

High resolution GPR survey to investigate the urban centres: the case of XX Settembre square of Fano (Fano, Italy)

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Abstract – This paper shows the preliminary results of a new archaeogeophysics investigations in Piazza XX Settembre in Fano carried out thanks to a collaboration between the Vitruvian Studies Center, the Superintendence of Archeology, Fine Arts and Landscape for the Provinces of Ancona and Pesaro and Urbino, the Institute of Heritage Sciences of the CNR of Rome and the Municipality of Fano. The new research includes a high-resolution georadar survey and a bibliographic and archival research, still in progress, concerning the square and its surrounding. The main purpose of this new study is to understand the evolution of this city's sector from the Roman period to the Medieval age, and intends also to investigate the historical and archaeological knowledge of this area located in the city's center of Fano.

I. INTRODUCTION

This paper presents a summary of the results obtained with new archaeogeophysical investigations carried out in the area of Piazza XX Settembre in Fano, made possible thanks to a collaborative project between the Centro Studi Vitruviani, the Superintendency of Archaeology, Fine Arts and Landscape for the Provinces of Ancona and Pesaro and Urbino, the Institute of Heritage Sciences (ISPC) of the CNR of Rome and the Municipality of Fano.

The research is part of a new systematic scientific investigation that has the square area as its object, aimed at reconstructing its transformations in relation to its different phases of life, from Roman to medieval times. The study starts from the need to deepen the knowledge of this sector of the city from a historical and archaeological point of view with the aim of making a new important contribution to the knowledge of the urban planning of Roman and medieval Fano, as well as providing any new enhancement elements to the already rich historical-archaeological heritage of the city [1], [2].

The studied area is located in the historic center of Fano at a topographic altitude between 12.60 and 13.54 m a.s.l. From a morphological point of view it tends to be flat with a humpback conformation that creates a difference in

height of about 1 m between the two short sides of the square (Fig. 1).

From a geological point of view, the Roman settlement of Fanum Fortunae was built on a plateau at about 9-10 m above sea level, consisting of a III order alluvial terrace originating from the deposits of the Metauro River and the Adriatic Sea. The geological substratum of the historic center of Fano is made up of blue marly clays interspersed with sands and sandstones which in the area of Piazza XX Settembre emerge at an altitude of about – 3.30 m below the current road level, as evidenced by geological and archaeological investigations carried out in this area and its surroundings [3], [4].

The square is bordered to the south by Corso Matteotti and to the north by Via Malatesta-Via Froncini which already represented two important road axes in Roman times and maintained this role also in the following medieval age, although during the Middle Ages the urban structure of the city was subject to notable changes and transformations, both in the road network and in the functional distinction between public and private urban spaces.

In Roman times, the area in question was located in a decentralized area of the city and probably played a residential role with domus and streets that articulated and delimited the blocks that made up the orthogonal urban structure of the ancient Fanum Fortunae.

During the Middle Ages this area underwent an important transformation with the construction of the Piazza Maggiore, as the sources mention it, thus becoming the fulcrum and beating heart of the city, where some of the most important civil and religious buildings were erected, such as the Palazzo della Ragione (today Teatro della Fortuna), the Civic Tower, the Church of S. Apollinare, the Church of S. Silvestro and the Palazzo Malatestiano. Piazza XX Settembre is therefore the result of centuries of transformations that took place in the historic center of Fano starting from the Roman time up to the present day, and for this reason it contains archaeological and historical-artistic testimonies from the most diverse eras.



Fig.1 – Centre of Fano; location of the XX Settembre square

Thanks to the recent GPR surveys conducted in Piazza XX Settembre, it is possible to integrate the data available so far with new information that contributes to clarifying and enriching the knowledge on the urban layout of this sector of the city in Roman and medieval times.

The information obtained through archive researches and the revision of the published material concerning the excavations, have been added to the geophysical results, to provide important indications regarding the presence of hypothesized archaeological structures present under the square and in the surrounding buildings.

II. METHOD

In the 2021, geophysical survey has been carried out to investigate the area of the square employing the high resolution Ground Penetrating Radar (GPR) method.

