likely characterized by the phenomenon of Romanization through dispersed settlements with typical villas of this period, especially in central Italy. One could also speculate about a Roman *castrum* on the northeastern hill of the Terra and its fortification, at least from the late medieval period.

Further field investigations, targeted excavation tests, and systematic surveys of the territory could confirm these hypotheses and enhance our knowledge of Borbona.

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AUTHOR CONTRIBUTION

Writing-original draft preparation: Introduction (Marilena Cozzolino, Cecilia Giorgi); Collection, cataloguing, and analysis of archaeological finds (Cecilia Giorgi); Archaeological field survey (Cecilia Giorgi); Analysis of topographic maps and historical and recent aerial photographs (Cecilia Giorgi); Proximal remote sensing (Cecilia Giorgi); Geophysical prospections (Marilena Cozzolino, Vincenzo Gentile, Paolo Mauriello); Conclusions (Cecilia Giorgi).

REFERENCES

[1] F. Battisti, T. Leggio, L. Osbat, L. Sarego, Itinerari Sabini. Storia e cultura di città e paesi della Provincia di Rieti, D.E.U.I, Rieti 1995. [In Italian]

[2] F. Palmegiani, Rieti e la regione sabina, rist. Secit Ed., Roma, 1988. [In Italian]

[3] M. Firmani, A proposito di promozione turistica nella Vallata del Velino. Ricerca e turismo. Due appunti, qualche nota e…un consiglio, Prospettive Sabine: rivista di cultura e turismo della Sabina, Antrodoco, 1988, n. 2-3, pp. 20-29. [In Italian]

[4] M. Cozzolino, V. Gentile, C. Giorgi, P. Mauriello, Unveiling the Hidden Past: exploring the historical evolution of Borbona (Rieti, Italy) through archaeological surveys and geophysical prospections, Proc. of the 2023 IMEKO TC4 Int. Conf. on Metrology for Archaeology and Cultural Heritage Rome, Italy, October 19-21, 2023, pp. 447-451. DOI: 10.21014/tc4-ARC-2023.085

[5] A. Carandini, Settefinestre: una villa schiavistica nell'Etruria romana, Panini Ed., Modena 1985, ISBN 88-7686-041-X [In Italian]

[6] G. Bertelli, G. Lepore, Masseria Seppannibale Grande in agro Fasano (BR). Indagini in un sito rurale (aa. 20023-2006), Mario Adda Editore, Bari, 2011, ISBN 9788880829317. [In Italian]

[7] G. A. Popescu, Traiano ai confini dell'impero, Catalogue of the exhibition, Ancona, Mole Vanvitelliana, 19 ottobre 1998 - 17 gennaio 1999, Electa, Milano 1998, ISBN 9788843566761. [In Italian]

[8] A. Borlenghi, A. Betori, F. Giletti, La dea Vacuna: attestazioni e geografia del culto in Sabina. Novità dal territorio di Montenero Sabino (RI), Archeologia Classica, Sapienza - Università di Roma, Roma 2020, n. 71, pp. 41-84. [In Italian] DOI: 10.48255/1299

[9] E. Farinetti, Cicolano Survey 2011. Il paesaggio d'altura attorno alla piana di Corvaro (Rieti), Proc. of Lazio a Sabina 9, Roma 2013, pp. 105-111. [In Italian]

[10] V. Di Flavio, Il registro delle chiese della diocesi di Rieti del 1398 nelle "Memorie" del vescovo Saverio Marini, 1779-1813, Japadre, L'Aquila 1989. [In Italian]

[11] V. Gaffney, W. Neubauer, P. Garwood, C. Gaffney, K. Löcker, R. Bates, P. De Smedt, E. Baldwin, H. Chapman, A. Hinterlietner, M. Wallner, E. Nau, R. Filzwieser, J. Kainz, T. Trausmuth, P. Schneidhofer, G. Zotti, A. Lugmayer, I. Trinks, A. Corkum, Durrington Walls and the Stonehenge Hidden Landscape Project 2010-2016, Archaeol. Prospect. 25(3) (2018), pp. 255-269. DOI: 10.1002/arp.1707

