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Geophysical investigations for the knowledge of the buried structures in the Basilica Julia at the Roman Forum

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***Abstract* – Within a research project aimed at the study of the archaeological context of the Basilica Julia in the Roman Forum and the reconstruction of the transformation phases of the building, different techniques of geophysical prospecting were performed. In particular, GPR and ERT surveys were carried out and allowed for the acquisition of interesting data on the foundations of the Basilica Julia, built during the late Republican period and rebuilt at the beginning of the Imperial age, and on the buried remains of the previous Basilica Sempronia, built in the 2nd cent. BC in the same area. Moreover, these investigations allowed for the identification of other Republican structures along the southern side of the Roman Forum and documented the route of the Cloaca Maxima and the palaeosoil.**

I. INTRODUCTION

Since 2015 the Basilica Julia Project, aimed at the study of this large building in the Roman Forum, is carried out by the "Dipartimento di Scienze dell'Antichità", Sapienza University of Rome (coord. M. Galli), the "Istituto per i Beni Archeologici e Monumentali" of the National Research Council of Italy (coord. T. Ismaelli) and the "Parco Archeologico del Colosseo, Palatino e Foro Romano", in cooperation with the "Dipartimento di Storia, Disegno e Restauro dell'Architettura" of Sapienza University. The project is aimed at the reconstruction of the building phases of this area located along the southern side of the square of the Roman Forum and combined: (i) the topographical and architectural surveys (including 3D laser scanning and digital photogrammetry) of the structures still visible on the surface and those excavated in the years 1960-1964; (ii) the analysis of the stratigraphic sequences and the study of the materials brought to light during the 1960-1964 excavations, and (iii) the geophysical surveys of the site. In particular, GPR and ERT prospecting were aimed at the documentation of the still buried structures in the sectors of the monumental complex that were never excavated and, more generally, at the knowledge of the ancient geomorphological features of the site.

II. STUDY AREA

The remains of the Basilica Julia, the large building commissioned by Julius Caesar and rebuilt by Augustus to provide a venue for economic transactions and judicial activities, lie along the southern side of the Roman Forum (Fig. 1). The structures were brought to light thanks to the excavations conducted in the course of the 19th century by Luigi Canina (1848-1852) and Pietro Rosa (1871-1872) [1]. The conserved structures of the monumental complex and the broad stretches of marble paving (Fig. 2) have made it difficult to investigate the more ancient phases of the area.

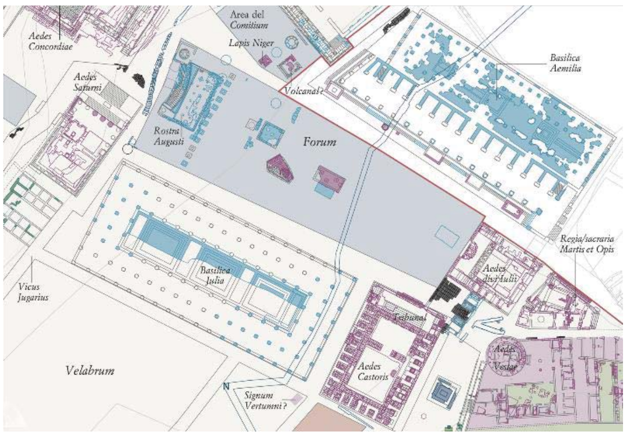

Fig. 1. Plan of the Roman Forum [3] (courtesy Paolo Carafa, graphic elaboration M.C. Capanna).

Fig. 2. Aerial photo taken in 2018 showing the remains of the Basilica Julia (from Google Earth): A, the eastern sector of the 1960-1964 excavations.

It was only in the years 1960-1964 that Laura Fabbrini, under the direction of the Superintendent for the Antiquities of Rome Gianfilippo Carettoni, was able to excavate two broad areas inside the central nave of the Basilica, the results of which have remained substantially unpublished [2]. While the central area was filled in again afterwards, the eastern one (ca. 13×17 m) was preserved beneath a platform supported by metal beams on concrete plinths.

The investigations performed within the Basilica Julia Project allowed for the identification of various phases in this area:

1. 5th century BC: construction of the first monumental building, probably with a private function;
2. Early 4th century BC: construction of a large dwelling with an atrium;
3. Construction of the Basilica Sempronia by the censor Tiberius Sempronius Gracchus (169 BC) [4];
4. Caesarian period: construction of a more extensive system of foundations;
5. Augustan period: reconstruction of the Basilica in accordance with a more monumental design.

III. GEOPHYSICAL INVESTIGATIONS

The geophysical investigations were conducted in 2018, with georadar and electrical methods. Specifically, GPR was performed using a Ris Hi Mod (IDS) equipped with 200 and 600 MHz antennas, along contiguous parallel profiles 50 cm wide, acquired at a rate of 512 samples per trace. The data were processed by background removal, bandpass filtering and migration. Most of the not excavated or not visible areas occupied by the Augustan building, subdivided into seven areas free of structures and architectural materials, was investigated for a total surface of about 3.000 sqm. GPR measurements highlighted the presence of numerous anomalies linked to buried structures (Fig. 3).

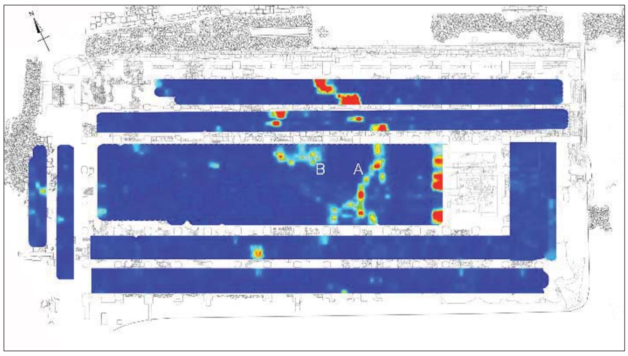

Fig. 3. GPR time slices at a depth of 1.4-1.8 m georeferenced in the new topographical map of the Basilica Julia.