For the GPR measurements, data were collected, along parallel profiles (Fig. 2), employing the SIR4000 (GSSI) system, equipped with a dual frequency antenna with 300/800 MHz with constant offset (Fig. 3) [5]. The horizontal spacing between parallel profiles used was 0.5 m for all sectors of the square. The spacing was chosen based on the indications of archaeologists regarding the size and dimension of the hypothesized structures in the studied area [5]. After the usual preliminary tests, the acquisition parameters have been set to a time window of 90ns (twt, two-way-time), according to the environmental conditions of the ground and on the depth at which the structures rest below the subsurface. Data was acquired as 32 bit (for SIR4000), 512 samples per radar scan and stack equal to 3. The radar traces were acquired in line scan mode, i.e. by making the antenna proceed along the profile in continuous recording. The investigations involved the entire area of the square from the Fontana della Fortuna to the perimeter wall of Palazzo Bambini.

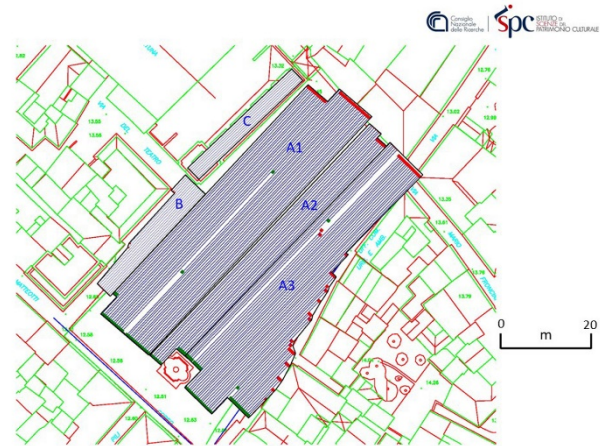


Fig.2 – Fano, XX Settembre square. Indication of the different sectors investigated with GPR method.



Fig.3 – Fano, XX Settembre square. GPR SIR4000.

III. PROCESSING AND RESULTS

All the GPR profiles collected with this standard equipment were processed with GPR-Slice v7.0 Ground Penetrating Radar imaging software [6]. The basic radargram signal processing steps included: post processing pulse regaining; DC drift removal; data resampling; band pass filtering; background filter and migration. With the aim of obtaining a planimetric vision of all possible anomalous bodies, the time-slice representation was calculated using all processed profiles showing anomalous sources up to a depth of about 3.5 m [6].

Fig. 4, 5, 6 and 7 show the GPR anomalies, individuated in the square area, at the estimated depth of 1.40 m, 1.70 m, 2.20 m and 2.60 m.

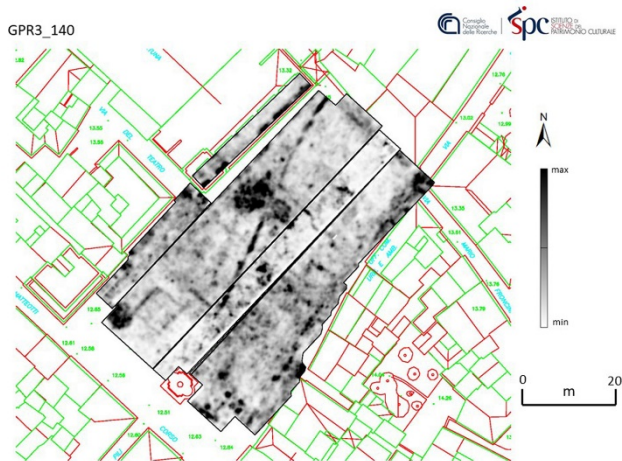


Fig. 4 – Fano, XX Settembre square. GPR time slices at the estimated depth of 1.40 m.

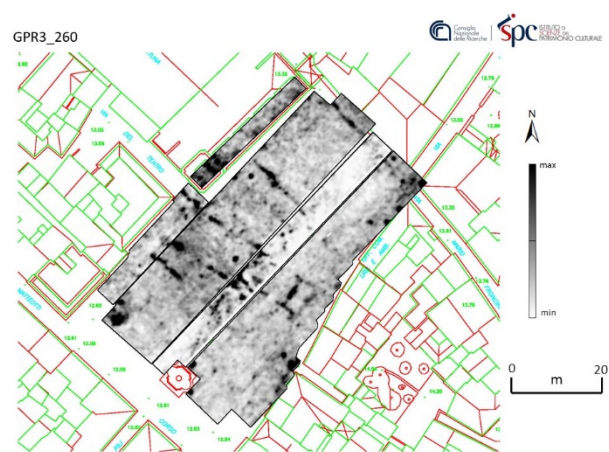


Fig. 7 – Fano, XX Settembre square. GPR time slices at the estimated depth of 2.60 m.