[12] T. Fitton, D. A. Contreras, A. O. Gidna, A. Z. Mabulla, M. E., Prendergast, K. M. Grillo, Detecting and mapping the 'ephemeral': magnetometric survey of a Pastoral Neolithic settlement at Luxmanda, Tanzania, Antiquity 96(386) (2022), pp. 298-318. DOI: 15184/aqy.2021.59

[13] J. Herwanger, H. Maurer, Alan G. Green, J. Leckebusch, 3-D inversions of magnetic gradiometer data in archaeological prospecting: Possibilities and limitations, Geophysics 65(3) (2020), pp. 849–860. DOI: 10.1190/1.1444782

[14] D. P. Bigman, The use of electromagnetic induction in locating graves and mapping cemeteries: an example from Native North America, Archaeol. Prospect. 19 (2012), pp. 31–39. DOI: 10.1002/arp.1416

[15] P. De Smedt, M. Van Meirvenne, D. Herremans, J. De Reu, T. Saey, E. Meerschman, P. Cromb`e, W. De Clercq, The 3-D reconstruction of medieval wetland reclamation through electromagnetic induction survey, Sci. Rep. 3(1517) (2013). DOI: 10.1038/srep01517

[16] R. Deiana, G. P. Deidda, E. D. Cusí, P. van Dommelen, A. Stiglitz, FDEM and ERT measurements for archaeological prospections at Nuraghe S'Urachi (West-Central Sardinia), Archaeol. Prospect. 29 (1) (2022), pp. 69–86. DOI: 10.1002/arp.1838

[17] A. Minelli, M. Cozzolino, A. Di Nucci, S. Guglielmi, M. Giannantonio, D. D'Amore, E. Pittoni, A. Groot, The prehistory of the Colombian territory: the result of the Italian archaeological investigation on the Checua Site (Municipality of Nemocòn, Cundinamarca Department), Journal of Biological Research, Bollettino Della Società Italiana Di Biologia Sperimentale, 85(1) (2012). DOI: 10.4081/jbr.2012.4073

[18] I. Akca, Ç. Balkaya, A. Pülz, H. S. Alanyalı, M. A. Kaya, Integrated geophysical investigations to reconstruct the archaeological features in the episcopal district of Side (Antalya, Southern Turkey), Journal of Applied Geophysics 163 (2019), pp. 22-30. DOI: 10.1016/j.jappgeo.2019.02.006

[19] O. S. Al-Saadi, V. Schmidt, M. Becken, T. Fritsch, Very-high-resolution electrical resistivity imaging of buried foundations of a Roman villa near Nonnweiler, Germany, Archaeol. Prospect. 25 (2018), pp. 209-218. DOI: 10.1002/arp.1703

[20] A. D. Booth, K. Szpakowska, E. Pischikova, K. Griffin, Structure of an ancient Egyptian tomb inferred from ground-penetrating radar imaging of deflected overburden horizons, Archaeol. Prospect. *22*(1) (2015), pp. 33-44. DOI: 10.1002/arp.1496

[21] W. Zhao, E. Forte, F. Fontana, M. Pipan, G. Tian, GPR imaging and characterization of ancient Roman ruins in the Aquileia Archaeological Park, NE Italy, Measurement 113 (2018), pp. 161-171. DOI: 10.1016/j.measurement.2017.09.004

[22] M. Cozzolino, E. Di Giovanni, V. Gentile, P. Mauriello, N. Pizzano, Ground-Penetrating Radar Survey for the Study of the Church of Saint Cosma in Helerito (Tagliacozzo, L'Aquila, Italy), Geosciences 10(244) (2020). DOI: 10.3390/geosciences10060244

[23] J. M. Reynolds, An Introduction to Applied and Environmental Geophysics, John Wiley & Sons, Chichester, 2011, p. 712, ISBN 978-0-471-48535-3.

[24] GSSI Geophysical Survey Systems, Inc., Profiler EMP-400. Online [Accessed 31 May 2024] www.geophysical.com