The three-dimensional electrical survey was performed by non-standard acquisition, measuring the distribution of the physical parameter of electrical resistivity (ρ). To this aim, a Syscal Kid resistivity meter with 24 active channels, suitably modified for the acquisition of data on highly resistive surfaces, was used. The device was configured in such a way as to measure profiles with non-standard geometry and the electrodes were distributed along the building's perimeter [5; 6], allowing for the investigation of a surface of 4.800 sqm. The execution of profiles with non-standard geometry made it possible to obtain a pseudo 3D grid of electrical resistivity values, from which both Vertical (XZ) and Horizontal (XY) Geoelectrical Tomographies were extracted at various intervals and depths (to 9 m). The electrical resistivity distribution models at various depths (Figs. 4-5) highlighted the presence of a heterogeneous subsoil with resistivity values ranging from 50 to 3500 ohm m. Specifically, there are areas with resistivity values of 2100-3500 ohm m corresponding to buried masonry.

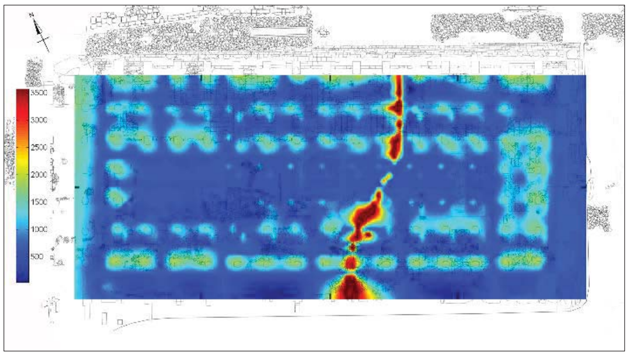

Fig. 4. Distribution of electrical resistivity in the subsoil at a depth of 1-1.5 m georeferenced in the topographical map of the Basilica Julia: anomalies with high ohm-m values (red and dark red in the centre of the investigated area) are linked to the 16th-century sewer, while anomalies with medium ohm-m values (light green) are linked to the foundations of the Augustan basilica.

IV. DATA INTEGRATION

In order to improve the interpretation of geophysical anomalies, GPR and ERT data were integrated with the 2D and 3D models produced by topographical and architectural surveys [7,8]. In particular, GPR and ERT time slices and profiles were georeferenced in the new topographical map of the Basilica Julia. Moreover, the acquired GPR and ERT data were transformed into point clouds, which were then "mapped" by associating them with the data from the architectural survey. Specifically, the point clouds arising from the geophysical prospecting were roto-translated and scaled to enable their correct alignment with respect to the references measured on the surface. The integration of these data in a single virtual space pushes the potential for interpretation beyond the boundaries of real physical perception by enabling the joint visualisation of visible and non-visible elements. In this sense, the process described uses the potential of the virtual world to optimise and enhance the reading of reality.

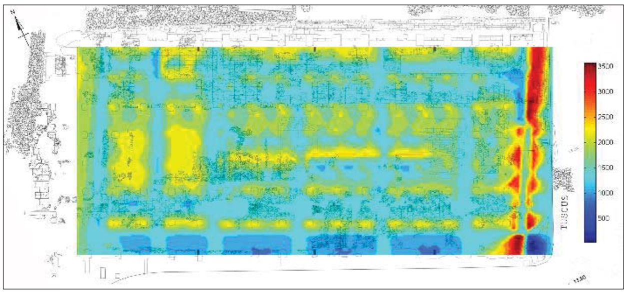

Fig. 5. Distribution of electrical resistivity in the subsoil at a depth of 3-3.5 m georeferenced in the topographical map of the Basilica Julia: anomalies with high ohm-m values (red and dark red in the eastern limit of the investigated area) are linked to the Cloaca Maxima, while anomalies with medium ohm-m values (yellow) are linked to the foundations of the Augustan basilica.

V. RESULTS AND DISCUSSION

The GPR results highlighted a series of anomalies regarding various buried structures, particularly interesting among which were the 16^{th} century sewer channel that crosses the area (Fig. 3, A) and the structures detected by the excavations of the 1960s, i.e. the central sector filled in again afterwards (Fig. 3, B).

Even Vertical (XZ) and Horizontal (XY) Geoelectrical Tomographies highlighted numerous anomalies corresponding to buried masonry (Figs. 4-5): in particular, these include the 16^{th} century channel at a depth of 2.5-3 m, the foundation of the Augustan basilica at a depth of 2.5-4 m, the Cloaca Maxima at a depth of 3-6 m and the structures of the Basilica Sempronia at depths of 4.5 to 6 m. In addition, the investigations highlighted the presence of the palaeosoil at a depth of 6.5-9.5 m, which slopes down towards the south; therefore, it was possible to understand the spatial and structural relationships of the palaeosoil with both the Basilica Sempronia and the later Basilica Julia.

VI. CONCLUSIONS

Thanks to the integration with archaeological and architectural data collected during the Basilica Julia Project, GPR and ERT surveys allowed for the acquisition of interesting data on the foundations of the Basilica Julia, built during the late Republican period and rebuilt at the beginning of the Imperial age, and on the buried remains of the previous Basilica Sempronia, built in the 2^{nd} cent. BC in the same area. Moreover, the geophysical investigations allowed for the identification of other structures, both of the 16^{th} century and the Republican period, and documented the route of the Cloaca Maxima and the level and morphology of the palaeosoil in the area located along the southern side of the square of the Roman Forum.

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