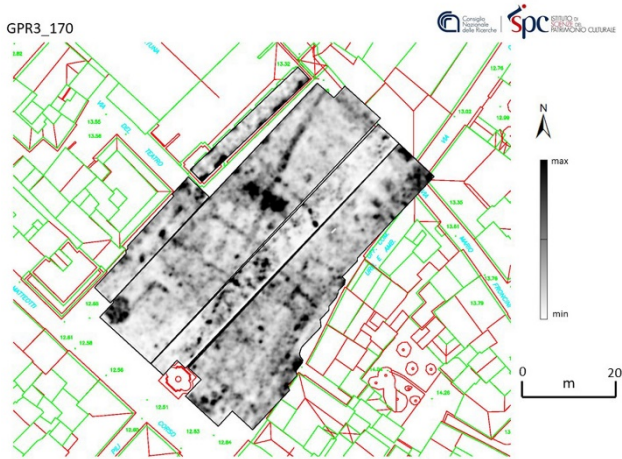


Fig. 5 – Fano, XX Settembre square. GPR time slices at the estimated depth of 1.70 m.

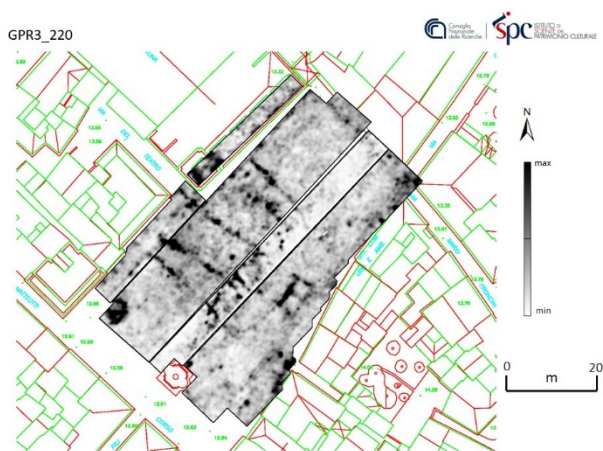


Fig. 6 – Fano, XX Settembre square. GPR time slices at the estimated depth of 2.20 m.

The anomalies identified have been included in the general plan of the historic center of Fano drawn up as part of the ArcheoFano Project which employs the Regional Technical Map on a scale of 1:2000 as a cartographic basis and in which the Roman time structures, found in the area, have been included.

The final plan of the GPR anomalies is the result of an interpretative synthesis that evaluated all the anomalies identified with the geophysical prospecting, for each of which the geometric and volumetric characteristics were examined (size, orientation and depth) so as to be able to correctly interpret and put in relation with the most reliable historical-archaeological context, Fig. 8. This process made it possible to exclude, from the final plan, both the anomalies referable to modern activities and those originating from collapses or layers of rubble that obliterate the underlying structures, which were intentionally omitted from the final plan.

IV. CONCLUSIONS

Together with archaeologists, the obtained anomalies have been interpreted to have a good matching with the expected searched structures. The results obtained in this way constitute an important element that enriches the knowledge of the urban planning of Roman and Medieval Fano. The anomalies referable to the Roman time, placed at a depth between -2.0 m and -3.20 m from the current level of the square, equivalent in terms of absolute altitude to about 11 – 10 m a.s.l., indicate the presence of numerous rooms of various shapes and dimensions that could be referable to *domus* with *tabernae* open on the street front, as would be indicated by the small rooms placed side by side along the road axis that longitudinally crosses the square, this road before the investigation was only hypothesized. It was probably during the middle of the

Middle Ages, probably starting from 11th – 12th century or perhaps earlier, that the area was transformed into a square and gradually the palaces that still overlook it were built.

REFERENCES

- [1] Alfieri N. L'urbanistica di Fano Romana. In F. Milesi (Ed.) Fano Romana, 1992, pp 77-86.1992.
- [2] Battistelli F., Deli A., 1983. Immagini di Fano Romana, Fano
- [3] Dell'Aglio P., 2017. Geomorphological and Anthropic control of the development of some Adriatic Historical Towns (Italy) Since the Roman Age. In *Quaestiones Geographicae*, 2017, vol. 36, n. 3, pp 111-123.
- [4] Purcaro V., 2015. Prima lettura delle testimonianze archeologiche di epoca romana su tre lati di Piazza XX Settembre a Fano. In *Nuovi Studi Fanesi*, 2015,

vol. 28, pp. 7-40.

- [5] Piro S., Zamuner D., 2016. Investigating the urban archaeological sites using Ground Penetrating Radar. The cases of Palatino Hill and St John Lateran Basilica (Roma, Italy). *Acta IMEKO*, Vol. 5, issue 2, pp 80-85. ISSN: 2221-870X. DOI: 10.21014/acta_imeko/v5i2.234 .
- [6] Goodman D., Piro S., 2013. *GPR Remote sensing in Archaeology*, Springer: Berlin.

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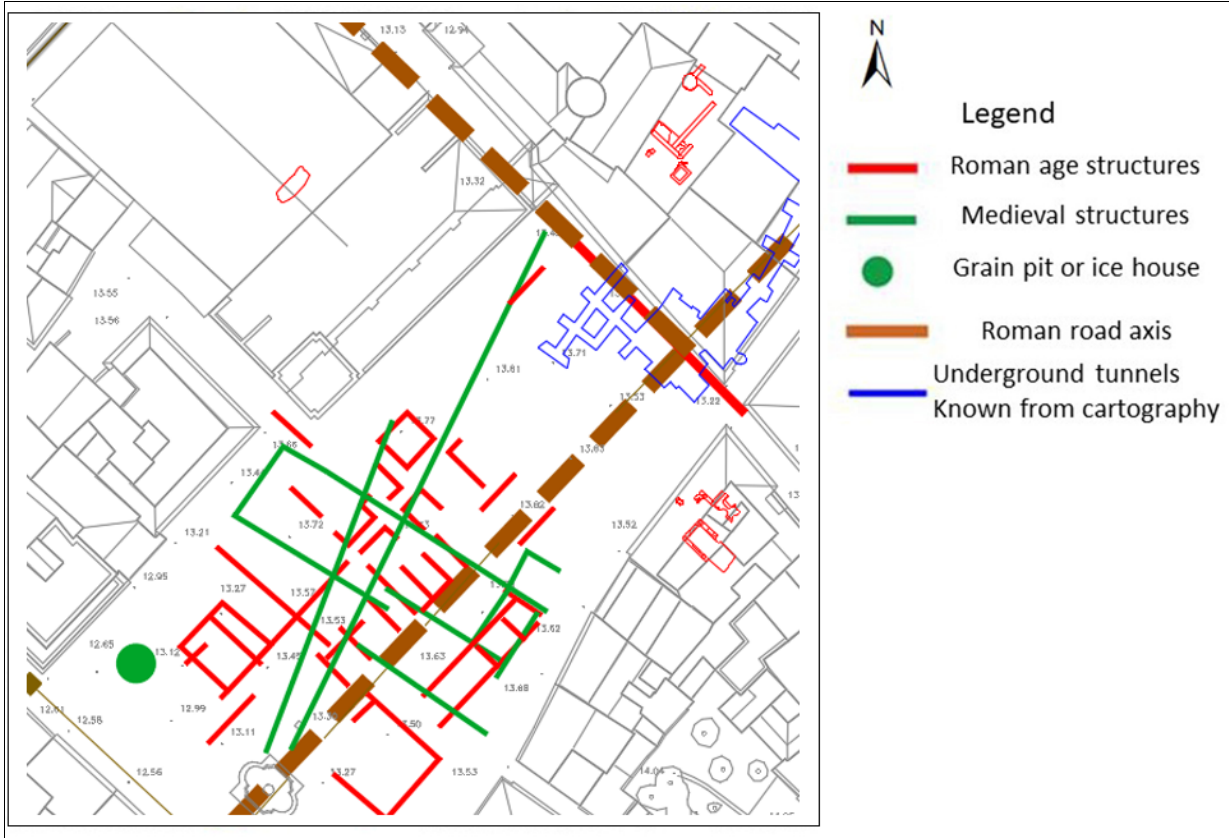


Fig. 8 – Plan of the Roman and medieval structures identified in the square.